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Royal Institution of Great Britain.
Physical Society (Guy's Hospital)
King's College London

Publication/Creation

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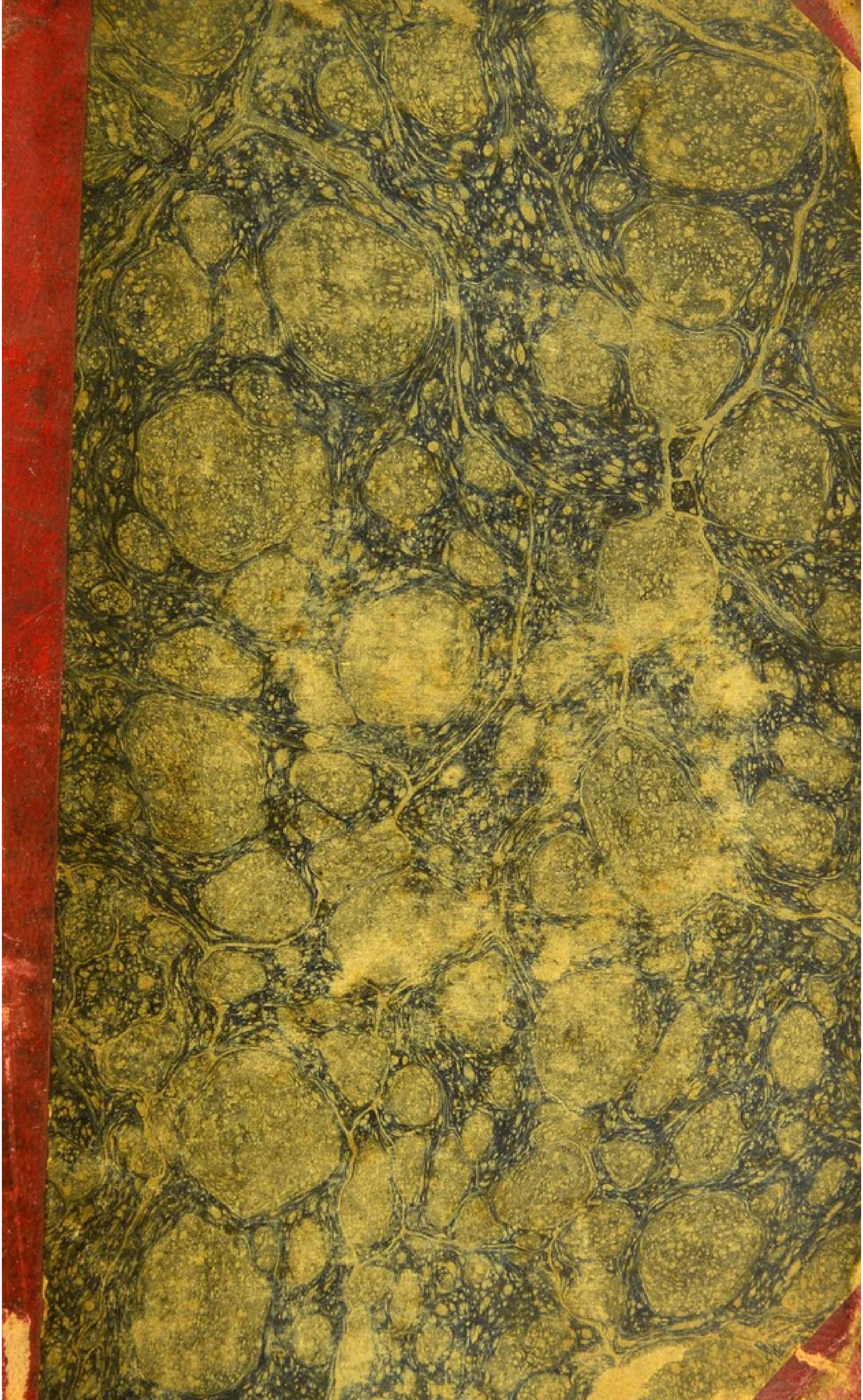

JOURNALS

OF

THE ROYAL INSTITUTION

OF GREAT BRITAIN.

VOLUME I.

LONDON:
SOLD AT THE HOUSE OF THE INSTITUTION, ALBEMARLE
STREET; BY CADELL AND DAVIES, STRAND;
JOHNSON, ST. PAUL'S CHURCH YARD; LONGMAN AND REES,
AND H.D. SYMONDS, PATERNOSTER ROW.

1802.

FROM THE PRESS OF THE ROYAL INSTITUTION OF GREAT BRITAIN:
W. SAVAGE, PRINTER.

ROYAL INSTITUTION OF GREAT BRITAIN.

May 1, 1802.

PATRON.

The King.

PRESIDENT.

The Earl of Winchilsea and Nottingham, F. A. S.

MANAGERS.

For One Year. (Elected 1800.)

The Earl of Morton, K.T. V.P.R.S. The Earl of Aylesford, F.R.S. Henry Cavendish, Esq. F.R.S.

For Two Years. (Elected 1801.)

The Earl of Egremont, F.R.S. The Rt. Hon. Lord Pelham, F.R.S. Richard Joseph Sullivan, Esq. F.R.S.

For Three Years. (Elected 1802.)

The Rt. Hon. Lord Dundas, F.R.S. The Rt. Hon. Sir Joseph Banks, Bart. K.B. P.R.S. Charles Hatchett, Esq. F.R.S.

VISITORS.

For One Year. (Elected 1800.)

The Earl Spencer, K.G. F.R.S. Sir William Young, Bart. M.P. F.R.S. Samuel Thornton, Esq. M.P. F.R.S.

For Two Years. (Elected 1801.)

The Lord Viscount Palmerston. The Earl of Dartmouth, F.R.S. The Rev. Samuel Glasse, D.D. F.R.S.

For Three Years. (Elected 1802.)

The Lord Bishop of Durham. The Earl of Bessborough, LL.D. Thomas Bernard, Esq.

The Rt. Hon. Lord Kinnaird, F.R.S. and F.A.S. *Treasurer.*

J. P. Auriol, Esq. *Secretary.*

Charles Butler, Esq. *Counsel.*

Claudius Stephen Hunter, Esq. *Solicitor.*

Thomas Young, M.D. F.R.S. *Professor of Natural Philosophy, and Superintendant of the House, and*

Humphry Davy, *Professor of Chemistry, and Director of the Chemical Laboratory, joint Editors of the Journals.*

Frederick Accum, *Assistant Chemical Operator.*

William Savage, *Clerk, and Printer.*

Kenneth M'Culloch, *Mathematical Instrument Maker.*

Charles Royce, *Superintendant of the Workshops.*

PREFACE.

The first volume of the Journals of the Royal Institution being completed, it is rather to be wished that the public may be able to judge, from what has already been accomplished, of what may be expected in future, than that promises should be made, which, whatever may be the exertions of their editors, they may not always be able to fulfil. There are however various reasons for presuming upon a considerable degree of improvement, with respect both to the extent of the information which will be contained in them, and to the frequency and regularity of the times of their publication.

In the overflow of unimportant novelties, which always accompanies a state of activity in literature and in society, it appears to be desirable, that a publication should exist, which, together with a sufficient degree of perspicuity, might possess the merit of conciseness and selection; which, without entirely neglecting what is old, but too little known, might more particularly notice all such new discoveries and inventions, as promise essential advantage to science, or to social life; and which, without presuming to dispense either commendation or censure, might still endeavour to assist its readers in discriminating the true from the false.

The peculiar privilege which the Royal Society has condescended to grant to the editors of these Journals, may tend to fill up a deficiency which has often been lamented, by procuring to the public early and authentic information of the whole proceedings of the most ancient and respectable of societies employed in the cultivation of science; and this advantage, together with the facility of consulting foreign publications in every language, procured by the most expeditious conveyances, will give this work at least an opportunity of becoming singularly interesting. Its plan resembles so little that of any other periodical publication, that it can scarcely supersede, or interfere with any. In proportion to the number of pages, its price will perhaps exceed that of many other books, but its annual expense will be moderate, and all possible emolument, that can be expected from its sale, will be a very inadequate recompense for the labour of its compilation. It may perhaps be wholly, or in great measure, transcribed by other writers; and if the matter which it contains is of importance, the more it is transcribed, the more the ends of the Royal Institution are answered: the candid will at least refer to the work from which they have borrowed, and will not attempt to appropriate to themselves the labours of others without acknowledgement.

The first three sheets were published under Count Rumford's direction, Dr. Young was the editor of the next four, and the subsequent parts have been conducted jointly by Dr. Young and Mr. Davy.

Y.

CONTENTS.

JOURNALS

OF THE

ROYAL INSTITUTION

OF

GREAT BRITAIN.

At a Meeting of the Managers of the Royal Institution of Great Britain, held at the House of the Institution, on Monday the 31*st of March,* 1800,

Resolved, I. That Count Rumford be requested to take such measures as shall be necessary, in order to facilitate the speedy publication of the Journals of the Institution; and that he be requested to superintend that publication, employing such persons as his cooperators and assistants, as he shall think proper.

II. That the Journals of the Royal Institution of Great Britain be exclusively devoted to the diffusion of the knowledge of new and interesting scientific discoveries, and of useful improvements in mechanics, arts, and manufactures; and particularly in making known all such new inventions and contrivances as tend to facilitate labour, and render it more productive;—to promote domestic economy, and increase the conveniences, comforts, and enjoyments of life. Neither political discussions,—nor religious disputes,—nor the common news of the day, is ever to find a place in these Journals: nor are the common advertisements of individuals ever to be published in them, on any pretext whatever.

III. That, in determining the price at which the Journals of the Institution shall be sold, care be taken to put such a price upon the work, as shall be at least sufficient to cover all the expenses of its publication, and pay those who shall be employed on wages in its compilation.

IV. That, as soon as it can be done with convenience, a printing press be established in the house of the Institution.

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IV. That this Committee be requested to superintend all the new philosophical experiments that shall be made at the house of the Institution; and when in the course of these experiments any scientific discovery shall be made, that shall by them be considered as new and interesting, that they be requested to cause to be drawn up, under their direction, an account of the same, in order to its being communicated by the Managers of the Institution, to the Royal Society of London.

V. That this Committee do consist of the following persons.

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Sir Charles Blagden, Knt. F.R.S.
Major Rennell, F.R.S.
Joseph Planta, Esq. S.R.S.
Edward Whitaker Gray, M.D. S.R.S.
Samuel Vince, A.M. F.R.S. Professor of Experimental Philosophy at the University of Cambridge.
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4. A committee for improving the construction of STOVES for warming dwelling houses.

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6. A committee for improving the most useful articles of HOUSEHOLD FURNITURE.

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13. A committee of MECHANICS, for the improvement of useful machines of all descriptions.

14. A committee for improving the various processes that are necessary in PROCURING IRON FROM ITS ORES, and in the working and refining of iron and steel.

Resolved, That these resolutions of the Managers to appoint the abovementioned *fourteen* committees be made known to the Proprietors and Subscribers to the Institution and to the Public; and that persons desirous of becoming members of any one or more of them, be invited to send in, to the Managers, their names as candidates for election, distinguishing the committees (by their numbers or otherwise) in which they think that their knowledge and talents would be most likely to be of use in promoting the objects of the Institution.

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Immediately under the repository will be constructed a lofty and capacious LABORATORY for chemical experiments.

All the open chimney fireplaces in the house have been altered, and fitted up on new principles; and in the course of a few months, a variety of different kinds of stoves, for warming rooms by closed fires, will be fitted up for public exhibition.

The kitchen belonging to the house, which was originally very capacious, has been still farther enlarged; and is now fitting up with a variety of new contrivances, calculated to facilitate and improve the various processes of cookery, and to economize fuel.

A model, of the full size, of a public kitchen, with four boilers, and four small iron ovens (the latter all heated by one fire), is nearly finished, and may soon be seen in actual use.

A complete roaster has likewise been put up in this kitchen; and near it an iron oven, on a new principle, contrived in such a manner as to serve occasionally as a roaster.

A variety of boilers, steamers, and other articles of kitchen furniture, on new principles, are preparing, and will soon be ready to be exhibited in this kitchen; together with several kitchen utensils designed for the use of cottagers.

Extracts from the Report of the Managers of the Royal Institution, laid before the Proprietors of the Institution, at a General Meeting of the Proprietors, held at the House of the Institution, on the 10th of February, 1800.

" The Managers, ever anxious to demonstrate their zeal in promoting the prosperity of the Institution (which assuredly ought not to be second to any other in any part of the world), presume to offer to the consideration of the Proprietors, and the friends of science in general, the outline of a plan, which, if adopted, would enable them to make a rapid progress towards the perfection of this truly useful establishment.

" An accurate survey has been made of the premises and great attention has been given to the most advantageous and economical appropriation of the spare ground belonging to the Institution.

" The sketch of a plan has been designed, comprehending a complete scientific theatre, or lecture room, which will accommodate nearly one thousand persons.

" The floor under the theatre is proposed to contain a capacious repository, coextensive with the theatre.

" Upon the sunk floor, is designed a complete chemical laboratory, which unfortunately this great metropolis of the British empire has yet failed to produce, but which is an essential appendage to the Royal Institution.

" The property of the premises in Albemarle Street, is vested by charter in '*the Corporation of Proprietors of the Royal Institution of Great Britain*,' who it is presumed have no other view than that of promoting the highly useful purposes of the establishment.

" The majority of the Managers, with the consent of five of the Visitors expressed in writing, are recognised by the charter as competent, 'for a valuable consideration, to sell, grant, devise, exchange, and dispose of, any lands, tenements, and hereditaments, belonging to the said corporation.

" It is proposed that 5000L. be immediately raised on the mortgage of the premises, by transferable debentures of 200L., 100L., and 50L. each, bearing an interest of 5L. per cent. per annum, payable half-yearly.

" The sums advanced on the debentures to be paid by instalments, at 25L. per cent. at equidistant periods, within eighteen months from the first of May ensuing.

" These proposals, if approved by a general meeting of the Proprietors, are to be laid upon the table in the Subscribers room of the Institution, with the plans and estimates, as soon as they are completed: together with a subscription book, in which those disposed to encourage the plan will be requested to enter their names, with the amount of the debentures they are willing to engage for, until the sum of 5000L. be completed.

The preceding Report, and proposals for constructing the additional buildings necessary to complete the establishment, were read, and approved (*nem. con.*) at the general meeting of Proprietors, on the 10th of February, 1800.

It was also resolved at the said general meeting, that although the sum subscribed, *during the Meeting*, amounted to 5200L., which is 200L. more than originally proposed, that further subscriptions should be received, as the estimate might fall short of the expense necessary to be incurred.

A Subscription having been opened for the aforesaid purpose, on the 10th of February, 1800, the following Sums have already been subscribed, by

The Earl of Winchilsea	L. 200
The Earl Spencer	500
The Earl of Bessborough	100
The Right Hon. Sir Joseph Banks	200
R. J. Sulivan, Esq.	200
Count Rumford	100
Sir J. C. Hippisley, Bart.	200
Thomas Bernard, Esq.	200
The Lord Bishop of Durham	200
R. Burdon, Esq.	100
Henry Hoare, Esq.	200
R. Clark, Esq. Chamberlain of London	100
The Earl of Egremont	200
J. Du Pré Porcher, Esq.	200
The Earl of Aylesford	200
The Right Hon. Lord Hobart	200
Alexander Davison, Esq.	200
John Sullivan, Esq.	200
Robert Thornton, Esq.	200
Lord Viscount Valentia	100
Earl Gower	L. 100
The Earl of Morton	100
J. Symmons, Esq.	100
Langford Millington, Esq.	200
Sir W. Wm. Wynn, Bart.	200
Edward Parry, Esq.	100
M. H. Grant, Esq.	100
Lord Viscount Palmerston	200
Right Hon. Lord Petre	200
Right Hon. Lord Heathfield	100
Samuel Mellish, Esq.	100
William Larkins, Esq.	100
John M'Arthur, Esq.	100
Dr. Hallifax	200
William Blake, Esq.	200
The Earl of Hardwicke	100
M. Wood, Esq.	100
The Earl of Aldborough	100
Charles Marsh, Esq.	100
The Right Hon. Lord Rancliffe	100
Richard Thompson, Esq.	200

Amount of the Subscriptions, April 12, 1800, L. 6600

An Account of the Number of the PROPRIETORS *and* SUBSCRIBERS *to the Royal Institution.*

	State of the Lists on the 3d of March 1800.	New Names added between the 3d of March and the 3d of April, 1800.	State of the Lists on the 3d of April, 1800.
Proprietors	151	97	248
Life Subscribers . .	157	102	259
Annual Subscribers . .	138	159	297
Ladies	33	64	97
Total	479	422	901

As new lists of the Proprietors and Subscribers are now preparing for publication, all persons belonging to the Institution, either as Proprietors, or as Subscribers, who have not already given in their names, with their proper additions and places of abode, to the Clerk, at the house of the Institution, are requested to do so as soon as possible, in order that the new lists may be correct.

The morning lectures begin precisely at 2 o'clock, P. M. and the evening lectures at 8 o'clock, P. M.

Those who come to the lectures in carriages, are requested to give orders to their coachmen to set down and take up with their horses heads towards Grafton Street.

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A variety of Boilers, Steamers, and other articles of kitchen furniture on new principles, are preparing, and will soon be ready to be exhibited in this kitchen, together with several kitchen utensils designed for the use of cottagers.

EXTRACTS *from the Report of the Managers of the Royal Institution, laid before the Proprietors of the Institution, at a General Meeting of the Proprietors, held at the House of the Institution, on the* 10*th of February*, 1800.

" THE Managers, ever anxious to demonstrate their zeal in promoting the prosperity of the Institution (which assuredly ought not to be second to any other in any part of the world), presume to offer to the consideration of the Proprietors and the friends of science in general, the outline of a plan, which, if adopted, would enable them to make a rapid progress towards the perfection of this truly useful establishment.

" An accurate survey has been made of the premises, and great attention has been given to the most advantageous and economical appropriation of the spare ground belonging to the Institution.

" The sketch of a plan has been designed, comprehending a complete Scientific Theatre, or

Lecture Room, which will accommodate nearly one thousand persons.

" The floor under the Theatre is proposed to contain a capacious Repository, co-extensive with the Theatre.

" Upon the sunk floor, is designed a complete Chemical Laboratory, which unfortunately this great metropolis of the British empire has yet failed to produce, but which is an essential appendage to the Royal Institution.

" The property of the premises in Albemarle-street, is vested by Charter in '*the Corporation of Proprietors of the Royal Institution of Great Britain*,' who, it is presumed, have no other view than that of promoting the highly useful purposes of the establishment.

" The majority of the Managers, with the consent of five of the Visitors expressed in writing, are recognized by the Charter as competent, 'for a valuable consideration, to sell, grant, devise, exchange, and dispose of, any lands, tenements, and hereditaments, belonging to the said corporation.

" It is proposed that £.5000 be immediately raised on the mortgage of the premises, by transferable debentures of £.200, £.100, and £.50 each, bearing an interest of £.5 per cent. per annum, payable half-yearly.

" The sums advanced on the debentures to be paid by instalments, at £.25 per cent. at equidistant periods, within eighteen months from the 1st of May ensuing.

" These proposals, if approved by a General Meeting of the Proprietors, are to be laid upon the table in the Subscribers' room of the Institution, with the plans and estimates, as soon as they are completed; together with a subscription book, in which those disposed to encourage the plan will be requested to enter their names, with the amount of the debentures they are willing to engage for, until the sum of £.5000 be completed."

The preceding Report, and proposals for constructing the additional buildings necessary to complete the establishment were read, and approved *(nem. con.)* at the General Meeting of Propritors, on the 10th of February, 1800.

It was also resolved at the said General Meeting, that although the sum subscribed *during the Meeting* amounted to £.5200, which is £.200 more than originally proposed, that further subscriptions should be received, as the estimate might fall short of the expense necessary to be incurred.

A Subscription having been opened for the aforesaid purpose on the 10th of February, 1800, the following Sums have already been subscribed, by

The Earl of Winchilsea	£. 200
The Earl Spencer - -	500
The Earl of Bessborough	100
The Right Hon. Sir Joseph Banks - -	200
R. J. Sulivan, Esq. -	200
Count Rumford - -	100
Sir J. C. Hippisley, Bart.	200
Thomas Bernard, Esq. -	200
The Lord Bishop of Durham - -	200
R. Burdon, Esq. -	100
Henry Hoare, Esq. -	200
R. Clark, Esq. Chamberlain of London - -	100
The Earl of Egremont -	200
J. Du Pré Porcher, Esq.	200
The Earl of Aylesford -	200
The Right Hon. Lord Hobart - -	200
Alexander Davison, Esq.	200
John Sullivan, Esq. -	200
Robert Thornton, Esq. -	200
Lord Viscount Valentia	£. 100
Earl Gower - -	100
The Earl of Morton -	100
J. Symmons, Esq. -	100
Leonard Millington, Esq.	200
Sir W. Wm. Wynn, Bart.	200
Edward Parry, Esq. -	100
M. H. Grant, Esq. -	100
Lord Viscount Palmerston	200
Right Hon. Lord Petre -	200
Right Hon. Lord Heathfield	100
Samuel Mellish, Esq. -	100
William Larkin, Esq. -	100
John M'Arthur, Esq. -	100
Dr. Halifax - -	200
William Blake, Esq. -	200
The Earl of Hardwicke	100
M. Wood, Esq. -	100
The Earl of Aldborough	100
Charles Marsh, Esq. -	100
The Right Hon. Lord Rancliffe - -	100
Richard Thompson, Esq.	200

Amount of the Subscriptions, April 12, 1800, £. 6600

An Account of the Number of the PROPRIETORS *and* SUBSCRIBERS *to the Royal Institution.*

	State of the Lists on the 3d of March 1800.	New Names added between the 3d of March and the 3d of April, 1800.	State of the Lists on the 3d of April, 1800.
Proprietors -	151	97	248
Life Subscribers	157	102	259
Annual Subscribers	138	159	297
Ladies - -	33	64	97
Total	479	422	901

As new lists of the Proprietors and Subscribers are now preparing for publication, all persons belonging to the Institution, either as Proprietors or as Subscribers, who have not already given in their names, with their proper additions and places of abode, to the Clerk, at the House of the Institution, are requested to do so as soon as possible, in order that the new lists may be correct.

Philosophical Lectures at the Royal Institution the following Week.

MORNING LECTURES.

On TUESDAY, the 8th instant, the Lecture will be on Charged Electrics, and the Theory of the Leyden Phial, illustrated by various experiments.

On THURSDAY, the subject of Respiration and Animal Heat will be continued, with the effects of Oxygen on the Blood.

On SATURDAY, the Lecture will be on Hydrogen Gas, and the Composition of Water: various experiments with Hydrogen Gas will be shown; the nature of sulphurated and phosphorated Hydrogen Gas pointed out; and a specimen of the philosophical Fire Works, with inflammable Air exhibited, and the method of making them shown.

EVENING LECTURES.

On MONDAY EVENING, the 7th instant, the subject of the Lecture will be Spontaneous Evaporation: after which will be considered the nature of Ignition and Inflammation; with some observations on Light.

On WEDNESDAY EVENING, the different Powers of Bodies, as Conductors of Heat, will be examined; and some experiments made with the Passage Thermometer; the method of confining Heat, and applying it to useful purposes with economy, will be pointed out.

FRIDAY next being Good Friday, no Lecture will be given on that day.

The Morning Lectures begin precisely at 2 o'clock, P. M. and the Evening Lectures at 8 o'clock, P. M.

Those who come to the Lectures in carriages, are requested to give orders to their coachmen to set down and take up with their horses' heads towards Grafton-street.

Printed by W. Bulmer and Co. Cleveland-Row, St. James's.

At a Meeting of the Managers of the Royal Institution of Great Britain, held at the House of the Institution, on the 25th Day of May, 1801,

The following Report, relative to the Progress which has been made in the Arrangement of the Institution,—its present State,—and its probable future Prosperity and Utility,—laid before the Managers by Count Rumford, was read, and approved; and was ordered to be printed in the Journals of the Institution, for the Information of the Public.

REPORT.

THE Royal Institution of Great Britain is one of those establishments which cannot be carried to perfection by slow degrees; or exist long upon a small scale without declining. —In order to its acquiring a solid foundation, and becoming extensively and permanently useful, it was absolutely necessary,—by a great exertion,—to call it suddenly into existence; and to render it extremely interesting and conspicuous.

The Managers of the Institution, deeply impressed with this truth, have constantly had it in view in all their proceedings; and the success that has attended their measures has fully justified their confidence in the principles they adopted.

The Institution is now placed on a most respectable foundation; and although none of the details of this great and extensive establishment are quite completed, yet enough has already been done to show that it must soon become extremely interesting, and very useful; and that it will long remain,—an ornament to the metropolis,—and a proud monument of the energy—wealth—and liberality—of the private individuals of the British nation.

In the infancy of the establishment, before the Institution had acquired a visible form, and adequate support, it was natural to expect that some doubts would be entertained, even by the most sanguine, of the possibility of completing so great a public undertaking, by the mere voluntary exertions of individuals; but all grounds for such doubts are now happily removed. The permanent existence of the Institution,—and even as a *body politic* and *corporate,*—has been secured by the authority of a ROYAL CHARTER; and the establishment has been taken under the immediate patronage of HIS MAJESTY.

The Lists of the Proprietors and Subscribers to the Institution contain the names of many of the most illustrious characters in this country; and the money subscribed to carry the proposed plans into execution amounts already to a sum almost incredibly great—to L.23200; and this, exclusive of L.7000 generously offered by a small number of the Proprietors (but which will not be wanted), for enabling the Managers to defray the expenses of erecting the new buildings.

Upon settling the accounts, and calling in, and paying off, all debts outstanding against the Institution, up to the first day of the present month, it was found, that a sum amounting to above L.10800 then remained at the disposal of the Managers; which sum will, no doubt, be quite sufficient, not only to defray all the expenses of finishing and furnishing the buildings of the Institution, in all their numerous and extensive details, but also for fitting up all the workshops; and providing them with tools; and a stock of materials for work.

The House and Premises, which have been purchased for the Institution, are extensive; the ground covered by the principal edifice having originally been allotted for building four houses for private families; and no situation could have been found, in this metropolis, more convenient, or better adapted to all the purposes of this public establishment.

Professors and Lecturers in Natural Philosophy, Chemistry, and Mechanics, have been engaged; and Lectures are now given, daily, in two spacious Lecture Rooms; the one capable of containing 300, the other 900, persons.

A spacious and most complete Chemical Laboratory has been built, and is now furnishing with all the implements and apparatus necessary for carrying on, upon a large scale, all the various processes of practical chemistry; and chemical analysis; and for making new and interesting experiments. A Director of the Laboratory has been appointed, and also a Chemical Operator; and the Managers are now in treaty with a very ingenious German Chemist, whom they hope to engage, as an Assistant in the Laboratory, and who will devote his whole time to the business of it.

The Workshops of the Institution, where models, &c. of new and useful inventions will be constructed, and sold at reasonable prices to such Proprietors and Subscribers as may apply for them, are quite finished; and are now furnishing with the most complete sets of tools that can be procured.

A Master of the Workshops has been engaged, who is himself a working Mathematical Instrument Maker and Model Maker; and will have the care of all the philosophical apparatus belonging to the Institution, and keep it constantly in repair and ready for use. He will reside in the house,—and superintend and direct all the workmen who are employed in the workshops:—he will likewise superintend and instruct all such ingenious and well-behaved young men as may, at the recommendation of Proprietors, be admitted into the workshops of the Institution, to receive instruction, and to complete their education in any one or more of the mechanic arts.

The following Workmen are already engaged for the workshops of the Institution, viz.

A Mathematical Instrument Maker.
A Model Maker.
A Cabinet Maker.
A Carpenter.
A Worker in Brass and Copper.
A Tin Plate Worker; and
An Iron Plate Worker.

To these will soon be added Bricklayers and Stone

Masons; who will be instructed, and enabled to instruct others, in setting new invented fire grates, roasters, ovens, boilers, &c.

A complete Kitchen, for a small family—with a small roaster, on the most simple construction—a cottage fire-place grate—and a small boiler with steamers,—has been put up in the Housekeeper's room; and may be examined by all those who frequent the house of the Institution.

The fitting up of the principal Kitchen, belonging to the house, which will be made as complete as possible, in all its parts, will be begun in a few weeks. This kitchen will contain roasters, ovens, boilers, steamers, &c. on the newest and most approved construction; and, in order that the proper method of managing them may be seen, they will be kept in daily use, and persons will attend to show them.

In order that the Proprietors and Subscribers may be enabled to judge, from actual experiment, of the merit of any new method of Cooking, or of any new dish that may be proposed, a *Dining Room* has been built, and will soon be ready for use, at the house of the Institution, in which the Managers will, occasionally, order *Experimental Dinners*, to which the Proprietors and Subscribers will be invited, in as far as the accommodations will admit; the expense of such dinners to be defrayed by those who partake of them.

To render the House of the Institution more pleasant and agreeable to such Proprietors and Subscribers as frequent it, an additional room has lately been set apart for their private and exclusive use:—This has been called the *Conversation Room;* and is distinguished by an inscription over the door. As conversation in the Reading Rooms could not fail to interrupt those who read, the Managers are confident, that all those who frequent the house will be so sensible of the reasonableness of the regulation, as to abstain from conversation in the Reading Rooms when any person engaged in reading is present.

To render the Conversation Room still more useful and agreeable, it will be furnished with a collection of good Maps; and, as soon as some necessary previous arrangements (which are now actually making) shall be finished, those who frequent this room will be furnished, at the most reasonable prices, from the Housekeeper's Room below, with Soups of various kinds—Tea—Coffee—Chocolate, and other refreshments.

For the accommodation of such of the Proprietors and Subscribers as may have occasion to write letters at the house of the Institution, pens and ink are provided, and kept in readiness in the Conversation Room; and the Clerk has received directions to be constantly provided with writing paper, of all kinds, to be furnished by him, on his own private account, to such Proprietors and Subscribers as may apply for it.

Two Letter Boxes, one for the General Post, and the other for the Twopenny Post, both furnished with locks and keys, have been established in the great hall, at the house of the Institution, and all letters put into them by Proprietors and Subscribers are taken care of, and duly forwarded: Those for the Twopenny Post are sent by the Messenger of the house, at the proper hours, to a post office in a neighbouring street: Those for the General Post are taken away every evening by a Postman, who, at stated hours, goes through the streets with a bell to collect letters. This Postman receives from the Institution a gratification of one guinea a year for that service, in lieu of the usual allowance of one penny for each letter; so that it is not necessary for Proprietors and Subscribers to put money into the box with their letters.

A complete Printing Office, with a press, types, and every other instrument and implement necessary in printing, has been established at the house of the Institution; and a Printer is engaged, and has for some time past been constantly employed in printing for the Institution. It is expected that the printing of the Journals of the Institution, which in a few months will begin to appear at regular intervals, probably once a week, will give full employment to this press: for as these Journals will contain not only an account of all that is doing at the Royal Institution, and in the country at large, to introduce new and useful inventions and improvements, but will also contain selections from all the newest foreign scientific journals, and other scientific publications, which will all be regularly taken in at the Royal Institution, there is no doubt but that the Journals of the Royal Institution of Great Britain will become one of the most interesting, and most useful periodical works that has ever appeared in any country; and, consequently, that they will be much sought after, and much read.

The Reports of the various Committees, for specific scientific investigations (which will soon be appointed by the Managers,) will, no doubt, furnish much interesting matter for the Journals of the Institution.

The following scientific periodical publications are regularly taken in at the house of the Institution, and are laid on the table in the Reading Room the moment they arrive. And so effectual are the measures that have been taken for procuring all new foreign scientific books without delay, that they frequently come to the Institution, from the continent, while they are yet wet from the press.

FOREIGN *Periodical Scientific Publications.*

FRENCH.

1. Journal de Physique.
2. Annales de Chimie.
3. Journal des Mines.
4. Journal de L'Ecole Polytechnique.
5. Séances des Ecoles Normales.
6. Mémoires de l'Institut National.
7. La Décade Philosophique.
8. Magasin Encyclopédique.
9. Annales des Arts.
10. Bibliotheque Britannique.
11. Rapports Généraux de la Société Philomathique.

12. Journal Général de la Littérature de France.
13. Journal Général de la Littérature Etrangère.
14. Bibliotheque Germanique.
15. Connaissance des Tems.

GERMAN.

16. Chemische Annalen, von Crell.
17. Journal der Chemie, von Scherer.
18. Annalen der Physik, von Gilbert.
19. Jena Literatur-Zeitung.
20. Neue Berlinische Monatsschrift.
21. Neuer Teutscher Merkur.

AMERICAN.

22. Transactions of the American Philosophical Society.
23. Transactions of the American Academy of Arts and Sciences.
24. Transactions of the Massachusetts Historical Society.
25. Monthly Magazine and American Review.

DOMESTIC *Periodical Scientific, and Literary, Publications.*

26. Transactions of the Royal Society of London.
27. Transactions of the Royal Society of Edinburgh.
28. Transactions of the Royal Irish Academy.
29. Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.
30. Publications of the Board of Agriculture.
31. Transactions of the Linnean Society.
32. Transactions of the Manchester Society.
33. Transactions of the Bath and West of England Society.
34. Transactions of the Dublin Society.
35. Prize Essays of the Highland Society.
36. Transactions of the Asiatick Society.
37. The Annals of Agriculture.
38. Nicholson's Journal of Natural Philosophy, &c.
39. The Philosophical Magazine.
40. The Repertory of Arts.

41. Anderson's Recreations in Agriculture, &c.
42. The Monthly Review.
43. The Critical Review.
44. The British Critic.
45. The Gentleman's Magazine.
46. The European Magazine.
47. The Monthly Magazine.
48. The Annual Register.
49. The Asiatic Annual Register.

The following NEW FOREIGN PUBLICATIONS, on scientific subjects, have been purchased by the Managers for the Library of the Royal Institution.

1. Chimie Optomatique.
2. Œuvres de Goudin.
3. De la Résolution des Equations Numériques de Tous les Degrés, par Lagrange.
4. Elémens d'Algèbre.
5. Complément des Elémens d'Algèbre, par Lacroix.
6. Traité Elémentaire de Trigonométrie, Rectiligne, et Sphérique, par Lacroix.
7. Elémens de Géométrie, par Lacroix.
8. Tableau Synoptiques de Chimie, par Fourcroy.
9. Systême des Connaissances Chimiques, par Fourcroy, 10 tom.
10. Traité des Différences et des Séries, par Lacroix.
11. Elémens, ou Principes Physico-Chimiques, par Brisson.
12. Cours d'Instruction d'un Sourd-Muet de naissance, par Sicard.
13. Mémoire, ou Considérations sur les Sourds-Muets de naissance, par Desmortiers.
14. Observations sur l'Histoire Naturelle, générale et particulière, par Lamoignon-Malesherbes, 2 tom.
15. Elémens de Minéralogie, par Traversay.
16. Méthodes Analytiques pour la Détermination d'un Arc du Méridien, par Delambre.
17. Du Calcul des Dérivations, par Arbogast.
18. Description des Pyramides de Ghize, par Grobert.

19. Méthode de Préparer et Conserver les Animaux, par Nicolas.
20. Elémens de Perspective Pratique, par Valenciennes.
21. Cours de Physique et de Chimie, par Jacotet, 2 tom.
22. Systême des Animaux sans Vertebres.
23. Voyages Physiques et Lythologiques, 2 tom.
24. Almanach, ou Dictionnaire Général du Commerce, des Sciences, et Arts, et d'Industrie, par Lacornée.

The second Reading Room, which is spacious and airy, is now fitting up with elegant book cases, and library tables; and, as it is furnished with double windows, and thin white window blinds, it is uncommonly quiet and pleasant as a reading room, though it is situated on the ground floor, and near the street. The carriages which pass are scarcely heard through the double windows; and as the blinds prevent its being overlooked from without, it has an air of stillness and retirement which is very striking, and very pleasant to those who frequent it.

The Managers have not as yet thought themselves authorized to lay out money for the purchase of any books, except periodical scientific and literary publications, and a few new foreign scientific works of eminence; but the liberality of individuals has done much to supply this deficiency, and will, no doubt, do still more.

Many valuable Books have been presented to the Library of the Institution, and it was not till all the book cases in the room were filled by these generous contributions, that new book cases were provided. All books proper to appear in a public library, those only excepted which are professedly on political questions, are received by the Managers, and their thanks are returned for them; and the name of the donor of each book, and the date of the donation, is written in each volume, opposite to the title page, previous to its being placed in the library. In all future catalogues of the library of the Royal Institution, the name of the donor of each book will be mentioned opposite to the title, in a column set apart for that purpose; it being agreeable both to the principles of justice, and to those of an enlightened policy, that acts of generosity should not be forgotten.

It was unanimously determined by the Managers, at a very early period, that, as the Royal Institution was specially designed for promoting mechanical improvement, and exciting and encouraging practical ingenuity and useful industry, the investigation of all subjects lying within the provinces of either of the *three learned professions* would be improper; consequently, all discussion relative to *Religion, Law,* and *Medicine,* will be carefully avoided.

Although political publications, and especially all such as relate to party disputes are, by this wise regulation of the Managers, excluded from the reading rooms, yet all the principal Newspapers of the Metropolis, nine in number, together with one of the Edinburgh Papers, and one of the Dublin Papers, are regularly taken in, and may always be found in a room specially set apart for reading Newspapers. The papers of the day are laid on the table; while those for the fortnight preceeding are kept regularly filed in drawers, and may at any time be consulted. When they are a month old they are taken away, and kept till the end of the year, when they are bound in large volumes, which, being gilt and lettered, are placed in the library.

One of the most interesting details of the Institution still remains to be mentioned:—It is the *Repository.* The measures necessary for forming it have not been neglected, but, from its nature, it cannot be finished, nor indeed can it be begun till the establishment is quite complete in all its other essential parts. Models of mechanical inventions and contrivances, in order to their being really useful, must be so made as to serve for imitation, consequently they must be constructed with the greatest care; and they cannot be made in the workshops of the Royal Institution till those shops are fitted up, and furnished with the best tools, and the best workmen. These workshops will soon be completed, and properly manned; in the mean time, a spacious and elegant room, 44 feet long, and 32 feet wide, with the ceiling supported by two rows of columns, has been built for the repository, and in less than one month will be perfectly finished, and ready for the reception of the machines and instruments which it may be judged proper to exhibit to public inspection.

It may be useful to observe here, that it never was the intention of the Managers, nor of any of them, to expose to the public view models of machines of all kinds indiscriminately. Considerable alarms have, it has been said, been occasioned among some of our principal manufacturers, from an idea that the construction of their machines, and the valuable secrets of their trade, on which the excellence of their manufactures depend, are in danger of being disclosed by means of the public lectures and exhibitions of the Royal Institution;—but the event will show that these apprehensions are without foundation.

The measure lately adopted by the Managers for equalising the height of the house of the Institution in front, by completing the attic story, and extending it over the south wing of the building, and; at the same time, new pointing and colouring the front of the house, and rendering its appearance from the street more uniform, and more elegant, will be carried into execution immediately; and the whole will be finished before the end of November.

As soon as this addition to the buildings shall be completed,—and not before,—there will be room in the house for the accommodation of a certain number of young men, from eighteen to twenty in number, of different mechanical professions, who, at the recommendation of Proprietors, will be taken into the house to be instructed;—who will be boarded and lodged in the house,—and be employed in the workshops;—and for whose improvement in Drawing,—Practical Geometry,—and Mathematics,—an Evening School, under the direction of the Clerk of the Works, who was formerly a teacher in such a school, will be established in the house, in a room adjoining the workshops.

As most of the young men who will be admitted into this seminary will probably come from distant parts of the country, and will return home, after a residence of three or four months at the Institution, carrying with them a perfect knowledge of such new and useful inventions, applicable to the common purposes of life, as may be deserving of being generally known and adopted, it is easy to foresee that this arrangement will be of great and extensive public utility. It is, perhaps, that part of the establishment precisely which will be the most interesting, and which will contribute the most powerfully to the attainment of the principal object of the Institution; "*The diffusing the knowledge, and "facilitating the general Introduction of useful Mechanical "Inventions and Improvements.*"

The number of the Proprietors of the Institution now amounts to 325;—the Life Subscribers to 268;—and the Annual Subscribers to 527;—making in the whole 1120 persons, who have already come forward in support of this great public undertaking.—This number is undoubtedly very great, but the lists of the members of the Royal Institution will appear doubly respectable when the many distinguished names which dignify them are taken into consideration. But if so many persons of great abilities,—high rank,—and most respectable character,—could be found to come forward and support an undertaking, not only unfinished, but new in its kind, and of the success of which doubts might well be entertained, we may safely look forward with confidence to a period, not far distant, when, the Royal Institution of Great Britain, completed in all its details, and in full activity, will become so interesting, that every person of liberality and discernment, who takes pleasure in contemplating the progress of human improvement, will be desirous of belonging to it, and willing to assist in promoting its permanent prosperity.

Observations relative to the Means of increasing the Quantities of Heat obtained in the Combustion of Fuel. By COUNT RUMFORD.

IT is a fact which has been long known, that clays, and several other incombustible substances, when mixed with sea coal, in certain proportions, cause the coal to give out more heat in its combustion than it can be made to produce when it is burnt pure or unmixed; but the cause of this increase of heat does not appear to have been yet investigated with that attention which so extraordinary and important a circumstance seems to demand.

Daily experience teaches us that all bodies,—those which are incombustible,—as well as those which are combustible, and actually burning,—throw off in all directions heat,—or rather calorific (heat-making) rays, which generate heat wherever they are stopped, or absorbed;—but common observation was hardly sufficient to show any perceptible difference between the quantities of calorific rays thrown off by different bodies, when heated to the same temperature, or exposed in the same fire; although the quantities so thrown off, might be, and probably are, very different.

It has lately been ascertained, that when the sides and back of an open chimney fireplace, in which coals are burned, are composed of firebricks, and heated redhot, they throw off into the room incomparably more heat than all the coals that could possibly be put into the grate, even supposing them to burn with the greatest possible degree of brightness. Hence it appears that a redhot burning coal does not send off near so many calorific rays as a piece of redhot brick or stone, of the same form and dimensions; and this interesting discovery will enable us to make very important improvements in the construction of our fireplaces, and also in the management of our fires.

The fuel instead of being employed to heat the room *directly*, or by the direct rays from the fire, should be so disposed, or placed, as *to heat the back and sides of the grate*; which must always be constructed of firebrick, or firestone, and *never of iron, or of any other metal.* Few coals, therefore, when properly placed, make a much better fire than a larger quantity; and shallow grates, when they are constructed of proper materials, throw more heat into a room, and with a much less consumption of fuel, than deep grates; for a large mass of coals in the grate arrests the rays which proceed from the back and sides of the grate, and prevents their coming into the room; or, as fires are generally managed, it prevents the back and sides of the grate from ever being sufficiently heated to assist much in heating the room, even though they be constructed of good materials, and large quantities of coals be consumed in them.

It is possible, however, by a simple contrivance, to make a good and an economical fire in almost any grate, though it would always be advisable to construct fireplaces on good principles, or to improve them by judicious alterations, rather than to depend on the use of additional inventions for correcting their defects.

To make a good fire in a bad grate, the bottom of the grate must be first covered with a single layer of balls, made of good firebricks, or artificial firestone, well burnt, each ball being perfectly globular, and about 2½ or 2¾ inches in diameter. On this layer of balls the fire is to be kindled, and, in filling the grate, more balls are to be added with the coals that are laid on; care must, however, be taken in this operation to mix the coals and the balls well together, otherwise, if a number of the balls should get together in a heap, they will cool, not being kept red hot by the combustion of the surrounding fuel, and the fire will appear dull in that part; but if no more than a due proportion of the balls are used, and if they are properly mixed with the coals, they will all, except it be those perhaps at the bottom of the grate, become redhot, and the fire will not only be very beautiful, but it will send off a vast quantity of radiant heat into the room; and will continue to give out heat for a great length of time. It is the opinion of several persons who have for a considerable time practised this method of making their fires, that more than one third of the fuel usually consumed may be saved by this simple contrivance. It is very probable that, with careful and judicious management, the saving would amount to one half, or fifty per cent.

As these balls, made in moulds, and burnt in a kiln, would cost very little, and as a set of them would last a long time,—probably several years,—the saving of expense in heating rooms by chimney fires with bad grates, in this way, is obvious; but still, it should be remembered that a saving quite as great may be made by altering the grate, and making it a good fireplace.

In using these balls, care must be taken to prevent their accumulating at the bottom of the grate: As the coals go on to consume, the balls mixed with them will naturally settle down towards the bottom of the grate, and the tongs must be used occasionally to lift them up; and, as the fire grows low, it will be proper to remove a part of them, and not to replace them in the grate till more coals are introduced:—A little experience will show how a fire made in this manner can be managed to the greatest advantage, and with the least trouble.

Balls made of pieces of any kind of well burnt hard brick, though not equally durable with firebrick, will answer very well, provided they be made perfectly round; but if they are not quite globular their flat sides will get together, and by obstructing the free passage of the air amongst them, and amongst the coals, will prevent the fire from burning clear and bright.

The best composition for making these balls, when they are formed in moulds, and afterwards dried and burnt in a kiln, is pounded crucibles mixed up with moistened Sturbridge clay; but good balls may be made with any very hard burnt common bricks, reduced to a coarse powder, and mixed with Sturbridge clay, or even with common clay. The balls should always be made so large as not to pass through between the front bars of a grate.

These balls have one advantage,which is peculiar to them, and which might perhaps recommend the use of them to the curious, even in fireplaces constructed on the best principles; they cause the cinders to be consumed almost entirely; and even the very ashes may be burnt, or made to disappear, if care be taken to throw them repeatedly upon the fire when it burns with an intense heat. It is not difficult to account for this effect in a satisfactory manner, and in accounting for it we shall explain a circumstance on which it is probable that the great increase of the heat of an open fire, where these balls are used, may, in some measure, depend. The small particles of coal, and of cinder, which, in a common fire, fall through the bottom of the grate, and escape combustion, when these balls are used can hardly fail to fall and lodge on some of them; and, as they are intensely hot, these small bodies which alight upon them in their fall, are soon heated redhot, and disposed to take fire and burn; and, as fresh air from below the grate is continually making its way upwards amongst the balls, every circumstance is highly favourable to the rapid and complete combustion of these small inflammable bodies. But if these small pieces of coal and cinder should, in their fall, happen to alight upon the metallic bars which form the bottom of the grate;—as these bars are conductors of heat, and, on account of that circumstance, as well as of their situation,—*below* the fire,—never can be made very hot,—any small particle of fuel that happens to come into contact with them, not only cannot take fire, but would cease to burn should it arrive in a state of actual combustion.

These facts are very important, and well deserving of the attention of those who may derive advantage from the improvement of fireplaces, and the economy of fuel.

There are some circumstances which strongly indicate that an admixture of incombustible bodies with fuel, and especially with coal, cause an increase of the heat, even when the fuel is burnt in a closed fireplace. No fireplace can well be contrived more completely closed than those of the iron stoves in common use in the Netherlands; but, in these stoves,—which are heated by coal fires,—a large proportion of wet clay is always coarsely mixed with the coals before they are introduced into the fireplace. If this practice had not been found to be useful it would certainly never have obtained generally; nor would it have been continued, as it has been, for more than two hundred years.

The combination of different substances,—combustible, and incombustible,—to form, artificially, various kinds of cheap and pleasant fuel, particularly adapted for the different processes in which the fuel is employed, is a subject well worthy of the attention of enterprizing and ingenious men. How much excellent fuel, for instance, might be made with proper additions, and proper management, of the mountains of refuse coal dust that lie useless at the mouths of coal pits; and how much would it contribute to cleanliness and elegance if the use of improved coke, or of hard and light fire balls, could be generally introduced in our houses and kitchens, instead of crude, black, powdery, dirty, sea coal.—Of the great economy that would result from such a change there cannot be the smallest doubt.

It is a melancholy truth, but, at the same time, a most undisputable fact, that, while the industry and ingenuity of millions are employed, with unceasing activity, in inventing, improving, and varying those superfluities which wealth and luxury introduce into society, no attention whatever is paid to the improvement of those common necessaries of life on which the subsistence of all, and the comforts and enjoyments of the great majority of mankind, absolutely depend.

Much will be done for the benefit of society, if means can be devised to call the attention of the active and benevolent to this long neglected, but most interesting, subject.

The Royal Institution seems to be well calculated to facilitate and expedite the accomplishment of this important object. Indeed it is more than probable that this, precisely, is the object which was principally had in view in the foundation and arrangement of that establishment.

On the USE *of* STEAM *as a Vehicle for conveying Heat from one Place to another.* *By* COUNT RUMFORD.

MORE than fifty years ago, Colonel William Cook, in a Paper presented by him to the Royal Society, and published in their Transactions, made a proposal for warming rooms by means of metallic tubes filled with steam, and communicating with a boiler situated out of the room; which proposal was accompanied by an engraving, which showed, in a manner perfectly clear and distinct, how this might be effected. Since that time this scheme has frequently been put in practice with success, both in this country and on the continent*.—Many attempts have likewise been made, at different periods, to heat liquids by means of steam introduced into them; but most of these have failed: And, indeed, until it was known that fluids are nonconductors of heat, and, consequently, that heat cannot be made to *descend* in them—(which is a recent discovery),—these attempts could hardly succeed; for, in order to their being successful, it is absolutely necessary that the tube which conveys the hot steam should open into the *lowest part* of the vessel which contains the liquid to be heated, or on a level with its bottom;—but as long as the erroneous opinion obtained, that heat could pass in fluids *in all directions,* there did not appear to be any reason for placing the opening of the steam tube *at the bottom of the vessel,* while many were at hand which pointed out other places as being more convenient for it.

But to succeed in heating liquids by steam, it is necessary, not only that the steam should enter the liquid at the bottom of the vessel which contains it, but also that it should enter it *coming from above.* The steam tube should

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* Although one should naturally imagine that the notoriety of these facts would have been sufficient to prevent all attempts in our days to claim a right to this invention, yet it is said that a PATENT for it was taken out only a few years ago.

be in a vertical position, and the steam should *descend* through it previous to its entering the vessel, and mixing with the liquid which it is to heat; otherwise this liquid will be in danger of being forced back by this opening into the steam boiler; for the hot steam being suddenly condensed on coming into contact with the cold liquid, a vacuum will necessarily be formed in the end of the tube; into which vacuum the liquid in the vessel—pressed by the whole weight of the incumbent atmosphere—will rush with great force, and with a loud noise; but if this tube be placed in a vertical position, and if it be made to rise to the height of six or seven feet, the liquid which is thus forced into its lower end will not have time to rise to that height before it will be met by steam and obliged to return back into the vessel.—There will be no difficulty in arranging the apparatus in such a manner as effectually to prevent the liquid to be heated from being forced backwards into the steam boiler; and, when this is done, and some other necessary precautions to prevent accidents are taken, steam may be employed with great advantage for heating liquids; and for keeping them hot, in a variety of cases, in which fire, applied immediately to the bottoms of the containing vessels, is now used.

In dying, for instance, and in brewing; and in the processes of many other arts and manufactures, the adoption of this method of applying heat would be attended, not only with a great saving of labour and of fuel; but also of a considerable saving of expense in the purchase and repairs of boilers, and of other expensive machinery: For when steam is used instead of fire for heating their contents, boilers may be made extremely thin and light; and, as they may easily be supported and strengthened by hoops and braces of iron, and other cheap materials, they will cost but little, and seldom stand in need of repairs. To these advantages we may add others of still greater importance: Boilers intended to be heated in this manner may, without the smallest difficulty, be placed in any part of a room—at any distance from the fire;—and in situations in which they may be approached freely on every side. They may moreover easily be so surrounded with wood, or with other cheap substances which form warm covering, as most completely to confine the heat within them, and prevent its escape. The tubes by which the steam is brought from the principal boiler (which tubes may conveniently be suspended just below the ceiling of the room) may, in like manner, be covered, so as almost entirely to prevent all loss of heat by the surfaces of them; and this to whatever distances they may be made to extend.

In suspending these steam tubes, care must, however, be taken to lay them in a situation *not perfectly horizontal* under the ceiling, but to incline them at a small angle, making them rise gradually from their junction with the top of a large vertical steam tube, connecting them with the steam boiler, quite to their farthest extremities: For, when these tubes are so placed, it is evident that all the water formed in them, in consequence of the condensation of the steam in its passage through them, will run backwards and fall into the boiler, instead of accumulating in them, and obstructing the passage of the steam,—which it would not fail to do were there any considerable bends or wavings, upwards and downwards, in these tubes—or of running forward and descending with the steam into the vessels containing the liquids to be heated;—which would happen if these tubes inclined *downwards,* instead of inclining upwards, as they recede from the boiler.

In order that clear and distinct ideas may be formed of the various parts of this apparatus,—even without figures,—I shall distinguish each part by a specific name: The vessel in which water is boiled in order to generate steam—and which, in its construction, may be made to resemble the boiler of a steam engine—I shall call the *steam boiler:* —The vertical tube, which, rising up from the top of the boiler, conveys the steam into the tubes (nearly horizontal), which are suspended from the ceiling of the room, I shall call the *prime conductor:* To the horizontal tubes I shall give the name of *horizontal conductors,* or simply, *conduc-*

tors of steam: and to the (smaller) tubes, which, descending perpendicularly from these *horizontal conductors*, convey the steam to the liquids which are to be heated, I shall, exclusively, appropriate the appellation of *steam tubes*.

The vessels in which the liquids are put that are to be heated I shall call the *containing vessels*.—These vessels may be made of any form; and, in many cases, they may, without any inconvenience, be constructed of wood, or of other cheap materials, instead of being made of costly metals, by which means a very heavy expense may be avoided.

Each *steam tube* must descend perpendicularly from the *horizontal conductor* with which it is connected, to the level of the bottom of the *containing vessel* to which it belongs; and, moreover, must be furnished with a good brass cock, perfectly steam-tight; which may best be placed at the height of about six feet above the level of the floor of the room.

This *steam tube* may either descend *within the vessel* to which it belongs, or *on the outside of it*, as shall be found most convenient. If it comes down on the outside of the vessel, it must enter it at its bottom, by a short horizontal bend; and its junction with the bottom of the vessel must be well secured, to prevent leakage. If it comes down into the vessel, on the inside of it, it must descend to the bottom of it, or at least to within a very few inches of the bottom of it; otherwise the liquid in the vessel will not be uniformly and equally heated,

When the steam tube is brought down on the inside of the containing vessel, it may either come down perpendicularly, and without touching the sides of it, or it may come down on one side of the vessel, and in contact with it.

When several steam tubes, belonging to different containing vessels, are connected with one and the same horizontal steam conductor, the upper end of each of these tubes, instead of being simply attached by soldering to the under side of the conductor, must enter, at least one inch, within the cavity of it; otherwise the water resulting from a condensation of a part of the steam in the conductor, by the cold air which surrounds it, instead of finding its way back into the steam boiler, will descend through the steam tubes and mix with the liquids in the vessels below; but when the open ends of these tubes project upwards within the steam conductor, though it be but to a small height above the level of its under side, it is evident that this accident cannot happen.

It is not necessary to observe here, that, in order that the ends of the steam tubes may project within the *horizontal conductor*, the diameters of the former must be considerably less than the diameter of the latter.

To prevent the loss of heat arising from the cooling of the different tubes through which the steam must pass in coming from the boiler, all those tubes should be well defended from the cold air of the atmosphere, by means of warm covering; but this may easily be done, and at a very trifling expense. The horizontal conductors may be enclosed within square wooden tubes, and surrounded on every side by charcoal dust,—fine sawdust,—or even by wool;—and the steam tubes, and prime conductor, may be surrounded, first by three or four coatings of strong paper, firmly attached to them by paste or glue, and covered with a coating of varnish, and then by a covering of thick coarse cloth. It will likewise be advisable to cover the horizontal conductors with several coatings of paper, for if the paper be put on to them while it is wet with the paste or glue; and if care be taken to put it on in long slips or bands, wound regularly round the tube in a spiral line, from one end of it to the other, this covering will be useful, not only by confining more effectually the heat, but also by adding very much to the strength of the tube, and rendering it unnecessary to employ thick and strong sheets of metal in the construction of it.

However extraordinary and incredible it may appear, I can assert it as a fact, which I have proved by repeated experiments, that if a hollow tube, constructed of sheet copper $\frac{1}{20}$ of an inch in thickness, be covered by a coating only twice as thick, or $\frac{1}{10}$ of an inch in thickness, formed of layers of strong paper, firmly attached to it by good glue, the strength of the tube will be *more than doubled* by this covering. I found by experiments, the most unexceptionable and decisive—of which I intend at some future period to give to the public a full and detailed account,—that the strength of paper is such, when several sheets of it are firmly attached together with glue, that a solid cylinder of this substance, the transverse section of which should amount to only one superficial inch, would sustain a weight of 30000 lbs. avoirdupois, or above 13 tons, suspended to it, without being pulled asunder or broken. The strength of hemp is still much greater, when it is pulled equally, in the direction of the length of its fibres. I found, from the results of my experiments with this substance, that a cylinder of the size above mentioned, composed of the straight fibres of hemp, glued together, would sustain 92000 lbs. without being pulled asunder.

A cylinder, of equal dimensions, composed of the strongest iron I could ever meet with, would not sustain more than 66000 lbs. weight; and the iron must be very good not to be pulled asunder with a weight equal to 55000 lbs. avoirdupois.

I shall not, in this place, enlarge on the many advantages that may be derived from a knowledge of these curious facts. I have mentioned them now in order that they may be known to the public; and that ingenious men, who have leisure for these researches, may be induced to turn their attention to a subject, not only very interesting, on many accounts, but which promises to lead to most important improvements in mechanics.

I cannot return from this digression without just mentioning one or two results of my experimental investigations relative to the force of cohesion, or strength of bodies, which, certainly, are well calculated to excite the curiosity of men of science.

The strength of bodies of different sizes, *similar in form*, and composed of the *same substance*,—or the forces by which they resist being pulled asunder by weights suspended to them, and acting in the direction of their lengths,—*are not in the simple ratio of the areas of their transverse sections*, or of their *fractures*;—but in a higher ratio;—and this ratio is different in different substances.

The *form* of a body has a considerable influence on its strength, *even when it is pulled in the direction of its length.*

All bodies, even the most brittle, appear to be *torn asunder*, or their particles separated, or fibres broken, *one after the other*; and hence it is evident, that that *form* must be most favourable to the strength of any given body, pulled in the direction of its length, which enables the greatest number of its particles, or longitudinal fibres, to be separated to the greatest possible distance—short of that at which the force of cohesion is overcome,—before any of them have been forced beyond that limit.

It is more than probable that the apparent strength of different substances depends much more on the number of their particles that come into action before any of them are forced beyond the limits of the attraction of cohesion, than on any specific difference in the intensity of that force in those substances.

But to return to the subject more immediately under consideration.—As it is essential that the steam employed in heating liquids, in the manner before described, should enter the containing vessel at, or very near, its bottom, it is evident that this steam must be sufficiently strong, or elastic, to overcome, not only the pressure of the atmosphere, but also the additional pressure of the superincumbent liquid in the vessel; the steam boiler must, therefore, be made strong enough to confine the steam, when its elasticity is so much increased by means of additional heat, as to enable it to overcome that resistance. This increase of the elastic force of the steam need not, however, in any case, exceed a pressure of five or six pounds upon a square inch of the boiler, or *one third part*, or *one half*, of an atmosphere.

It is not necessary for me to observe here, that in this, and also in all other cases, where steam is used as a vehicle for conveying heat from one place to another, it is indispensably necessary to provide *safety valves* of two kinds; —the one for letting a part of the steam escape, when, on the fire being suddenly increased, the steam becomes so strong as to expose the boiler to the danger of being burst by it;—the other for admitting air into the boiler, when, in consequence of the diminution of the heat, the steam in the boiler is condensed, and a vacuum is formed in it; and when, without this valve, there would be danger, either of having the sides of the boiler crushed, and forced inwards by the pressure of the atmosphere from without; or of having the liquid in the containing vessels forced upwards into the horizontal steam conductors, and from thence into the steam boiler. This last mentioned accident, however, cannot happen, unless the cocks in some of the steam tubes happen to be open.—The two valves effectually prevent all accidents.

The reader, will, no doubt, be more disposed to pay attention to what has here been advanced, on this interesting subject, when he is informed that the proposed scheme has already been executed on a very large scale, and with complete success; and that the above details are little more than exact descriptions of what actually exists.

A great mercantile and manufacturing house at Leeds, that of Messrs. Gott, and Co. had the courage, notwithstanding the mortifying prediction of all their neighbours, and the ridicule with which the scheme was attempted to be treated, to erect a *dying house,* on a very large scale indeed, on the principles here described and recommended.

On my visit to Leeds the last summer, I waited on Mr. Gott, who was then mayor of the town, and who received me with great politeness, and showed me the cloth halls, and other curiosities of the place; but nothing he showed me interested me half so much as his own truly noble manufactory of superfine woollen cloths. I had seen few manufactories so extensive, and none so complete in all its parts. It was burnt to the ground the year before I saw it, and had just been rebuilt, on a larger scale; and with great improvements in almost every one of its details. The reader may easily conceive that I felt no small degree of satisfaction on going into the dying house to find it fitted up on principles which I had had some share in bringing into repute, and which Mr. Gott told me he had adopted in consequence of the information he had acquired in the perusal of my *seventh* Essay. He assured me that the experiment had answered, even far beyond his most sanguine expectations; and, as a strong proof of the utility of the plan, he told me, that his next door neighbour, who is a dyer by profession, and who, at first, was strongly prejudiced against these innovations, has lately adopted them, and is now convinced that they are real improvements. Mr. Gott assured me that he had no doubt but that they would be adopted by every dyer in Great Britain in the course of a very few years.

The dying house of Messrs. Gott and Co. which is situated on the ground floor of the principal building of the manufactory, is very spacious, and contains a great number of coppers of different sizes; and as these vessels, some of which are very large, are distributed about promiscuously, and apparently without any order in their arrangement, in two spacious rooms,—each copper appearing to be insulated, and to have no connection whatever with the others,—all of them together form a very singular appearance. The rooms are paved with flat stones, and the brims of all the coppers—great and small—are placed at the same height—about three feet—above the pavement: Some of these coppers contain upwards of 1800 gallons; and they are all heated by steam from one steam boiler, which is situated in a corner of one of the rooms.

The horizontal tubes which serve to conduct the steam from the boiler to the coppers are suspended just below the ceiling of the rooms: They are made—some of lead—and some of cast iron; and are from four to five inches in diameter; but when I saw them, they were naked, or without any covering to confine the heat. On my observing to Mr. Gott that coverings for them would be useful, he told me that it was intended that they should be covered, and that coverings would be provided for them.

The vertical *steam tubes*, by which the steam passes down from the horizontal *steam conductors* into the coppers, are all constructed of lead, and are from ¾ of an inch to 2½ inches in diameter; being made larger or smaller according to the sizes of the coppers to which they belong. These steam tubes all pass down on the *outsides* of their coppers; and enter them horizontally at the level of their bottoms. Each copper is furnished with a brass cock, for letting off its contents; and it is filled with water from a cistern at a distance, which is brought to it by a leaden pipe. The coppers are all surrounded by thin circular brick walls, which serve not only to support the coppers, but also to confine the heat.

The rapidity with which these coppers may be heated, by means of steam, is truly astonishing. Mr. Gott assured me that one of the largest of them, containing upwards of 1800 gallons, when filled with cold water from the cistern, requires no more than *half an hour* to heat it till it actually boils!——By the greatest fire that could be made under such a copper, with coals, it would hardly be possible to make it boil in less than an hour.

It is easy to perceive that the *saving of time* which will result from the adoption of this new mode of applying heat will be very great;—and it is likewise evident that it may be increased, almost without limitation, merely by augmenting the diameter of the steam tube: Care must, however, be taken that the boiler be sufficiently large to furnish the quantities of steam required.——The *saving of fuel* will also be very considerable: Mr. Gott informed me that, from the best calculation he had been able to make, it would amount to near two thirds of the quantity formerly expended, when each copper was heated by a separate fire.

But these savings are far from being the only advantages that will be derived from the introduction of these improvements in the management of heat: There is one, of great importance indeed—not yet mentioned—which alone would be sufficient to recommend the very general adoption of them.—As the heat communicated by steam can never exceed the mean temperature of boiling water by more than a very few degrees, the substances exposed to it can never be injured by it. In many arts and manufactures this circumstance will be productive of great advantages, but in none will its utility be more apparent than in cookery; and especially in public kitchens,—where great quantities of food are prepared in large boilers;—for, when the heat is conveyed in this manner, all the labour now employed in stirring about the contents of those boilers, to prevent the victuals from being spoiled by burning to the bottoms of them, will be unnecessary; and the loss of heat occasioned by this stirring, prevented;—and, instead of expensive coppers, or metallic boilers, which are difficult to be kept clean, and often stand in need of repairs,—common wooden tubs may, with great advantage, be used as culinary vessels; and their contents may be heated by *portable fireplaces*, by means of steam boilers, attached to them.

As these portable fireplaces and their steam boilers, may, without the smallest inconvenience, be made of such weight, form, and dimensions, as to be easily transported from one place to another by two men, and be carried through a door-way of the common width—with this machinery, and the steam tubes belonging to it, and a few wooden tubs,—a complete public kitchen, for supplying the poor and others, with soups; and also with puddings, vegetables, meat, and all other kinds of food prepared by *boiling*, might be established in half an hour, in any room, in which there is a chimney (by which the smoke from the portable fireplace can be carried off); and, when the room should be no longer wanted as a kitchen, it might, in a few minutes, be cleared of all this culinary apparatus, and made ready to be used for any other purpose.

This method of conveying heat is peculiarly well adapted for heating baths: It is likewise highly probable that it would be found useful in the bleaching business, and in washing linen. It would also be very useful in all cases where it is required to keep any liquid at about the boiling point for a long time without making it boil; for the quantity of heat admitted may be very nicely regulated by means of the brass cock belonging to the steam tube. Mr. Gott showed me a boiler in which shreds of skins were digesting in order to make glue, which was heated in this manner; and in which the heat was so regulated, that, although the liquid never actually boiled, it always appeared to be upon the very point of beginning to boil.

This temperature had been found to be best calculated for making good glue. Had any other *lower* temperature been found to answer better, it might have been kept up with the same ease, and with equal precision, by regulating properly the quantity of steam admitted.

I need not say how much this country is obliged to Mr. Gott, and his worthy colleagues.—To the spirited exertions of such men—who abound in no other country—we owe one of the proudest distinctions of our national character;—that of being an enlightened and an enterprising people.

An Account of a new EUDIOMETER. *By* MR. DAVY.

THE dependance of the health and existence of animals upon a peculiar state of the atmosphere, and the relations of this state to processes connected with the most essential wants of life, have given interest and importance to inquiries concerning the composition and properties of atmospheric air.

This elastic fluid has been long known to consist chiefly of oxygene and nitrogene, mingled together, or in a state of loose combination, and holding in solution water.

A variety of processes have been instituted with the view of determining the relative proportions of the two gases, but most of them have involved sources of inaccuracy; and lately all, except two (the slow combustion of phosphorus, and the action of liquid sulphurets), have been generally abandoned.

Both phosphorus and solution of sulphuret of potash absorb the whole of the oxygene of atmospheric air at common temperatures, and they do not materially alter the volume, or the properties of the residual nitrogene; but their operation is extremely slow; and in many cases it is difficult to ascertain the period at which the experiment is completed.

I have lately employed as an eudiometrical substance the solution of green muriate, or sulphate, of iron, impregnated with nitrous gas; and I have found that it is in some respects superior to many of the bodies heretofore used, as it rapidly condenses oxygene without acting upon nitrogene; and requires for its application only a very simple and a very portable apparatus.

This fluid is made by transmitting nitrous gas through green muriate, or sulphate, of iron, dissolved to saturation in water*. As the gas is absorbed, the solution becomes of a deep olive brown, and when the impregnation is completed it appears opaque and almost black. The process is apparently owing to a simple elective attraction; in no case is the gas decomposed; and under the exhausted receiver it assumes its elastic form, leaving the fluid with which it was combined unaltered in its properties.

The instruments necessary for ascertaining the composition of the atmosphere, by means of impregnated solutions, consist simply of a small graduated tube, having its capacity divided into one hundred parts, and greatest at the open end; and of a vessel for containing the fluid.

The tube, after being filled with the air to be examined, is introduced into the solution; and, that the action may be more rapid, gently moved from a perpendicular towards a horizontal position. Under these circumstances the air is

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* Dr. Priestley first observed this process: for a particular account of it, see Researches, Chemical and Philosophical, page 152. Johnson.

rapidly diminished; and, in consequence of the dark colour of the fluid, it is easy to discover the quantity of absorption. In a few minutes the experiment is completed, and the whole of the oxygene condensed by the nitrous gas in the solution in the form of nitrous acid.

In all eudiometrical processes with impregnated solutions, the period at which the diminution is at a stand must be accurately observed; for, shortly after this period, the volume of the residual gas begins to be a little increased, and, after some hours, it will often fill a space greater by several of the hundred parts on the scale of the tube, than that which it occupied at the maximum of absorption.

This circumstance depends upon the slow decomposition of the nitrous acid (formed during the experiment), by the green oxide of iron, and the consequent production of a small quantity of aëriform fluid (chiefly nitrous gas)*; which, having no affinity for the red muriate, or sulphate, of iron produced, is gradually evolved, and mingled with the residual nitrogene.

The impregnated solution with green muriate is more rapid in its operation than the solution with green sulphate. In cases when these salts cannot be obtained in a state of absolute purity, the common or mixed sulphate of iron may be employed. One cubic inch of moderately strong impregnated solution is capable of absorbing five or six cubic inches of oxygene, in common processes; but the same quantity must never be employed for more than one experiment.

A number of comparative experiments, made on the constitution of the atmosphere at the Hotwells, Bristol, in July, August, and September, 1800, with phosphorus, sulphurets of alkalies, and impregnated solution, demonstrated the accuracy of the processes in which the last substance

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* The decomposition of nitrous acid, by solutions containing oxide of iron, at its minimum of oxidation, is a very complex process. The green oxide, during its conversion into red oxide, not only decomposes the acid, but likewise acts upon the water of the solution; and ammoniac is sometimes formed, and small portions of nitrous oxide and nitrogene evolved with the nitrous gas.

was properly employed. The diminutions given by the sulphurets were indeed always greater by a minute quantity than those produced by phosphorus and impregnated solutions: but the reason of this will be obvious to those who have studied the subject of Eudiometry. In no instance was it found that 100 parts in volume of air contained more than 21 of oxygene: and the variations connected with different winds, and different states of temperature, moisture, &c. were too small, and too often related to accidental circumstances, to be accurately noticed.

In analysing the atmosphere in different places, by means of impregnated solutions, I have never been able to ascertain any notable difference in the proportions of its constituent parts. Air, collected on the sea at the mouth of the Severn, on October the 3d, 1800, which must have passed over much of the Atlantic, as the wind was blowing strong from the west, was found to contain 21 per cent. of oxygene in volume; and this was nearly the proportion in air sent from the coast of Guinea, to Dr. Beddoes, by two surgeons of Liverpool.

If we compare these results, with the results gained more than twenty years ago, by Mr. Cavendish, from experiments on the composition of atmospherical air, made at London and Kensington; considering, at the same time, the researches of Berthollet in Egypt and at Paris, and those of Marti in Spain, we shall find strong reasons for concluding, that the atmosphere, in all places exposed to the influence of the winds, contains very nearly the same proportions of oxygene and nitrogene: a circumstance of great importance; for, by teaching us that the different degrees of salubrity of air do not depend upon differences in the quantities of its principal constituent parts, it ought to induce us to institute researches concerning the different substances capable of being dissolved or suspended in air, which are noxious to the human constitution: particularly as an accurate knowledge of their nature and properties would probably enable us, in a great measure, to guard against, or destroy, their baneful effects.

The following Outlines of a View of Galvanism are chiefly extracted from a Course of Lectures on the Galvanic Phenomena, read at the Theatre of the Royal Institution by MR. DAVY.

OUTLINES OF A VIEW OF GALVANISM.

I. *Historical Introduction.*

§ 1. THE science relating to the peculiar action of different conductors of electricity on each other, has lately excited a considerable degree of attention in the philosophical world.

Owing its origin to the phenomenon discovered by Galvani *, the production of muscular contraction by the application of metals to the nerves and muscles of animals, it has derived its name from that philosopher.

Galvanism was at first limited in its application to organized bodies ; but, in consequence of the labours and inventive genius of experimentalists, our contemporaries, it has gradually become connected with chemistry and general physics; it has afforded powerful instruments of investigation ; and its operations have been traced throughout the whole of nature.

In giving an account of the progress of this science, in its relation to the powers of the human mind, it will be sufficient to notice such experiments only, as have derived their origin from extensive theoretical views, and such discoveries as have led to accurate generalisations of phenomena already known.

Though the history of galvanism extends only through the period of the last nine years, yet we may notice in it four epochs, each of them distinguished by the develope-

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* The first fact, relating to the action of metals on the animal organs, was observed by Sulzer, who has described the sensation of taste produced by the contact of lead and silver with the tongue, in his *Theorie des Plaisirs*, published in 1767.

ment of facts, variously interesting from their novelty and the extent of their application.

§ 2. Considering the first epoch as formed by the publication of the fundamental galvanic fact, we may derive the second from the discovery of the existence of inorganic galvanism. Till the researches of Fabroni, Dr. Ash, and Creve, had been made known, the galvanic influence was generally considered as existing only in living animal organs. But the discovery of the peculiar action of metals in contact with each other upon water, demonstrated the production of it in arrangements composed wholly of dead matter, and laid the foundation for a new class of investigations, which have intimately connected the galvanic phenomena with known physical effects.

§ 3. The third epoch in the history of the science is, perhaps, the most brilliant and most important. It will long be celebrated on account of the discovery of the accumulation of the galvanic influence. Before this discovery was made, the world, in general, beheld nothing deeply interesting in galvanism: it had no relations to the common wants of life, and the facts that composed it were so obscure as to be difficultly comprehended, except by long attention. The galvanic battery of Volta not only gratified the passion for novelty, by the curious effects it produced, but likewise awakened the love of investigation, by distinctly exhibiting the analogy between galvanism and common electricity.

§ 4. The fourth and last epoch in galvanism may be considered as founded upon the knowledge of the general connexion between the excitement of galvanic electricity, and chemical changes; and it chiefly owes it existence to the labours of British experimentalists[*]. The discovery of the chemical agencies of galvanism has led to researches which finally cannot fail to elucidate the philosophy of the imponderable, or ethereal fluids. The year that is just past will long be distinguished in the history of science; seldom has

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[*] Messrs. Nicholson, Carlisle, Cruikshank and Henry, Dr. Wollaston, and Major Haldane.

physical investigation been pursued with greater ardour; and if new facts, by being sometimes insulated and incapable of application to established theories, have perplexed the public mind, yet they have at the same time been useful to it, by producing a habit of rational and active scepticism, which cannot fail of becoming, at a future period, the parent of truth.

II. *Of the least complicated Galvanic Arrangements,* i. e. *simple Circles.*

§ 1. The conductors of electricity, which, by their action on each other, are capable of producing galvanic effects, may be divided into two classes*. The one class comprises, what may be called perfect conductors, oxidable metallic substances and charcoal. The other includes less perfect conductors, which are either oxidated fluids, or substances containing these fluids.

The simplest galvanic arrangements require for their formation at least two bodies of the same class and one of a different class*.—With regard to the form of their aggregation, they must be so disposed, that the bodies of the one class may be in contact with each other, in one or more points, at the same time that they are connected in other distinct points with the body of the other class.

§ 2. The simple galvanic circles may be divided into two general kinds.

The first is formed by two different metallic substances, or one metallic substance and charçoal, and a peculiar fluid.

The second is composed by two different fluids and one metallic substance.

Thus, if plates of zinc and of silver be made to touch in one point, and be connected together in other points by a portion of common water or of muriatic acid, a galvanic simple circle is formed of the first order.

Or if separate portions of nitric acid and of water, moisten-

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* Volta.

ing pieces of cloth or bibulous paper, be brought in contact with each other on a small surface, at the same time that other surfaces of them are connected with different parts of a plate of tin, a circle of the second kind is composed*.

§ 3. All arrangements, however, of two conductors of one class with one of the other are not capable of producing galvanic effects. And even the powers of acting circles are very different in degree. It appears from all the facts, that chemical changes taking place in some of the parts of the circle are intimately connected with its agencies. For though a momentary circulation of galvanic influence may possibly be produced by the contact of three different bodies, yet it appears most likely that the permanent excitation of it depends upon a certain exertion of their chemical affinities.

The most powerful circles of the first kind are those composed of two solids of different degrees of oxidability, and of a fluid capable of oxidating at least one of the solids †. And, even in the feeblest circles, it appears that some chemical action is uniformly exerted either by oxidating fluids or solutions of alkaline sulphurets.

Thus silver and gold do not appear to evolve galvanic influence when in contact with pure water, which is incapable of acting chemically upon either of the metals; though when they are connected with water, holding in solution nitric acid, or any other fluid decomposable by silver, they form an active galvanic arrangement*.

And zinc and silver, which act very little with pure water, form a powerful combination with water holding in solution atmospheric air, or acids ‡.

The following table of some circles of the first kind, in which the different substances are arranged according to the order of their known galvanic powers, will show how intimately chemical agencies are related to the production of galvanism.

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* D. † Ritter. ‡ Fabroni.

TABLE OF SOME GALVANIC CIRCLES.

Composed of two perfect Conductors and one imperfect Conductor.

More oxidable substances.	Less oxidable substances.	Oxidating fluids.
Zinc.	With gold, charcoal, silver, copper, tin, iron, mercury.	Solutions of nitric acid in water, of muriatic acid and sulphuric acid, &c. Water holding in solution oxygene, atmospheric air, &c.
Iron.	. . . . gold, charcoal, silver, copper, tin.	
Tin.	. . . . gold, silver, charcoal.	
Lead.	. . . . gold, silver.	
Copper.	. . . . gold, silver.	Solution of nitrate of silver and mercury. Nitric acid, acetous acid.
Silver.	. . . . gold.	Nitric acid.*

The most active single circles of the second order are those in which the two imperfect conductors are capable of exerting different chemical agencies on the perfect conductor, at the same time that they are possessed of power of action on each other. But even circles in which only one of the fluid parts is decomposable by the solid, are possessed of power of action,

Thus copper, silver, or lead, acts very powerfully when connected in the proper order with solutions of alkaline sulphurets and of nitrous acid, both of which fluids are possessed of distinct chemical agencies upon them †. And copper or silver acts, though with less intensity, when water, or a fluid which they are incapable of decomposing, is substituted for one of the chemical agents.

The following table contains some powerful galvanic combinations of the second order, arranged according to the intensity of their action.

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* Dry nitre, caustic potash, and soda, are conductors of galvanism when rendered fluid by a high degree of heat; but the order of their conducting powers has not been yet ascertained.

† D.

TABLE OF SOME GALVANIC CIRCLES.

Composed of two imperfect Conductors and one perfect Conductor.

Perfect conductors.	Imperfect conductors.	Imperfect conductors.
Copper. Silver. Lead. Tin. Iron. Zinc.	Solutions of alkaline sulphurets, capable of acting on the first three metals, but not on the last three.	Solutions of nitrous acid, oxygenated muriatic acid, &c. capable of acting on all the metals.

§ 4. Arrangements, exactly similar in their action to the common simple circles, may be formed by the combination of more than three conductors. For that simple galvanic action may be evolved, nothing more is apparently requisite, than that the points of contact between the solid and fluid parts of the circle, i. e. the places where chemical affinities are liable to be exerted, be immediately preserved; at the same time that those parts are respectively homogeneal, or composed respectively of similar conductors. Thus zinc, silver, iron, gold, and water, arranged in a circle, in the order of their enumeration, produce action, exactly analogous to zinc, gold, and water. And, nitrous acid, water, solution of caustic potash, solution of sulphuret of potash, and silver, evolve galvanic influence in the same manner as nitrous acid, water, solution of sulphuret of potash, and silver.

It appears, however, that the length, and surface of the conducting series, connecting the exciting parts of the circle, are in some measure related to the quantity of action it is capable of exhibiting. This law, indeed, applies only analogically to perfect conductors; though with regard to imperfect conductors, it is demonstrated experimentally; as in all cases a diminution of power, in some unknown ratio, is produced by the increase of the length, or what is apparently equivalent, the diminution of the surface of the chain which they compose.

The limits of surface, and of length, of imperfect conductors in circles, connected with the maximum and minimum of their activity, have not been yet ascertained; and there is every reason to believe that they will be different in different imperfect conductors. Thus, portions of sulphuric acid and of nitrous acid, will probably form better conducting series than similar portions of water; and a chain of water will perhaps act better than an equal chain of water mixed with alcohol.

From several experiments, it would appear that the powers of circles are particularly connected with the extension of the surfaces of contact between the perfect and imperfect conductors.

§ 5. All galvanic influence in single circles is manifested, either by its efficiency, in affecting living animal organs, forming part of the arrangement, or by its power in modifying the chemical changes produced by the action of the perfect on the imperfect conductors.

A. When one fluid part of a powerful single circle, is made to touch the tongue at the same time that another fluid part is connected with some irritable surface of the body, an acid taste is perceived *, which becomes less distinct in proportion as the contact is longer preserved.

If the eye be made part of the galvanic circuit, a transient flash of light is produced at the moment the chain is completed †: and when the bared cutis is employed, a faint painful sensation uniformly denotes the circulation of the galvanic influence ‡.

But the most distinct mode of exhibiting, by animal excitement, the existence of small quantities of galvanic power, is by connecting one part of the circle with a nerve, and another part with a muscle, in a limb just separated from the body of a living animal. In this case, whenever the connexion of the arrangement is made, or broken, muscular contractions are produced ||.

B. In galvanic simple circles all primary chemical action taking place between the imperfect and perfect conduc-

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* Sulzer, Volta, Robison, and other philosophers.

† Mr. Hunter. ‡ Humboldt. || Galvani.

tors is apparently increased by their galvanic arrangement. Thus, zinc, which oxidates when in contact with common water alone, oxidates much more rapidly when forming a galvanic circle with it by means of gold, or other difficultly oxidable metals*. And tin appears to dissolve faster in diluted nitric acid, when composing a circle with it by the contact of gold, than when singly immersed in it†.

C. But increase of primary chemical action is not the only inorganic effect of galvanism; for it changes the nature of this action in a very peculiar manner. In the oxidating circle with common water no perceptible quantity of hydrogene is evolved, as in common processes; but an alkaline substance appears to be formed at the point of contact of the least oxidable perfect conductor with the fluid. Thus, if zinc and silver be made to form a circle with distilled water, holding in solution air, for many weeks, a considerable oxidation of the zinc is perceived, without the perceptible evolution of gas; and the water, at its point of contact with the silver, becomes possessed of the power of tinging green, red cabbage juice, and of rendering turbid, solution of muriate of magnesia†.

In the oxidating circles with acids, gas is not only evolved from the parts of the conductors undergoing chemical change, but likewise from other parts in which no primary action apparently exists. Thus, when zinc and silver form a circle with diluted muriatic acid, gas is not only given out at the points of contact of the acid with the zinc, but likewise at the place where it is connected with the silver§. And in the circle with tin, gold, and diluted nitric acid, nitrous gas is evolved from the gold as well as from the tin†.

D. Indeed in all the single galvanic circles, whenever an oxidating influence is exerted at one of the places of contact of the perfect and imperfect conductors, a deoxidating action appears to be produced at the other place. Thus, when iron, which oxidates rapidly when forming a circle

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* Dr. Ash. † Original experiment, D. § Dr. Wollaston.

with silver and common water, is arranged with zinc and common water, it remains perfectly unaltered, whilst the zinc is rapidly acted upon.

§ 6. The phenomena exhibited by the simple galvanic circles cannot well be theorized upon, except in the laws of their connexion with the more complicated and more striking galvanic facts. And it is from the discovery made by Volta, of the accumulation of galvanism only, that the instruments of investigation are derived, by means of which the nature of this influence is known, and its most important agencies and relations ascertained.

III. *Of Compound Galvanic Circles, or Galvanic Batteries.*

§ 1. The instruments for accumulating galvanic power, or the compound galvanic circles, are composed of the same elements as the simple circles: but those elements are disposed in a different form of aggregation.

To compose a galvanic battery, series of the conductors capable of forming simple circles are required. And they must be arranged in such a manner, that the conductors of the same class in every series, may be in contact with each other, in one or more points, at the same time that they are respectively connected with different conductors of the other class, and one of them belonging to the same series, a regular alternation being observed.

Thus, the order of a compound galvanic circle is, conductor of the one class, conductor of the one class, conductor of the other class; conductor of the one class, and so on, in uniform arrangement.

§ 2. The compound galvanic circles, like the simple circles, may be divided into two general orders.

The first order is composed of series, containing, at least, two perfect conductors, and one imperfect conductor. The second is formed by arrangements, consisting of not less than two imperfect conductors, and one perfect conductor*.

Thus, if plates of zinc, and of silver, and pieces of cloth, of

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* D.

the size of the plates, moistened in water, or diluted muriatic acid, be arranged in the order of zinc, silver, cloth; zinc, silver, cloth, and so on, till twenty series are perfectly connected, a galvanic battery is formed of the first class*.

And if plates of copper, and pieces of cloth, moistened, some in water, and some in solution of sulphuret of potash, be connected in a circle, in the order of copper, cloth moistened in water, cloth moistened in solution of sulphuret of potash, and so on, a compound circle will be formed of the second class†.

The most elegant mode, however, of arranging the metals of compound circles with fluids, is by means of vessels, composed of electrical nonconductors, such as glasses, or boxes formed of baked wood.

Thus, plates of copper, and of zinc, paired, and soldered together at their edges, may be cemented into a trough composed of baked wood, in regular alternation, and in such a manner, as to leave a number of water tight cells, corresponding to the number of series. And this arrangement will become active when the cells are filled with water, or saline solutions, and when the extreme metals are properly connected‡.

Or, instead of the double plates, single plates of copper, and of horn, or glass, may be used in uniform alternation; when the cells must be filled with different fluid chemical agents in the regular order, so as to be connected together by pieces of moistened cloth, passing over the nonconducting plates||.

§ 3. The substances most active in the single circles, are likewise most active in the compound circles. And in all cases, the relative quantities of galvanic power, exhibited by equal numbers of different series, are, in some measure, proportional to the intensity of the peculiar primary chemical agencies, exerted by the different conductors composing them, on each other†.

Thus, in the battery with zinc and silver, there is little, or

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* Volta. † D. ‡ Mr. Cruikshank. || Count Rumford.

no action produced, when the connecting fluid is pure water, or water holding in solution hydrogene gas, which is incapable of acting on the metals*. The action is greater with water saturated with oxygene† than with water saturated with atmospheric air, and it is most intense when solution of red sulphate of iron, or of nitric acid, is employed.

The tables of the single circles will indicate, with the necessary change of arrangement, the relative powers of the series forming compound circles.

§ 4. Provided those places of contact in the compound circle, in which the peculiar chemical changes are produced, remain permanent, the parts of the series which do not immediately act chemically on each other, may be connected together in the same manner as in single circles, by means of conductors of their own class, without any alteration of the nature of the agencies.

Thus, in the circle with copper, iron, and water, the copper and iron may be connected by means of a wire of brass‡. And even the continuity of the portions of water may be broken by moist muscular fibre, and other imperfect conductors, without any other change in the effect than a diminution of its intensity§.

§ 5. The galvanic influence, when highly accumulated, produces very extraordinary chemical and physical effects, and, in many of its appearances, assumes the precise form of common electricity.

A. When in a powerful battery (one for instance containing two hundred series) the communication, after being broken, is again rendered complete, by the contact of two perfect conductors, a flash or spark of light is perceived, analogous to that produced by electricity‡. This spark, or flash, when the battery is most powerful, is capable of passing through a considerable stratum of air‖, and of inflaming mixtures of oxygene and hydrogene**. When the metallic substances, by which it is transmitted, are of very small volume, it is possessed of the power of ig-

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* D.

† Major Haldane.

‡ Volta.

§ Pfaff, Ritter, and D.

‖ Mr. Cruikshank.

** Mr. R. Boulton.

niting them; and of making them enter into combustion when in contact with oxygene[*].

B. The galvanic influence, when highly concentrated, affects the electrometer, and is capable of communicating weak charges to the condenser and Leyden phial[†]. In all compound circles of the first class, the most oxidable part of the metallic plates evolves the influence, appearing as positive electricity, whilst the least oxidable part seems negatively electrified. In the second class of circles it is, however, probable that this order is reversed.

C. Galvanism, moderately accumulated, affects the animal organs in nearly the same manner as common electricity. When the human body is made part of the circle, a shock is perceived at the moment of connexion; and a subsequent numbness and tingling sensation denote the permanent circulation of the influence.

The fresh limbs of frogs undergo violent contractions, and soon lose their excitability, when placed in the circuit of a powerful battery.

D. The chemical actions taking place in the compound galvanic circle, present curious and most unexampled appearances: all the primary changes taking place in the different conductors being increased, and modified to a great extent.

In all batteries of the first order, when the connexion is completed, changes take place which denote the evolution of influences capable of producing from *common* water, oxygene and hydrogene, acid and alkali, in different parts of every series[‡].

Thus in the battery with series of zinc plates, silver wires, and common water, oxide of zinc is formed on all the plates of zinc, whilst hydrogene is produced from the silver wires, and if the water in contact with them be tinged with red cabbage juice, it becomes green[§].

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[*] Professors Tromsdorf, Böckmann, Fourcroy, and Vauquelin.

[†] Mr. Nicholson and Mr. Cruikshank.

[‡] Mr. Nicholson, Mr. Carlisle, and Mr. Cruikshank.

[§] D.

And in the battery with silver, gold, and weak nitric acid, the silver is dissolved, whilst the acid becomes green, and slowly evolves gas at its points of contact with the gold.

The chemical agencies exerted in the compound batteries of the first class can be best observed by the substitution of single metallic wires for some of the double plates; for, in this case, the changes taking place in the series with wires, will be exactly analogous to those produced in the series with plates; silver, and all the more oxidable metals, oxidating in water, in the usual place; and gold and platina evolving oxygene gas.

Thus, when into two small glass tubes, connected by moist animal substance, and filled with distilled water, two gold wires are introduced from a large battery, in the proper order, oxygene is produced in one quantity of water, and hydrogene in the other, nearly in the proportions in which they are required to form water by combustion*. And if the process be continued for some time, the apparatus being exposed to the atmosphere, the water, in the oxygene-giving tube, will become impregnated with an acid (apparently the nitrous); whilst that, in the hydrogene-giving tube, will be found to hold in solution an alkali, which, in certain cases, has appeared to be fixed†.

From some experiments it would appear probable that the quantities of hydrogene, produced in series, are small, and the quantities of alkali great, in proportion as the surfaces of contact of the least oxidable metals with the water are more extended*.

All the oxygenated solutions of bodies possessing less affinity for oxygene than nascent hydrogene, are decomposed when exposed to the action of the metal occupying the place of the least oxidable part of a series in the com pound circle.

Thus, sulphur may be produced from sulphuric acid; and

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* Original experiment, D.

† Mr. Cruikshank, the first discoverer of the galvanic production of alkali, supposes that the hydrogene wire in common water, generates ammoniac. Perhaps the presence of muscular fibre is connected with the production of fixed alkali in the experiment detailed in the text.

copper and other metals precipitated in the metallic form from their solvents *.

But little knowledge has yet been obtained concerning the chemical changes taking place in the second class of galvanic batteries. But from several experiments it would appear that they are materially different in the laws of their production from those taking place in the first class.

Thus, when single metallic wires with water, are placed as series in powerful batteries of the second order, the influence producing oxygene seems to be transmitted by the point, in the place of that part of the plate, which was apparently incapable of undergoing oxidation; whilst the hydrogene is evolved from that point, where the oxidating part of the primary series appeared to exist †.

§ 6. The agency of the galvanic influence, which occasions chemical changes, and communicates electrical charges, is probably, in some measure, distinct from that agency which produces sparks, and the combustion of bodies.

The one appears (all other circumstances being similar) to have little relation to surface in compound circles, but to be great, in some unknown proportion, as the number of series are numerous. The intensity of the other seems to be as much connected with the extension of the surfaces of the series, as with their number.

Thus, though eight series composed of plates of zinc and copper, about ten inches square, and of cloths of the same size moistened in diluted muriatic acid, give sparks so vivid as to burn iron wire; yet the shocks they produce are hardly sensible, and the chemical changes indistinct ‡. Whilst twenty-four series of similar plates and cloths, about two inches square, which occasion shocks and chemical agencies more than three times as intense, produce no light whatever.

§ 7. A measure of the intensity of the power in galvanic batteries, producing chemical changes, may be derived

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* Mr. Nicholson, Mr. Cruikshank, and Mr. Henry, jun.

† D. ‡ Fourcroy, Vauquelin, and Thenard.

from the quantity of gas it is capable of evolving from water, in a given time; or from the length of the fluid chain through which it can be transmitted. For the same law of diminution of activity that was applied to single circles in § 4. page 54, may be likewise applied to compound circles.

The general relative forces of different batteries may be ascertained by connecting them in opposite orders, so as to produce a certain annihilation of power. For in all cases when the most oxidable part of one series is placed opposite to the same part of another equal series, and connected with it by means of a fluid, the galvanic agencies of both are destroyed.

IV. *General Observations.*

§ 1. From a valuable experiment lately made*, it appears, that, when common electricity is passed through water, by means of two very fine metallic points, chemical changes are effected by it, analogous to those occasioned by the transmission of the galvanic influence.

This fact, singly, presents a very strong analogy between galvanism and the common electrical influence. And when compared with the other facts, it amounts almost to a demonstration of their identity.

On this theory, it seems most probable, that all the different galvanic phenomena owe their existence to electricity, excited in the different arrangements, in consequence of a change in the electrical capacity of such of their parts as undergo chemical action; this action being always connected with alterations in the surfaces and conducting powers of bodies.

The circulation of electricity in galvanic circles, from its different points of excitation, appears to depend, in a great measure, upon certain specific attractions for it, in the different conductors, inexplicable by known laws.

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* By Dr. Wollaston.

§ 2. In all cases of simple galvanic action, negative and positive electricity, as respectively exhibited by their deoxidating and oxidating influences, after being once excited, can be multiplied by a certain alternation of surface.

Thus, in the circle with zinc, iron, and water, in which, as was stated in page 57, the zinc oxidates, and the iron undergoes no change, if a drop of water be placed on an insulated surface of the iron, it will rapidly act upon it, and produce red oxide; whereas if it be placed upon a similar surface of the zinc, it will undergo very little change*.

This fact will, perhaps, in some measure, lead to an explanation of the cause of the accumulation of galvanism in compound circles. For in those circles, all the series are so constituted, as to produce a perfect correspondence between the electricity excited by chemical action, and that produced by compensation.

§ 3. The general chemical agency of galvanism is at present involved in obscurity. The facts relating to the separate production of oxygene and hydrogene, acid and alkali in water, are totally incommensurable with the usually received theory of chemistry. And, even supposing that the appearance of the two last of these bodies is connected with the presence of atmospheric air, it is still extremely difficult to conceive, that either oxygene or hydrogene can pass in an invisible form through fluids, or organic bodies. Common physical facts present us with no analogies sufficiently distinct to enable us to reason on this subject; and the elucidation of it will probably be connected with perfectly new views of corpuscular action.

§ 4. The appearance of galvanic action in living matter, particularly in the torpedinal organ, leads to curious inquiries. Chemical changes are perpetually going on in different parts of the living body, which must be connected with alterations in their states of electricity: and organized beings contain all the substances requisite for forming species of galvanic arrangements. These circumstances combined

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with the facts of the production of muscular contraction by common galvanism, and the dependance of irritability, and even life, upon the oxygenation of the blood, afford analogies which render it probable that some phenomena, similar to the galvanic phenomena, may be connected with muscular action and other processes of life. These analogies, however, at present are very indistinct; and they ought to be considered of importance, only so far as they are likely to lead to the discovery of new instruments of experimental investigation.

Conclusion.

The relations of galvanism to the different branches of physical science, are too numerous and too extensive to be connected with the preceding details; and, although in their infancy, they will probably long constitute favourite subjects of investigation amongst philosophers, becoming the sources of useful discoveries.

The new galvanic facts have given an importance to the science sufficient to render it interesting, and to ensure its progression. The spirit of inquiry is awakened in the public mind, and it is difficult to imagine the existence of causes capable of destroying it.

Galvanism may be pursued with greater facility than most of the other sciences; it requires less time and attention; it is less connected with manual labour, and the most delicate organs are the best fitted for performing and observing its operations.

The instruments required for galvanic experiments are few, and but little expensive.—A battery composed of fifty plates, when arranged with chemical agents, forms a combination sufficiently powerful for common experiments. With such a combination, a few glass tubes having gold wires attached to them, and a gold leaf electrometer, may investigations be pursued, and principles discovered, extending not alone to the laws of dead matter, but even to those of animated nature.

If, to render galvanism a popular study, it were necessary to prove that it bore relations to the common wants of life, it might be stated, that its agencies are likely, at some period, to become useful in the arts. When our galvanic instruments are rendered more perfect and more powerful, we may be readily enabled, by means of them, to procure the pure metals; and to form immediately from their elements, nitrous acid, and alkali. The connexion of galvanism with philosophical medicine is evident. The electrical influence in its common form, as excited by machines, has been employed with advantage in the cure of diseases; in a new state of existence it may possibly be possessed of greater, and of different powers.

But, independent of the immediate applications of this science, much is to be hoped from the elucidations which it may bestow upon the kindred sciences. And a discovery so important as to excite our astonishment, cannot fail of becoming, at some period, useful to society. All the different branches of human knowledge are intimately connected together, and theoretical improvements, cannot well be made in them without being accompanied by practical advantages.

Royal Institution, Sept. 1, 1801.

At a Meeting of the Managers of the Royal Institution of Great Britain, held at the House of the Institution, on the 29th Day of June, 1801,

Resolved, That a permanent committee be appointed for the general purposes of chemical investigation and analysis; and that this committee be authorized to hold their meetings at the house of the Institution, and to make such experiments in the laboratory of the Institution as they may think useful.

Resolved, That Charles Hatchett, Esq. be chairman of this committee.

Resolved, That the following persons be appointed to this committee, as members thereof.

The Right Honourable Lord Dundas.
Mr. Carlisle.
Mr. Chenevix.
Mr. Howard.
Mr. Nicholson.
George Pearson, M. D.
Mr. W. H. Pepys, Jun.

Resolved, That Mr. Hatchett, Mr. Howard, and Mr. Nicholson, be requested to meet together and draw up a few short rules and regulations respecting the ordinary meetings of the chemical committee, and the manner of conducting the business of it.

Resolved, That the committee of chemistry be allowed to dine together at the house of the Institution once a month, or once a fortnight, if they think proper so to do.

At a Meeting of the Managers of the Royal Institution of Great Britain, held at the House of the Institution, on the 7th Day of September, 1801.

As it will be proper that those persons who shall be appointed by the managers to be members of the different committees formed, or to be formed, at the Royal Institution, for the purpose of specific scientific investigation, should be properly qualified, by being versed in the science so to be investigated.

Resolved, That no additions be made of members to any of those committees, after they shall have been once formed, without previously consulting with such committee on that subject, and taking their opinion on the qualifications of the candidate proposed for election.

Resolved further, That this resolution be communicated to the committee of chemistry, and also to such other committees as shall in future be formed at the Royal Institution, for the purpose of specific scientific investigation.

ROYAL SOCIETY.

The meetings of the Royal Society commenced for the season, on Thursday the 5th of November.

The Croonian lecture on muscular motion, by Everard Home, Esq. was read. Its subject was the capacity of the eye to change its focal distance, after being deprived of the crystalline lens. Mr. Home relates an experiment, where it was shown by Dr. Young's optometer, that a person from whose eye the lens had been extracted, retained a greater power of accommodating it to different distances, than is found in some eyes which are entire. On repeating the experiment, the faculty appeared to be considerably diminished; a circumstance which Mr. Home attributes to fatigue. The optometer was found to be much more manageable in its simple state, than with the addition of a lens; and it was singular, that this person saw distinctly from about 9 to 13 inches without the use of any glass.

On the 12th and 17th, Dr. Young's Bakerian lecture was read. The subject was the theory of light and colours. It contained an extension of the system, which the author had submitted to the Royal Society in a former paper; and its unexpected application to a great variety of phenomena, most of which had been observed by Newton, but never sufficiently explained, and others were advanced from the author's own experiments. Dr. Young first shows how little difficulty there is, for such as admit the Newtonian doctrines, to allow the truth of this theory, and how much those doctrines have been misunderstood by Euler and others. After recapitulating, and extending the explanation of the more common phenomena of optics, the author enters into the detail of those applications which are the most novel and striking; by which it appears to be a general law, that, whenever two portions of the same pencil of light arrive at the same point by different routes, the production of colours depends uniformly on the difference of the length of those routes; and from this principle, the colours of striated surfaces, of thin and of thick plates, and of inflected light, are shown to be necessary consequences of the combination of undulations, in the same manner as the beating of two sounds, or the interference of the tides at sea: and all the measures laid down by Newton, are found to agree precisely with this law. Such a coincidence Dr. Young cannot help considering as fully sufficient, to turn the scale of probability in favour of the undulatory system of light.

On the 26th, Mr. Hatchett's paper, on a new metallic substance, found in an ore from the state of Massachusets, was read. It appears to resemble in its properties the metallic acids, and in its natural state, is combined with iron; but it is distinguishable from other substances, by the orange coloured precipitate thrown down from its solution by the gallic acid, and the olive green colour of the precipitate by the prussic acid. All attempts to reduce it to the metallic form have hitherto been unsuccessful: but, from the colours of the precipitates, and from other circumstances, Mr. Hatchett thinks that its base will be found to be an acidifiable metal, and he gives it the name columbium.

On the 30th, the day of the anniversary, the Copleian medal was conferred by the council on Mr. Astley Cooper, in consequence of his success in the cure of cases of deafness, arising from obstructions of the eustachian tube, by the operation of perforating the membrane of the tympanum.

The President, in an appropriate speech, bestowed on Mr. Cooper the encomiums merited by his important improvement, and noticed, at the same time, that, in all probability, Cheselden would have been equally fortunate, had he not been prevented by popular prejudice, from trying the experiment on a condemned criminal.

The meeting of the 10th of December was occupied by an abridged translation of a pamphlet of Mr. Piazzi, on the supposed planet, which he discovered at Palermo, and which he has named Ceres Ferdinandia. Its apparent diameter was seven seconds, its distance from the sun nearly three times that of the earth, and its period somewhat more than five years. It does not, however, appear to be by any means fully ascertained, that it deserves to be considered as a true planet. The paper was communicated by Dr. Maskelyne.

On the 17th, Mr. Home's account of the anatomy of the ornithorhynchus paradoxus was read. This singular animal appears to form the link between the mammalia and the amphibia, for while in its general appearance and in its sanguiferous system it resembles the mammalia, especially some of the order of bruta, both the absence of mammae, and its internal anatomy render it probable that it is oviparous. Its teeth too, when they are found, are but four in number, and resemble the substance of horn more than of bone. Its food is unknown, but its residence is in the water. On its hind feet only, besides the five toes connected by a web, there is a detached process armed with a spur. The paper was accompanied with numerous drawings, and a dried specimen of the animal.

On the 24th, a paper on friction, by Mr. Southern, was communicated by Mr. Vince. Mr. Southern made a number of accurate experiments on the motions of large grindstones revolving with great rapidity, and ascertained the power of friction on their axes from the number of revolutions which they performed when set in motion with various velocities. He considers the results as fully confirming Mr. Vince's principles that friction is a uniformly retarding force: although the resistance of the air and other accidental circumstances introduced great irregularities into the experiments. He found this force equal to about one fortieth of the weight: the steel spindles running on brass, with the interposition of an unctuous substance.

The Society adjourned to Thursday the fourteenth of January.

Extract of a Report made to the Mathematical and Physical Class of the National Institute at Paris, on the Experiments of Volta, by a Committee consisting of Laplace, Coulomb, Hallé, Monge, Fourcroy, Vauquelin, Pelletier, Charles, Brisson, Sabatier, Guyton, and Biot.

——Your committee proposes at present to give an account of those fundamental experiments, and of the manner in which Mr.Volta has employed them for the establishment of his theory. The committee is under great obligations to this gentleman, for having been so good as to repeat them several times before its members, who have thus had an opportunity of enabling themselves to give testimony of their truth and accuracy.

The principal fact, on which the rest depend, is the following:

If two different metals, insulated, and having only their natural quantity of electricity, are brought into contact, they assume, when again separated, different electric states; the one is positive and the other negative.

This difference, which in each contact is very small, becomes, when successively accumulated by means of an electrical condenser, sufficiently strong to separate the electrometer very sensibly. The action does not take place at a distance, but only upon the contact of the different metals: it exists as long as the contact continues; but its intensity is not the same for all metals.

It will be sufficient to take for example copper and zinc. In their mutual contact, the copper becomes negative, and the zinc positive.

After having proved the developement of metallic electricity, independently of any humid conductor, Mr. Volta next introduces such conductors.

If we form a metallic plate of two portions, the one of zinc, the other of copper, by soldering their ends together, and, taking the zinc between our fingers, touch with the copper the upper plate of the condenser, which is also of copper, the condenser becomes negative. This agrees obviously with the former experiment.

But, if on the contrary, we hold the copper in our fingers, and touch the upper plate of the condenser with the zinc; upon removing the metals and raising the upper plate of the condenser, it indicates no electricity, notwithstanding the lower plate is connected with the common reservoir in the earth.

But, as soon as we interpose between the zinc and the plate of the condenser, a piece of paper moistened with pure water, or any other moist conductor, the condenser becomes charged with positive electricity. It becomes also charged, but negatively, when we hold the zinc in our fingers, and touch, with the copper, the humid conductor laid on the condenser. These facts are incontestable: they have been verified by the committee.

Mr. Volta thus explains them, and connects them with the former fundamental fact.

Metals, and probably all other substances, exert, as we have just seen, a reciprocal action on their respective electricities at the moment of contact. When we hold the metallic plate by the copper, a part of its electric fluid passes into the zinc; but if this zinc is in immediate contact with the condenser, which is also of copper, the condenser tends with equal force to discharge its own fluid into the zinc, and therefore can receive nothing from the zinc, consequently, after the contact, it must remain in its natural state. If, on the contrary, we place wet paper between the zinc and the copper of the condenser, the force tending to displace the electricity, which exists only upon the contact of the two metals, is now destroyed; the water, which appears to possess this property, but in a very weak degree, with regard to the metallic substances, very little impedes the transmission of the fluid of the zinc to the condenser, and the condenser is at liberty to become positively charged.

Finally, when we touch the condenser with the end which is of copper, the interposition of the wet paper, of which the proper action is very weak, does not prevent the transition of a part of the positive electricity of the condenser into the plate of zinc: so that after separation, the condenser is found to be charged negatively.

It is easy, from this theory, to explain the pile of Mr. Volta. For the sake of simplicity, we will suppose it to be insulated, and we will represent by unity, the excess of the electricity of a piece of zinc above that of a piece of copper in immediate contact with it *.

If the pile is composed but of two pieces, the lower one of copper, the upper one of zinc, the electric state of the first will be represented by $-\frac{1}{2}$, and that of the second by $+\frac{1}{2}$.

If we add a third piece, which must be of copper, we must separate it, in order that the fluid may be displaced, by wet pasteboard, from the piece of zinc below it; and, in this case, it will acquire the same state of electricity with the zinc; at least neglecting the proper action of the water, which appears to be very feeble, and also the slight degree of resistance which the water may oppose to the communication as an imperfect conductor of electricity. The apparatus being insulated, the excess of the upper piece can only be acquired at the expense of the lower piece of copper: and, in this case, the charges of the respective pieces will be different from the former experiment. The lower piece of copper will be $-\frac{2}{3}$; the piece of zinc, which is in immediate contact with it, $-\frac{2}{3}+1$, or $\frac{1}{3}$; and the upper piece of copper, separated from the zinc by wet pasteboard, will have the same charge, that is $+\frac{1}{3}$; so that the negative charge of the lower piece will be equal to the sum of the

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* The quantities of electricity accumulated in a body beyond its natural state, are, every thing else being equal, proportional to the repulsive force with which the particles of the fluid tend to separate from each other, or to repel a new particle which we attempt to add to them. This repulsive force, which, in unconnected bodies, is balanced by the resistance of the air, constitutes what we shall call the *tension* of the fluid; which is not proportional to the separation of the straws in Volta's electrometer, nor to that of the balls in the electrometer of Saussure, and which can only be accurately measured by means of the electrical balance.

positive charges of the two others, the whole quantity being the same as in the natural state.

If on this pile we place another piece of zinc, this piece will demand a greater quantity of electricity by unity, than the copper on which it is placed: but, since this excess can only be obtained at the expense of the pieces below, the pile being insulated, we shall have,

For the lower piece of copper, — 1

For the second piece, which is of zinc, 0

that is, it will be neutral.

For the third piece, which is of copper, separated from the second piece by wet pasteboard 0

For the upper piece, which is of zinc, and in contact with the third, + 1

By pursuing the same mode of reasoning, we may find the electrical state of each piece of the pile, supposing it insulated and formed of any given number of pieces; the quantities of electricity will increase at each step, from the base to the summit of the pile, in an arithmetical progression, of which the sum will vanish.

Supposing, for the sake of simplicity, the number of constituent parts to be even, we may discover, by a very easy calculation,

That the piece of copper, which is the first, and the piece of zinc, which is the last of the pile, must be equally electrified, the one positively, the other negatively; and the same will be true of any pieces taken at equal distances from the extremities of the pile.

Between the positive and the negative states, the electricity will vanish; and there will always be two pieces, one of zinc, the other of copper, which will be in the natural state. They will be in the middle of the pile, as has already been shown in the example of four pieces.

Let us now make a communication between the lower part of the pile and the earth: it is evident, that then the lower piece of copper, which is negatively electrified, will tend to absorb from the ground what it has lost; but its electrical state cannot change, unless that of the superior pieces be also varied, since the difference of the pieces must always be the same, in the state of equilibrium. Therefore all the negative quantities of the lower half of the pile, must be neutralised at the expense of the common reservoir; and in this case,

The lowest piece, which is of copper, will have the electricity of the earth, which we call 0.

The second piece, which is of zinc, and in immediate contact with the first, will have + 1.

The third, which is of copper, and separated from the zinc below it by wet pasteboard, will also have + 1.

The fourth, which is of zinc, and in immediate contact with the third, will have + 2.

And, in the same manner, the electricity of the different elements will continue to increase in arithmetical progression.

If we then touch, with our hands, the two extremities of the pile, these excesses of electricity will be discharged through our bodies into the common reservoir, and will produce a shock so much the more sensible, as the loss is quickly repaired from the earth, and an electrical current is formed, of which the rapidity is greater within the pile, than within the animal body, which is an imperfect conductor; so that the internal parts of the pile are at liberty to resume a degree of tension approaching to that which they had when in the state of equilibrium.

The communication with the earth being still preserved, if we bring the summit of the pile into contact with the upper plate of a condenser, of which the lower is connected with the ground, the electricity which was accumulated at the summit with a very slight degree of tension, will pass into the condenser, where the tension may be considered as evanescent; but the pile not being insulated, this loss will be repaired from the earth: the new portions of electricity recovered by the upper part of the pile, will pass into the condenser like the preceding, and will at last be so accumulated there, that when we remove the plate of the condenser, we may find in it very evident marks of electricity, and we may even take sparks from it.

With respect to the limit of this condensation, it is evident that it depends on the thickness of the stratum of gum which separates the two plates of the condenser; for, in consequence of this thickness, the electricity accumulated in the collecting plate, being only able to act at a distance on that of the inferior plate, is always more considerable than that which counterbalances it in the latter; and from hence results a small tension in the collecting plate, which is here limited by the tension of the superior part of the pile.

In the same manner as the electricity of the pile is accumulated in the condenser, it may be accumulated on the inside of a jar, of which the outside communicates with the earth; and since, in proportion as the pile is discharged, it recovers its charge from the ground, the jar will be equally charged, whatever may be its capacity; but its interior tension will never exceed that of the summit of the pile: if we then withdraw the jar, it will give a shock proportionate to this degree of tension; and this is confirmed by experience.

All this must happen, neglecting the very small action of the water on the metals: and supposing,

1. That there is a transmission of the fluid from one pair of pieces to another in the insulated pile, through the pieces of wet pasteboard which separate them, even when there is no communication between the two ends of the pile.

2. That the excess of electricity, which the zinc receives from the copper, is constant for the two metals, whether they are in their natural state or not.

Mr. Volta supports the first proposition by an experiment which we have already related, and in which the condenser becomes charged, when we touch its collecting plate, covered by moist paper, with a piece of copper united at the other end to a piece of zinc, which is held in the fingers.

As for the second supposition, it is the simplest that can be imagined; but it would require a series of very delicate experiments, which we have had no opportunity of making, in order to be assured of its conformity to nature.

Hitherto we have supposed, in order to assist the comprehension, that the pile is formed of copper and zinc: the same theory is equally applicable to any other two metals; and the effects of the different piles which might be composed of them must depend on the differences of electricity which would result from their contact.

The same may be said of all other substances between which a similar action takes place: thus, although this action appears in general to be very weak between liquids and metallic substances, yet there are some liquids, such as the alkaline sulfurets, of which the action with metals becomes very sensible: thus, the English have succeeded in substituting these sulfurets for one of the metallic elements of the column; and, before them, Mr. Pfaff had employed them in his experiments for the same purpose.

In this respect, Mr. Volta has discovered a very remarkable relation between the metallic substances, which renders it impossible to construct a pile with these substances alone. We shall explain it after him: but we have had no opportunity of confirming it.

If we arrange the metals in the following order, silver, copper, iron, tin, lead, zinc, each of them will become positive by its contact with the preceding, and negative by its contact with the following metal: the electricity will therefore pass from the silver to the copper, from the copper to the iron, from the iron to the tin, and so forth.

Now the property, of which we are speaking, is this; the moving power of the silver towards the zinc, is equal to the sum of the moving powers of all the metals comprehended between them in the series: whence it follows, that if they be placed in contact, either in this order, or in any other that we please, the extreme metals will always be in the same state as if they touched each other immediately; and consequently, supposing any number of elements thus disposed, and terminated, for example, by silver and zinc, we shall have the same result as if the elements were formed of these two metals only, that is to say, there will be no effect at all, or no more than would have been produced by a single element.

This property extends, as far as we are at present acquainted with it, to all solid bodies; but it does not exist between them and liquids: and for this reason, we succeed in the construction of the pile, by means of the latter. Hence arises Volta's division of conductors into two classes, the first comprehending solid bodies, the second liquids. Hitherto, we have only been able to form the pile of a proper mixture of these two classes: it becomes impossible with the first alone, and we are not yet sufficiently acquainted with the mutual actions of the substances composing the second, to pronounce if it is the same with respect to them.

We have supposed the pasteboards placed between the elements of the pile, to be moistened with pure water. If we employ, instead of water, a saline solution, the shock becomes incomparably stronger; but the tension indicated by the electrometer does not appear to increase, at least not in the same degree. Mr. Volta demonstrated to us this assertion, by means of the apparatus of a circle of cups, pouring successively into them pure water and a diluted acid.

He concludes from this experiment, that acids and saline solutions favour the action of the pile, principally because they increase the conducting power of the water with which the pasteboards are moistened. As for the oxidation, he regards it as an effect which produces a closer contact between the elements of the pile, and thus contributes to render its action more continued and more energetic.

Such is the summary of the theory of Mr. Volta on the electricity which has been denominated galvanic. His object has been to reduce all the phenomena to a single one, of which the existence is now fully confirmed: that is, the developement of metallic electricity by the contact of two metals. It appears to be proved by these experiments, that the particular fluid, to which the muscular contractions, and the phenomena of the pile were for some time attributed, is only the ordinary electric fluid, put in motion by a cause, of which the nature is unknown to us, but of which we see the effects.

According to the demand made by one of your members, which you have referred to the committee, we propose to you, to offer to Mr. Volta the gold medal of the Institute, as a testimonial of your approbation of the important discoveries with which he has lately enriched the theory of electricity, and as a proof of your gratitude, for his having communicated them to you.

An Account of a Method of Constructing Simple and Compound Galvanic Combinations, without the use of Metallic Substances, by means of Charcoal and different Fluids.

By MR. DAVY.

1. If a piece of well burned charcoal be brought in contact at one of its surfaces with a portion of water, and at another surface with a portion of nitric acid, a simple galvanic combination will be formed when the two fluids are connected together. And the powers of it are demonstrated by its agencies upon the limbs of frogs, and by its effects upon the organs of sense.

2. A compound galvanic combination or a galvanic battery may be formed from a number of series composed of the same substances: but in this case the fluid elements of each series, not being immediately in contact, must be connected with similar elements in other series in an order of regular alternation, such as water, charcoal, acid; water, charcoal, acid; and so on.

3. The best mode that has yet occurred of constructing galvanic batteries with charcoal, is by means of a number

of glasses, which are made to contain, alternately, nitrous acid, and water, and which are connected in pairs by means of moistened cloth. The pieces of charcoal used are made from very dense wood, such as box, or lignum vitæ; and in this case the fluids will not penetrate into them by capillary attraction, much beyond the places of their primary contact. Their forms are those of arcs, so that each piece connects together two glasses; but in instances where single pieces of charcoal cannot be obtained of the proper shape, two long and thin slips may be fastened together by silk, so as to form the angle necessary to their insertion into the glasses.

4. Twenty series in a battery of this kind produce sensible but feeble shocks, and when a single metallic series with a gold wire and two glasses of water is substituted for one of the primary series, hydrogene is given out by the metallic point in the glass of water in the place of the acid, whilst oxygene is evolved from the point in the other glass.

5. In the galvanic batteries with charcoal, sulphuric acid may be substituted for nitric acid; and solution of sulphuret of potash for the water, without any material alteration in the nature of the agency; the solution of the sulphuret indeed, seems, in some measure, to increase its intensity, and combinations containing this substance, dense charcoal, and concentrated nitric acid, appear to be superior in activity to similar combinations containing copper, and the same fluid elements, and to be nearly equal to those composed of zinc, silver, and water.

January 9, 1802.

PRESENTS

Received by the Royal Institution, from January to February, 1802; *with the Names of the Donors.*

Presents. January 19, 1802.	Donors.
A Journal of Natural Philosophy, Chemistry, &c. By William Nicholson. No. 1. 8vo.	Mr. W. Nicholson.
Transactions of the Dublin Society, Vol. 2, Part I. 8vo.	The Dublin Society.
An Essay, or Practical Inquiry concerning the Hanging and Fastening of Gates and Wickets. By Thomas N. Parker. London, 1801. 8vo.	T. N. Parker, Esq.
A Box of Patterns of the Iron Work for Ditto.	————
Scotia Depicta; or the Antiquities, Castles, Public Buildings, Noblemen and Gentlemen's Seats, Cities, Towns, and Picturesque Scenery of Scotland, No. 1, 2, 3. 4to.	The Proprietors.
A Journal of Natural Philosophy, Chemistry, &c. By William Nicholson. No. 2. 8vo.	Mr. W. Nicholson.
Hints on Longevity. By Sir John Sinclair, Bart. 4to.	Sir John Sinclair, Bart.

Mr. Stanhope of the General Post Office has also had the goodness to assist the Royal Institution in procuring regularly from the continent by the packets,

Jenaische Literatur-Zeitung.
Gilbert's Annalen der Physik.
Crell's Chemische Annalen.
Hamburg Correspondent.
Bulletin de la Société Philomathique.
Le Moniteur.
Le Journal des Débats.

Le Publiciste.
Le Journal de Francfort.
La Gazette de Mannheim.
La Gazette de Leyde.

At a Meeting of the Managers of the Royal Institution of Great Britain, held at the House of the Institution, on the 1st *Day of February,* 1802,

14. *Resolved,* That each Proprietor be furnished with one additional transferable ticket of admission to the lectures of the Royal Institution. That these new tickets, which are designed to facilitate the admission of such artists and mechanics as may derive advantage from the public lectures delivered at the Institution, which will give admittance to the gallery only of the great lecture room, and to no other part of the house, be made in all respects like those already furnished to proprietors, excepting only that they be blue instead of being red.

Resolved, That this new arrangement, which is intended merely as an experiment, do continue as long as the Managers shall deem it expedient.

Resolved, That these new tickets be procured as soon as possible, at the expense of the Institution, and sent to the Proprietors, each accompanied by a printed copy of these resolutions.

15. *Resolved,* That the following foreign newspapers be taken in at the house of the Institution.

Le Moniteur.
Le Journal des Débats.
Le Publiciste.
Le Journal de Francfort.
La Gazette de Mannheim.
La Gazette de Leyde.
Der Hamburgische Correspondent.

Resolved, That these, and all other foreign newspapers, which in future may be taken in at the Institution, be kept in the Conversation Room.

At a Meeting of the Committee of Chemistry of the Royal Institution of Great Britain, held at the House of the Institution, on the 31*st Day of August,* 1801.

The Chairman presented, from the committee of rules and regulations, an outline drawn up pursuant to the 4th resolution of the managers aforesaid. The same was read and approved, as follows:

Resolved, That it would be expedient and highly useful,

1. That the ordinary meetings should be held on the third Wednesday of every month, at the hour of seven in the evening: and regular summonses should be sent by the clerk for that purpose.

2. That the committee should have power to adjourn their ordinary meetings, and also to meet at whatever other times they may think proper.

3. That all decisions of the committee should be made by ballot.

4. That the decisions of the committee, respecting experiments to be undertaken, should be made by a majority, consisting of three or more members.

5. That the orders and instructions of the committee to the proper officers of the Institution, concerning experiments, should be strictly attended to, and be immediately carried into effect.

6. That the committee should be permitted to recommend to the managers such persons, from time to time, as they shall think likely to prove useful members thereof.

7. That in all deliberations respecting future members, the vote of the committee should be unanimous.

8. That no question should be put, until the same shall

have been moved, seconded, and handed to the chair in writing.

9. That the committee should propose to the managers the purchase of such apparatus and materials of permanent use as they may think necessary, together with an estimate of the probable cost, in order that the same may be provided; but that with regard to such other apparatus or materials as the committee may judge to be immediately required in the progress of experiment, they should be authorised to provide them without such reference.

11. That the clerk should be ordered to attend the meetings of the committee to take the minutes, to read communications, and perform other similar duties, and that he should make fair copies and registers of all proceedings, according to the instructions of the committee.

At a Meeting of the Committee of Chemistry of the Royal Institution of Great Britain, held at the House of the Institution, on the 20th Day of January, 1802.

1. *Resolved,* That Mr. Davy and Mr. Pepys be a Sub-Committee for procuring the apparatus according to the inventory delivered to the committee and approved at the meeting on the 28th day of October, 1801.

2. The Committee of Chemistry having taken into consideration the present state of knowledge respecting the history of metallic alloys, and being of opinion that this branch of chemistry (so eminently important to science, and so useful to various arts,) has not been hitherto investigated with due accuracy,

Resolve, That a series of experiments shall be made in the Laboratory of the Royal Institution, in order to ascertain with all possible precision, the physical and chemical properties of these metallic compounds.

Lectures delivered at the Theatre of the Royal Institution.

It cannot be expected that in a course of elementary lectures, many experiments or observations should be made, that are either original, or sufficiently important to be brought before the public in the regular form of a scientific essay. At the same time since the object of the Journals of the Royal Institution is not to enter deeply into all the intricacies of philosophical research, but to present to their readers, in a more familiar form, discussions tending either to practical utility, or to the illustration of the principles of science, it is presumed that it will not be deemed superfluous, to notice in them the particulars of any mode of demonstration, either new or not commonly known, that may occur in the lectures, both in order that it may be the more easily retained by those who have been present, and that the subscribers who have been prevented from attending, may be in some measure acquainted with what has been done in their absence. Not that any thing like an abstract is intended; for this may be found in the compendiums already published; but it may be the more proper to notice some experiments, as it has not been possible to introduce an enumeration of experiments into those compendiums.

DR. YOUNG's *Lectures on Mechanics.*

The first lecture was delivered on Wednesday the 20th of January. After an introductory view of the nature and objects of the Royal Institution, and of the particular plan of the lectures, Dr. Young commenced the immediate subject of mechanics with the doctrine of motion. He particularly endeavoured to inculcate the necessary dependence of the idea of motion upon the relations of two or more bodies, and observed that there was no criterion by which a single body, considered as existing alone, could be determined to be either in motion or at rest, nor by which it could be ascertained, among any number of bodies moving relatively, without foreign interruption, which or whether any of them must be considered as absolutely at rest; and that this statement served as a foundation for demonstrating mathematically the principal laws of motion, which some have considered as demonstrable from experience only.

In the second lecture of the 25th, the composition of motion was illustrated by an improved instrument: a pencil sliding on a moveable arm, described the diagonal of the parallelogram; of which the angles were variable, by changing the position of the arm; and the proportions were changed, by passing the thread over a pulley, which caused the pencil to move with one half the velocity of the arm. The equal momentums of two bodies, in consequence of a reciprocal action, was also shown by two pieces of wood floating in water, and separated from each other by the action of a spring: and in order to avoid any interruption from external force in detaching the spring, it was set at liberty by burning a thread, which retained it in a state of flexure.

On the 27th, the effects of accelerating forces were shown by Atwood's machine: it was found most convenient to hold the thread supporting the lower weight, until the descent was to begin, and to let it go without touching the upper weight, the weight being less agitated by this method than even by holding a rod under it, as proposed by the inventor of the machine. A half second pendulum was also employed.

Astronomy.

The first astronomical lecture was delivered on Friday the 22nd of January. It was devoted to the consideration of the fixed stars; or of those celestial bodies which shine by their own light, and have little relative motion. With respect to their distance and magnitude, Dr. Young stated it as probable that the annual parallax of the nearest could scarcely exceed two fifths of a second, and their distance being about 100 million million miles, their magnitude must be considerably greater than that of the sun: not on account of the angle which they appear to subtend, which probably depends only on the imperfection of our instruments, but from a comparison of their light with that of the sun as reflected from the moon and planets: he mentioned an easy method of comparing the light of any two stars, by viewing them at the same time, one with each eye, through apertures of different sizes in two cards. From the number of the stars observed by Dr. Herschel in the milky way, Dr. Young inferred that on the supposition of their being all as remote from each other as the nearest stars are from us, a ray of light must probably be half a million of years in traversing this immense nebula.

In order to convey an idea of the relative situation of the principal fixed stars, they were exhibited by a chart perforated and illuminated from behind. The projection was of the same kind as the small map inserted in the syllabus, which appears to have some advantages, and which may therefore deserve a particular description.

When a spherical surface has been projected on a plane it has been usual to consider it as viewed from a particular point, either infinitely remote, as in the orthographical projection, or situated in the opposite surface of the sphere, as in the stereographical. The latter method produces the least distortion, and is the most commonly used, but even here, at the extremities of the hemisphere, the scale is twice as great as in the middle. Sometimes another principle is employed, and the hemisphere is divided into segments, by omitting portions in the directions of their radii, as if the paper were intended to be fixed on a globe; and in the same form as if a spherical surface were cut in the direction of its meridians, and spread on a plane. If the number of these divisions be increased without limit, the result will be the projection, which is employed in the circular part of the diagram inserted in the syllabus, and in the same manner the zone on each side the equinoctial being cut open by innumerable divisions, so as to be spread on a plane, will coincide with the two remaining portions. By these means the distortion becomes inconsiderable. In the common stereographical projection indeed, the distortion would be of no consequence if it represented always those stars only, which are at once above the horizon of a given place, for we actually imagine the stars in the zenith to be much nearer together than when they are near the horizon, and the picture would appear to agree very well with the original: but their positions being continually changing, the inconvenience remains.

It is not however necessary in projections of the stars to refer them in any instance to a spherical surface. Among Doppelmayer's charts, published at Nuremberg, there are six which represent the sides of a cube, on which the various parts of the constellations are represented; the eye being probably supposed to be situated in the centre. Funck and others have represented the stars as projected on the inside of two flat cones. But the most convenient representation of this kind, and which would approach very near to the projection that was exhibited, would be to consider the eye as placed in the centre of a hollow cylinder, so proportioned that all the circumpolar stars should be represented on one of its flat ends, and all those which rise and set on its concave surface; or if it were desired to have a division without referring to any particular latitude, the circular part might extend to the limits of the zodiac, and the parallelogram, into which the cylinder unfolds, might, comprehend all the stars to which the planets approach. The horizon and other great circles would form lines of various and contrary curvatures.

On Friday the 29th, the sun and the primary planets were described, and their various motions explained by the assistance of a very magnificent apparatus, consisting of an orrery constructed by Rowley, a planetarium, and a representation of the Jovian system, obligingly lent to the Institution by Mr. Wright, optician in Leadenhall Street; together with a small, but very accurate instrument, constructed by the Rev. William Pearson, a proprietor of the Royal Institution.

On the 5th February Dr. Young read an extract from the Moniteur, and an account of some letters addressed to the Royal Society, respecting the new planet Ceres, discovered by Piazzi at Palermo, of which the existence has now been confirmed by repeated observations, and proceeded to enumerate the most remarkable affections of the secondary planets and comets. The proportionate dimensions and distances of the planets were illustrated by a diagram on a large scale.

ROYAL SOCIETY, 14th January, 1802.

A paper on the propriety of separating geometrical from analytical expressions. By Robert Woodhouse, M.A. of Caius College, Cambridge.

Mr. Woodhouse refers to his former communication, printed in the Philosophical Transactions in 1801, for the investigations which gave rise to the present discussion. He had there stated the frequent imperfection of geometrical analogy, when inferences are made from one figure to others of a similar kind, and had insisted on the conclusiveness of demonstrations, in which imaginary quantities are employed, when understood in their true sense. He now continues the inquiry into the distinguishing characters of geometry and algebra, and while he allows the advantage of the geometrical method, in simple cases, he gives a preference to algebraical analysis in all problems of a more complicated nature: and endeavours to add still more to the purity of the analytical representation by banishing from them all expressions which have any reference to geometry. The computations inserted were not capable of being read to the Society, but the author states in the conclusion that he has deduced, in a manner purely algebraical, the formulas for the sine in terms of the arcs, for any multiple of an arc, and for other similar angular functions which have been usually considered as most intimately connected with geometry.

21st January. A paper on the phenomena of galvanism. By George Smith Gibbes, M. D. F. R. S.

Dr. Gibbes begins with reciting some experiments on the oxidation produced during the union of tinfoil with mercury, first in the air, and then under water. He assumes the contrary opinion to that of Dr. Wollaston, respecting the origination of electricity in chemical changes, and maintains, on the contrary, that the electrical changes are to be considered as preceding and favouring the chemical. He imagines that the simple contact of various substances produces changes of electrical equilibrium, and that the action of acids is effectual in promoting these changes by bringing their surfaces into contact. Dr. Gibbes observes upon Dr. Wollaston's experiment of immersing zinc and silver in an acid solution, that if they are placed in two separate portions of the fluid, and the parts not immersed are brought into contact, there is no emission of gas from the silver; but that it is copiously produced when the contact takes place in the same fluid. He proceeds to relate some experiments which seem to show a difference between galvanism and electricity, particularly that galvanism does not appear to be attracted by metallic points. He also states an experiment in which a piece of paper is placed on tinfoil, and rubbed with elastic gum, and although the tinfoil is not insulated, sparks are produced on raising the paper. Dr. Gibbes concludes with some arguments against the doctrine of the decomposition of water; and advances as a probable opinion that oxygen and hydrogen gas are composed of water as a basis united with two other elements, which, combined form heat.

The meetings of the 28th January, the 4th and 11th February were principally occupied by a paper on the hyperoxygenized muriatic acid, by Richard Chenevix, Esq. F. R. S.

Mr. Chenevix, after adverting to the observations of Berthollet and Mr. Hoyle, proceeds to relate a series of his own experiments, made in order to investigate minutely the composition and properties of the hyperoxygenized muriatic acid. It was already known that in the oxygenized muriat of potash the acid contains much more oxygen than in its separate form. Mr. Chenevix finds that the simply oxygenized acid contains in 100 parts, 85 of common muriatic acid, and 15 of oxygen. Berthollet, from a less accurate experiment, imagined that it contained only 10 per cent of oxygen. But the hyperoxygenized acid which is the subject of the present paper, appears to consist of 36 parts only of muriatic acid, and 64 of oxygen.

Mr. Chenevix has not succeeded in obtaining the hyperoxygenized muriatic acid in a separate state. In treating the hyperoxygenized muriat of potash with concentrated sulfuric acid, a violent explosion took place, upon the application of heat: this was avoided by adding the salt gradually to the acid, or by using the diluted acid. In the order of affinities this acid appears to stand next above the benzoic: it changes blue vegetable colours to red. When the salts formed of it are decomposed by the addition of the sulfuric, nitric, or muriatic acids, a flash of light is observed; hence Mr. Chenevix takes occasion to question the Lavoiserian doctrine of the light in combustion being supplied by the oxygen gas consumed: and in confirmation of his remark he observes that plants growing in the dark, contain a great proportion of mucilage, and that mucilage burns without emitting any light. The sudden explosion of many combustible substances with hyperoxygenized muriat of potash, when thrown into an acid, led Mr. Chenevix to attempt the combustion of diamond powder in the same way: but this experiment did not succeed.

Mr. Chenevix has examined very minutely the various salts formed by this acid in combination with alkalis, earths, and metals. He finds that it has not, like some other acids, a power of carrying over a portion of silex when mixed with other earths. He combined it with metals by suspending their oxids in water, through which the gas was passed: and he found that like the nitric acid, it contained too much oxygen to unite with the whole of the red oxid of lead exposed to it. He observes that the nitric and other acids appear to stand lower in the scale of elective attraction to the metallic oxids, in proportion as they dissolve the pure metals more readily. Mr. Chenevix unexpectedly procured the hyperoxygenized muriatic acid in submitting platina to the action of the nitromuriatic acid. Pursuing the analogy suggested by Mr. Berthollet, of the three states, of sulfur, the sulfureous, and sulfuric acid, Mr. Chenevix proposes to appropriate to the common muriatic acid, which he supposes to contain no oxygen, the term muriatic radical, or some equivalent denomination, and to call the acid in the two stages of oxygenization here described, the muriatous, and muriatic acid respectively.

On the 4th February a letter from Dr. Maskelyne announced that he had observed the new planet of Mr. Piazzi passing the meridian between three and four o'clock in the morning, having about 188° 43′ right ascension, and 12° 38′ north declination, appearing like a star of the eighth magnitude.

Another letter from Mr. von Zach, was read, informing the Society that he had observed this planet at Seeberg on the 7th of December, within half a degree of the place before determined in his journal. Mr. Olbers saw it at Bremen on the 2nd of January. With a power of above 120 it presented no observable disc.

On the 11th a second letter from the Astronomer Royal informed the Society that he had repeated his observation of the new planet, so as fully to ascertain its motion. It appeared to have a visible disc when on the meridian, and viewed with a power of 50. When the air was very clear the disc was round and well defined, but somewhat smaller than that of the 34th of Virgo, a star of the 6th magnitude near it. Dr. Maskelyne observes that the smallness and roundness of the appearance of the disc of the fixed stars is a good criterion of the clearness of the air.

Another letter from Alexander Aubert, Esq. F. R. S. was also read. Mr. Aubert discovered the planet Ceres on Sunday morning, having about 188° 41′ right ascension, and near 13° declination, its motion at present being retrograde.

From the MONITEUR, 4 Pluv. An 10. No. 124.

On the New Planet. By CITIZEN BURCKHARDT.

The planet which Mr. Piazzi discovered at Palermo the first of January 1801, was again seen the first of January, 1802, by Mr. Olbers, at Bremen, nearly in the place where it was expected from the calculations of Mr. von Zach. The 2nd January 1802, at 18h. 58′ 36″, mean time, at Bremen, its right ascension was 185° 9′, and its declination 11° 9′ north, in the wing of Virgo, near a star of which Lalande had given the position, in the Connaissance des Tems, Year 9, p. 254. The 5th January, at 17h. 36′ its right ascension was 185° 43′, and its declination 11° 8′, nearly. It appears as a star of the ninth magnitude, but it will become more conspicuous. With a telescope magnifying 106 times, it cannot be distinguished from a small star.

The 1st January it fortunately made a right angled triangle with two small stars mentioned in Lalande's Histoire Céleste; the following day the form of the triangle was changed, and by means of this change the planet was recognised. It will be on the parallel of the 20th of Virgo.

The elements of this planet have occupied several astronomers. Messrs. Oriani, Zach, and Bode, had suspected at once that it was a planet, because it had been observed stationary, and without nebulosity. But having received only two complete observations, they had not been able to confirm their suspicions. Some time afterwards, Mr. Lalande first obtained a complete copy of the observations of Mr. Piazzi, who could not refuse them to one, under whom he had so long applied to the study of astronomy. By means of these observations, I was the first that demonstrated, in a memoir presented to the National Institute, that there was no parabolic orbit that could agree with the observations, although confined to an arc of 10 degrees. I gave at the same time the elements of a circular and of an elliptic orbit, and I showed the great uncertainty that necessarily remains when the elements are deduced from so small an arc.

Having received a more exact copy of these observations, Mr. Olbers endeavoured to determine from them the elements of an elliptic orbit; but he found so much uncertainty that he was obliged to prefer a circular orbit, since he thought it impossible to determine if the planet was near its aphelion, or its perihelion. I had proceeded on the former supposition; Mr. Gauss preferred the latter, and endeavoured at the same time to accommodate his calculations to all the observations of Mr. Piazzi: and this he performed with a difference of only a few seconds. These are his elements:

Epoch of 1801	2*s*	[17?]°	36′	34″
Aphelion	10	26	27	38
Node	2	21	0	44
Inclination		10	36	57
Greatest equation of the centre		9	27	41
Heliocentric and tropical diurnal motion			12	50.914

Mean distance 2.7673. Eccentricity .0825.

Revolution 1681 days, or 4 years 7 months.

I had found the revolution 5 months and a half shorter.

According to M. Lalande's calculations, Mr Gauss's elements give the longitude greater by a degree than Mr. Olbers's observation: according to Mr. von Zach, my elements give it four degrees less, and Piazzi's, ten degrees less than the observation.

The idea of searching for this planet among the immense collection of observations of the Histoire Céleste Française could not fail to present itself to all those who have attended to the subject: but it was impossible to undertake the inquiry with any hopes of success, before the elements were corrected by new observations. I shall now apply to it without delay.

Mr. Piazzi has named his planet Ceres Ferdinandia. Lalande proposes to call it Piazzi.

Mr. Piazzi was born at Ponte in the Valteline; and was professor at Malta, and at Palermo. When an observatory was about to be established at Palermo, in 1787, he came to Paris; he then went to London, where he procured some excellent instruments: and he has already published two volumes of valuable observations: he is now preparing to measure a degree in Sicily, and Mr. Lalande has already sent him instruments for this purpose.

Extract from Bode's Kurzer Entwurf der Astronomischen Wissenschaften. Berlin, 1794. § 387.

Is it probable that Uranus, or the Georgian planet, is really situated at the utmost limit of our solar world? This appears to be very doubtful, considering the immense space interposed between it and the nearest fixed stars. Other planets perhaps may be still more remotely situated, and may perform their revolutions unseen by human eyes. We can scarcely suppose that any planet exists nearer to the sun than Mercury: but considering the proportions of the distances of the planets from the sun, we observe between Mars and Jupiter, a distance far greater than a comparison of the other distances would lead us to expect, and this space may perhaps be occupied by a planet yet unknown.

This appears to follow from a certain proportion which we find among the distances of the seven planets already known. Calling the distance of Saturn 100, that of Mercury will be nearly 4, of Venus $4+3=7$; of the Earth $4+2\times3=10$; of Mars $4+4\times3=16$; we then want a planet at the distance $4+8\times3=28$: the distance of Jupiter is $4+16\times3=52$; of Saturn $4+32\times3=100$; and of the Georgian planet $4+64\times3=196$.

It will, however, still be doubted by many if the conjecture quoted from Professor Bode can be thought to have been probable at the time that it was made. Calling the distance of the Earth 10, the real proportional distances are, in the nearest units, ☿ 4, ♀ 7, ⊖ 10, ♂ 15,(⚳28,) ♃ 52, ♄ 95, ♅ 192. Instead of ♂ 16, ♄ 100, and ♅ 196.

Letters from Sir Henry Englefield, Bart. F. R. S. to Thomas Young, M. D. F. R. S. on the Planet Ceres.

Sir, Blackheath, Friday.

I have seen the new planet twice, on Sunday night, and again last night. It is just visible to a common nightglass. With a power of 90 in my great telescope it was less bright than the 34 ♍ near which it is. With a power of 200 no disk is visible, and with 300 I can scarcely say that it has a sensible diameter, more than what arises from irradiation, for small stars seen with such powers always appear dilated.

I looked at the Georgian soon after the new planet, but clouds came on, and I did not try 300 on it last night. With 200 the Georgian is, I am sure, the brighter, and it was a very much more visible object in the nightglass.

Sunday.

Last night I again saw the new planet, and observed it with a power of 400. With this great power it seemed to have an apparent magnitude, but was extremely small, faint, and ill defined. I then turned the telescope to the Georgian (which as you know is very near), and the superiority in size and brightness was very striking. The Georgian was not well defined, but I am sure it was full four times the diameter of the new planet; and much brighter in proportion to the different size. Indeed the brightness of the Georgian is very surprising, its vast distance from the sun being considered. I really think that the diameter of the new planet cannot exceed a second; and it is of a very faint light even for that diameter. I looked then at the double star gamma ♍, and saw the two stars distant from each other full three times their apparent diameter, a proof of the good adjustment and high power of my telescope. I am, &c. H. E.

PRESENTS

Received by the Royal Institution, from February to March, 1802; *with the Names of the Donors.*

Presents. February 15, 1802.	Donors.
A Walk through Southampton. By Sir Henry C. Englefield, Bart. Southampton, 1802. 4to.	Sir Henry C. Englefield, Bart.
Eight Letters on the Peace; and on the Commerce and Manufactures of Great Britain. By Sir Frederick Morton Eden, Bart. London, 1802. 8vo.	Sir Frederick Morton Eden, Bart.
February 22.	
Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. Vol 19. London, 1802. 8vo.	The Society for the Encouragement of Arts, &c.
A Historical Report on Ramsgate Harbour. By John Smeaton. London, 1791. 8vo.	T. R. Underwood, Esq.
March 1.	
Scotia Depicta; or the Antiquities, Castles, Public Buildings, Noblemen and Gentlemen's Seats, Cities, Towns, and Picturesque Scenery of Scotland, No. 4. 4to.	The Proprietors.
March 8.	
An Analytical History of the World. No. 1.	The Author.
Horatius cum Græcis scriptoribus collatus. Auctore Stephano Weston, S.T.B. R.S.S. S.A.S.	The Author.
March 15.	
The Statistical Observer's Pocket Companion. London, 1801.	The Editor.

ROYAL SOCIETY.

Correction respecting Mr. Chenevix's Paper.

It appears that Mr. Chenevix did not mean to deny, but rather to assert, that the common muriatic acid might be supposed to contain oxygen. Far from intending to decide prematurely upon this question, Mr. Chenevix rather wished to avoid the term acid, which appeared to carry the analogy too far. The mistake originated in the error of an amanuensis.

On the 18th of February a letter from Mr. von Zach was read, containing a continuation of his observations on the planet Ceres, and mentioning an account from M. Harding that two faint spots had been seen at the distance of 20 and 35 seconds from this planet, which it was conjectured might possibly be satellites: although the fact had not by any means been ascertained.

Dr. Herschel sent an account of the appearance of the new planet, as viewed through his telescopes. He had sought for it in vain until he received Dr. Maskelyne's determination of its place. When viewed with powers of 600 and 1200, it could not be decidedly distinguished from a star, until it was found to change its place. Its apparent diameter was not large enough to be directly determined, but it was certainly not larger than one fourth of that of the Georgian planet, and perhaps equal only to one sixth. From a rough computation of its magnitude, Dr. Herschel concludes that its real diameter is about $\frac{5}{8}$ of that of the moon: its light is of a reddish hue.

Mr. Gilpin also gave the Society an account of observations on the 8th and 12th of February. He found the planet's right ascension change from 188° 41′ to 188° 30′, while its declination increased. Mr. Gilpin observes that its light resembles that of the planet Mars.

Thursday, 25th February. A letter from Mr Schroeter of Lilienthal, respecting the planet Ceres Ferdinandia, informed the Society that Mr. Schroeter had observed a nebulosity round the planet, somewhat resembling that of a comet: the diameter of the true disc being 1.8″, and that of the nebula 2.6″, but the distinction was not always equally observable. Mr. Schroeter considers this body as of a hybrid nature, or a medium between a planet and a comet; but he imagines the apparent nebulosity to be owing to an atmosphere, and that, according to the different states of this atmosphere, the light reflected from the planet is either white, bluish, or reddish.

A table of observations of the same planet was also communicated by Mr. Mechain, through Sir Henry Englefield.

An account of certain stony and metalline bodies which at different times are said to have fallen on the earth, by Edward Howard, Esq., occupied the remainder of this meeting, and the principal part of the two following.

Mr. Howard begins with an historical detail of the various relations of this kind which are found on record, and particularly refers to the essays of Mr. King, and Professor Chladni, and to various authors quoted by them. But the first instances with which chemistry has interfered, are those of a stone presented to the French Academy by the Abbé Bachelay in 1768; and another examined afterwards by Professor Barthold. The stones from Sienna in 1794; the large stone of 56lbs. weight which fell in Yorkshire in 1795, and was exhibited soon after in London; and the substances which fell at Benares in 1798, are the immediate subjects of Mr. Howard's investigation. All these agree in the general appearance of an ash grey stony substance, mixed with spangles of pyrites, and of native iron, and externally of a dark colour, covered with a semi-vitrified and blistered crust. The Abbé Bachelay's was supposed to contain 8½ sulfur, 36 iron, and 55½ earth, and some of the others were found to consist of similar ingredients. The stone which fell near Mr. Topham's house in Yorkshire, penetrated 12 inches deep into the earth, and 6 more into a chalk rock: its fall was accompanied with noises like a discharge of artillery. A very particular and perfectly authenticated account is given, in the words of Mr. Williams, of several substances which fell about 12 miles from Benares, and penetrated some inches into the earth in several spots within the distance of 100 yards; their fall being accompanied by a very vivid light.

Mr. Howard proceeds to mention another specimen from the Museum Bornianum, now in the possession of Mr. Greville, said to have fallen in Bohemia, which agrees with the rest in its characters. A mineralogical description of these stones by the Count de Bournon is subjoined. They appear to consist principally of substances of four kinds, besides the dark crust which surrounds them; the first of these substances is in the form of dark grains, of a conchoidal fracture, from the size of a pin's head to that of a pea; the second is a kind of pyrites, the third is metallic iron, and the fourth a grey earthy substance, serving as a cement to the rest. The proportions of these substances appear to differ in some measure in the different specimens, the iron abounding most in the specimens from Yorkshire, and from Bohemia. Mr. Howard has ascertained by a chemical analysis that silica, iron, magnesia, sulfur, and nickel, are contained in the different parts of these substances. The globular bodies and the cementing earth each contained about 50 silex, 15 magnesia, 34 iron, and 2½ nickel.

From 150 grains of the earthy part of the stone from Sienna, Mr. Howard obtained about 70 silica, 34 magnesia, 52 oxid of iron, and 3 oxid of nickel; the contents of the specimens from Yorkshire and from Bohemia were not materially different. Mr. Howard proceeds to inquire into the causes of the difference in the results of his analysis and those of the foreign chemists, with respect to the species of the earths. After having shown the striking analogy between these substances, and their total dissimilarity to other mineral products, Mr Howard examines into the form and contents of various specimens of native iron: observing that Mr. Proust detected nickel in a large mass of native iron found in South America; Mr. Howard discovers a portion of the same metal in every specimen that he has examined from different parts of the world. A description of these specimens by the Count de Bournon is inserted, and the large mass discovered by Professor Pallas in Siberia, is particularly described. It is found to contain detached masses of semitransparent substances considerably resembling some of the constituent parts of the stones from Benares. Mr. Howard does not give a decided opinion respecting the origin of all these substances; he only observes, that they agree in several remarkable properties, distinguishing them from all other bodies, that they all appear, from well authenticated accounts, to have fallen on the earth, attended in most instances by meteors or lightning, and that it is remarkable that the native iron in all the stones contains nickel, as well as the other native irons.

A letter was also read on the 11th March from Mr. von Zach, confirming Mr. Schroeter's observation of the changeable light of the planet Ceres, which Mr. von Zach had at first attributed to the haziness of our own atmosphere, until he found that MM. Olbers and Schroeter were agreed in deriving it from a real change in the light reflected. Y.

On the Decomposition of Water. By the late PROFESSOR LICHTENBERG.

In consequence of the late discoveries respecting the operation of galvanic electricity, several authors have called in question the prevalent opinions respecting the decomposition of water, and have advanced other hypotheses as new, which appear to have been in great measure anticipated. Without intending to adopt, or even to favour these hypotheses, we may still deem it interesting to compare them with the suggestions of the late very ingenious Professor Lichtenberg, published in the preface to Erxleben's Naturlehre, 1794, an extract from which is here translated.

"The celebrated and very important experiment made at Amsterdam, on the decomposition of water by electricity, has been considered as completely decisive in favour of the new system of chemistry. To this, much might be objected, and perhaps this experiment may be ultimately that system's most dangerous enemy. Granting the elastic fluid produced to have been a mixture of oxygen and hydrogen gas, it is still a great question, whether the electrical fluid has not been decomposed, and a part of it with the aqueous vapour formed inflammable and the other dephlogisticated air. To say, that the decomposition depends only on the greater attraction of the component particles of water for caloric, in consequence of an increase of temperature, is a hypothesis perfectly arbitrary, a *car tel est notre plaisir*. We seem to make use of this variation of temperature beyond all bounds of probability. That the combustion of hydrogen and oxygen gas produces no electricity, as I have often experienced, proves nothing, until we have examined whether the electricity that might have been produced is not exactly the quantity required for the saturation of the water obtained in the experiment; it may also be too inconsiderable to be ascertained by our instruments. It is possible that lightning may be derived from combinations of this kind in the atmosphere. Where fire and electricity produce similar effects, we may certainly venture to ask, Are they produced by the heat of the electricity, or by the electricity of the heat?—I am not discussing the subject with the decided systematist, but with the cautious philosopher, who is always aware, that much, of great importance, is still unknown, and who wishes to make use of every circumstance that can bring him into a nearer acquaintance with a fluid so extensively active as the electrical fluid, of which we have for some time known a few of the effects, as we had known for thousands of years the effects of the motions of the atmosphere, and of the properties of the air, while we are still as ignorant of the real nature of the electrical fluid, as we were a thousand years ago of the component parts of the air. The new chemistry must and will continue its progress; all its discoveries will at a future time become members of a new system, and serve a purpose foreign to its immediate object. Provided that our activity be excited, it matters little how. All human passions are subservient to a higher end than that to which they immediately tend. Tycho's system of the universe was at last most fully confuted by those very observations, which that great and indefatigable astronomer had made, in hopes of confirming it. Perhaps some antiphlogistian will soon give us a chemical analysis of the electric fluid. Might I be permitted to propose such a doctrine, it should be, that it consists of oxygen and hydrogen combined with caloric only; and inflammable and dephlogisticated air should be composed of hydrogen and oxygen respectively, with caloric and water. Something must be done sooner or later upon this subject, for we cannot possibly rest satisfied with the bare assertion that the electrical fluid is so perfectly unessential to this operation." Y.

Lectures delivered in the Theatre of the Royal Institution.

DR. YOUNG'S *Lectures on Mechanics.*

In the Lecture of Monday the 1st of February, the truth of the principal propositions respecting central forces was shown by the whirling table. In particular it was proved by means of a stop watch, that when the velocity of the revolving body exceeds that which would be acquired in falling through half the radius, by the operation of the central force that retains it, it immediately has a tendency to fly off, and actually does fly off as soon as the friction and resistance of the apparatus permit it.

On Wednesday, the subjects of projectiles and pendulums were illustrated by experiments: a model of Mr. Bunce's regulator, applied by Mr. Watt as a steam governor, was exhibited; and to illustrate the principle on which it proceeds, it was shown by the whirling table that any number of balls suspended from the same point by threads or wires of different lengths, and revolving in the same time, will ascend to the same vertical heights, and remain in the same horizontal plane, making allowance only for the resistance of the air; the time of revolution being equal to that of a double vibration of a pendulum of which the length is equal to that height: so that while the arm of the steam governor remains near its lowest position, its revolutions must be very nearly isochronous. A similar apparatus was indeed long ago applied to the regulation of a timepiece.

In order to show the difficulties in making experiments on the descent of bodies in given surfaces, arising from friction, and rotatory motion, Dr. Young exhibited the descent of two cylinders along an inclined plane: their weights were equal, the circumferences on which they rolled were precisely similar, and they differed in nothing but the disposition of the principal part of the weight; the one having a leaden axis, the other being loaded externally with sheet lead; and when they were allowed to descend at the same instant, that which had the weight at its axis acquired a much greater velocity than the other, on account of the greater quantity of rotatory motion necessary to be produced in the descent where the lead was placed at the circumference. Dr. Young observed, that although the demonstration of the properties of the lever inserted in the syllabus, and resembling Dr. Hamilton's, appeared to be most natural and general, yet that Maclaurin's mode of beginning with equal weights, and then supposing the fulcrum to be changed, might be somewhat more obvious and convincing.

In the seventh lecture, on the 10th, a model was exhibited which showed the mode of varying the activity of a given force in any required ratio, which has been applied by Mr. Watt for opening the valve of a steam engine, by uniting two levers by a bar or rope which varies its obliquity: the effect of weights supported by oblique threads was also shown by experiment; and the principle of the double capstan was explained, where the rope is passed over a pulley and returns to be coiled round a smaller cylinder fixed on the same axis; it was observed that the effect is precisely the same as if the capstan were single, and its diameter equal to the difference of the two radii; but that such a cylinder would be much too weak for its work, and would produce great resistance from the flexure of the rope into so small a circumference.

The doctrines of rotatory power and preponderance were considered after those of equilibrium; the apparatus intended for illustrating the effects of rotatory power was not completed; but an experiment was made in a subsequent lecture, in confirmation of the propositions respecting the most advantageous disposition of power in machines. Six equal weights were attached to as many threads, and each pair of threads was passed in opposite directions round the different portions of three pullies. The first pulley was so formed that its larger portion was to its smaller as 3 to 2, the second was in the ratio of 5 to 2, and the third as 4 to 1; and the three weights, of which the threads were coiled round the smaller part of each pulley, being suffered to rise at the same instant, the middle weight rose evidently much faster than either of the others. Dr. Young however remarked that the greatest velocity would not in all cases be practically desirable, on account of the injury that the machinery would sustain from the shock in stopping it. A model of a wheel with moveable weights for producing perpetual motion, was employed for showing the fallacy of all projects of this kind; and it was observed that a general demonstration of their insufficiency might be deduced from the properties of the centre of gravity. The principles of mechanical power and equilibrium were also applied to explain the various ways in which weights may be supported, the distribution of the burden between two porters, and the effect of a change of the position of the arms on that distribution, in ascending a hill, or a flight of steps.

In the lecture of the 17th, on graphical instruments, the various modes of writing, engraving, and printing, were enumerated; and specimens of a new method of taking impressions of drawings were exhibited. The drawings are made on a calcarious stone, with a crayon or ink which acts as a varnish, and prevents the stone from imbibing moisture wherever it is laid on, but when the other parts of the stone are sufficiently moistened, they are incapable of retaining the printing ink when it is applied to them; it adheres therefore only to the varnished parts, and a very perfect impression is thus taken, especially when a little art has been used in etching away the unnecessary parts of the stone. Mr. André, the patentee, obligingly furnished Dr. Young with some very elegant specimens, from drawings of Mr. West and Mr. Charles Heath: they had all the spirit and character of the old engravings in wood, the whites being remarkably brilliant. The various instruments employed as measures of different kinds, as well as for geometrical purposes, were exhibited and described.

Dr. Young observed in the following lecture, that the usual estimate of the length of a pendulum vibrating seconds, which is 39.2 inches, is unquestionably too great. Desaguliers informs us that the mean of a great number of experiments by Graham, gave 39.13 inches, none of them differing from it more than $\frac{1}{100}$ of an inch; Mr. Whitehurst makes the length about 39.12, and Borda's accurate and repeated experiments in the observatory of Paris, when reduced to English measure, with proper correction for the latitude, give nearly 39.14: we may therefore safely take 39.13 as the nearest to the truth. The fundamental doctrines of perspective were elucidated in the same lecture by a model, and by examples.

The various modes of ascertaining the weights of bodies, together with the force of friction, were the subjects of the eleventh lecture. The properties of balances, as dependent on the place of the centre of gravity, were illustrated by a balance with moveable points of suspension (Leup. Theatr. Static. t. iii. f. 14). With respect to friction, the truth of Mr. Vince's doctrine was demonstrated by experiments. The pulley of Atwood's machine was subjected to considerable friction by tightening the screws which support its axis, and the box was found to descend with a uniformly accelerated motion, describing spaces which were as the squares of the times, notwithstanding the friction; and the velocity in one experiment appeared rather to lessen than to increase the resistance. By turning a paralellepiped of wood on different sides, it was also shown that the friction is somewhat increased by increasing the surface.

But in the next lecture it was proved, that a tolerable estimate of the force of friction may be obtained by the common rule of taking half the weight for stone or brick, one third for wood, and one fourth for metal. The brick was made to slide on wood; when placed on a piece of firestone the friction was somewhat less: and in the experiment on metal, the surfaces being of tin plate, not highly polished, the resistance was greater than the estimate. Dr. Young proceeded to make experiments on the force necessary for crushing substances of various magnitudes; cylinders of chalk of different diameters were compared; and it appeared that the force increased faster than the area of the section, but not very considerably; the strength was also somewhat diminished by an increase of length, but not in a very material degree. The forces required to break rods of lime tree of different dimensions were next investigated; and when two pieces of the same length and section were supported at their extremities, the one simply, and the other firmly fixed at each end, the strength of the second appeared to be not only double that of the first, according to the theory, but considerably more: while Belidor on the contrary found that the strength was scarcely increased one half by fixing the ends firmly. It appeared however that the flexure was, in the present experiment, so considerable as to allow the rod to act as a tie, calling its cohesive powers into action throughout its extent, so that the force was increased by a cause foreign to the calculation.

Astronomy.

In the fourth astronomical lecture, Dr. Young read a passage from Hooke's Attempt to prove the Motion of the Earth, published in 1674, in which that great philosopher expresses his opinion very clearly upon the nature of gravitation; but he remarked that there could be no reason to think with Gregory that either Pythagoras or Lucretius had any just ideas upon the subject. It was observed that the length of the cone of total darkness in the earth's shadow, or of that part which receives no refracted light from the atmosphere, is about two thirds of the moon's mean distance, so that it must have been by a very extraordinary concurrence of circumstances, that the moon has sometimes become wholly invisible in a total eclipse. A mistake in the syllabus respecting the change of the obliquity of the ecliptic was noticed and corrected. Another inaccuracy of a similar nature occurs, where it is said that the nutation of the earth's axis changes the inclination of the equator only 8″, instead of 9″ or 10″; it arose from the error of a very respectable author, who asserts that the shorter, instead of the longer axis, of the little ellipsis described by the pole, coincides with the solstitial colure. As an illustration of the nature of the precession of the equinoxes, the effect of a magnet on a revolving ring of iron was exhibited, in the manner suggested by Professor Robison.

In taking a general view of the particularities that would occur to a spectator situated on each of the different planets, Dr. Young remarked that the most singular circumstance respecting the new planet Ceres must be its comparatively diminutive bulk, its surface scarcely equalling that of the empire of Russia. For it is pretty certain from Sir H. Englefield's, and from Dr. Herschel's observations, that its apparent diameter does not exceed a second, and it is by no means ascertained that its diameter is so great as this. Now supposing its mean distance 2.8, and its present elongation from the sun about 140°, its distance from the earth must be near 2.0: and the distance of the moon being about $\frac{1}{400}$ of that of the sun, the moon's diameter at the distance 1 would be 4.5″, and at 2, 2.25″, so that the diameter of Ceres must be to that of the moon, or to 2163 miles, nearly as 100 to 225; whence the diameter of the new planet must be less than 1000 English miles.

On the 26th, a small transit instrument was shown and explained, and a model illustrative of the principles of dialling was exhibited. It was remarked that the French appear to have left it uncertain whether the beginning of their year is to depend on the autumnal equinox, or upon a regular intercalation, resembling the Gregorian (Lalande, Abregé d'Astronomie, 1795, Addition). Y.

Mr. Davy's *Lectures on Chemistry.*

Morning Course.—General Chemistry.

The Introductory Lecture was delivered on Thursday the 21st of January.

On Saturday the 23d, the doctrine of chemical affinity was illustrated by various experiments. And a fact of chemical action which is not perhaps commonly known, was adduced as a proof of that law of chemical attraction which assumes "That the force of the attraction of composition is influenced by the numbers of the combining particles, that is, by the masses of the acting bodies." It was shown that a large quantity of solution of caustic potash in water is capable of producing a permanent precipitation of barytes in a solution of muriate of barytes, though a small quantity produces no effect.

In the lectures of the 28th and 30th of January, and 2nd of February, the chemical apparatus was exhibited; and the history of the simple substances commenced by an examination of the properties of oxygene, hydrogene, and nitrogene gases; and of phosphorus, sulphur, and the diamond.

On the 4th of February, the metals were exhibited, and their common properties demonstrated by experiment. In this lecture the combustion of the imperfect metals upon ignited charcoal by means of a stream of oxygene gas was shown. Tin burnt with a vivid white flame, violet at the circumference; zinc with a bluish white flame; antimony with a yellowish flame; and copper with a green flame. The perfect metals, gold, silver, and platina, were acted upon by the galvano-electric spark. And in this case the gold and silver being in thin leaves, burnt with great vividness; gold producing a yellow light, and silver a red and green light; but the platina, which was in pretty thick slips, produced only scintillations, and was not perceptibly consumed.

On the 6th, the earths and fixed alkaline substances were exhibited. It was shown that an intense degree of heat is produced during the action of potash, soda, lime, magnesia, strontian, and barytes, upon the strong mineral acids. It was stated that in the dark a distinct luminous appearance was produced during the process with the first four of these bodies, and it was mentioned as probable, that this appearance was connected with their common phosphorescent property.

Evening Course.—Outlines of Chemical Science, and Chemistry of the Arts.

The introductory lecture was delivered on February 9. It commenced with a general view of the advantages derived by society from the cultivation of the chemical arts. A concise outline was given of the present state of these arts, and it was shown how much remains to be effected in them. An attempt was made to prove the necessity of the application of theory to the processes of manufactories; and a statement was given of the probable advantages which might be expected from a more intimate relation between the artist and the man of science. This part of the subject was concluded by the following observations.

" Chemistry is composed of a number of arrangements of different facts, which as yet are not generally connected by perfect analogies. Whenever therefore the arts have this science wholly for their basis, the theoretical knowledge which relates to them may be easily attained; and the chemical manufacturer cannot fail of being eminently benefited by an acquaintance with fundamental scientific principles.

"By giving him accurate views of the extent of his powers, they induce him to model his exertions after plans of utility; they prevent him from wasting his time in researches after imaginary objects, and they enable him to discover his true relations to society.

"The artist who is accurately acquainted with the nature of the actions which the different substances employed in his art exert on each other, will seldom feel acute disappointment at his want of success in performing certain operations. The reason of this want of success will generally be soon obvious to him. He will know that the laws of nature are uniform in their agencies; and, capable of listening to the voice of experience, he will gain new and important truths even in consequence of his failures.

"The common workman when informed to a certain extent by science, must rise into a new state of existence. His moral character will be improved. He will lose that servitude of ideas which the constant repetition of a series of similar operations had given to him. He will perceive that his exertions are connected not only with the welfare of those at present existing, but likewise with the happiness of future generations. And he will combine the mind that conceives with the hand that executes.

"But independent of these particular views, the contemplation of the connexion of chemistry with the arts cannot fail of being useful to all the different classes of society.

"Every thinking man must necessarily be interested in that knowledge which makes him acquainted with the sources from which most of his comforts and enjoyments are derived; and with those facts by which he is enabled to ascertain the quantity of labour required for producing the different necessaries and luxuries of life.

"By studying the effects of human industry, we are able to form more accurate ideas concerning the future hopes of the human species. By examining what has been done, we are enabled to calculate concerning what may be effected. And man is never presented to us in a more sublime point of view, than when in his office of acting upon nature by means of his artificial operations; when exerting his powers of producing new combinations of substances; or of destroying them so as to render them subservient to important ends.

" By attending to the common labours and occupations of men, we must evidently gain more perfect notions of human nature. In perceiving how much we owe to those occupations, we cannot avoid feeling a certain degree of gratitude with regard to the beings who are employed in them. Hence we mingle more intimately with our kindred men, and in gaining knowledge we likewise gain sympathy.

" Even in a national point of view, we are deeply concerned in the progress of the chemical arts. Britain has long been distinguished from other countries by the eminence of her artists, and by the degree of perfection of their processes; and with these circumstances her commerce is intimately connected, and her existence as a great people.

" Aware of this fact the most powerful of the neighbouring nations have lately paid a more than common attention to the most important of the arts. Their men of science have been employed in developing the principles of them; and the manufacturers have been encouraged in their labours by great emoluments.

" At this moment, therefore, more particularly we ought to be ambitious of preserving our ancient fame. To be surpassed in the theory of the arts would be disgraceful to us; to be excelled in the practice of them would be ruinous. And independence and dignity of national character can only be produced by ideas of superiority, and of power."

The second lecture was delivered on February 17, and contained a general account of the physical and chemical properties of air, and of the agencies of the atmosphere. D.

At a Meeting of the Managers and Visitors of the Royal Institution of Great Britain, held at the House of the Institution, on the 26th Day of April, 1802,

The following Report, relative to the present State of the Institution, was laid before them by Count Rumford.

On the 25th of May last year I had the honour to lay before the Managers an account, which by their directions was published in the journals of the Institution on the 13th of June, respecting the progress that had been made in the arrangement of the Institution at that time, and of the works that were then going on at the house of the Institution; and I shall now briefly state to the Managers and Visitors what has since been accomplished, and what still remains to be done to complete this great and interesting establishment in all its details.

The New Lecture Room has been finished, and is acknowledged to be one of the most beautiful, and most convenient scientific theatres in Europe. It is so favourable to the propagation of sound, that though it is sufficiently capacious to contain 900 persons, a whisper may be distinctly heard from one extremity of it to the other, and no echo is ever perceived in it on any occasion. It is so contrived, that day light may be entirely excluded in a moment, by lowering the moveable ceiling of the lantern, by which the light enters the room from above, and allowing it to rest on the cornice which makes the finish of the lower part of the lantern, just above the level of the flat part of the ceiling of the room.

The form of the room is semicircular, with an addition of a parallelogram, equal in length to the diameter of the circular part of the room (60 feet), and 15 feet wide; and there are eleven rows of seats rising one above the other below, and three rows of seats in the gallery: and there is a covered circular passage 8 feet wide, all round the room, without, under the higher rows of seats, next the wall, and four convenient openings or *vomitoria,* with light doors with two wings, which shut of themselves without noise, forming so many passages of communication between the lower part of the theatre or pit, and the arched gallery or passage without.

The floor and seats of this theatre are painted of a dark green colour; and the seats are all covered with green moreen cushions. The floor of the circular passage without, which surrounds the pit, and the stairs belonging to the *vomitoria,* are all covered with green cloth to prevent the noise of the footsteps from being heard of those who come in, or go out of the theatre, during the lecture.

The windows which form the lantern (which is 15 feet in diameter), are all double, which not only renders the temperature of the room very equal and pleasant, but also prevents so effectually all noises from without disturbing the silence which reigns in the room, that even the rumbling of the carriages which pass in the neighbouring streets is never heard in it.

This theatre is warmed in cold weather by steam, which coming in covered and concealed tubes, from the lower part of the house, circulates in a large semicircular copper tube, 8 inches in diameter, and above 60 feet long, which is concealed under the rising seats of the pit.

Adjoining to this new theatre, is the Apparatus Room, which communicates with it by a door which is on one side of the large open chimney fireplace within the theatre, and just behind the Lecturer's table, which chimney fireplace serves for placing the furnaces that are occasionally used in the chemical experiments.

The Repository, which is 44 feet long, and 33 feet wide (the ceiling of which, and the floor of the theatre, which is above it, being supported by two rows of handsome columns), is finished, and already contains a considerable number of specimens of new and useful mechanical contrivances.

The Chemical Laboratory, in which there is provision made for placing and using no less than 16 furnaces of different kinds, at the same time, is quite finished, and has been furnished under the direction of the Committee of Chemistry (which has been formed since the last year) with a very complete chemical apparatus, and also with a considerable provision of materials necessary in making chemical experiments.

All the Workshops of the Institution are now quite finished; and they have been furnished with the most complete sets of tools that could be procured; and several excellent workmen are now employed in them; and a great variety of useful articles, designed as models for imitation, have already been manufactured in the house, and are ready to be delivered to any of the Proprietors or Subscribers to the Institution who may be disposed to purchase them.

The Great Kitchen at the house of the Institution has been finished, and now contains a variety of new and useful utensils, and implements of cookery, many of which are in daily use, and others which are not, are so exposed to view as to be easily understood, and their merit appreciated.

The Dining Room, and the Managers Room, which is adjoining to it, have both been quite finished and furnished.

The Conversation Room has been finished, and every thing has been prepared for its being used as a coffee room. It is now set apart for the reading of the domestic newspapers, of which no less a number than ten are regularly taken in, and it has been furnished with a set of the best geographical Maps and Charts that were to be procured. In selecting them, the advice and assistance of that able Geographer, Major Rennell, were obtained. The maps are fitted up according to a new method, which has been found to be very convenient, and at the same time to contribute much to the economy of space, and to the preservation of the maps.

The first Reading Room (that nearest to the great hall) has lately been appropriated exclusively to the reading of foreign newspapers. It is lighted up as formerly every evening; and on the table are found seven foreign gazettes, from different parts of the continent, in the French and German languages, which are regularly taken in, and which, coming by the post, constantly arrive at the earliest periods.

Mr. Stanhope, of the General Post Office, has generously undertaken to manage the whole business of procuring these foreign newspapers, and to cause them to be delivered at the house of the Institution free of all expenses for postage.

The second, or principal Reading Room, which is 26 feet long by 24 feet wide, has been fitted up in a very complete and elegant manner, and furnished with neat book-cases, which now extend round three sides of the room, affording space for more than 3800 volumes. This arrangement has rendered it possible to allow the second Lecture Room (which at some future period is to become the library) to remain for some time longer in its present state; and it will no doubt be found very useful for giving, occasionally, lectures on particular subjects, unconnected with the general courses of lectures that are regularly given in the great lecture room by the Professors and Lecturers of the Institution. This second lecture room will likewise be found very convenient for the meetings of the committees of the Institution, and for exhibiting new experiments to select meetings of scientific men.

But to return to the principal reading room. The accommodations for those who frequent this room have been greatly augmented since the last year. There are now two long mahogany tables (each 11 feet in length, and 3 feet 10 inches wide), covered with green cloth, which are placed parallel to each other, on opposite sides of the room; and each of these tables is well lighted at night by an elegant Grecian lamp of three branches, suspended by a chain from the ceiling of the room, and covered with a shade of white silk.

On these tables are found no less than 54 foreign and domestic, scientific and literary periodical publications, which are regularly taken in.

The books in the library of the Institution have been considerably increased during the last year, both by presents, and by new purchases.

The principal reading room has been ornamented by an elegant bust of his Majesty, our MOST GRACIOUS SOVEREIGN, PATRON of the Institution;—and by the busts of those great luminaries of science, BACON, and the immortal NEWTON.

With regard to the public opinion respecting the Institution, I have the most sensible satisfaction in being able to lay before the Managers and Visitors indisputable proofs of its growing reputation. The reading rooms and lectures at the house of the Institution are considerably more frequented this year than they ever have been before; and, although the prices of proprietors shares, and of life and annual subscriptions have been considerably raised, the lists of Proprietors and Subscribers have, during the last ten months, been augmented by no less than 154 new names; as will appear by the following statement.

There were belonging to the Royal Institution

	On the 5th June, 1801.	On the 26th April, 1802.	Augmentation.
Proprietors —	325	341	16
Life Subscribers —	268	284	16
Annual Subscribers	527	649	122
Total	1120	1274	154

The income and pecuniary resources of the Institution have, of course, kept pace with the increase of its Proprietors and Subscribers; and its expenses, though they have necessarily been very heavy, while so great and extensive a plan has been carrying into execution, yet they have been regulated with so much order and economy that the Proprietors will, no doubt, be satisfied with the accounts that will be laid before them at their next annual meeting, which will be held in a few days.

It will still be fresh in the recollection of the Managers and Visitors that, when, in the year 1800, it was finally determined by the Proprietors to undertake the additional buildings at the house of the Institution, it was then thought to be quite impossible to complete so great and expensive an undertaking without a loan of at least L.5000: and it will likewise be remembered that, on opening a subscription for that purpose, no less a sum than L.7000 was generously offered, by a comparatively small number of the Proprietors, in a very short time. It will also be recollected that I took the liberty in the Report which I had the honour to lay before the Managers last year, on the 25th of May, to express a hope that not only the expenses of the new buildings above mentioned, but of others also, which were wanted, and of all the alterations and additions that would be necessary to be made to finish the house in the most complete manner, and to furnish it elegantly, might, perhaps, with due care and attention, be defrayed without calling for any part of that sum of L.7000, which had been subscribed to enable the Managers to complete this great undertaking.

I have now, in common with my two colleagues of the Committee of Expenditure (Lord Pelham and Mr. Sulivan), who, with myself have been specially charged by the Managers of the Institution with the superintendance and control of these expenses, the pleasure to state that, these hopes have not been disappointed.

By the accounts which have been laid before the Visitors it appears,

That the whole of the sums that have from time to time become due to Mr. Hancock, who contracted with the Managers for completing the new buildings, have been regularly paid.—That his work having been finished, and regularly examined by the Surveyor of the Institution, his accounts have been closed, and the balance due to him from the Institution has been settled.

That the instalments agreed to be advanced to him, on his separate contract for completing the attic story, have likewise been regularly paid, and that no more than about L.500 will be due to him, on his last contract, when he shall have completed the whole of that work; which will be finished in a few weeks.

It appeared likewise, by these accounts, that all the carpenters, plumbers, painters, and glaziers bills, for extra work at the house of the Institution;—not included in Mr. Hançock's contracts,—have been brought to account; that the salaries and wages of those who constitute the establishment of the Institution have been regularly paid, and that all the tradesmens bills have been duly checked, and regularly discharged.

And, lastly, that all the sums due from the Institution on current accounts, including every demand that can be brought against the Institution, even after all the new works now carrying on at the house of the Institution shall have been completed, amounts to about L.3900, while the sums belonging to the Institution in the hands of their different bankers, added to those sums which are due to the Institution from Proprietors and Subscribers, and from some other persons, amounts to about L.8100.

From this statement it is evident, that the Institution has been completed without any debt being incurred; and by an account which has been laid before the Managers and Visitors it appears that the present annual income of the Institution is quite sufficient to defray all the expenses of keeping it up. The Royal Institution of Great Britain may therefore be considered as finished and firmly established. That it may long continue to flourish is, no doubt, the ardent wish of those who are connected with it; and also of all those who are acquainted with the principles on which it is founded, and who know how powerfully it must contribute to the general diffusion of an active spirit of inquiry and useful improvement among all ranks of society.

ROYAL SOCIETY.

An Appendix to Mr. Chenevix's paper, on Oxygenized Muriatic Acid, was read on the 18th of March.

This addition relates principally to the various muriates of mercury. It appears that Mr. Berthollet once considered the acid in corrosive sublimate as oxygenized, but he afterwards renounced that opinion; and Mr. Proust also thinks as Mr. Berthollet now does. Mr. Fourcroy still calls it a hyperoxygenized muriate of mercury; and of course supposes the excess of the oxygen in corrosive sublimate above that in calomel, as combined with the acid, and not with the oxid. Mr. Chenevix however determines from experiment that corrosive sublimate contains no particle of hyperoxygenized muriatic acid. In 100 parts he finds 69.7 of mercury, 12.3 of oxygen, and 18 of muriatic acid; but in calomel, 79, 9.5, and 11.5 respectively: so that in calomel the metal is less oxidized, and the oxid is combined with a smaller proportion of the acid. A piece of copper was found to throw down from a solution of corrosive sublimate a very pure calomel. Mr. Chenevix observes that Scheele's calomel contains a portion of subnitrate of mercury, precipitated with it by the water; and that this may be avoided either by using the nitrate of mercury before it has boiled, or by adding to the dilute solution of muriate of soda, by which it is precipitated, a little muriatic acid, to engage the superfluous subnitrate. By passing a current of oxygenized muriatic acid gas through water containing red oxid of mercury, a true hyperoxygenized muriate was obtained, more soluble than corrosive sublimate, and distinguishable by its smell when decomposed; and the remaining oxid became of a dark brown colour.

The meetings of the 25th of March, and the 1st and 8th of April, were occupied by part of a paper on the corundum, by the Count de Bournon, F. R. S.

The Count de Bournon had already stated some mineralogical reasons for classing the corundum with the sapphire and other oriental gems: their affinity was afterwards confirmed by the analysis of Mr. Klaproth; yet Mr. Haüy still hesitating to admit that they ought to be placed near to each other in the system, the Count de Bournon endeavours to establish the character much more fully. He divides the specimens of corundum into two principal kinds; the one larger, less regularly formed, and generally of a greyish colour, capable of being easily reduced by fracture to a rhomboidal form: the other kind more regularly crystallized, and of more diversified colour.

The author proceeds to consider the different varieties of the corundum, first with regard to colour, which chiefly constitutes the distinctions of the sapphire, the oriental ruby, topaz, amethyst, emerald, and chrysolite; and afterwards with respect to transparency, hardness, and other particulars. He observes that these stones strike fire with steel less readily than flint: that they are phosphorescent when rubbed in the dark, the ruby in particular emitting a light similar to that of red hot iron. The specific gravity varies, that of the sapphire being usually about 4.1, but most of the other varieties generally 3.9. The diversified forms of the crystals are next considered, the basis of them all being a rhomboid, contained by parallelograms, of which the angles are 96°, and 84°: the specimens of an original rhomboid of this kind are very rare. The derivative crystals have their angles variously replaced, the portions thus becoming more or less regularly formed pyramids.

The cohesion of these gems is next compared with their colour, and a general connexion between these qualities is found; the blue being in general the most difficultly broken. Several circumstances respecting the crystallizations are still more minutely described, and the figures to which the reflection of light is owing are particularly considered. The author observes that in order to form the appearance of the rays of a regular star, by reflection from the laminæ of these gems, which has frequently given them the denomination of asterites, the best section is to make them terminate obtusely a little below the sharp angle of the rhomboid. The objections of Mr. Haüy to classing the sapphire and other oriental gems with the corundum are still further considered. An analogy to the two principal divisions of corundums into regular and irregular crystals, is shown in the forms of the feltspar, which is similarly distinguished into the very different appearances of feltspar in granite, and the crystallized adularia, besides some other similar variations. The matrix of the corundums, particularly in the carnatic, is a rock of a loose texture, somewhat resembling sandstone in appearance, but containing small masses of a substance irregularly crystallized, which is decomposed by exposure to the air, and then appears to abound in carbonat of lime. The Count de Bournon refers, for a complete confirmation of his mineralogical opinions, to Mr. Chenevix's chemical analysis of all the substances that he has examined, which is to form a continuation of this elaborate essay.

Some observations of the place of the planet Ceres, by Professor Bode, of Berlin, were also communicated on the 8th by Dr. Herschel; and the Society adjourned to the 29th.

Y.

From the BIBLIOTHEQUE BRITANNIQUE, No. 148.

Comparison of the French definitive Metre with an English Standard, brought from London by M. A. PICTET, *one of the Editors of the Bibliothéque Britannique.*

The measurement of the earth, and the investigation of its figure, were the subjects, at various times in the course of the eighteenth century, of the labours of a number of philosophers of the first eminence in different countries. Some Swedish Astronomers are now employed in a second measurement of the same degree which was measured sixty years ago by the French Academicians in Lapland, under the polar circle. In France, when the idea of seeking in the dimensions of the globe itself the unit to which all measures and weights might be referred, had once been conceived and adopted, it was necessary to make an effort proportional to the importance of an undertaking which was thus become national. In the midst of a long and sanguinary war, together with difficulties of every other kind, a chain of triangles has been formed between Dunkirk and Barcelona, comprehending the tenth part of the arc of the meridian which extends from the Equator to the pole, and which is equal to one fourth of the circumference of the globe; and the ten millionth part of this arc, thus determined, has been adopted for the unit of the metrical system: it has been fixed by the construction of standards made of substances proper to resist the attacks of time; and by a careful examination of the precise relation of the length of the metre to that of the pendulum vibrating seconds, on the level of the sea, in a given latitude, the determination of this unit has been rendered independent of any accident that might destroy or impair the standards representing it; while in the formation of these standards all the precautions have been employed that could be suggested by the present improved state of natural philosophy, and of the arts.

In England, on the other hand, operations have been carried on for these five and twenty years, which are to be the foundations of an exact map of Great Britain. These labours, begun by the late General Roy, have been conducted with much sagacity and precision; and the results are likely to procure very interesting information respecting the figure of the earth. Sir George Shuckburgh, an eminent member of the Royal Society of London, has successfully employed himself in private, in researches intended to fix the precise length of the standards, which have served as bases for the measurements made in Great Britain.

It was therefore to be regretted, that operations so similar, conducted in two neighbouring countries, and capable of acquiring a new interest by comparison, should remain unconnected, for want of an actual standard of the measures of the one country, which might be transported into the other, after the definitive determination of the French measure. This regret we had deeply felt at various times when these objects were laid before our readers; and we may say with truth, that if the hope of procuring this medium of comparison was not the only motive of the journey to England that one of us has made, it at least greatly contributed to induce him to undertake it.

Our collegue took some steps in his passage through Paris, to obtain an authentic metre, in order to be submitted to the examination of the Royal Society, to which he has the honour of belonging, but he did not remain long enough in Paris to be able to succeed in this attempt. He took advantage of his longer stay in England, in procuring from the hands of Mr. Troughton, an artist celebrated for his accuracy in the construction and division of geometrical and astronomical instruments, a standard rigourously conformable to that which he had made for Sir George Shuckburgh, and with which this Philosopher had compared the principal English standards. Our collegue procured also from the same artist the comparative apparatus of Sir George Shuckburgh, composed of two excellent microscopes, the one bearing a micrometer which divides the English inch into ten thousand equal parts. Upon his return to Paris he made haste to exhibit these instruments to the Minister of the Interior, and to the National Institute. This learned body nominated three of its members, in order to proceed to the regular comparison of the definitive metre with the English standard. The undertaking, by no means so easy as it at first appeared, occupied the committee in five different meetings, of nearly four hours each; and it was performed with all the care and precaution that the nature of the subject required. Mr. Prony, who, as the translator of General Roy's memoir on the first trigonometrical operations in England, was particularly interested in these researches, acted as secretary to the committee, and it was at his house, and with the assistance of a comparative apparatus belonging to him, that the principal experiments were made. He has been so obliging as to furnish us with an authentic copy of the report made to the Institute, which was deemed of sufficient consequence to be read at the public sitting of the last quarter. He adds, that "This report will soon be followed by a memoir, in which he will enter into more circumstantial details of all the observations that he has made; and in which he will give a description and a figure of his comparative instrument." We shall bear in mind this promise, and in the mean time we shall give our readers a copy of the report; informing them that we have bestowed on the correction of the proofs of this important paper all the attention necessary to enable us to affirm that no typographical error has been committed in the numbers.

National Institute of Sciences and Arts. 6 *Nivose, Year* 10 (27*th December*, 1801).

A Member read, in the name of a committee, the following report on the comparison of the standard metre of the Institute with the English foot.

Mr. Pictet, Professor of Natural Philosophy at Geneva, submitted to the inspection of the class in the month of Vendémiaire, an interesting collection of objects relative to the sciences and arts, which he collected in his journey to England.

Among them was a standard of the English linear measure, engraved on a scale of brass, of 49 inches in length, divided by very fine and clear lines into tenths of an inch.

It was made for M. Pictet by Troughton, an artist in London, who has deservedly the reputation of dividing instruments with singular accuracy; it was compared with another standard made by the same person for Sir George Shuckburgh, and it was found that the difference between the two was not greater than the difference between the divisions of each; that is, it was a quantity absolutely insensible. This standard may therefore be considered as identical with the standard described by Sir George Shuckburgh in the Philosophical Transactions for 1798.

M. Pictet also exhibited to the Institute a comparer, or an instrument for ascertaining minute differences between measures, constructed also by Mr. Troughton. It consists of two microscopes with cross wires, placed in a vertical situation, the surface of the scale being horizontal, and fixed at proper distances upon a metallic rod. One of them remains stationary at one end of the scale, the other is occasionally fixed near to the other end; and its cross wires are moveable by means of a screw, describing in its revolution $\frac{1}{100}$ of an inch, and furnished with a circular index, dividing each turn into 100 parts; so that having two lengths which differ only one tenth of an inch from each other, we may determine their difference in ten thousandths of an inch. The wires are placed obliquely with respect to the scale, so that the line of division must bisect the acute angle that they form, in order to coincide with their intersection. General Roy has described, in the 75th volume of the Philosophical Transactions, a similar instrument made by Ramsden, for measuring the expansion of metals.

M. Pictet offered to the class the use of the standard, with the micrometer described, for the determination of the comparative length of the metre, and the English foot: the offer was accepted with gratitude, and MM. Legendre, Méchain, and Prony were appointed to cooperate with M. Pictet in the comparison of the standard metre of platina and the English foot.

The first meeting was on the 28th Vendémiaire (21st of October), at the house of Mr. Lenoir.

At first a difficulty occurred from the different manner in which the measures were defined: the English scale was graduated by lines; the French standards were simply cut off to the length of a metre: hence the length of the metre could not easily be taken by the microscopes; nor could the English scale be measured by the method employed for making new standard metres, which consists in fixing one end against a firm support, and bringing the other into contact with the face of a cock or slider, adjusted so as barely to admit the original standard between it and the fixed surface.

Mr. Lenoir attempted to overcome this difficulty by reducing to a thin edge the terminations of a piece of brass of the length of a metre; so that it was compared with the standard metre in the usual manner, and its extremities, when placed on the English scale, constituted two lines parallel to those which were really engraved on the scale, and capable of being viewed by the microscopes.

The standard metre of platina, and another standard of iron, belonging also to the Institute, were thus compared with the English foot; each of these two measures being equal, at the temperature of melting ice, to the ten millionth part of the quadrant of the meridian. At the temperature of 15.3° of the decimal thermometer, or 59.5° of Fahrenheit, the metre of platina was equal to 39.3775 English inches; and that of iron to 39.3788, measured on Mr. Pictet's scale.

These first experiments showed, however, that the method employed was liable to some uncertainty, arising from the difficulty of placing the cross wires precisely at the extremity of the thin edge of the plate of brass employed in the comparison; a reflection or irradiation of light, which took place at that extremity, prevented its being distinctly observed if the optical axis of the microscope was precisely a tangent to the surface exactly at the termination.

In order to remove this inconvenience, another arrangement was proposed by one of the committee (It was Mr. Prony that suggested this ingenious method, and M. Paul of Geneva, who happened to be present, that executed it. B. B.). A line was traced on a small metallic ruler, perpendicular to its length; the end of the ruler was fixed against a solid obstacle, and the cross wires made to coincide with the line: the standard metre was then interposed between the same obstacle and the end of the piece, and the line traced on it, which had now obviously advanced the length of the metre, was subjected to the other microscope. The microscopes thus fixed, were transferred to the graduated scale; one of them was placed exactly over one of the divisions, and the micrometer screw was turned in order to measure the fraction, expressing the distance of the other microscope from another division.

The comparison was repeated in the same manner the 4th Brumaire (26th October) last, at the house of one of the committee, and after several experiments, agreeing very satisfactorily with each other, it was found that at the temperature 12.75°, or 55° of Fahrenheit, the standard of platina was 39.3781, and that of iron 39.3795 English inches.

The two metres being intended to be equal at the temperature of melting ice, these operations may be verified by reducing their results to that temperature. For this determination we are provided with the accurate experiments made by Borda, and the committee of weights and measures, on the dilatation of platina, brass, and iron; from which it appears, that for every degree of the decimal thermometer, platina expands .00000856; iron .00001156; and brass .00001783; for Fahrenheit's scale these quantities become 476, 642, and 990 parts in a hundred millions. From these data we find that, at the freezing point, the standard metre of platina was equal to 39.38280, and that of iron to 39.38265 English inches of M. Pictet's scale. The difference is less than the 500th of a line, or the 200000th of the whole metre, and is therefore wholly inconsiderable.

The result of the whole comparison is therefore this. Supposing all the measures at the temperature of melting ice, each of the standard metres is equal to the 10000000th part of the quadrant of the meridian, and to 39.38272 English inches of M. Pictet's scale.

At the class of mathematical and physical sciences of the National Institute, 6 Nivose, year 10.

Legendre, Méchain, and Prony, *Reporter.*

This report is approved, and its conclusions adopted by the class. Certified by Delambre.

Paris, 26 Nivose, year 10 (16th January, 1802).

On examining the reduction of the standards of platina and iron to the freezing point, it appears that they differ somewhat less than is stated in the report, and that they coincide within an unit in the last place of the decimals expressing their magnitudes, or one ten thousandth of an inch. The standard of platina at the freezing point becomes equal to 39.37380, and that of iron to 39.37370 English inches on the scale of brass at 55°, and the mean of these to 39.37100 English inches at 62°, which is the temperature that has been universally employed in the comparison of British standards, and in the late trigonometrical operations in particular. This result agrees surprisingly with Mr. Bird's determination of the lengths of the toises sent by Mr. Lalande to Dr. Maskelyne, of which the mean was 76.734 inches: hence the metre, having been found to contain 36.9413 French inches, appears to be equal to 39.3702 English inches: or rather to be either 39.3694 or 39.3710, accordingly as the one or the other of the two toises happens to have been the more correct; we may therefore give the preference to that which measured 76.736 inches.

Allowing the accuracy of the French measurements of the arc of the meridian, the whole circumference of the globe will be 24855.43 English miles, and its mean diameter 7911.73. Taking the ellipticity at $\frac{1}{230}$, the axis will be nearly 7893½, the equatorial diameter 7928, and the diameter of a sphere of equal solid content about 7916 miles; the brass standard being at the temperature of 62° of Fahrenheit.

As long, therefore, as the English standard continues to be reduced to this temperature, we must consider the metre as equivalent to 39.3710, and not to 39.3827 English inches.

Upon these joint authorities it may be of use to reprint here a table of the principal measures and weights now used in France, with the very slight corrections which this last comparison has introduced into it. In translating the French terms into English, we are fully at liberty to rescue them, in some measure, from the barbarisms in orthography which have been committed in forming them.

Measures of length, the metre being at 32°, the foot at 62°.

	English inches.
Millimetre	.03937
Centimetre	.39371
Decimetre	3.93710
Metre	39.37100
Decametre	393.71000
Hecatometre	3937.10000
Chiliometre	39371.00000
Myriometre	393710.00000

	M.	F.	Y.	Ft.	In.
A decametre is	0	0	10	2	9.7
A hecatometre	0	0	109	1	1
A chiliometre	0	4	213	1	10.2
A myriometre	6	1	156	0	6

8 chiliometres are nearly 5 miles.

Measures of capacity.

	Cubic inches E.
Millilitre	.06103
Centilitre	.61028
Decilitre	6.10280
Litre, a cubic decimetre	61.02800
Decalitre	610.28000
Hecatolitre	6102.80000
Chiliolitre	61028.00000
Myriolitre	610280.00000

A litre is nearly $2\frac{1}{8}$ wine pints. 14 decilitres are nearly 3 wine pints. A chiliolitre is 1 tun, 12.75 wine gallons.

Weights.

A gramme is the weight of a cubic centimetre of pure water at its maximum of density. It has been found equal to 18.827 French grains, of which 576 made 472.5 English; and 489.5058 grammes make a pound of the standard of the mint at Paris.

	E. grains.
Milligramme	.0154
Centigramme	.1544
Decigramme	1.5444
Gramme	15.4440
Decagramme	154.4402
Hecatogramme	1544.4023
Chiliogramme	15444.0234
Myriogramme	154440.2344

A decagramme is 6 dwts. 10.44 gr. tr.; dr. iiß. gr. 4.44 apoth.; or 5.65 dr. avoird. A hecatogramme is 3oz. 8.5 dr. av. A chiliogramme is 2lbs. 3 oz. 5 dr. av. A myriogramme is 22lbs. 1.15 oz. av. 100 myriogrammes are 1 ton wanting 32.8lbs.

Agrarian measures.

Are, 1 square decametre	3.95 perches.
Hecatare	2 acres, 1 rood, 35.4 perches.

For fire-wood.

Decistere, $\frac{1}{10}$ stere	3.5317 cub. f. E.
Stere, 1 cubic metre	35.3171 cub. f.

MONEY. *Copper.*

	E. grains.
Centime, 1 gramme	15.4
5 centimes, or sous	77.2
Decime	154.4
2 decimes	308.8

Silver $\frac{9}{10}$ or $\frac{36}{40}$ fine.

Franc, 5 grammes,	3 dwts. 5.2 gr.
5 francs,	16 dwts. 2.1 gr.

The franc is nearly the same with the livre tournois, and worth about 10d. Bolton's penny weighs 435 gr.; his halfpenny 165; a shilling nearly 93 gr. $\frac{37}{40}$ fine.

It appears from Mr. Borda's experiments, that in latitude 45°, a pendulum of the length of a metre would perform in a vacuum 86116.5 vibrations in a day: the length of a pendulum being supposed to increase with the latitude, in the proportion of the square of the sine of the latitude, multiplied by .000567, while the time of its vibration remains unaltered.

Y.

From the ANNALES de CHIMIE, 13 Ventose, An X.

Observations on the Acetous and Acetic Acids. By M. Darracq.

1. Mr. Darracq begins this memoir by stating the opinions of Mr. Adet and Mr. Chaptal, concerning the nature of the acetous and acetic acids. Mr. Adet had considered them as existing in the same states of oxygenation, and as differing chiefly in consequence of the different proportions of water with which they are combined. Mr. Chaptal had supposed that the acetous acid contained a larger proportion of carbon than the acetic acid.

2. After ascertaining by new researches the accuracy of Mr. Adet's experiments, the author attempted to produce a change in the nature of the acetous acid, by means of the nitric and oxygenated muriatic acid, but without success; for after having been exposed to these powerful agents, its nature and properties remained the same.

3. He then exposed equal parts of the salts usually called acetite and acetate of potash to a heat sufficiently strong to decompose them; justly supposing that if the acids differed in their nature, they would evolve different products; this however was not the case; the volatile substances given out by them appeared to be the same, and the quantities of charcoal existing in the fixed residuums were nearly equal.

The results were similar when the acetate and acetite of soda were employed.

4. He next distilled a mixture of equal parts of sulphate of copper and acetite of lead, but no aëriform products were generated; no charcoal was deposited; and he obtained a liquor exactly analogous to *acetic acid.*

5. He likewise decomposed by heat equal parts of the acetate and acetite of copper; he obtained from each of them acetic acid or radical vinegar; the same quantities

of carbonic acid and of inflammable gas* were disengaged during the operation; and the portions of residual charcoal also were equal.

6. Convinced from the comparison of these results, that the acetous and acetic acid do not differ either by containing different quantities of oxygene or carbon, the author proceeded to examine them minutely in their common states; and, from many observations, he concludes, that the acetous acid not only contains more water than the acetic acid, but likewise that it is distinguished from it by holding in solution mucilage, and extractive matter. By distilling the acetous acid twice from muriate of lime, he obtained it in a concentrated state, and free from these last substances; no charcoal was deposited in the process; and the rectified acid was precisely the same with the acetic acid or radical vinegar prepared by other modes. The subject is concluded by some observations concerning nomenclature: as the nature of the common acid of vinegar and radical vinegar is the same, M. Darracq proposes that they should bear the same denomination, that of the acetic acid; and that the salts, now called acetates and acetites, as being the same, should be denoted by the name, of acetates. D.

Observations on Gluten. By C. L. Cadet.

The observations of the author chiefly relate to the solubility of gluten in alcohol, after it has undergone fermentation. They are not important as to their chemical relations; but as the conclusions may lead to some useful practises, we shall give them in detail. They are,

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* The author uses the term "gas hydrogene"; but he surely cannot mean pure hydrogene gas. It appears from Dr. Higgins's experiments upon the acetous acid, that carbonated hydrogene gas is produced in all cases of its decomposition by heat. See Higgins's Experiments, page 292.

1. That common gluten is insoluble in alcohol.

2. That it becomes soluble in alcohol when it has undergone the acid fermentation.

3. That gluten is precipitated from its solution in alcohol by water.

4. That the solution of gluten in alcohol evaporated to the consistence of a syrup, furnishes a varnish which may be employed in the arts.

5. That this solution may be used for mixing with pigments; and that it enables them to adhere to the smoothest bodies.

6. That vegetable colouring matters are more easily mixed with gluten than metallic oxides.

7. That paintings made with the solution of gluten, dry very quickly, have no disagreeable smell, and may be washed without damage.

8. That the solution of gluten, when mixed with lime, forms a useful lute, which is very consistent and solid.

D.

From the DECADE PHILOSOPHIQUE, No. 21.

National Institute. Experiments showing that all bodies are subject to the magnetic influence, even in a degree which is capable of being measured.

These experiments were made by Mr. Coulomb, and repeated by him before the Institute. He employed all the substances that he examined in the form of a cylinder, or a small bar; he suspended them by a thread of silk in its natural state, and placed them between the opposite poles of two magnets of steel. Such a thread can scarcely support more than two or three drams without breaking; it was therefore necessary to reduce these needles to very small dimensions. Mr. Coulomb made them about a third of an inch in length, and about a thirtieth of an inch in thickness; and those of metal only one third as thick.

In making the experiments, he placed the magnets in the same right line. Their opposite poles were separated about a quarter of an inch more than the length of the needle which was to oscillate between them. The result was, that of whatever substance the needles were formed, they always ranged themselves accurately in the direction of the magnets; and if they were deflected from this direction, they returned to it with oscillations, which were often as frequent as thirty or more in a minute. Hence, the weight and figure of the needles being given, it was easy to determine the force that produced these oscillations.

The experiments were made in succession with small plates of gold, silver, copper, lead, and tin; with little cylinders of glass, with a bit of chalk, a fragment of bone, and different kinds of wood.

In the course of his lecture on magnetism on the 30th of April, Dr. Young repeated some of these experiments with wires of different kinds: one of them was of tin, and suspended within a cylindrical glass jar by a single silkworm's thread: its oscillations were so slow as to occupy several minutes, and it was scarcely affected by turning the cross bar to which the thread attached; so that the suspension must have been sufficiently delicate: under these circumstances the opposite poles of two strong magnets were applied close to the jar, and at the distance of about twice the length of the suspended wire: but the effect was absolutely imperceptible: in the morning, indeed, there had been an appearance of oscillations occupying about a minute, and tending to the direction of the magnets, perhaps derived from some superficial particles of iron which had lost their magnetic property by oxidation in the course of the day. There must at any rate be a doubt whether the presence of a quantity of iron too small to be ascertained by chemical tests, might not have been the cause of the effects described by Mr. Coulomb, although they indicate a force something greater, upon a rough calculation, than one 2000th of the weight of the substance. Y.

A SUMMARY *of the most useful Parts of* HYDRAULICS, *chiefly extracted and abridged from Eytelwein's Handbuch der Mechanik und der Hydraulik.* Berlin, 1801.

The theory of hydraulics has never been carried to a very high degree of perfection upon mathematical foundations alone; nor has it hitherto, even with the assistance of experiment, been rendered of much practical utility. Newton began the investigation of the motions of fluids: Daniel Bernoulli added to Newton's propositions much valuable matter, both from calculation and from experiment; D'Alembert and many later authors have exercised their analytical talents in inquiries of a similar nature. But another and a more practicable mode of attaining hydraulic knowledge has been attempted by a distinct class of investigators, at the head of whom stands the Chevalier de Buat. These have begun from experiment alone, and have laboriously deduced from very ample observations of the actual results of various particular cases, the general laws by which the phenomena appear to be regulated, or at least the formulas by which the effect of new combinations may be predicted. But it must be confessed that these formulas, however accurate, are too intricate to be retained in the memory, or to be very easily applied to calculations from particular data.

Mr. Eytelwein, a gentleman already known to the public by his translation of Buat's work into German, with important additions of his own, and honoured with several employments and titles relative to the public architecture of the Prussian dominions, has collected into this compendium of mechanics and hydraulics, the principal facts that have been ascertained, as well by his own experiments, as by those of former authors, especially such as are the most capable of practical application; and he appears to have done this in so judicious a manner, as to make his book a most valuable abstract of every thing that can be deduced from theory respecting natural and artificial hydraulics. This elegant conciseness deserves so much the more praise, as his countrymen in general appear too often to make a merit of prolixity; and we shall have occasion to remark, that besides the convenience of simplicity, he has sometimes been fortunate enough to unite with it the advantage of superior accuracy.

The first part of the work is but short; it relates to proper mechanics, and has little that is remarkably new or interesting. In treating of pendulums, the author informs us, with reference to another work of his own, that the Rhinland or Brandenburg foot contains 139.13 French lines. Hence it appears that 100 Rhinland feet are exactly 103 English; and in this paper, the measures will be reduced accordingly.

The second part, relative to hydraulics, contains besides a short introduction, twenty-four chapters, almost every one of which presents to us something of importance.

Chapter 1. Of the motion of water flowing out of reservoirs, and of the contraction of the stream.

§ 89. The velocity of water flowing out of a horizontal aperture, is as the square root of the height of the head of water.

That is, the pressure, and consequently the height, is as the square of the velocity: for the quantity flowing out in any short time, is as the velocity; and the force required to produce a velocity in a certain quantity of matter in a given time, is also as that velocity; therefore the force must be as the square of the velocity. The proposition is fully confirmed by Bossut's experiments; the proportional velocities, with a pressure of 1, 4, and 9 feet, being 2722, 5436, and 8135, instead of 2722, 5444, and 8166; a very inconsiderable difference.

There is another mode of considering this proposition, not mentioned by Eytelwein, which is a very good approximation. Supposing a very small cylindrical plate of water immediately over the orifice, to be put in motion at each instant by means of the pressure of the whole cylinder standing on it, and supposing all the gravitation of the column to be employed in generating the velocity of the small cylindrical plate, neglecting its own motion, this plate would be urged by a force as much greater than its own weight as the column is higher than itself; and this, through a space shorter in the same proportion than the height of the column. But where the forces are inversely as the spaces described, the final velocities are equal. (Young's Syllabus, 35.) Therefore the velocity of the water flowing out must be equal to that of a heavy body falling from the height of the head of water, which is found very nearly by multiplying the square root of that height in feet by 8, for the number of feet described in a second. Thus a head of 1 foot gives 8; a head of 9 feet, 24.

The well known circumstance of the contraction of the stream or vein of water running out of a simple orifice in a thin plate, reduces the area of its section, at the distance of about half its diameter from the orifice, from 1 to .660 or .666 according to Bossut, to .631 according to Venturi, and to .64 or $\frac{16}{25}$ according to the author's own experiments: hence the diameter is reduced to $\frac{4}{5}$.

The quantity of water discharged is very nearly, but not quite, sufficient to fill this section with the velocity due, or corresponding to the height: for finding more accurately the quantity discharged, the orifice must be supposed to be diminished to .619, or nearly $\frac{5}{8}$. Hence we may multiply the square root of the height by 5 instead of 8, for this mean velocity in a simple orifice.

If we apply the shortest pipe that will cause the stream to adhere every where to its sides, which will require its length to be twice its diameter, the discharge will be about $\frac{13}{16}$ of the full quantity, and the velocity may be found by taking $6\frac{1}{2}$ for a multiplier.

The greatest diminution is produced by inserting a pipe so as to project within the reservoir, probably because of the greater interference of the motions of the particles approaching its orifice in all directions: in this case the discharge is reduced nearly to a half.

A conical tube, approaching to the figure of the contraction of the stream, procured a discharge of .92; and when its edges were rounded off, of .98, calculating on its least section.

Venturi has asserted that the discharge of a cylindrical pipe may be increased by the addition of a conical tube nearly in the ratio of 5 to 2; but Mr. Eytelwein finds this assertion somewhat too strong, and observes, that when the pipe is already very long, scarcely any effect is produced by the addition of such a tube. He proceeds to describe a number of experiments made with different pipes, where the standard of comparison is the time of filling a given vessel out of a large reservoir, which was not kept always full, as it was difficult to avoid agitation in replenishing it, and this circumstance was perfectly indifferent to the results of the experiments. They confirm the assertion that a compound conical pipe may increase the discharge to twice and a half as much as through a simple orifice, or to more than half as much more as would fill the whole section with the velocity due to the height: but where a considerable length of pipe intervenes, the additional orifice appears to have little or no effect.

The chapter concludes with a general table of the coefficients for finding the mean velocity of the water discharged by the pressure of a given head under different circumstances.

For the whole velocity due to the height, the coefficient, by which its square root is to be multiplied, is 8.0458.

For an orifice of the form of the contracted stream, 7.8.

For wide openings, of which the bottom is on a level with that of the reservoir; for sluices with walls in a line with the orifice; for bridges with pointed piers, 7.7.

For narrow openings, of which the bottom is on a level with that of the reservoir, for smaller openings in a sluice with side walls, for abrupt projections and square piers of bridges, 6.9.

For short pipes from two to four times as long as their diameter, 6.6.

For openings in sluices without side walls, 5.1.

For orifices in a thin plate, 5.

Chapter 2. Of the discharge of water by horizontal and by small lateral orifices, in a vessel continuing full.

The principles detailed in the first chapter are here applied to particular cases.

Chapter 3. Of the discharge by rectangular orifices in the side of a reservoir, extending to the surface.

The velocity varying nearly as the square root of the height, may here be represented by the ordinates of a parabola, and the quantity of water discharged by the area of the parabola, or two thirds of that of the circumscribing rectangle. So that the quantity of water discharged may be found by taking two thirds of the velocity due to the mean height, and allowing for the contraction according to the form of the opening, as explained in the first chapter.

The author has found this mode of calculation sufficiently near to the results of Buat's experiments, and to some accurate observations of his own.

He proposes for example a lake in which a rectangular opening is made without any oblique lateral walls 3 feet wide, and extending 2 feet below the surface of the water. Here the coefficient of the velocity, corrected for contraction, is 5.1, and the corrected mean velocity $\frac{2}{3}\sqrt{2}\times5.1=4.8$; therefore the area being 6, the discharge of water in a second is 28.8 cubic feet, or nearly four hogsheads.

The same coefficient serves for determining the discharge over a were of considerable breadth; and hence it is easy to deduce the depth or breadth requisite for the discharge of a given quantity of water. For example, a lake has a were 3 feet in breadth, and the surface of the water stands at the height of 5 feet above it: it is required how much the were must be widened in order that the water may be a foot lower. Here the velocity is $\frac{2}{3}\sqrt{5}\times5.1$, and the quantity of water $\frac{2}{3}\sqrt{5}\times5.1\times3\times5$; but the velocity must be reduced to $\frac{2}{3}\sqrt{4}\times5.1$, and then the section will be $\frac{\frac{2}{3}\sqrt{5}\times5.1\times3\times5}{\frac{2}{3}\sqrt{4}\times5.1}=\frac{\sqrt{5}\times3\times5}{\sqrt{4}}=7.5\sqrt{5}$; and the height being 4, the breadth must be $\frac{7.5}{4}\sqrt{5}=4.19$ feet.

Chapter 4. Of the discharge from reservoirs with lateral orifices of considerable magnitude, with a constant head of water.

This may be found by determining the difference in the discharge by two open orifices of different heights: but in most cases the problem may be solved with nearly equal accuracy, by considering the velocity due to the distance of the centre of gravity of the orifice below the surface.

Chapter 5. Of the discharge from reservoirs receiving no supply of water.

For prismatic vessels, all the particulars of the discharge may be calculated from the general law that twice as much would be discharged from the same orifice if the vessel were kept full during the time which is required for its emptying itself (Young's Syllabus, 245). Where the form is less simple, the calculations become intricate, and are of little importance.

Chapter 6. Of the discharge from compound or divided reservoirs.

The author observes from Buat, that the discharge through an orifice between two reservoirs, below the surface, is the same as if the water ran into the open air. Hence he calculates the discharge when the water has to pass through several orifices in the sides of as many reservoirs open above. In such cases, where the orifices are small, the velocity in each may be considered as generated by the difference of the heights in the two contiguous reservoirs, and the square root of the difference will therefore represent the velocity; which must be in the several orifices, inversely as their respective areas; so that we may calculate from hence the heights in the different reservoirs when the orifices are given. Mr. Eytelwein then considers the case of a lock which is filled from a canal of an invariable height, and determines the time required, by comparing it with that of a vessel emptying itself by the pressure of the water that it contains, observing that the motion is retarded in both cases in a similar manner; and he finds the calculation agree sufficiently well with experiments made on a large scale. The motion of water through different compartments of a closed cavity is also determined.

Chapter 7. Of the motion of water in rivers.

The simple theorem by which the velocity of a river is determined, appears to be the most valuable of M. Eytelwein's improvements; although the reasoning, from which it is deduced, is somewhat exceptionable. The friction is nearly as the square of the velocity; not because a number of particles proportional to the velocity are torn asunder in a time proportionally short, for according to the analogy of solid bodies, no more force is destroyed by friction when the motion is rapid than when slow; but because when a body is moving in lines of a given curvature, the deflecting forces are as the squares of the velocities (Young's Syllabus, 40, 35, 46), and the particles of water in contact with the sides and bottom must be deflected, in consequence of the minute irregularities of the surfaces on which they slide, nearly into the same curvilinear path, whatever their velocity may be.

At any rate we may safely set out with the hypothesis, that the principal part of the friction is as the square of the velocity. And the friction is nearly the same at all depths: for Professor Robison found that the time of the oscillation of the fluid in a bent tube was not increased by increasing the pressure against the sides, being nearly the same when the principal part of the tube was situated horizontally as when vertically. The friction will however vary according to the surface of the fluid which is in contact with the solid, in proportion to the whole quantity of fluid: that is, the friction for any given quantity of water will be as the surface of the bottom and sides of a river directly, and as the whole quantity of water in the river inversely: or supposing the whole quantity of water to be spread on a horizontal surface, equal to the bottom and sides, the friction is inversely as the height at which the river would then stand, which is called the hydraulic mean depth.

Now when a river flows with an uniform motion, and is neither accelerated nor retarded by the action of gravitation, it is obvious that the whole weight of the water must be employed in overcoming this friction; and if the inclination vary, the relative weight or the force that urges the particles along the inclined plane, will vary as the height of the plane when the length is given, or as the fall in a given distance (Young's Syllabus, 54); consequently the friction, which is equal to the relative weight, must vary as the fall, and the velocity which is as the square root of the friction, must be as the square root of the fall; and supposing the hydraulic mean depth to be increased or diminished, the inclination remaining the same, the friction would be diminished or increased in the same ratio; and therefore in order to preserve its equality with the relative weight, it must be proportionally increased or diminished by increasing the square of the velocity in the ratio of the hydraulic mean depth, or the velocity in the ratio of its square root. We may therefore expect that the velocities will be conjointly as the square root of the hydraulic mean depth and of the fall in a given distance, or as a mean proportional between these two lines. Taking two English miles for a given length, we must find a mean proportional between the hydraulic mean depth and the fall in two miles, and inquire what relation this bears to the velocity in a particular case, and thence we may expect to determine it in any other. According to Mr. Eytelwein's formula, this mean proportional is $\frac{11}{10}$ of the velocity in a second.

In order to examine the accuracy of this rule, we may take an example which could not have been known to Mr. Eytelwein. Mr. Watt observed, as Professor Robison informs us in the article River of the Encyclopædia Britannica, that in a canal 18 feet wide above, and 7 below, and

4 feet deep, having a fall of 4 inches in a mile, the velocity was 17 inches in a second at the surface, 14 in the middle, and 10 at the bottom: so that the mean velocity may be called 14 inches or somewhat less, in a second. Now to find the hydraulic mean depth, we must divide the area of the section, $2.\ (18+7)=50$ by the breadth of the bottom and length of the sloping sides added together, whence we have $\frac{50}{20.6}$, or 29.13 inches: and the fall in two miles being 8 inches, we have $\sqrt{(8 \times 29.13)}=15.26$ for the mean proportional, of which $\frac{10}{11}$ is 13.9; agreeing exactly with Mr. Watt's observation. Professor Robison has deduced from Buat's elaborate theorems 12.568 inches for the velocity, which is considerably less accurate.

For another example we may take the Po, which falls 1 foot in two miles, where its mean depth is 29 feet; and its velocity is observed to be about 55 inches in a second. Our rule gives 58, which is perhaps as near as the degree of accuracy of the data will allow.

On the whole, we have ample reason to be satisfied with the unexpected coincidence of so simple a theorem with observation: and in order to find the velocity of a river from its fall, or the fall from its velocity, we have only to recollect that the velocity in a second is $\frac{10}{11}$ of a mean proportional between the hydraulic mean depth and the fall in two English miles. This is however only true of a straight river flowing through an equable channel.

For the slope of the banks of a river or canal, Mr. Eytelwein recommends that the breadth at the bottom should be $\frac{2}{3}$ of the depth, and at the surface $\frac{10}{3}$: the banks will then be in general capable of retaining their form. The area of such a section is twice the square of the depth, and the hydraulic mean depth $\frac{2}{3}$ of the actual depth. He then investigates the discharge of a canal of which the bottom is horizontal. The velocity appears in this case to be somewhat greater than in a similar canal, of which the bottom is parallel to the surface.

The author remarks that the velocity is greater near the concave than the convex side of a flexure: a circumstance probably occasioned by the centrifugal force accumulating the water on that side. No general rule can be given for the decrease of the velocity in going downwards: but sometimes the maximum appears to be a little below the surface. In the Arno the velocities are at 2 feet below the surface $39\frac{1}{2}$ inches; at 4, $38\frac{1}{2}$; at 8, 37; at 16, $33\frac{1}{2}$; at 17, 31. In the Rhine at 1 foot, 58 inches; at 5, 56; at 10, 52; at 15, 43. As an approximation to the mean velocity, the author directs us to deduct from the superficial velocity $\frac{1}{130}$ for every foot of the whole depth. For instance; if the depth were 13 feet, and the superficial velocity 5 feet, to take $4\frac{1}{2}$ as the average velocity of the whole river. This can however only be true in large rivers: for in the canal, measured by Mr. Watt, the superficial velocity must be diminished nearly $\frac{1}{5}$ for a depth of only 4 feet. And we may in general come quite as near to the mean velocity by taking $\frac{9}{10}$ of the superficial velocity; although this may still differ materially from the true medium. But comparing this with the former theorem for the velocity, which gives a result oftener above than below the truth, we may bring them both into a form easily recollected, thus;

The superficial velocity of a river is nearly a mean proportional between the hydraulic mean depth and the fall in two miles; and the mean velocity of the whole water is, still more nearly, ninetenths of this mean proportional.

We may find a double confirmation of these principles in Major Rennel's account of the Ganges (Phil. Trans. 1781, p. 87).

He informs us that " at 500 miles from the sea, the channel is 30 feet deep when the river is at its lowest; and it continues at least this depth to the sea," that " a section of the ground, parallel to one of its branches, in length 60 miles, was taken by order of Mr. Hastings;" that " the windings of the river were so great as to reduce the declivity on which the water ran, to less than 4 inches per mile;" that " the medium rate of motion of the Ganges is less than three miles an hour, in the dry months;" that is, its superficial velocity. Now allowing a little for the banks or shelving sides, we may take exactly 30 feet as the hydraulic mean depth; then if the fall in two miles were precisely $\frac{2}{3}$, we should have $\frac{2}{3}\times30=20$; and $\sqrt{20}=4.47$ for the velocity in a second, or 3.05 miles in the hour: which is a little greater than the observed velocity, because the fall was assumed somewhat too great.

Again (p. 110), "the river when full, has thrice the volume of water in it, and its motion is also accelerated in the proportion of 5 to 3. We may assume, that the hydraulic mean depth is doubled at the time of the inundation, whence the velocity will be increased in the ratio of 7 to 5: but the inclination of the surface is probably somewhat increased at the same time, which may easily be supposed to increase the velocity still further, from 1.4 to 1.7.

Chapter 8. Of the discharge and the swell in the case of weres, falls, and contractions, in rivers and canals.

The methods employed in the third chapter require here some modification, since the water arrives at the place of descent with a considerable velocity; and it is evident from mechanical, as well as from hydraulic considerations, that the ultimate velocity will exceed that which is due to the depth of the stream at the place of its descent, and that it will correspond to a height equal to the sum of the heights capable of producing these velocities. Hence we may calculate the effect of a bar in elevating the surface of a river; how broad a were must be, in order to produce a certain elevation, and how much water will run over a given were according to collateral circumstances. When a bar is below the level of the lower water, we must consider the difference of the two levels, as constituting the fall; the whole of the stream below the level of the lower water deriving its additional velocity from this difference only.

The extent of the swell produced by a given elevation of the surface of a river in consequence of the effect of a were or bar, may be determined by calculating from the rules for finding the velocity of rivers, the inclination necessary for producing a given discharge; the depth being greater, the inclination immediately above the bar will be less, but the effect of the swell does not terminate at the point where the new surface, if straight, would have met the original surface; for on account of the rounding off of this angle, it extends nearly twice as far. The effect of reducing the breadth of a river may be determined in a manner nearly similar. The author remarks, that a considerable diminution of breadth produces but a small elevation, a result which appears to be conformable to experience; but that where depth is required for navigation, it may often be obtained by a projection built out from the bank, which may be sufficient to increase the river's velocity, and to cause it to excavate its bed.

Chapter 9. Of the motion of water in pipes.

The author has attempted to simplify this subject nearly in the same manner as that of the motion of rivers, and apparently with considerable success. He observes, that the head of water may be divided into two parts, one of which is employed in producing velocity, the other in overcoming the friction: that the height employed in overcoming the friction must be as the length of the pipe directly; and also directly as the circumference of the section, or as the diameter of the pipe, and inversely as the content of the section, or as the square of the diameter; that is, on the whole, inversely as the diameter; this height too must vary, like the friction, as the square of the velocity.

Hence $f=\frac{al}{d}.v^2$, f denoting the height due to the friction, and a a constant quantity: therefore, $v^2=\frac{fd}{al}$. Now the height employed on the friction, corresponds to the difference between the actual velocity and the actual height, or $f=h-\frac{v^2}{b^2}$, where b is the coefficient for determining the velocity from the height; consequently, $v^2=\frac{b^2dh-dv^2}{ab^2l}$, and $v^2=\frac{b^2dh}{ab^2l+d}$. Now $b=6.6$, and from Buat's experiments, ab^2 is determined to be .0211, which agrees the most accurately where the velocity is between 6 and 24 inches in a second. Whence we have $v^2 = \frac{43.6dh}{.0211l+d}$, or $v = 45.5 \surd\left(\frac{dh}{l+47d}\right)$; but it is somewhat more accurate to make $v = 50 \surd\left(\frac{dh}{l+50d}\right)$; all the measures being expressed in English feet.

When the pipe is bent into angles, or rather arcs, we must diminish the velocity thus found, by taking the product of its square multiplied by the sum of the sines of the several angles of inflection, and then by .0038; which will give the degree of pressure employed in overcoming the resistance occasioned by the angles: and deducting this height from the height corresponding to the velocity, we may thence find the corrected velocity.

Mr. Eytelwein proceeds to investigate, both theoretically and experimentally, the discharge of water by compound pipes, with apertures of various dimensions between them: he allows at each orifice for the contraction of the stream, and calculates the height necessary to produce the increase of velocity in each instance, allowing also for the friction of the pipe. But the velocity thus found is somewhat smaller than the result of his experiments; probably because the whole of the force of the water accelerated at any orifice, is not immediately lost as soon as it arrives at a wider part of the pipe. The ascent of water in a compound pipe, to the level of a reservoir, is next considered, a case which often occurs in pumpwork; and an approximation to the velocity of ascent is deduced from theory and compared with experiment.

Chapter 10. Of jets of water.

This chapter contains little that is new or interesting; it is well known, that the velocity of a jet is greatest when it springs through an orifice in a thin plate, and in this case, the height falls little short of that of the reservoir.

Chapter 11. Of the impulse or hydraulic pressure of water.

There are three principal cases of the impulse of water falling perpendicularly on plane surfaces: when a detached jet of water strikes the plane; when the plane moves in an unlimited extent of water, or is very small in respect to a stream that strikes it; and when the impulse takes place in a limited channel.

Supposing a stream of water to strike against a plane so as to lose all its motion, it is obvious, that the force that destroys the motion must be equal to the force that generates it; that is, to the weight of the column of water operating during the time necessary for its acquiring the given velocity: and the quantity of water arriving during this time, being equal to twice the column of which the length is the height due to the velocity, the hydraulic pressure must be twice the weight of such a column. The relative impulse against a plane in motion, must be determined from the difference of the velocities: but when all the water of a stream strikes against a plane, the effect of the impulse may be more simply determined, as if a solid body struck the plane with the relative velocity; and this is nearly what happens in undershot waterwheels.

When a detached jet strikes against a plane, it appears, from the experiments of Bossut and Langsdorf, that its effect is equal to the weight of an equal column of twice the height due to the velocity; but the plane must be at least four times as large in diameter as the jet; if it be only of the same size, the effect will be but one half as great. In an unlimited stream, the impulse is also nearly determined from the height corresponding to the velocity; and it appears, that the effect is nearly doubled by confining the stream to prevent its diverting laterally from the floatboards.

For oblique surfaces, the effect of a detached jet in its own direction, appears to vary as the square of the sine of the angle of incidence; but, for motions in open water, we must add to this square about $\frac{2}{5}$ of the difference of the sine from the radius; a correction which is tolerably accurate, until the inclination becomes very great. Mr. Eytelwein found the resistance to the motion of a sphere nearly $\frac{4}{5}$ of the resistance to a circle equal to its section: perhaps it was a hemisphere, otherwise it is difficult to reconcile the result with other experiments in which it has appeared to be only $\frac{2}{3}$.

Mr. Eytelwein informs us, that at the temperature 14° of Reaumur, or $63\frac{1}{2}$° of Fahrenheit, a cubic foot of distilled water weighs 66.0656 pounds of Cologne, or 65.9368 commercial pounds of Berlin. According to Sir George Shuckburgh's experiment, an English cubic foot of distilled water at 66° weighs 997 ounces avoirdupois; and water expands for every degree .000165: hence the pound of Cologne is 1.0312 English avoirdupois pounds, and that of Berlin 1.0332.

Chapter 12. Of overshot waterwheels.

The power which operates upon overshot wheels, is divided into two parts, one derived from the weight of the water in the cells or buckets, the other from the impulse of the water falling on it: the effect of the first is constant, that of the second varies with the velocity: the maximum is found to be when the velocity is half that of the water received; but the variable part being the smaller, the rule is of little practical consequence, and the velocity of the wheel is generally greater than this. The author observes, that by turning the stream back upon the nearer half of the wheel, we remove the resistance of the lower water, since it runs off in the same direction with that of the waterwheel.

Chapter 13. Of undershot waterwheels.

The author enters into a minute description of the parts of an undershot waterwheel: he observes, that the most advantageous position for the floatboards in a straight channel is, when they are perpendicular to the water at the time that they rise out of it: that only one half of each should ever be below the surface, and that from three to five should be immersed at once, according to the magnitude of the wheel. When there is sufficient fall, the floatboards should be divided and made into buckets, so that the wheel may become a breast wheel; the position of the external portion being such, that a line drawn through it at the time when the water enters, may divide the vertical radius in the same proportion that it divides the quadrant of the circumference;

that is, if the water is received, for instance, at one third of the quadrant from the bottom, the line must leave one third of the radius above it. A formula is laid down for calculating the actual force of a given stream of water on a wheel, and it is shown, that half the velocity of the stream is that which gives the maximum of effect, the theory agreeing perfectly with the experiments of Smeaton and others: for, since the effect is estimated by the product of the force into the velocity of the parts upon which it acts, and since the force is in this case simply as the relative velocity, because the quantity of water is given, and the whole of it is supposed in all cases to act; therefore, the effect will be expressed by the product of the relative and absolute velocity of the wheel, or $e=va$; but $r=v-a$, v being the velocity of the stream, and $ra=av-aa$, which is obviously greatest when $v=2a$, as is evident either by taking the fluxion, or by considering that the greatest ordinate of a semicircle is the radius.

To show the advantage of breast wheels over common undershot wheels, the author quotes Mr. Banks's experiments. He also observes, that by placing two wheels after each other in the same stream, about one fourth more force may be obtained than either by a single wheel, or by two wheels side by side; but that a single wheel has less friction, and is generally less expensive.

Chapter 14. Of the properties of the air, as far as they relate to hydraulic machines.

What Mr. Eytelwein quotes as Mariotte's discovery of the increase of the air's density in proportion to the pressure, was well known to Hooke and Boyle. From the experiments of Woltmann and Schober, he remarks, that the force of the wind against a perpendicular plane, is nearly equal to four thirds of the weight of a column of air, of a length equal to the height due to the velocity. The height of a column of water nearly equivalent to the force or resistance may be found, by taking the square of $\frac{1}{200}$ of the velocity in a second, in English feet.

Thus, if the velocity were 1000 feet in a second, the resistance would be equal to a column of water in the same surface, 25 feet in height; and the resistance to a sphere about half as much.

For another example, if we had a cubic foot of a substance equal in specific gravity to water, and were desirous of knowing the greatest velocity that it could acquire by falling through the air; the height of the column of water is here 1, and its square root 1, which multiplied by 200 gives 200 feet in a second for the velocity, when the resistance would be equal to the weight, which of course is the limit beyond which the velocity could never pass. Hence we may form an idea of the utmost velocity that a stone, of moderate size, could acquire in descending from the upper regions of the atmosphere, or even from the neighbourhood of the moon; a velocity that would be much less than that of a bomb or a cannon ball, even when it may be followed by the eye.

Again, Mr. Garnerin's parachute contains about 860 square feet of surface, and weighs, together with the aeronaut suspended from it, about 230 pounds. Here the weight is $\frac{23}{86}$ of a pound for each square foot, which is equivalent to $\frac{1}{230}$ of a foot of water; multiplying the square root by 200, we have about 13 feet in a second for the utmost velocity; which is the same, as if one leaped from a height of between two and three feet. Mr. Garnerin, however, finds the mean velocity of descent only eight feet, which agrees better with the experiments of Borda, in which the resistance appeared to be $\frac{5}{3}$ of the weight of the column due to the velocity, and exceeded this proportion as the surface increased in magnitude.

Chapter 15. Of siphons.

For estimating the discharge of a siphon, the head of water must be reckoned equal to the difference between the levels of the surface of the water, and of the lower orifice. The author observes, that the theory of waves has been treated in a new and improved manner by Lagrange in his Mécanique Analytique. The problem is, however, not yet completely solved: Lagrange's formula includes the depth of the water agitated as a given quantity, but it does not inform us how to determine this depth from theory.

Chapter 16. Of sucking pumps.

The length of a sucking pump must never be greater than 30 feet below the moveable valve: and there may be a loss of time in the ascent of the water, unless it be made even a few feet shorter. The motions to be produced, and the resistances to be overcome, are considered in detail: but the author refers, for still further information, to Langsdorf's Treatise on Machinery.

The velocity of the stroke should never be less than four inches, nor greater than two or three feet in a second; the stroke should be as long as possible, to prevent loss of water by the frequent alternations of the valves. The diameter of the pipe should be about $\frac{2}{3}$ or $\frac{3}{4}$ of that of the barrel. The lifting pump is also here described; it only differs from the sucking pump in having the lower valve moveable, and the upper one fixed. A number of valves and pistons are described in this chapter; chiefly from models of English manufactory.

Chapter 17. Of forcing pumps.

In describing the different kinds of solid piston, the author gives the preference to that which has a conical leather projecting on each side; but remarks, that there is another form which has the advantage in the situation of the ring for receiving the rod, which is precisely in the centre of the piston, and is therefore fitter for communicating motion in each direction. He says, that where the barrel is well polished, the piston may be used without either wadding or leather.

The first pump, invented above a century before Christ, by Ctesibius of Alexandria, to whom also music is indebted for the organ, and whose name Mr. Eytelwein mentions in speaking of sucking pumps, was in reality a forcing pump, as may easily be collected from its description by Vitruvius (L. X. cap. 12.).

Chapter 18. Of mixed pumps, or the combination of sucking and forcing pumps.

When the lower valve is above the surface of the water, the forcing pump can only raise the water by suction, but the construction remains the same. Such is Mr. Buchanan's patent ship pump. De la Hire's pump is more complicated; both the ascending and descending strokes of the piston being made effective, by means of a double apparatus of valves and pipes.

Chapter 19. Of acting columns of water.

The mechanism of a pump may be employed for converting the weight of water descending in its barrel, to the purpose of working another pump. The author describes a machine of this kind invented by Mr. Höll, and improved by Langsdorf. A similar arrangement, used in Cornwall, has lately been described in Nicholson's Journal, by Mr. Trevithack. The only objection to it appears to be the magnitude of the friction.

Chapter 20. Of the spiral pump.

If we wind a pipe round a cylinder, of which the axis is horizontal, and connect one end with a vertical tube, while the other is at liberty to turn round and receive water and air in each revolution, the machine is called a spiral pump. It was invented about 1746, by Andrew Wirz, a pewterer in Zurich, and was employed at Florence with Bernoulli's improvement, in 1779. At Archangelsky, near Moscow, a pump of this kind was erected in 1784, which raised a hogshead of water in a minute, to a height of 74 feet, and through a pipe 760 feet in length. The force employed is not mentioned, we may therefore conjecture that it was turned by water. Mr. Eytelwein enters very minutely into calculations of the effect of such a machine under different circumstances; and the results of theory, as well as of experiment are such, as to induce us to expect that it will in time come into common use, instead of forcing pumps of a more complicated and expensive construction. The watertight joint presents the only difficulty: the pipe may form either a cylindrical, a conical, or a plane spiral, and it appears to be uncertain which is the most advantageous: the vertical pipe should be nearly of the same dimensions as the spiral pipe, which may without difficulty be made of wood.

Chapter 21. Of the screw of Archimedes, or the watersnail, and of the waterscrew.

The screw of Archimedes consists either of a pipe wound spirally round a cylinder, or of one or more spiral excavations, formed by means of spiral projections from an internal cylinder, covered by an external coating so as to be watertight. But if the coating is detached, so as to remain at rest while the spirals revolve, the machine is called a waterscrew. Mr. Eytelwein enters into an accurate determination of the effects of these machines in given circumstances, and the results of the theory agree remarkably well with experiment. He observes, that the screw of Archimedes should always be so placed, as to fill exactly one half of a convolution in each turn; and that very unfavourable reports have sometimes been made of the machine from want of attention to this circumstance; for when the orifice remains constantly immersed, the effect is very much diminished: this appears also to have happened in some late experiments in London. Where the height of the water is so variable as to render this precaution impossible, Mr. Eytelwein prefers the waterscrew; although, in this instrument, one third of the water generally runs back, and it is easily clogged by accidental impurities in the water. The screw of Archimedes is generally placed so as to form an angle of between 45° and 60° with the horizon; but the open waterscrew at an angle of 30° only: for great heights, the spiral pump is preferable to either.

Chapter 22. Of bucket wheels and throwing wheels.

In the construction of wheels for raising water in buckets, there is little room for refined theory; whether the buckets be fixed or suspended on an axis. It is sometimes convenient to raise water to the height of 3 or 4 feet by the revolution of a wheel with simple floatboards; and such a wheel may be either in a vertical or an inclined position; it must of course be inclosed in a sweep.

Chapter 23. Of cellular pumps and paternoster works.

Water has been sometimes raised by stuffed cushions connected with an endless rope, and caused by means of two wheels or drums to rise in succession in the same barrel, and to carry water with them: but the magnitude of the friction appears to be an objection. From the resemblance of the apparatus to a string of beads, it has been called a paternoster work. When flat boards are united by chains, and employed instead of these cushions, the machine may, without impropriety, be called a cellular pump: here the barrel is generally square, and placed in an inclined position. But these machines are very rarely employed.

Chapter 24. Of instruments for measuring the velocity of streams of water.

The superficial velocity of a stream is ascertained without difficulty, by observing in calm weather the motion of a body barely floating on it. But it is more difficult to determine the velocity of a river at a considerable depth. Pitot's tube, as improved by Buat, furnishes one of the easiest methods. A funnel is presented to the stream, and the water in a vertical tube connected with it, is elevated above the level of the river, nearly to the height corresponding to the velocity: but the result will be more accurate, if the funnel be covered by a plate perforated only in the centre by a small orifice: in this case, the elevation in the tube will be half as great again as the height due to the velocity. Other instruments for appreciating the impulse of the water against a flat board, require some previous comparative observation. In Woltmann's hydrometrical fly, the number of revolutions of a wheel, in a given time, indicates the velocity of the water, which strikes against two inclined planes, and carries round the arm to which they are fixed.

It is presumed, that this abridged account of Mr. Eytelwein's book, will not only do justice to his diligence and ingenuity, but will convey to the English reader some matter perfectly new, and capable of frequent application in practical hydraulics; which is perhaps of the more value, as there is little probability that the work will be translated at length. To disseminate information of this kind must always be the principal object of the Journals of the Royal Institution. Y.

On the Effect of Sound upon the Barometer. By Sir HENRY C. ENGLEFIELD, *Bart. F.R.S.*

During the time I spent at Brussels in the years 1773 and 1774, it occurred to me, that the effect of sound on the barometer had not, to my knowledge, been attended to; and that it was by no means certain, whether that instrument was capable of being sensibly affected by those elastic vibrations caused in the atmosphere, by the percussion of a sonorous body. I thought the idea worthy of being pursued, and the means of making satisfactory experiments were most opportunely in my power.

The sound of a very large bell appeared to me the most powerful, and, at the same time, to be approached with the greatest security and ease to the observer. The explosion of artillery, besides the very disagreeable smoke and danger of the recoil, might be objected to, on account of the sudden production of elastic and heated vapour, which might, independent of the sound, instantaneously alter the state of the atmosphere, and thereby lead the observer into very great and unavoidable errors.

Every one who has been in the Low Countries must know, that very large bells, and immense numbers of them, are the pride of their churches, and that they are rung quite out, not tolled, on every great festival. The great bell of the collegiate church of St. Gudula, at Brussels, weighs, as I was told, sixteen thousand pounds, and on this I determined to found my experiment.

Two objections only could be made to the result of this trial, the one, that the motion of the bell might cause a vibration in the walls of the building, which would hinder the placing the barometer in a state of repose; the other, that the swinging so large a mass with a considerable degree of velocity, might of itself agitate the air so as to cause vibrations in the mercury, totally independent of sound.

The strength of the walls of the steeple, and manner of hanging the bell, which was contained in a frame of timber, founded on a strong vault, and totally independent of the walls of the steeple, might alone have answered the first of these objections, but happily a most complete and satisfactory answer to both of them was furnished by the manner in which the bell was rung.

As the bell was to ring out full in an instant, at a signal given from below; it is necessary to have it in motion some time beforehand; and during that time, the clapper is fixed to one side by a strong stick crossing the mouth of the bell, which, at the signal, is pulled out by the hand of a person placed for that purpose. If then, our barometer showed no variation during all this time; we were absolutely certain that whatever motion was perceived afterwards, was wholly owing to the sound.

Mr. Pigott who was then at Brussels, was kind enough to lend me one of his barometers, made by Ramsden, and his son made the following observations jointly with myself.

At 2 o'clock in the afternoon of the first of November 1773, we went into the northwest tower of St. Gudula's church, and having fixed the barometer firmly in the opening of a window, not above 7 feet from the bottom of the bell, we waited quietly for its ringing.

The height of the mercury before the bell began to swing as observed by Mr. Pigott, was 29.478 inches. The bell being in full swing no alteration whatever was perceptible.

The instant that the clapper was loosed, the mercury leaped up, and continued that sort of springing motion at every stroke of the clapper, during the whole time of the ringing of the bell. These were our observations.

During the ringing of the bell, Mr. P.	29.469
During the ringing, by myself	
Highest	29.480
Lowest	29.474

Highest	29.482
Lowest	29.472

These observations were made with the greatest attention; and considering their delicacy and the difficulty of observing, agree very nearly. They appear to give from 6 to 10 thousandths of an inch for the effect of this sound on the barometer. It is to be observed, that Mr. Pigott in general, estimated the height of the mercury about 5 thousandths lower than myself, which brings our observations to a very near agreement. The following observations prove this.

On the top of the tower Mr. P.	29.424
Ditto, by me	29.430
At the foot of the tower Mr. P.	29.639
Ditto, by me	29.642
In the court of the English Nuns, by Mr. Pigott	29.676
Ditto, by me.	29.682

And I should think, that the difference of eyes may frequently cause such a variation among different observers; at least, in delicate observations, it will be always prudent to make the experiment.

Note by DR. YOUNG.

These observations appear to agree too well with each other, to allow us to doubt of their accuracy. It therefore becomes necessary to inquire after the cause of the different heights of the barometer. It is indeed barely possible, that a sudden stroke of the clapper on the bell might produce a greater agitation of the building than the preceding alternate motion of the bell itself: but this explanation cannot be called satisfactory. It is certain, that there was neither more nor less air in the tower while the bell was sounding, than while it was silent; the mean density of the air could therefore not have been changed; and if the alternate motions of the particles of air which constitute sound, had taken place by equal degrees and with equal velocities in each opposite direction, there is no reason to suppose that the increase of pressure on the surface of the mercury, at one instant, could have tended to raise it, more than the decrease of pressure, in the opposite state of the undulation, would have depressed it. But the same consequence does not follow, if we conceive the motion of the air in advancing to be more rapid, but of shorter continuance, than its retrograde motion. For if the wind blew for one hour with a velocity of 4, and the same air returned in the course of two hours with a velocity of 2, an obstacle upon which it had acted in both directions, would not be found in its original place; for the action of the wind upon an obstacle, is as the square of the velocity, and the time would not compensate for the difference of force. It is therefore easy to suppose, that the law of the bell's vibration was in this experiment such, that the air advanced towards the barometer with a greater velocity than it receded, although for a shorter time, and that hence the whole effect was the same as if the mean pressure of the air had been increased. Such a law might easily result from a combination of a more regular principal vibration with one or more subordinate ones, in different relations; and similar cases may sometimes be observed in the vibrations of chords. Here we find a slight degree of repulsion in consequence of the undulations of an elastic medium. Dr. Hooke attempted to explain the phenomena of attraction, by means of similar undulations of an ether, which he supposed to be the medium serving for the communication of heat, but it must be confessed, that the conjecture has little appearance of probability.

ROYAL SOCIETY.

The Count de Bournon's paper on corundum, was concluded on the 13th of May. After having considered the matrix of imperfect corundum from the peninsula of India, with the feltspar, the fibrolite, the thallite, or epidote of Haüy, the hornblende, the quartz, the talc and mica, the garnets, the zircon, and the black oxid of iron, that this matrix usually contains, some of them substances now first named, the author proceeds to the matrix of imperfect corundum from China, and from the kingdom of Ava, which is a granite rock, composed of feltspar, fibrolite, mica, and black oxid of iron, without the peculiar substance, which is the basis of the matrix of the imperfect corundum from the Carnatic: sometimes a little chlorite and thallite occur in this matrix. Next, the matrix of perfect corundum from Ceylon is investigated, but it is principally from conjecture that the author determined the spinelle ruby to be one of the substances accompanying it, since it is found in the sands, together with the corundum. The crystals of the spinelle are described as either complete tetraedrons, or rhomboids with plane angles of 60°, or dodecaedrons, or lastly tetraedral prisms terminated by pyramids: its colour is often yellowish or bluish. Its matrix is sometimes a calcarious stone, and sometimes a kind of adularia. Another substance frequently found in these sands is the tourmalin. Its primitive crystal is a very obtuse rhomboid; the solid angle being 139°; the second form is a prism, either hexaedral, enneaedral, or dodecaedral, abruptly terminated; and there are some other varieties: the colour differs very considerably in different specimens; it is sometimes yellowish, bright green, or purplish red; and sometimes the crystals are colourless. A specimen of remarkable magnitude and beauty is mentioned, which was presented to Mr. Symes by the sovereign of Ava, and placed by him in Mr. Greville's collection. The Ceylonite of Lametherie, or the pleonast of Haüy, is also found in the sands of Ceylon; it is usually of a brownish green, and it greatly resembles the spinelle, but is somewhat softer. Small crystals of zircon, with scattered fragments of some other stones, help also to compose this sand, as it is sent to Europe. Of all these substances, the spinelle is the most abundant.

It appears to be doubtful, whether or no corundum is found in any part of the world, except the East Indies; yet the Count de Bournon has reasons for thinking that it has been discovered in some of the mountains of France. But the specimens from Germany and from Tiree, appear to have been of other descriptions. Whether or no it has been found in the neighbourhood of Philadelphia, is a disputed point. Mr. Haüy considers the specimens from the neighbourhood of Montbrison as a harder kind of feltspar; but the Count de Bournon is persuaded that they are corundums, nearly resembling the sapphire, but combined in some degree with feltspar. The emeralds found in the same place are more strongly characterized.

On the 6th of May, Dr. Herschel's observations on the two lately discovered celestial bodies were read.

Dr. Herschel begins with stating the result of his attempts to measure the diameter of the stars discovered by Piazzi and Olbers. He employed the lucid disc micrometer, which consists of an illuminated circle viewed with one eye, while the other compares with it the magnified image formed by the telescope; and he concludes, that the apparent diameter of Ceres was .22″, and of Pallas .17″ or .13″, at the distance of nearly 1.634, and 1.187 from the earth respectively, whence the apparent diameters at the distance of the earth from the sun would be .35″ and .21″ or .16″ respectively, and that their real diameters are about 163 and 95 or 71 English miles. There is no probability that either of these stars can have a satellite. The colour of Ceres is more ruddy than that of Pallas. They have generally more or less of a haziness, or coma, but sometimes, when the air is clear, this nebulosity scarcely exceeds the scattered light surrounding a very small star. From a view of all these circumstances, Dr. Herschel proceeds to consider the nature of the new stars. He thinks that they differ from the general character of planets, in their diminutive dimensions, in the great inclination of their orbits, in the coma surrounding them, and in the mutual proximity of their orbits: that they differ from comets in the want of eccentricity, and of a considerable nebulosity. Dr. Herschel, therefore, wishes to call them asteroids, a term which he defines as a celestial body, which moves round the sun in an orbit either little or considerably eccentric, of which the plane may be inclined to the ecliptic in any angle whatever, the motion being either direct or retrograde, and the body being surrounded or not by a considerable atmosphere or a very small coma. This definition is intended to include such other bodies of the same kind as, Dr. Herschel supposes, will, in all probability, be hereafter discovered. Some additional observations show, that the apparent comas surrounding Ceres and Pallas, scarcely exceed those which are caused by aberration round the images of minute fixed stars.

The meetings of the 20th and 27th of May were occupied by an analysis of corundum, and of some of the substances which accompany it, with observations on the affinities which the earths have been supposed to have for each other in the humid way. By Richard Chenevix, Esq. F.R S. and M.R.I.A.

After several ineffectual attempts to procure a solution of corundum, Mr. Chenevix succeeded by means of subborate of soda, or common borax. He took 100 grains of corundum, and having pulverised it in a steel mortar, after repeatedly plunging it when red hot into cold water, he washed off by muriatic acid whatever iron might have adhered to it, and then levigated it in a mortar of agate, noting the augmentation of its weight in the operation. He exposed the powder with 200 grains of calcined borax in a crucible of platina to a violent heat; it was then boiled in the same vessel with muriatic acid, which in about 12 hours dissolved the glass. The earths were precipitated by an alkaline carbonate; and being redissolved in muriatic acid, the silica was separated by evaporation. The alumina was precipitated and redissolved by an excess of potash, and separated from it by muriate of ammoniac. The process is particularly exemplified in the instance of the sapphire, in which Mr. Chenevix found about one twentieth of its weight of silica, although Mr. Klaproth could scarcely perceive the presence of any silica. The constituent parts of many different corundums are enumerated; they all agree in the great proportion of alumina. The matrix from the peninsula of India contained silica, alumina, lime, iron, and a small quantity of manganese: the feltspar found in it, consisted of nearly the same ingredients, with a greater preponderance of silica; but the fibrolite was remarkable for being composed almost wholly of alumina and silica, in the proportion of 3 to 2: the thallite contained besides these two earths, considerable portions of lime and iron. The fibrolite of the matrix from China contained alumina, silica and iron. The feltspar from Ceylon differed but little from the Indian specimens. Mr. Chenevix observes that in such analyses, crucibles of platina or silver ought to be exclusively employed: but that for boiling earths in potash, silver must be preferred, since platina is copiously dissolved by potash, its affinity with this alkali being such as to enable it to form triple salts with it, a property which the Spanish government employs for detecting platina in gold. Mr. Chenevix thinks, that the reddish colour produced in a weak solution of platina by muriate of tin, is a more delicate test of its presence. He observes, that neither potash nor soda, is, properly speaking, a fixed alkali, especially when a little water is present.

In the second part of the paper, Mr. Chenevix considers the supposed affinities of the earths for each other. He had himself maintained the existence of some of these affinities: Kirwan and Guyton had carried the opinion much further. But Mr. Darrac has combated this extension of the doctrine with considerable success, and Mr. Chenevix has repeated most of his experiments with a similar result. Dr. G. M. at Freyberg, has excited further doubts on the subject. Mr. Chenevix here enumerates the experiments of Guyton, and considers them all as inaccurate, except those which related to the solution of silica in potash, and which were not new; and even these he thinks scarcely sufficient to justify, without further examination, the conclusion of an affinity between this earth and others: and he explains Guyton's error from the impurity of his materials, especially from the presence of sulfuric acid, which Mr. Chenevix detected in the precipitates whenever they occurred. The solubility of silica in acids after the action of an alkali, is, he thinks, a circumstance which has given the greatest superiority to all modern analyses; and the solution is in some measure facilitated by the presence of alumina. Alumina also appears to be capable of entering into combination with magnesia, so as no longer to be taken up by potash; and the same earth seems to promote the solution of lime in potash. So that on the whole, the existence of affinities between some of the earths appears to be established, although not to the extent supposed by M.M. Kirwan and Guyton. Mr. Chenevix allows the truth of Mr. Berthollet's position respecting the effect of masses on chemical affinities, but observes, that this effect is by no means unlimited; and that the proposition, if true in its full extent, would very much increase the difficulties of chemical analyses, and lessen the important benefits which they confer on the science of mineralogy. Y.

An Account of some Experiments on Galvanic Electricity, made in the Theatre of the Royal Institution. By H. Davy.

The apparatus employed in these experiments, was composed of 150 series of plates of copper and zinc of 4 inches square, and 50 of silver and zinc of the same size. The metals were carefully cemented into four boxes of wood in regular order, after the manner adopted by Mr. Cruikshank, and the fluid made use of was water combined with about $\frac{1}{100}$ part of its weight of nitric acid*.

The shock taken from these batteries in combination, by the moistened hands, was not so powerful but that it could be received without any permanently disagreeable effects.

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* Messrs. Van Marum and Pfaff, Journal de Chimie, par Van Mons, have attempted to show, that acids are less efficacious than muriate of ammoniac in increasing the power of the pile; but their experiments were made with cloths, a case in which the series can only be constructed slowly, and where, when they are numerous, the acid in those first formed must be wholly, or in a great measure, decomposed before the last are put together. To those who have been accustomed to operate with boxes, troughs, or glasses, in which the communication by the fluids is very speedily effected, there can be no doubt of the superiority of the nitric and muriatic acids over muriate of ammoniac, muriate of soda, and the alkalies, in increasing all the sensible galvanic effects.

Charges were readily communicated by means of them to coated jars, and to a battery; but in this case, the effects produced by the electricity were much less distinct than in the case of immediate application.

When the circuit in the batteries was completed, by means of small knobs of brass, the spark perceived was of a dazzling brightness, and in apparent diameter at least $\frac{1}{8}$ of an inch. It was perceived only at the moment of the contact of the metals, and it was accompanied by a noise or snap.

When instead of the metals, pieces of well burned charcoal were employed, the spark was still larger, and of a vivid whiteness, an evident combustion was produced, the charcoal remained red hot for some time after the contact, and threw off bright coruscations.

Four inches of steel wire, of $\frac{1}{170}$ of an inch in diameter, on being placed in the circuit, became intensely white hot at the point of connexion, and burnt with great vividness, being at the same time red throughout the whole of their extent.

Tin, lead, and zinc, in thin shavings were fused, and burnt at their points of contact in their circuit, with a vivid light, and with a loud hissing noise. Zinc gave a blue flame, tin a purplish, and lead a yellow flame, violet at the circumference.

When copper leaf was employed, it instantly inflamed at the edges with a green light and vivid sparks, and became red hot throughout the whole of its diameter, when it did not exceed four inches.

Silver leaf gave a vivid light, white in the centre and green towards the outline, with red sparks or coruscations. Platina in thin slips, when made to complete the circuit, became white hot and entered into fusion, and gave scintillations at the edges; but whether any part was converted into oxide could not be accurately determined.

When gold leaf, attached by gum water to white paper, was burnt by the spark, the light was of a bright yellow, and the noise comparatively loud; the gold was converted into an oxide of a purplish brown colour, which firmly adhered to the paper; and by regulating the course of the spark by means of the communicating wire, letters and figures were traced by the combustion, which appeared semitransparent when exposed to the light.

When the galvano-electric spark was taken, by means of two pieces of charcoal, partially covered with cotton, the cotton was readily inflamed; whether in its simple state, or sprinkled over with resin or sulphur.

Fulminating mercury and gunpowder were deflagrated by means of the communication by charcoal; and hydrogene, and the compound inflammable gases were readily made to burn when simply in contact with the atmosphere; and to detonate when mixed with oxygene.

A few only of these results have any claim to originality. On the phenomena of the combustion of bodies by galvanism, we have been already furnished with many striking experiments, by our own countrymen, and by the German and French philosophers. And after the path is once discovered in researches of this kind, to pursue it requires but little ability or exertion. An account of common facts, under new circumstances, particularly when they are accompanied by striking phenomena, can however, never be wholly useless; and it sometimes gives a novel interest to the subject, and tends to awaken curiosity.

Lectures delivered in the Theatre of the Royal Institution.

DR. YOUNG'S *Lectures on Mechanics.*

The subjects of the twelfth lecture, delivered the 3d of March, were architecture and carpentry. It was observed, that the advantage of forming a beam so as to have a considerable depth in a vertical direction, is not only generally known, but sometimes much overrated. But, although the strength is merely as the square of the depth, the stiffness is as its cube; since the utmost strength is exerted at a less angular flexure in proportion as the beam is deeper; and it often happens, that stiffness is as useful as strength. Dr. Hooke's theory of the arch was illustrated, by means of models of beads and rods connected by flexible substances, so as to show, that the same form affords the stable equilibrium of a chain, and the tottering equilibrium of an arch. A chain was also loaded with portions of a similar chain placed at equal distances, and trimmed off so as to represent the road way of a bridge: the form thus determined for an arch, differed very little, in the case of the experiment, from a circular arch of about 120°. In illustration of the construction of roofs, a model of a roof by the late Mr. Reveley was exhibited; it was obligingly lent, for the occasion, by his brother. With respect to the slope of a roof, Dr. Young observed, that the only advantage of a high roof in point of strength, is the avoiding a great transverse thrust upon the walls or tie beam; and that, in other respects, a low roof is stronger than a high one. A box of models of the iron work of gates, presented to the Royal Institution by Mr. Parker, was also introduced and explained.

The thirteenth lecture was employed in the consideration of wheelwork, and of cordage. Among the modes of communicating motion, Dr. Hooke's universal joint was mentioned as very useful in some cases, where a connexion is to be formed between two axes little inclined to each other; but in great obliquities, it was observed, that the motions of the two axes no longer keep pace with each other, nearly for the same reason as the sun's uniform motion in the ecliptic becomes a variable motion when referred to the equinoctial, and produces part of the equation of time. A specimen of a chain made of wire, by a machine of Mr. Vaucanson, which had been presented to the Royal Institution by Professor Pictet, was exhibited as very proper for communicating slow motions to a distant wheel, by receiving pins, fixed on the circumference, into its links. The property of the involute of a circle, by which it is capable of communicating equable motion between two wheels, of which the teeth are formed according to it, was demonstrated by two surfaces terminated by this curve, and fixed on centres at a proper distance from each other, so that right lines drawn from each centre, and dividing the surfaces into equal angular parts, always met each other as the different parts of the curves came successively into contact. The friction or lateral adhesion of spiral fibres, on which the strength of union by twisting depends, was illustrated by its application to retard the descent of a weight in the rope coiled round the grooved cylinder of the fire escape. Specimens of ropes and cordage, of different kinds, were furnished by Messrs. Huddart and Co.; and the advantage of the more equable tension of the fibres in their patent cordage, was shown to be as consonant to theory as to experiment.

The next lecture was on the economy of motion, and on its regulation by timekeepers. Several models of different escapements were introduced; they were made on a large scale for the use of these lectures. Mr. Haley also permitted Dr. Young to exhibit an excellent model of his detached escapement.

The different machines for raising and removing weights were considered in the sixteenth lecture. Some of them were illustrated by models made by the late Mr. Ferguson, and obligingly lent to the Royal Institution by Dr. Lettsom, who purchased the whole of Mr. Ferguson's apparatus. But for the greater number of inventions for these purposes, Dr. Young was obliged to refer to the figures and descriptions contained in Leupold's Theatre of Machines, and the Transactions of the Society for the Improvement of Arts. On the subject of carriages, it was observed, that the circumstances in which a low wheel has any advantage over a high one are so rare, that the arguments in favour of low wheels could only have been supported by collateral circumstances in the experiments, or by the nature of the materials to be employed; and that in common spring carriages, much of the irregular motion occasioned by the roughness of the road is converted into rotatory motion, but that in long coaches, this can scarcely happen in any degree, so that those who find the motion of a common coach inconvenient, would do well to try if the motion of a long coach might not be less disagreeable to them.

The seventeenth lecture, on presses, mills, and other instruments, mentioned in the three last sections of the Syllabus, concluded the mechanical part of the course. Dr. Young insisted particularly on the efficacy of velocity, in all machines intended for penetration, or for division, and observed, that the attempt to substitute the pressure of a screw for the percussion of a hammer, in driving bolts, could only have originated from inattention to this principle. On the subject of warlike engines, he read a translation from Plutarch's life of Marcellus, describing the exertions of Archimedes in the defence of Syracuse, but remarked, that the opinions attributed to Archimedes, who is represented as esteeming all that related to practical mechanics ignoble and sordid, in comparison with the pure contemplation of abstract truth, could scarcely have been the genuine sentiments of that great and admirable mathematician.

An Account of a method of copying Paintings upon Glass, and of making Profiles, by the agency of Light upon Nitrate of Silver. Invented by T. Wedgwood, *Esq. With Observations by* H. Davy.

White paper, or white leather, moistened with solution of nitrate of silver, undergoes no change when kept in a dark place; but, on being exposed to the day light, it speedily changes colour, and, after passing through different shades of grey and brown, becomes at length nearly black.

The alterations of colour take place more speedily in proportion as the light is more intense. In the direct beams of the sun, two or three minutes are sufficient to produce the full effect. In the shade, several hours are required, and light transmitted through different coloured glasses, acts upon it with different degrees of intensity. Thus it is found, that red rays, or the common sunbeams passed through red glass, have very little action upon it: yellow and green are more efficacious; but blue and violet light produce the most decided and powerful effects*.

The consideration of these facts enables us readily to understand the method by which the outlines and shades of paintings on glass may be copied, or profiles of figures procured, by the agency of light. When a white surface, covered with solution of nitrate of silver, is placed behind a painting on glass exposed to the solar light; the rays transmitted through the differently painted surfaces produce distinct tints of brown or black, sensibly differing in intensity according to the shades of the picture, and where the light is unaltered, the colour of the nitrate becomes deepest.

When the shadow of any figure is thrown upon the prepared surface, the part concealed by it remains white, and the other parts speedily become dark.

For copying paintings on glass, the solution should be applied on leather; and, in this case, it is more readily acted upon than when paper is used.

After the colour has been once fixed upon the leather or paper, it cannot be removed by the application of water, or water and soap, and it is in a high degree permanent.

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* The facts above mentioned are analogous to those observed long ago by Scheele, and confirmed by Senebier. Scheele found, that in the prismatic spectrum, the effect produced by the red rays upon muriate of silver was very faint, and scarcely to be perceived; whilst it was speedily blackened by the violet rays. Senebier states, that the time required to darken muriate of silver by the red rays, is 20 minutes, by the orange 12, by the yellow 5 minutes and 30 seconds, by the green 37 seconds, by the blue 29 seconds, and by the violet only 15 seconds. Senebier sur la Lumière, Vol. III. p. 199.

Some new experiments have been lately made in relation to this subject, in consequence of the discoveries of Dr. Herschel concerning the invisible heat-making rays existing in the solar beams, by Messrs. Ritter and Böckmann in Germany, and Dr. Wollaston in England.

It has been ascertained, by experiments upon the prismatic spectrum, that no effects are produced upon the muriate of silver by the invisible heat making rays which exist on the red side, and which are least refrangible, though it is powerfully and distinctly affected in a space beyond the violet rays out of the visible boundary. See Annalen der Physik, siebenter Band, 527. D.

The copy of a painting, or the profile, immediately after being taken, must be kept in an obscure place. It may indeed be examined in the shade, but, in this case, the exposure should be only for a few minutes; by the light of candles or lamps, as commonly employed, it is not sensibly affected.

No attempts that have been made to prevent the uncoloured parts of the copy or profile, from being acted upon by light have as yet been successful. They have been covered with a thin coating of fine varnish, but this has not destroyed their susceptibility of becoming coloured; and even after repeated washings, sufficient of the active part of the saline matter will still adhere to the white parts of the leather or paper, to cause them to become dark when exposed to the rays of the sun.

Besides the applications of this method of copying that have been just mentioned, there are many others. And it will be useful for making delineations of all such objects as are possessed of a texture partly opaque and partly transparent. The woody fibres of leaves, and the wings of insects, may be pretty accurately represented by means of it, and in this case, it is only necessary to cause the direct solar light to pass through them, and to receive the shadows upon prepared leather.

When the solar rays are passed through a print and thrown upon prepared paper, the unshaded parts are slowly copied; but the lights transmitted by the shaded parts, are seldom so definite as to form a distinct resemblance of them by producing different intensities of colour.

The images formed by means of a camera obscura, have been found to be too faint to produce, in any moderate time, an effect upon the nitrate of silver. To copy these images, was the first object of Mr. Wedgwood, in his researches on the subject, and for this purpose he first used the nitrate of silver, which was mentioned to him by a friend, as a substance very sensible to the influence of light; but all his numerous experiments as to their primary end proved unsuccessful.

In following these processes, I have found, that the images of small objects, produced by means of the solar microscope, may be copied without difficulty on prepared paper. This will probably be a useful application of the method; that it may be employed successfully however, it is necessary that the paper be placed at but a small distance from the lens.

With regard to the preparation of the solution, I have found the best proportions those of 1 part of nitrate to about 10 of water. In this case, the quantity of the salt applied to the leather or paper, will be sufficient to enable it to become tinged, without affecting its composition, or injuring its texture.

In comparing the effects produced by light upon muriate of silver, with those produced upon the nitrate, it seemed evident, that the muriate was the most susceptible, and both were more readily acted upon when moist than when dry, a fact long ago known. Even in the twilight, the colour of moist muriate of silver spread upon paper, slowly changed from white to faint violet; though under similar circumstances no immediate alteration was produced upon the nitrate.

The nitrate, however, from its solubility in water, possesses an advantage over the muriate: though leather or paper may, without much difficulty, be impregnated with this last substance, either by diffusing it through water, and applying it in this form, or by immersing paper moistened with the solution of the nitrate in very diluted muriatic acid.

To those persons not acquainted with the properties of the salts containing oxide of silver, it may be useful to state, that they produce a stain of some permanence, even when momentarily applied to the skin, and in employing them for moistening paper or leather, it is necessary to use a pencil of hair, or a brush.

From the impossibility of removing by washing, the colouring matter of the salts from the parts of the surface of the copy, which have not been exposed to light; it is probable, that both in the case of the nitrate and muriate of silver, a portion of the metallic oxide abandons its acid, to enter into union with the animal or vegetable substance, so as to form with it an insoluble compound. And, supposing that this happens, it is not improbable, but that substances may be found capable of destroying this compound, either by simple or complicated affinities. Some experiments on this subject have been imagined, and an account of the results of them may possibly appear in a future number of the Journals. Nothing but a method of preventing the unshaded parts of the delineation from being coloured by exposure to the day is wanting, to render the process as useful as it is elegant.

From the JOURNAL de CHIMIE et de PHYSIQUE. By J. B. VAN MONS. No. 5. p. 173.

"*Decouverte, &c.*" *Discovery of two New Gases. By* M. C. F. BUCHOLZ.

From the title of this extract, which is taken from Crell's Chemical Annals, 1801, No. 2, one is lead to expect much more than it really contains. Mr. Bucholz in endeavouring to ascertain the nature of the action of ignited charcoal and carbonate of barytes on each other, found that a considerable quantity of inflammable gas was evolved in the process. From his experiments on this gas, it appeared to be chiefly composed of the gaseous oxide of carbon of Cruikshank, combined with an aëriform fluid analogous to the prussic acid. His observations are not detailed at full length, and he promises to give, at a future time, a more complete statement of facts. With regard to his conclusion, that the nitrogene of the prussic acid is supplied by the barytes, few chemists will probably be at present of the same opinion. He operated in an earthen retort, which, as is well known, becomes at a high degree of heat capable of transmitting volatile products from the fire; and no mention is made of the absolute purity of the materials employed. When so important a discovery as that of the decomposition of a body before considered as simple, is supposed to have been made, we have a right to expect the greatest precision and accuracy of experiment, and till they are attained it is much better to doubt than to amuse ourselves with hopes that are too often vain.

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"*Examen, &c.*" *Chemical Examination of a New Gas, composed of Hydrogene, Carbon, and Phosphorus. By* J. B. TROMMSDORFF.

Mr. Trommsdorff obtained this gas during the decomposition of phosphoric acid by ignited charcoal. In its common state it is mixed with carbonic acid, which may be separated from it by agitation in lime water.

The new gas is nearly of the same specific gravity as common air; it is insoluble in water, and undergoes no change when mixed with oxygene, at common temperatures; but it detonates with that aëriform fluid by the action of heat. It is possessed of no agency upon the solutions of metallic oxides which are not reducible by heat, but it decomposes the fluid saline compounds containing gold, silver, or mercury. During its combustion with oxygene, water, phosphoric acid, and carbonic acid are formed, and hence Mr. Trommsdorff is inclined to conclude that it is a triple compound of phosphorus, hydrogene, and carbon; and he proposes to call it by a name, which may be translated by the term of phosphorated carbonated hydrogene gas.

A part only of the memoir from which this account is taken is as yet published. Concerning the action of the new gas upon metallic solutions, and other phenomena presented by it, the learned author promises to enter upon some additional details. Without wishing to anticipate any of his reasonings upon the subject; with the simple hope of throwing out a hint for future discussions, we shall venture a general observation or two in relation to it.

If hydrogene exists in the gas, it must apparently arise from the decomposition of water contained by the concrete acid or the charcoal; for, as would appear probable from the experiments of Desormes and Clement*, well burnt charcoal contains no ascertainable quantity of combined hydrogene. By separately igniting the phosphoric acid and the charcoal, before they were made to act on each other, the water contained by them would be driven off; and, under such circumstances, it would be curious to ascertain if the gas of Mr. Trommsdorff would be produced.

As phosphorus has a very strong affinity for oxygene, we should be disposed, a priori, to conclude, in reasoning upon the facts lately discovered concerning the gaseous oxide of carbon, that this substance would be formed and evolved with the carbonic acid in the process of the decomposition of phosphoric acid by charcoal. Is it not possible that the new gas may be a mixture of a triple compound of carbon, phosphorus, and oxygene, with carbonated hydrogene produced from the decomposition of water united to the primary ingredients? There is nothing in the experiments detailed in the memoir which militates against this supposition, and it might be submitted to the proof of a new experiment, at the same time with the theory of the author. D.

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* Annales de Chimie, No. 125. An account of these experiments will appear in our next number.

"*At a Meeting of the Managers of the Royal Institution of Great Britain, held at the House of the Institution, on the 5th Day of April,* 1802,

"*Resolved,* That the Resolution of the Managers of the Royal Institution, of the 31st of March, 1800, Article 4," already inserted in the Journals, "be communicated to the Royal Society; and that the Royal Society be requested to direct their Secretaries to communicate, from time to time, to the Editor of the Journals of the Royal Institution, such information respecting the papers read at the meetings of the Society as it may be thought proper to allow to be published in those Journals."

"*At a Meeting of the Council of the Royal Society, on the 15th of April,* 1802,

"*Resolved,* That the Council agree to the request of the Royal Institution, as expressed in the above minute of the 5th of April, and that they thankfully accept the offer made them in the minute of the 31st of March."

In consequence of this resolution, the editors of the Journals of the Royal Institution have the privilege of inspecting all the papers communicated to the Royal Society, and of extracting from them such notices as they may think interesting to the public, without being sufficient to supersede the necessity of consulting the original memoirs, when printed in the Philosophical Transactions.

Miscellaneous Extracts from the Tenth Volume of GILBERT's *Annalen der Physik,* 1802.

Mr. Lüdicke of Meissen has published in these annals a comparison of Mr. Leslie's hygrometer, consisting of two spirit thermometers, with hygrometers of other kinds: and he considers the result as highly favourable to the instrument. He proposes to improve it, by employing two mercurial thermometers with very fine tubes, fixed to the same support, and having their bulbs very near together: one of the tubes is to be curved; and the bulb, being first blown larger than is necessary, is to have a portion depressed, so as to form a dish for the reception of water, which it will supply for many hours, without the interruption occasioned by renewing it: the cold produced by the evaporation is then considered as the measure of the dryness of the air. It would however be easy to supply the quantity of water necessary, without giving the bulb a form so peculiar. The hair hygrometer appeared in the comparison to indicate the maximum of moisture too early.

In No. 2, we find an abridgement of the hygrometrical theory of Professor Parrot, of Riga. He considers the moisture contained in air as existing in two distinct states, of chemical and of physical vapour: he thinks the chemical vapour is sustained merely by the oxygen gas contained in the air, and that it is precipitated in consequence of the diminution of the oxygen; and the physical vapour he supposes to be merely interposed between the interstices of the elastic particles of air, and retained in its situation by heat: that the chemical solution of water or ice resembles oxydation, but that no physical evaporation can take place under the freezing point. Mr. Parrot builds his theory principally on eudiometrical experiments with phosphorus, which are attended with a copious precipitation, while the absorption of oxygen seems also to be much accelerated by the presence of water; but these experiments do not appear to be, by any means, decisive in favour of Mr. Parrot's theory. The same paper contains a proposal for inoculating the clouds with thunder and lightning, by projecting a bomb to a sufficient height.

Several German naturalists are employed in making comparative observations on shooting stars, and in calculating their actual situations. Dr. Benzenberg, in Hamburg, has communicated a continuation of these observations, made in the course of the autumn, although the season was not favourable. He gives two instances in detail. September 15. A shooting star of the fifth magnitude. Elevation of the beginnig 7.7 geographical miles, of the end 8.2. Length of the path 1.5 miles. Longitude of the place of disappearance 28° 3′; Latitude 53° 22′. Observed by Brandes, in Ekwarden, and Benzenberg, in Ham, near Hamburg; length of the base 14 miles. October 3. Another of the fourth magnitude observed by the same persons. The termination 7.1 geographical miles above the earth. Longitude 27° 7′; Latitude 53° 5′. These observations show, says Dr. Benzenberg, that a long base will furnish as accurate a comparison as a shorter one; that even meteors of the fourth and fifth magnitude may be seen at places distant above fourteen geographical miles from each other; and they confirm the former observations made at Gottingen with a base of but one or two miles. Dr. Pottgiesser, in Elberfeld, forty miles distant from Hamburg, saw a meteor on the 2nd of October, in the zenith, which appears to have been the same as was seen at Hamburg in the horizon; its height is estimated at 25 miles. It is intended to continue these observations with unremitting assiduity.

No. 3. Description of a new instrument for measuring the expansive force of steam, and of experiments performed with it, by Beker and Rouppe, of Rotterdam; from the Transactions of the Society at Rotterdam. These experiments appear to coincide very accurately with those of Professor Schmidt, and to confirm his formula for ascertaining the height of a column of mercury, equivalent to the expansive force, in hundredths of a French inch, by raising the temperature t, in degrees of Reamur, to the power $1.4113 + .005t$, or $e = t^{1.4113+.005t}$. It appears from the table of the results, that the expansive force of steam at 247½° was equal to two atmospheres, the barometer being at 29 Rhinland, or 29.87 English inches; and at 270½° to three atmospheres. The force was measured by the height of a barometrical column of mercury inserted into the digester. In Professor Robison's experiments, the elasticity appeared to be a little greater (Enc. Br. XVII, p. 739).

This number contains also experiments of Simon, who asserts that no change of temperature attends the galvanic extrication of gases; and of Reinhold, in order to examine the fundamental laws of galvanism; he concludes that the principal effect of the battery consists in induced electricity. Very striking cases of deafness relieved by moderate shocks of galvanic batteries are related by several observers.

Mr. Böckmann recommends, for viewing the sun, an eye glass composed of four pieces, a light violet, a light green, a dark green, and a dark blue.

Professor Wolke, of Jever, gives, in the 4th number, an account of a waterspout which passed immediately over the ship, in which he was sailing, in the Gulph of Finland: it appeared to be about 25 feet in diameter, consisting of drops about the size of a cherry; the sea was agitated round its base through a space of about 130 feet in diameter: the relater rather supposes that the water was ascending than descending. The same gentleman fully confirms the authenticity of Mr. Sprenger's successful treatment of deafness by galvanism. Dr. Reuss, in Stuttgard, gives similar accounts of his own patients. Y.

Note on Lenoir's *Comparative Apparatus.* (See p. 125.)

In the Bibliothéque Britannique, Vol. 19, No. 4, we find a description of the comparer of Lenoir, by Mr. Prony. Its peculiarity consists in the application of a bent lever, of which the shorter arm is pressed against the end of the substance to be measured, while the longer serves as an index, carrying a vernier, and pointing out on a graduated arch the divisions of a scale, which by this contrivance is considerably extended in magnitude. It does not, however, at first sight, appear to be certain that the difficulty of fixing the axis of the lever with perfect accuracy, and of forming a curve for the surface of the shorter arm, or of reducing the graduation of the arc to equal parts of the right line in the direction of the substance to be measured, might not in practice more than counterbalance the advantage of this mechanical amplification of the scale, over the simpler optical method employed in the English instruments. Y.

From ANNALES de CHIMIE, No. 125. p. 121.

"*Experiences, &c.*" *Experiments on Charcoal. By* MESSRS. CLEMENT *and* DESORMES.

In this memoir an account is given of various phenomena relating to the combustion of charcoal in oxygene, and to its action upon, and combination with, sulphur. The authors were induced to carry on their researches in consequence of doubts which they entertained respecting the common opinion "that the charcoal produced from organized matters contained, even after it had been highly heated, a certain portion of the volatile principles with which it was originally combined, and particularly of hydrogene."

In burning well made charcoal, which had been heated immediately before, in various processes they never could perceive the deposition of any sensible quantity of water; and, in consequence of the results of many comparative experiments, they are induced to believe, that the quantity of moisture held in solution by the carbonic acid formed in the combustion of the charcoal, very little, if at all, exceeds that previously contained by the oxygene gas made use of.

All the different kinds of charcoal that they experimented upon consumed in burning almost precisely the same quantity of oxygene; and produced, in proportion to this consumption, similar quantities of carbonic acid. Thus 1.63 parts of charcoal of sugar required 3.93 parts of oxygene to enable it to form 546 grains of carbonic acid; 2.44 parts of plumbago demanded 6.36 of oxygene, and produced 8.80 of carbonic acid; and no greater differences were observed between charcoal from wax, animal charcoal, and anthracolite.

These facts, the authors think, are sufficient to prove that charcoal, in whatever way it may have been procured, when well burned, is really the same in its nature, and contains no ascertainable quantity of hydrogene, and this conclusion is still further countenanced by the particular phenomena of its action upon sulphur.

When sulphur, in a state of sublimation, is passed over charcoal ignited in a porcelain tube, a peculiar action takes place between the two substances, no gas is disengaged; and they enter into combination, so as to form a body which differs in its properties accordingly as the circumstances under which it is produced are different. The experiment requires some precautions, and the heat must be only slowly applied to the sulphur. When the results are perfect, the charcoal wholly disappears. The most interesting combination is formed when the charcoal is in excess. It is a fluid at common temperatures, and they give to it a name which may be translated by carbureted sulphur. When the sulphur is in excess, a solid crystallised compound is formed, the *physical* properties of which are analogous to those of sulphur.

There are other methods of producing the fluid compound of sulphur and charcoal. When sulphuret of antimony is highly heated with charcoal, a small quantity is formed; and it is evolved, though in an impure state, during the distillation of a mixture of sulphur and wax.

Carbureted sulphur is possessed of very singular properties, which, in some measure, vary with its composition. The specific gravity of a specimen of it examined was to that of water as 13 to 10. It is extremely volatile, and evaporates slowly at the common temperature of the atmosphere, producing in this process, a considerable degree of cold; when placed under the receiver of an air pump, it rises in the form of gas when the mercury in the barometer gage stands at about 10 inches.

Carbureted sulphur is extremely inflammable, and in burning produces a strong odour of sulphureous acid, and leaves a residuum of charcoal. When introduced into any of the gases it considerably augments their volume.

Oxygene gas, when holding it in solution, may be made to detonate with great force. And in nitrogene gas, and even in nitrous gas, the volatilized carbureted sulphur is inflammable.

Carbureted sulphur is not acted upon by either the sulphuric, muriatic, or nitric acid, when cold, but it is attacked by the last substance when assisted by heat. It is not possessed of any agency upon sulphureous acid, but it is slowly decompounded by oxygenated muriatic acid. It is not soluble in water, but it appears to effect a partial decomposition of that fluid when suffered to remain long in contact with it. It rapidly combines with phosphorus, and forms with it a fluid substance. It is soluble in oil of olives. When introduced into alcohol, or ether, it undergoes change, a part of it is dissolved, and another part becomes solid; in alcohol it remains soft, but in ether it forms crystals.

The authors detail many experiments which they think prove, that carbureted sulphur contains no hydrogene, and consequently, that that substance cannot exist in the charcoal from which it was produced.

In distilling sulphur and charcoal in a retort, and in decomposing the sulphates by charcoal, they obtained, amongst other products, a peculiar gas, which was inflammable, and which in combustion produced carbonic acid and sulphureous acid: and they are inclined to think that it may be a particular aëriform combination of sulphur and charcoal.

They were unable to combine charcoal with phosphorus, by the means that they employed to unite it with sulphur.

Towards the end of the memoir they make various inductions from their experiments, the most interesting of which had been before mentioned; and they conclude with the following passage. "Carbureted sulphur is not a discovery entirely new; since our experiments have been made, we have learned that it had been before, in some measure, announced." D.

ROYAL SOCIETY.

On the 3d of June, A description of the anatomy of the Ornithorhynchus hystrix, by Everard Home, Esq. F. R. S. was laid before the Society.

This animal has been described and figured by Dr. Shaw, under the name of myrmecophaga aculeata, but from the absence of mammae, and from its greater internal resemblance to the ornithorhynchus than to the other myrmecophagea, Mr. Home chooses to consider it as belonging to the same genus with that singular animal, although he thinks it possible that it may hereafter be found to require a distinct generic name. It is a native of New South Wales, and several specimens have been brought over in spirits: its length is about seventeen inches; it is covered with hair and with quills. Its bill somewhat resembles that of the ornithorhynchus, but wants the lateral lips. Its teeth are horny, and confined to the tongue and the palate: the hind legs are furnished with a spur. The stomach has a number of horny papillae near the pylorus: it is much larger than that of the ornithorhynchus paradoxus: the animal appears to swallow a considerable quantity of sand with its food. The second branch of the fifth pair of nerves is extremely small, so that this species has probably no peculiar sense of feeling on its bill: that of smell appears to compensate the deficiency. The small bones of the ear are only two, corresponding to the malleus and stapes; the divisions of the cochlea are cartilaginous. The contents of the pelvis agree with those of the ornithorhynchus, in greatly resembling the class of birds. Mr. Home has examined several other species of manis and myrmecophaga, but finds that they all are furnished with mammae. The peculiar characters of the genus ornithorhynchus appear to be the spur on the hind legs, the absence of nipples, the smooth beak, and the horny teeth. From all these considerations, Mr. Home infers that the genus forms a connecting link between the mammalia, aves, and amphibia. The Society adjourned to the 17th.

On the 17th an analysis of a pulmonary calculus, by P. Crampton, Esq. was communicated by the Hon. G. Knox, F.R.S.

Mr. Crampton found in 100 parts of the pulmonary calculus that he examined, 45 of lime, 37 of carbonic acid, and 18 of animal matter and water; this was probably albumen, being coagulable in acids. He thinks it probable that this specimen may have been of a different nature from those which are described by Fourcroy, and which have been supposed to contain phosphate of lime. Mr. Crampton thinks it easier to understand how phosphate of lime might have been separated from the blood than carbonate; but he conceives that even this may be deposited in the lungs by a morbid process, similar to the healthy one by which it is secreted to form a considerable part of the bones.

The same evening a letter from Mr. Carlisle to the president was read, containing a description of two kinds of eyes observed in the Gryllus gryllotalpa; with other circumstances respecting the structure and natural history of that animal.

Mr. Carlisle first describes the eyes, commonly so called: he observes that a membrane, which appears under the microscope to be reticulated, and covered with a dark brown opaque, pulpy matter, is applied in immediate contact with all the interior surfaces of the cornea, and that behind this there is a portion of brain. It appeared, on exposing a section of the head to the direct rays of the sun, that the dark coloured substance intercepted the light almost completely. Mr. Carlisle therefore thinks that these eyes are principally subservient to measuring the intensity of light, and to denoting the illuminated and shadowed parts of objects. The stemmata, which have a greater resemblance to the eyes of quadrupeds, are two in number, situated in the summit of the head; they are pellucid, brilliant lenses, of a horny substance, $\frac{1}{50}$ of an inch in diameter: under them is found a portion of jelly, and next to this a semi-opaque membrane, on which the figures of surrounding objects are painted by the lens, and may be discovered by the help of a microscope: behind it is a white mass, connected with the brain, and a branch of the bronchial tubes is so nearly in contact with it, that Mr. Carlisle thinks it may possibly affect the distance of the membrane, receiving the image, from the lens. The two setaceous projections from the tail of the insect Mr. Carlisle supposes to serve the purpose of antennae, since the insect runs backward as readily as forward, and never turns in its burrow: this passage is formed simply by compressing the earth, without throwing any of it out. The abdomen of the insect contains a craw, a gizzard, and a digesting stomach: it appears to live on other insects, chiefly coleopterous. The peculiar noise caused by the friction of the upper wings against each other, which appears to be a mode of conveying intelligence between the sexes, indicates that these insects must be provided with organs of hearing. They are incapable of flying, but their wings assist them in swimming.

On the 24th of June, two communications from William Hyde Wollaston, M.D. F.R.S. were read. The first was on a method of examining refractive and dispersive powers, by prismatic reflection. It was suggested to the author by a consideration of the prismatic speculum employed by Sir Isaac Newton in his reflecting telescope. The angle at which the total reflection of light of any kind first takes place at the surface of a rarer medium depends on the comparative density of the two mediums in contact, and hence the measurement of this angle readily furnishes a determination of the ratio of refraction at the common surface, for the kind of light observed. Thus by means of a triangular prism, a drop of each of two or more fluids being placed side by side on the under surface, it may easily be found, by inclining the prism more and more, which of the dark spots first disappears, and it follows that the respective fluid has the weakest refractive power. But when a solid is examined, it must in general be united by the interposition of some fluid of a higher refractive density, otherwise the contact will be too imperfect; and it is easily shown that this interposition does not affect the ultimate result. But for determining at once the numerical ratio of the sines, Dr. Wollaston has invented an apparatus where, by means of a rectangular prism of flint glass, the index of refraction of each substance is read off at once by a vernier, the three sides of a moveable triangle performing the operations of reduction of the ratios in a very compendious manner. In this method it is obviously unnecessary that the substances to be examined should be of any determinate form; and it is as easy to ascertain the refractive density of the most opaque as of the most transparent bodies, provided they be less refractive than the prism employed. It may also serve as a chemical test, for example in essential oils, which when adulterated are generally rendered less refractive; and a very minute quantity is sufficient for the experiment. Where the medium is of variable density, this is almost the only mode in which its refractive power can be ascertained; hence it is of singular utility in examining the refraction of the crystalline lens. (Phil. Trans. 1801. p. 41.) A copious table of the refractive powers of various substances is here inserted. The dispersive powers of different substances are inferred from similar observations upon the fringes which usually accompany, or rather constitute, the boundary of reflection: the author observes that they are sometimes wanting, or even reversed, when the dispersion is equal at different angles of deviation, or when it is greater even with a less deviation, as when oil of sassafras is applied to a prism of flint glass, as well as in many cases of spars with fluids. Solutions of metallic salts in general are found to be very highly dispersive: by weakening the solution till the line of separation became colourless, and then noting the refractive density, Dr. Wollaston has been able to compare the dispersive powers of several such substances with that of plate glass. He has also arranged a number of substances in a table in the order of their dispersive powers, at a given deviation; an order materially different from that of their refractive density. A very important observation concludes this part of the essay. Dr. Wollaston observes, that, by looking through a prism at a distant crevice in a window shutter, the division of the spectrum may be seen more distinctly than by any other method, and that the colours are then only four, red, yellowish green, blue, and violet, in the linear proportions of the numbers 16, 23, 36, 25; and that these proportions will be the same whatever refractive substance be employed, provided that the inclination of the prism remain unchanged. In the light of the lower part of a candle, the spectrum is distinguished by dark spaces into five distinct portions.

The second paper was on the oblique refraction of Iceland crystal. It contains a confirmation of the experiments of Huygens on this substance, with additional evidence, deduced from the superiority of Dr. Wollaston's mode of examining the powers of refraction. He observes, that Dr. Young has already applied the Huygenian theory with considerable success to the explanation of several other optical phenomena, and that it appears to be strongly supported by such a coincidence of the calculations deduced from it with the results of these experiments, as could scarcely have happened to a false theory. Huygens supposes the undulations of light to be propagated in Iceland crystal in a spheroidal instead of a spherical form: and infers that the ratio of the sine of incidence to the oblique ordinate of refraction must be constant in any one section, but different for different planes. Dr. Wollaston observes, that, though we do not fully understand the existence of a double refraction, and are utterly at a loss to account for the phenomena occurring upon a second refraction by another piece of the spar, yet that the oblique refraction when considered alone, is nearly as well explained as any other optical phenomenon.

On the first of July, a paper was read, entitled, an account of some cases of the production of colours not hitherto described, by Thomas Young, M. D. F. R. S.

When a small fibre, such as a human hair, or a silkworm's thread, is held near the eye while it is directed to a minute or distant luminous object, an appearance of parallel fringes of coloured light is produced, the colours succeeding each other in the same order as those of thin plates seen by transmitted light, and being larger and more distant as the diameter of the fibre is smaller. Dr Young explains this circumstance from the general law of the interference of light (Syllabus, 376.); the two portions being here found in the light reflected and inflected from opposite sides of the fibre: and from a single experiment, calculated to determine the angular distance of the fringes, produced by a hair of known magnitude, he deduces a measure agreeing within one ninth with the dimensions of the thin plates as ascertained by Newton, and he considers this experiment both as a confirmation of Newton's measures, and of the explanation of these colours. It appears probable that the colours of all atmospherical halos are produced in a similar manner.

The colours of mixed plates constitute another new class of phenomena. When a little moisture, or oil, is scantily interposed between two pieces of glass, proper for exhibiting the common rings of colours seen by transmitted light, we may observe an appearance of other rings much larger than these, which are most conspicuous when they are placed a little out of the line joining the eye and the luminous object. These appear to originate in the interference of two portions of light, passing, the one through the particles of water or oil, the other through the air interposed, and travelling, of course, with different velocity: the explanation is confirmed by the effect of substances of different refractive densities, applied either with air intervening or with each other; and the measures agree with the calculation.

Dr. Young observes, that he has repeated Dr. Wollaston's experiments on the division of the prismatic spectrum with success; and thinks it probable that the separation of the bluish light of a candle, into distinct portions, is a phenomenon of the same kind, as is observable when the light transmitted through a thin plate of glass or air is analysed by means of a prism. He also adds, that he has had an opportunity of confirming his former observations upon the very low dispersive power of the human eye in its collective state.

A paper on the composition of Emery was communicated to the Society by Smithson Tennant, Esq. F. R. S. This substance has in general been considered as an ore of iron, but it appears to have very little title to that denomination. Mr. Wiegleb conceived that it consisted principally of silex, but there appears to have been some mistake with respect to the substance that he examined. Mr. Tennant finds that emery is dissolved with some difficulty in a strong heat by carbonate of soda, and after the subsidence of a little iron, the earth contained in the solution is almost purely argillaceous. This result is exactly similar to Mr. Klaproth's analysis of diamond spar or corundum. From 100 parts Mr. Tennant procured 80 of argil, 3 of silex, and 4 of iron, with an undissolved residuum of 3 parts, and a loss of 10, great care having been taken to separate the parts attracted by the magnet: some portions however contained almost one third of iron. The hardness of emery and diamond spar appear to be equal. The emery used in England is brought principally from the island of Naxos; it is imported in the form of angular blocks, incrusted with iron ore, with pyrites and mica; substances which usually accompany the corundum from China.

A catalogue of 500 new nebulae, nebulous stars, planetary nebulae, and clusters of stars, was laid before the Society, by William Herschel, LL. D. F. R. S.; and the preliminary remarks on the construction of the heavens were also read.

Dr. Herschel takes a very enlarged view of the sidereal bodies composing the universe, as far as we can conjecture their nature: and enumerates a great diversity of parts that enter into the construction of the heavens, reserving a more complete discussion of each to a future time. The first species are insulated stars; as such the author considers our sun, and all the brightest stars, which he supposes nearly out of the reach of mutual gravitation; for, stating the annual parallax of Sirius at 1″, he calculates that Sirius and the sun, if left alone, would be 33 millions of years in falling together; and that the action of stars of the milky way, as well as others, would tend to protract this time much more. Dr. Herschel conjectures that insulated stars alone are surrounded by planets. The next are binary sidereal systems, or double stars; from the great number of these which are visible in different parts of the heavens, and the frequent apparent equality of the two stars, Dr. Herschel calculates the very great improbability that they should be at distances from each other at all comparable to those of the insulated stars; hence he infers, that they must be subjected to mutual gravitation, and can only preserve their relative distances by a periodical revolution round a common centre. In confirmation of this inference, he promises soon to communicate a series of observations made on double stars, showing that many of them have actually changed their situation in a progressive course, the motion of some being direct, and of others retrograde. The proper motion of our sun does not appear to be of this kind, but to be rather the effect of some perturbations in the neighbouring systems. The same theory is next applied to triple, quadruple, and multiple systems of stars, and particular hypothetical cases are explained by diagrams. Some such cases, Dr. Herschel is fully persuaded, have a real existence in nature. The fourth species consists of clustering stars, and of the milky way: the stars thus disposed constitute masses, which appear brighter in the middle, and fainter towards the extremities, being perhaps collected in a spherical form. Groups of stars the author distinguishes from these by a want of apparent condensation about a centre of attraction : and clusters of stars, by a much more complete compression near such a centre, so as to exhibit a mottled lustre, almost resembling a nucleus. The eighth species consists of nebulae, which probably differ from the three last species only in being much more remote; some of them, Dr. Herschel calculates, must be at so great a distance, that the rays of light must have been nearly two millions of years in travelling from them to our system. The stellar nebulae, or stars with burs, form a distinct species. A milky nebulosity is next mentioned, which may in some cases resemble other nebulae, but in others appears to be diffused, almost like a fluid: the author is not inclined to consider it as either resembling the zodiacal light of the sun, or of a phosphorescent nature. The tenth species is denominated nebulous stars; these are stars surrounded with a nebulosity like an atmosphere, of which the real magnitude must be amazingly great; for the apparent diameter of one of them, described in the catalogue, was 3′. The planetary nebulae are distinguished by their equable brightness, and circular form, while their light is still too faint to be produced by a single luminary of great dimensions. When they have bright central points, Dr. Herschel considers them as forming a twelfth species, and supposes them to be allied to the nebulous stars, which might approach to their nature, if their luminous atmospheres were very much condensed round the nucleus.

On the 8th of July, the first part of a paper on the rectification of the conic sections was laid before the society by the Rev. John Hellins, B. D. F. R. S. It contained nine theorems for the rectification of the hyperbola, by means of infinite series, one only of which had been before published, each having its particular advantages, in particular cases of the proportions of the axis and of the ordinates, so that they appear to contain a complete practical solution of this important problem, and they are illustrated by a variety of examples. The author observes that Dr. Waring's theorems for computing the length of the curve from ordinates referred to the asymptote, are in their present form of little use, but might easily be corrected in a manner similar to that which he has pursued. He defers, to a future opportunity, the publication of similar investigations relative to the ellipsis.

Observations on Heat, and on the action of bodies which intercept it. By Mr. Prevost, Professor of Natural Philosophy at Geneva.

This paper was read on the same evening. It consists chiefly of inferences from Dr. Herschel's important experiments on the transmission of heat by different refracting mediums, especially the different kinds of glass. Mr. Prevost sets out with the law of the interchange of heat as ascertained by the experiments of MM. Kraft and Richmann, that while the time flows equably, the differences of the temperature of two contiguous bodies flow proportionally, or are in geometrical progression. Hence from three observations of the actual temperature of a thermometer, at given intervals of time, we may determine the progression of the differences, and consequently the actual heat of the medium. The author applies this method to Dr. Herschel's experiments on the heat of a solar ray transmitted through different mediums, and the conclusions are very different from what we should at first sight infer: for instance, in Dr. Herschel's 24th experiment, the blue glass intercepted one tenth only of the rays of heat, and not one fourth, as the thermometer seemed to indicate. But the immediate interception must have been somewhat greater than one tenth, for a certain portion of heat actually communicated to the glass, must have radiated afresh towards the thermometer, and contributed to produce the temperature observed; and accordingly as this circumstance took place in a greater or less degree, the thermometer must have been variously and irregularly affected. Of such an irregularity almost every one of the experiments shows evident marks; and the apparatus is not minutely enough described to furnish data for calculating its magnitude. From these principles an experiment of Mr. Pictet, on the interception of heat, is reconciled with Dr. Herschel's experiments.

In the second part of this paper Mr. Prevost treats of the reflection of heat and of cold. He observes that Bacon suggested the inquiry respecting the concentration of invisible heat by glasses. Lambert attributed the effect of the reflection from a common fire to its invisible heat. Mr. de Saussure suggested to Mr. Pictet to confirm Lambert's suspicion by experiment, and the success is well known. His experiment on the reflection of cold Mr. Prevost has already employed in support of the opinion that the equilibrium of heat is not a quiescent equilibrium, or an equilibrium of tension, but an equilibrium of motion, where the interchanges of heat on either side are equal: and this theory has been adopted by Professor Pictet, and by other philosophers. Hence the author endeavours to deduce the law already inferred from Richmann's experiments. Mr. Prevost observes that, this theory would be equally applicable to the opinion of those who consider heat as consisting in the undulations of an elastic medium; although he thinks that opinion liable to many objections, especially on account of the resistance which the motions of the planets must suffer from it. In a note added by Dr. Young, who communicated the paper, the assertion of Newton is quoted in answer to this objection, yet Dr. Young confesses that Newton appears to have calculated erroneously: but he observes that if the slightest difficulty of this kind should occur from astronomical considerations, it might be avoided by considering the luminiferous ether as unconcerned in the phenomena of cohesion, and then its rarity might be assumed as great as we chose to make it.

The Society adjourned to November 4.

An Account of MR. SYMINGTON'S *New Steam Boat.*

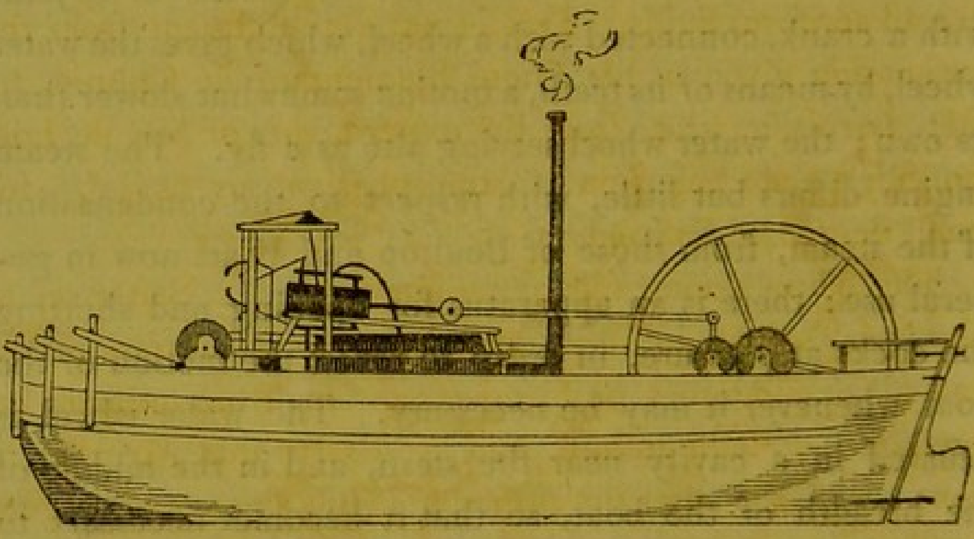
Several attempts have been made to apply the force of steam to the purpose of propelling boats in canals, and there seems to be no reason to think the undertaking by any means liable to insuperable difficulties. Mr. Symington appears already to have had considerable success, and the method that he has employed for making a connexion between the piston and the water wheel is attended with many advantages.

By placing the cylinder nearly in a horizontal position, he avoids the introduction of a beam, which has always been a troublesome and expensive part of the common steam engines: the piston is supported in its position by friction wheels, and communicates by means of a joint with a crank, connected with a wheel, which gives the water wheel, by means of its teeth, a motion somewhat slower than its own; the water wheel serving also as a fly. The steam engine differs but little, with respect to the condensation of the steam, from those of Boulton and Watt now in general use: there is an apparatus for opening and shutting the cocks at pleasure, in order to revert the motion of the boat whenever it may be necessary. The water wheel is situated in a cavity near the stern, and in the middle of the breadth of the boat, so that it becomes necessary to have two rudders, one on each side, connected together by rods, which are moved by a winch near the head of the boat, so that the person who attends the engine, may also steer. It has been found most advantageous to have a very small number of float boards in the water wheel.

Another material part of the invention consists in the arrangement of stampers, at the head of the boat, for the purpose of breaking the ice on canals, an operation which is often attended with great labour and expense. These stampers are raised in succession by means of levers, of which the ends are depressed by the pins of wheels, turned by an axis communicating with the water wheel.

Mr. Symington calculates that a boat capable of doing the work of twelve horses may be built for eight or nine hundred pounds. An engine of the kind has been actually constructed at the expense of the proprietors of the Forth and Clyde Navigation, and under the patronage of the governor, Lord Dundas: it was tried in December last, and it drew three vessels of from 60 to 70 tons burden at the usual rate of two miles and a half an hour. Mr. Symington is at present employed in attempting still further improvements, and when he has completed his invention, it may, perhaps, ultimately become productive of very extensive utility.

A general idea of the arrangement of the parts may be formed from the figure here inserted, taken from a model which was brought by Mr. Symington, at the desire of Lord Dundas, to the Royal Institution. Y.



From JOURNAL des MINES, No. 66. p. 527.

Notice concerning the Dilatation of Aëriform Fluids by Heat.

Mr. Guay Lussac has lately presented to the National Institute of France, a memoir on the dilatation of various elastic fluids by the agency of heat. In examining the experiments of different philosophers on this subject, he states that the great discordancy in their results is chiefly owing to the presence of water in the apparatus employed, which being dissolved by the gas employed, or converted into vapour in it, in different proportions at different temperatures, causes it to undergo irregular expansions.

By the methods that he employed, the vessels and instruments made use of were rendered completely dry, and under these circumstances, he found that the volumes of all the permanent elastic fluids, whether soluble or insoluble in water, underwent an uniform and equal change of volume with every change of their temperature; and that they suffered an expansion of $\frac{80}{219}$ of their bulk in passing from the temperature of 32° Fahrenheit, to 212°.

The vapour of ether obtained by heat followed the same law of equable dilatation; and calculating upon it, it appears, that with every increment of a degree of Fahrenheit there is an increment of volume of nearly $\frac{1}{493}$, probably, for all aëriform fluids. This is not very different from the estimation given in his Traité Elementaire de Chimie, by Mr. Lavoisier, who, from the experiments of Mr. de Luc, considers the expansion of atmospherical air as $\frac{1}{474.5}$ for each degree of Fahrenheit.

The editor quotes the experiments of Mr. Saussure, as showing that air, in all its different states of saturation with moisture, undergoes uniform expansions from uniform increments of temperature, and he asserts that Mr. Amontons has proved that the principle is the same with regard to pressure. D.

Lectures delivered in the Theatre of the Royal Institution.

Dr. Young's Lectures on Hydrodynamics.

The lectures on hydraulics and optics commenced on Monday the 22d of March. Dr. Young observed in the first lecture, that, although the term hydrodynamics has not been in common use in this country, yet its etymology is correct, and it has long been employed on the continent.

The term hydraulics properly implies the art of raising water by pipes, it could not therefore be sufficiently extensive to include the theory of elastic fluids: and there are several reasons for comprehending the doctrine of optics in the general description of the motions of fluids, even if we allow the opinion of those who choose to call light a discrete fluid. For showing the nature of the equilibrium of fluid, the water employed was whitened with a little milk, which made it more conspicuous when seen on a dark ground. The whirling table was also introduced, in order to show, by the arrangement of different fluids revolving within a globe, the forms necessary for equilibrium, under different circumstances. Mr. Keir's hydrostatical lamp was exhibited as a good example of the counterpoise of fluids of different densities. The different nature of the equilibrium of floating bodies was illustrated by two ovals made of different materials; when the oval is placed on a plane, the equilibrium is stable when its greatest axis is horizontal, and unstable when it is vertical; and the same is true when the oval floats with its centre above the surface of a fluid; but when the centre is below the surface, the stability of the equilibrium is reversed; and if the centre is neither above nor below the surface, both equilibriums become neutral.

The second lecture was upon hydrostatic instruments, and on the properties of elastic fluids. It was observed, that the story of live fishes losing their weight in water, does not imply so strong an absurdity as might at first sight be supposed: for, when a fish, by compressing its air bladder, becomes specifically heavier than water, it begins to descend: now part of the force of gravitation, being employed in generating motion, no longer produces a pressure on the vessel and the scale containing it, so that while the descent is accelerated, the effect of the weight is actually diminished: the difference, however, must be too minute to be easily ascertained by experiment.

The third and fourth lectures were principally employed in explaining and illustrating the theory of hydraulics; the summary of hydraulics, which has been lately inserted in the Journals of the Royal Institution, renders it unnecessary to repeat here many practical observations upon this subject. Some experiments, however, may deserve to be mentioned. In order to show that, in the time that a cylindrical vessel empties itself by a small orifice, twice as much of the fluid would be discharged if it were kept full, four equal cylindrical vessels were employed, two of them with equal perforations in the bottoms; and both of these having been filled, while the first was suffered to empty itself, the water of the other two was gradually poured into the second, and both these operations were completed at the same instant. The difference of the discharge through orifices of equal sections, but of different forms, was shown by filling two jars at the same time from two pipes of different forms fixed side by side in a cistern. One of the pipes had a smaller one inserted laterally near its origin, in the manner described by Venturi, and while the larger pipe was filled by the stream, a quantity of water was drawn up by the lateral pipe from another vessel. With respect to the discharge of water from a reservoir by a descending pipe, Dr. Young observed, that Venturi had found it corresponding to the whole height of the surface of the reservoir above the orifice of the pipe; but that the accuracy of the experiment appeared scarcely credible, for supposing the depth of the reservoir evanescent, and the length of the pipe 16 feet; in this case, a velocity of 32 feet would be generated in each particle of water in half a second, which is equal to that which it would have acquired by a free descent in a whole second: so that the effect seemed disproportionate to the cause. Upon this subject, however, a subsequent experiment will be hereafter related. In speaking of the resistances of fluids, Dr. Young observed, that the motions of their particles, in retiring from the moving body, must probably be such, as to produce the least possible change of place; not from any tendency in nature to such a minimum of effort as some have made a fundamental law of mechanics, but because a smaller effect is sooner produced than a greater one, and if the obstacle is once removed, there can be no opportunity for the exertion of a greater force.

The two following lectures were devoted to the consideration of hydraulic and pneumatic machines. Several small working models were exhibited, some of them made for the occasion, others obligingly furnished by Mr. Wood and Mr. Tatham. The air vessels of Chemnitz, the spiral pump, the centrifugal machine, and the fountain of Hero, were illustrated by models made in the house. The original air pump of Otto von Guerike, was described from his Experimenta Magdeburgica, and the construction of Smeaton's air pump, with later improvements, was explained by showing separately its different parts. A passage was read from the Marquis of Worcester's Century of Inventions, where the first steam engine is described under the name of a fire waterwork. A model of a modern steam engine was also exhibited, but it was not sufficiently in repair to continue working.

In the seventh lecture, on Monday the 12th of April, the general doctrine of sound was considered. The composition of vibrations was illustrated by a small pendulum hanging from the weight of a larger one; the permanence of the initial form was shown by a chord inflected in different ways, and compared with a right line drawn under its quiescent position. The subdivisions in which chords are capable of vibrating, were shewn by pieces of paper placed on the longer strings of a small piano forte, while they were made to sound by striking other notes in the scale. Professor Chladni's figures were exhibited by means of sand strewed on a plate of glass, which was made to sound by a bow. It was observed, that a rod held loosely at one end, is incapable of producing any musical note, that its principal tone is heard when it is held at one fifth of its length from one end, and that when held in the middle, the note becomes about an eleventh higher; results perfectly conformable to the theories of Euler and Riccati.

In the eighth lecture, Dr. Young observed that the minute vibrations discovered by Professor Chladni, as actually and frequently existing, might be of use in enabling us to form an idea of the vibrations of which all natural bodies are supposed to be susceptible, by those who maintain the opinion of the vibratory nature of heat; and that the longitudinal sound of chords, described also by Chladni, may probably be owing to similar vibrations. The nature of echoes, together with the equality of the angles of incidence and reflection, were illustrated by the waves excited in a circular bason of mercury. The point of an elastic wire was employed for exciting waves of equal magnitude, to represent those of a musical sound, and when they were made to diverge from a point near the centre, they were again evidently collected in a point at an equal distance on the other side of the centre, the circle coinciding nearly enough with an ellipsis of which the points would be the foci. The parts of the internal ear were described, and their apparent uses explained. An experiment was made on the sound of an organ pipe in different kinds of gas; it was placed in the neck of a jar, open below, and the gas was forced through it from above: in hydrogen gas, the note was about an octave higher; in carbonic acid gas a minor third lower. The hydrogen gas was procured by means of zinc and muriatic acid, but it was not weighed. The experiment upon carbonic acid agrees perfectly with the calculation from its specific gravity; as well as the experiments made long ago by the Academicians del Cimento, upon a small pipe included with its bellows, in rarified and in condensed air, which produced in all cases the same note.

These considerations were continued in the ninth lecture. From Mr. Canton's experiments on the compressibility of water, it was calculated, that the velocity of an impression transmitted through water, is about five times as great as in air; and in steam, the velocity must be nearly equal to that in pure hydrogen gas, between three and four times as great as in air. The motions of undulations were still further illustrated by an apparatus calculated to show the waves of water very distinctly. A shallow vessel of water, with a bottom of glass, was placed over a looking glass, which reflected the light of a candle through the water, upon a screen placed obliquely above it, and depicted there the shadows of the waves; the sides of the vessel were made sloping, in order to prevent the continual reflections which would have been produced by abrupt terminations. The effects of the combinations of sound, as well as the nature of harmony in general, were shown by a peculiar arrangement of sliders, so placed, as to represent the ordinates of a curve, and capable of being fixed upon any other curve in such a manner, as to represent by their extremity, a third curve, resulting from the combination of the ordinates of the two former. Hence the phenomena of beats, and of grave harmonics were explained.

The subjects of the tenth lecture were the general theory of music, and the construction and operation of musical instruments. It was observed, that the sound of the violin depends on a circumstance mentioned in the lectures on mechanics, the superiority of the force of cohesion to that of friction; the string adhering to the bow at a time when it is nearly quiescent with respect to it, and remaining attached to it by means of the resin, until its tension has overcome the adhesion: the force of friction being no longer able to prevent its return, it proceeds in its vibration until a new adhesion is formed. The human larynx was described, and its operation in the formation of the voice was explained. Organ pipes of various forms, and other musical instruments, were also exhibited.

Experiments on the Separation of Light and Heat by Refraction. In a Letter from Sir H. C. ENGLEFIELD, *Bart. F. R. S. to Thomas Young, M. D. F. R. S.*

Dear Sir,

In pursuance of your desire, I communicate to you the experiments which I made in consequence of Dr. Herschel's most interesting discovery of the separation of solar heat and light by the prism. They carried with them, to my mind, a complete conviction of the truth and accuracy of the Doctor's assertions on that subject. Should you judge them worthy of insertion in the Journals of the Royal Institution, I shall think myself honoured by their publication.

I am, Dear Sir,
Your faithful Servant,
H. C. ENGLEFIELD.

As I was desirous not only to ascertain, by actual observation, the very curious discovery of Dr. Herschel, but to obviate the objection made by Mr. Leslie to the mode in which his experiments had been made, I contrived an apparatus totally different in its arrangement from that which had been used by the Doctor; and disposed in such a manner that it was impossible that the thermometers should be affected by any foreign heat reflected from any part of it. As to the heat reflected from the floor, it could not influence the results, since it was the same, whatever colour was thrown on the ball of the thermometer.

As I had nothing to do with light, it was not necessary to darken the room; and as I wished to accumulate as large a portion of solar heat as possible, I placed the prism in an open window, instead of admitting a beam through an aperture in a shutter, as is the usual practice. The prism I used is a very good one; and it was lent to me for this purpose by Mr. Walker, of Conduit Street. It is three inches long, and equilateral, each side being 1.15 inch broad.

It was supported by an horizontal arm, projecting from a pole like that of a fire screen. The arm could be adjusted to any height by a screw; and the prism was likewise capable of being turned on its axis to any required position.

The coloured spectrum was thrown on a very good lens, of four inches in diameter, and about 22 inches focal length. This lens formed part of a machine well known, and used for viewing prints; it stands on a foot adjustable in any direction, and to any height; and the mounting being of wood, and merely sufficient to support the lens, scarcely any heat can be accumulated in any part of it. The whole lens, as well as its mounting, was covered with a thick white pasteboard screen, in which was cut a slit of 3 inches long, and half an inch wide; this slit was over the centre of the lens; and through it any one of the colours required was admitted on the lens, while all the rest of the spectrum was totally excluded. A light wooden arm, of two feet long, projected at right angles from the lower part of the mounting of the lens. This arm carried a small screen of polished card, which received the image formed in the focus of the lens. This was found necessary, in order to find with certainty where to place the thermometer; when the focal distance was found, the screen was moved back, about a diameter of the bulb of the thermometer used, which was then held by hand in the focus of the lens, which was done with great ease and certainty, as nothing more was necessary than to fix the eye on the card screen, and keep the ball of the thermometer in the centre of the luminous image. The whiteness and polish of the screen totally precluded any accumulation of heat in it; nor indeed would such accumulation have been of any detriment to the experiments had it existed; for, as it must have been entirely owing to the ray under examination, it would have done nothing more than increase the effect of it on the thermometer.

The thermometers used were mercurial, and very sensible. The scales were ivory tubes, embracing the stem, and graduated within. The ball of the instrument was therefore unconnected with any mounting; and no false heat could possibly affect it. The balls were mostly blackened with indian ink, carefully laid on; but some were used naked, and one, covered with white watercolour paint.

The lens, with its apparatus, was placed about three feet from the prism; and, as the sun was pretty high in the greater part of the experiments, and the descending spectrum was in general used, the floor under the stand of the lens was in shade, from the wall below the window, and had been so all the day, as the window at which most of the experiments were made, fronted the south.

Some part of this detail might seem superfluous, had not such stress been laid on the supposed accumulation of heat in Dr. Herschel's experiments, that it was necessary to obviate any objection on that head; or to show, at least, the utter improbability of any cause of that nature having affected the results of these experiments.

I now proceed to relate the experiments themselves: which I shall transcribe from the original notes made at the moment.

April 6, 1801.

The apparatus being disposed as above described, the coloured rays of the descending spectrum of the prism were successively thrown on the slit in the screen, covering the lens; and the thermometer with a blackened ball, placed in the focus of the lens, rose as follows.

In the blue in 3′, from 55° to 56°.

Green in 3′, from 54° to 58°.

Yellow in 3′, from 56° to 62°.

Full red in 2½′, from 56° to 72°.

In the confines of the red in 2½′, from 58° to 73½°.

Quite out of visible light in 2½′, from 61° to 79°.

Between each of the observations the thermometer was placed in the shade so long as to sink it below the heat to which it had risen in the preceding observation: of course its rise above that point, could only be the effect of the ray to which it was now exposed*. A thermometer placed constantly in the shade near the apparatus, scarcely varied during the experiments.

April 17th, 11, A. M.

Three thermometers, used afterwards in the experiments, were exposed to the sun's rays until they became stationary.

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* In all the experiments the thermometer was continued in the focus long after it had ceased to rise; therefore the heats given are the greatest effect of the several rays on the thermometer in each observation.

The thermometer with

Naked ball	58½°
Whitened ball	58½°
Blackened ball	63°

The apparatus being placed all as before, the blackened thermometer

In full red ray in 3′, from 58° to 61°.

In quite dark in 3′, from 59° to 64°.

The whitened thermometer

In full red ray in 3′, from 55° to 58°.

In quite dark in 3′, from 58° to 58½°.

The blackened thermometer was now again placed in the quite dark, and rose in 3′, from 58° to 61°.

This is what I expected, as a thick smoky haze had come on since the experiments were begun, and increased much towards the end of them.

April 18, 11, A.M. Sun clear. All the apparatus as before.

In the confines of the red.

Black thermometer in 3′, from 59° to 71°.

White thermometer in 3′, from 57½° to 60½°. Clouds came on and put a stop to the experiments.

April 19, 3½, P. M. Sun clear.

In the full red ray.

Black thermometer in 3′, from 66° to 82°.

White thermometer in 3′, from 66° to 69½°.

In the confines of the red.

Black thermometer in 3′, from 67° to 79½°. But thin streaky clouds had come over the sun.

In quite dark, half an inch out of the red.

Black thermometer in 3′, from 70° to 84°.

When the thermometer was carried into the faint red light it sunk quickly, and rose again as quickly when carried into the dark focus; but when carried into the dark on the other side of the red light it sunk very rapidly, and did not appear to receive any heat at all. Thin clouds increased, and rendered the sun's light too faint for further experiments.

April 20, from 10½ to 11½, A. M. Sun quite clear.

Although it could not be supposed that effects of the refracted light could differ in the two spectra, yet in order to ascertain the fact, the horizontal spectrum was used in the subsequent experiments.

The apparatus all the same as in the former.

In the full red ray.

Black thermometer in 3′, from 67° to 71½°.

Quite out of the ray.

Black thermometer in 3′, from 68° to 77½°.

The ray was now so far removed from the slit in the screen, that scarce any light was perceptible in the focus of the lens. The black thermometer was now placed near half an inch from the bound of the visible light in the focus, and rose in 3′, from 69° to 79½°.

The utmost edge of the prismatic spectrum was now removed an eighth of an inch from the edge of the slit in the screen; and no light was now visible in the focus of the lens.

Black thermometer in 3′, from 70° to 79°.

Mr. Cary, optician, in the strand, and Dr. Hunter, were present at these experiments; and repeatedly saw the thermometer in the second experiment sink when carried into the light, and rise again when removed back into the dark. Dr. Hunter also received the focus on the palm of his hand, where the heat was sensibly felt; and, on shutting his eyes and pointing with a long pen to where the heat was greatest, he always touched his hand beyond the visible light.

As the red image has been continually mentioned in the course of the above recited experiments, it may not be improper to describe it more particularly. The diameter of the red spot, formed by the ray in the focus of the lens, was just two tenths of an inch in diameter, at right angles to the length of the spectrum, and well defined: in the direction of the spectrum it was elongated, as might be expected, and less well defined.

When the whole visible spectrum from the prism was received on the screen which covered the lens, and the utmost edge of the red rays was removed a full eighth of an inch from the edge of the slit in the screen, there was still a faint blush of red, of a semioval form, visible when the focus of the lens was thrown on a white screen; and it was in these circumstances that the greatest effect of heat was constantly produced on the thermometer, not by placing it in the red light, but out of it, in the axis of the lens.

I have only to add, that, in the course of the month of June, 1802, I repeated most of these experiments with the same apparatus, in presence of Mr. Davy, with the most complete success; the sun's altitude being greater, the effect of his rays was so great as to raise the thermometer in the invisible ray to 98°, while the visible red never raised it above 87°. At the suggestion of Mr. Davy, we tried several experiments with respect to the power of the several coloured rays in rendering Canton's phosphorus luminous; and we found, without a possibility of doubt, that the blue rays possessed that power in a much higher degree than the red. There was great reason to suspect that this power, like that of blackening the nitrate of silver, extended beyond the visible blue ray; but our apparatus was not prepared for the more delicate part of these experiments, which are only mentioned with a view of exciting further researches on this very interesting subject, and of giving to Mr. Davy the credit due to him for having first thought of the experiment.

Account of some Experiments made in the Laboratory of the Royal Institution, relating to the Agencies of Galvanic Electricity, in producing Heat, and in effecting Changes in different fluid Substances. By H. Davy, *Prof. Chem.*

I. It has been shown, by a very interesting experiment made in France, by Messrs. Fourcroy, Vauquelin, and Thenard, that the power of galvanic batteries containing large plates, to ignite metallic substances, is much greater than that of batteries composed of an equal number of small plates; though their agencies upon water, and upon the human body, are nearly the same.

In examining the circumstances of the action of a galvanic apparatus, or trough, constructed in the Royal Institution, and containing twenty series of plates of copper and zinc, square, and thirteen inches in diameter, I observed that the same relations between chemical agency and the production of galvanic electricity existed as in other cases. When pure water was used for filling the cells, the sparks, as well as the shocks, were extremely indistinct; and the battery was capable of igniting only about a line of iron wire of $\frac{1}{170}$ of an inch in diameter. With solution of muriate of soda it acted better; and diluted nitric acid was still more efficacious. With this last substance, it became capable of rendering white-hot three inches of the iron wire of $\frac{1}{170}$, and of causing two inches to enter into fusion.

In comparing the effects produced by a solution of nitrous acid, of the specific gravity of 1.4, in about sixty parts of water, with those occasioned by a concentrated solution of carbonate of potash, the acid was found to produce by much the greatest intensity of action; which can hardly be ascribed to any other cause than its chemical agency; for, with regard to conducting power, it appeared very much inferior to the other solution. There is every reason to believe, that with pure water, that is, water deprived of air and of all saline substances, no action would be produced in this battery. I was unable to ascertain the fact by a direct experiment; but I found repeatedly, that a pile, composed of thirty six series of square plates, of copper and zinc, of five inches in diameter, lost its activity in nitrogene and hydrogene gases, in about two days; and it was constantly restored by common air; and rendered more intense by oxygene gas.

II. When the galvanic battery, with large plates, was in full action, it was found that a wire of $\frac{1}{80}$ of an inch in diameter, and two feet long, when placed in the circuit, was rendered so hot as to cause a small quantity of water, brought in contact with it, speedily to boil. It continued warm for many minutes; and, by an occasional momentary interruption and completion of the circle, the heat was permanently kept up. When three or four inches of the wire of $\frac{1}{170}$ were placed in any part of the conducting chain, they continued red-hot for more than a minute; and, by a succession of interruptions and contacts, they were kept partially ignited for five or six minutes. When that part of the communicating chain containing the small wire was introduced into a small quantity of ether, alcohol, or oil, the fluid soon became warm; and olive oil, the only substance that was exposed for a sufficient time, was made to boil.

III. When two small pieces of well burned charcoal, or a piece of charcoal and a metallic wire, were made to complete the circle, in water, vivid sparks were perceived, gas was given out very plentifully, and the points of the charcoal appeared red-hot in the fluid, for some time after the contact was made; and, as long as this appearance existed, elastic fluid was generated, with the noise of ebullition. The *sensible* phenomena were nearly the same with the volatile and fixed oils, ether, and alcohol; and, by means of charcoal, the spark could be produced in concentrated sulphuric and nitric acids, which are amongst the best of the less perfect conductors.

The gases produced from different fluids by the galvano-electric spark, were examined; and as the results were, in most cases, what might have been expected from theory;

the analysis of them was not made with very minute attention.

When water was acted upon by sparks taken from two pieces of charcoal, the elastic products evolved were about $\frac{1}{8}$ of carbonic acid, $\frac{1}{8}$ of oxygene, and the remainder an inflammable gas, which required a little more than half its volume of oxygene for its combustion. With gold and charcoal, the gold being on the zinc side, the gas produced appeared to be chiefly a mixture of oxygene and hydrogene, for it diminished $\frac{7}{10}$ by the electric spark.

The gas disengaged from alcohol, the spark being taken by gold connected with the zinc end, and charcoal, was a mixture of nearly two parts of oxygene and eleven parts of inflammable gas, which appeared to be partly light hydrocarbonate.

Ether, in the same method of operating, gave four parts of oxygene and twelve parts of inflammable gas.

From sulphuric acid, oxygene and hydrogene were produced very rapidly, (the oxygene being more than sufficient for the saturation of the hydrogene by combustion,) and the acid became blue.

The gas from nitric acid detonated with great violence by the electric spark, and the residuum was oxygene, mixed with a little nitrogene.

The products from the acids, there is every reason to believe, were evolved chiefly in consequence of the decomposition of the water they contained. And, in operating upon these substances, as well as upon pure water, a portion of the elastic fluids must have been produced at the time of the silent transmission of the electricity, during the momentary interruptions of contact. The apparent ignition of the charcoal in the different fluids depended, probably, in some measure, upon its being surrounded, at the moment of contact, by globules of gas, which prevented the heat, produced at the points of it, from being rapidly carried off by the fluid.

When the spark was taken by means of iron wires, in phosphorus rendered fluid by heat, under a stratum of water, permanent gas was produced from it, but in a quantity too small to be examined, after a process that continued an hour. I purpose to repeat the experiment, with conductors of dry charcoal.

IV. When gold wires, connected with the ends of the battery, were made to act upon fluids in the common method of communication, being placed at a distance from each other, it was found that the rapidity of the evolution of the gases was much more influenced by the conducting power of the fluid, than it is in common cases with small plates. In comparing the action of a battery of twenty plates, of five inches in diameter, upon sulphuric acid, nitric acid, and various saline solutions, with that of the large battery, it was observed, in several experiments, that the gas was disengaged much faster, and in larger quantities, from the wires connected with the large plates, whilst the action of the two arrangements upon water was nearly the same. This fact, combined with other facts of the same kind, seems to show, that the quantity of electricity excited in the arrangements with large surfaces, is much greater than that produced in those with small surfaces; and that it is capable of passing with facility through the more perfect conductors, whilst, from the nature of the series, its circulation is impeded, comparatively to a great extent, by imperfect conductors; a conjecture that has been already formed by different philosophers.

V. As the great quantity of electricity made to circulate through perfect conductors, by means of the large apparatus, increases their affinity for oxygene more perhaps than any known agent, and as charcoal by means of it can be rendered white-hot, and kept in constant combustion in oxygene gas or atmospherical air, I thought of trying the effects of the electrical ignition of this substance, upon muriatic acid gas confined over mercury.

The experiment was made by means of a small glass tube*,

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* For a description of this apparatus, see p. 214.

containing a slip of platina hermetically sealed into it, and having a piece of charcoal attached to its lower extremity: the communication was effected by means of iron wires; and the charcoal was made white-hot, by successive contacts continued for nearly two hours. At the end of this time, the muriatic acid gas had diminished a very little in volume: much white matter had formed upon the charcoal, which was not sensibly consumed. When the gas was examined, $\frac{3}{4}$ of it were instantly absorbed by water, and the remainder proved to be inflammable. The process was repeated three times; and, when the spark was most vivid, a white cloud was always perceived at the moment of its production. I am inclined to attribute this phenomenon, and the other phenomena, to the decomposition of the water held in solution in the gas, by the charcoal and the mercury adhering to it; and the white matter was probably muriate of mercury. The acid gases are rapidly absorbed by charcoal; and this substance, when well made, will take up more than 30 times its volume of muriatic acid gas; so that, in the process of ignition, a part of the water and of the acid must have been acted upon in a very condensed state.

The want of success in this experiment, the results of which are very similar to those obtained by Mr. William Henry, in his trials with common electricity, prevented me from carrying on the process upon fluoric acid gas, as I had at first intended. Many of the compound gases that are decomposable by heated charcoal, might probably, however, be analysed in a very simple manner, by means of the ignition of that substance by galvanic electricity; and this mode of operating may be conveniently applied, for ascertaining the relations of the affinities of charcoal for the constituent parts of compound gases at very high temperatures.

Apparatus for taking the Galvano-electrical Spark in Fluids and Aëriform Substances.

Fig. 1.

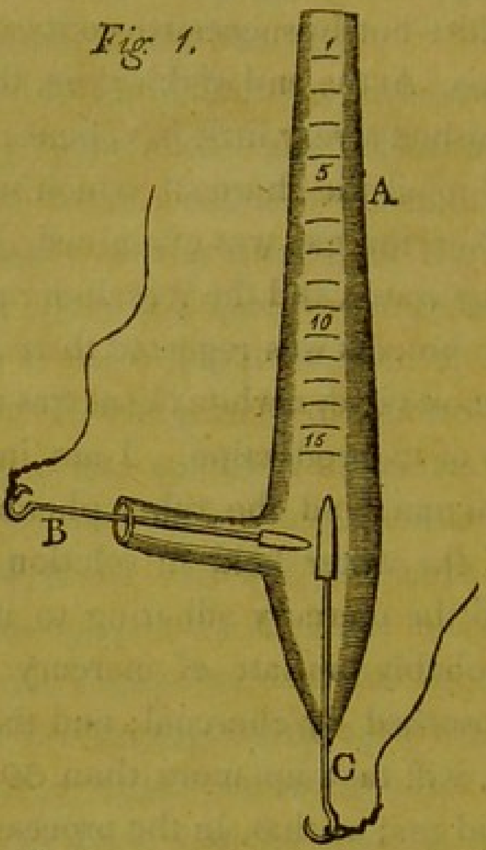


Fig. 2

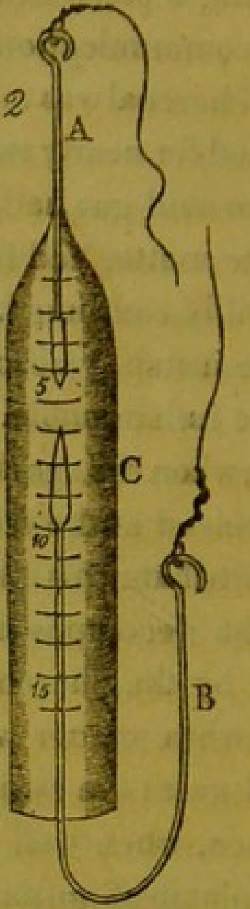


Fig. 1 represents the apparatus for taking the spark in fluids. A is a tube, graduated to grain measures. C is a platina wire, hermetically sealed into the tube, and having a piece of charcoal attached to its top. B is a moveable platina wire, having charcoal at its top; the effect is produced by making the contact between the pieces of charcoal. In cases when the fluids are very imperfect conductors, the wires may be used without the charcoal.

Fig. 2 represents the apparatus for taking the spark in gases; it is used over mercury. A and B are the communicating platina wires, to which the charcoal is fastened; and C is the graduated tube in which the gas is acted upon.

On the Velocity of Sound. By Thomas Young, *M. D. F. R. S.*

Sir Isaac Newton first calculated, from a comparison of the elasticity and specific gravity of the air, the velocity with which, according to the laws of motion, the effects of sound ought to be transmitted by it from place to place. But the velocity, thus determined, is only five sixths of the velocity found by experiment: and Newton attempted to make up the deficiency, by supposing each constituent corpuscle of air to be of the specific gravity of water, and to be absolutely incompressible; and also, that a number of vapours float in the air, and add to its apparent weight, without partaking of all its motions. These conjectures have not been generally adopted; and several others have been brought forward in their place. I have ventured to suggest, that probably "the particles of air are surrounded by a more highly elastic medium, which assists in transmitting the impulse, but which is either displaced, or rendered less elastic, when the air is slowly compressed." (Syllabus, 289.)

In the Bulletin de la Société Philomathique, No. 3, Tome III, we have an account of a communication of Biot, to the National Institute at Paris, in which he has prosecuted an idea, suggested by Laplace, that the heat caused by condensation might so far increase the elasticity of the air as to cause the acceleration in question. The idea is certainly very ingenious; and it is difficult to deny the probability of the existence of such an effect. At first sight, it might be imagined, that a loud sound ought to be more accelerated by heat than a weak one; but, on a more accurate examination, we shall find that the law of isochronism of small vibrations will remain unimpaired; it is however by no means equally certain, that the whole effect of the heat will be considerable enough to be sensible. Mr. Biot has calculated, that in order to produce the necessary correction, the condensation of a quantity of air, into a space of half the dimensions, ought to raise it from the temperature of freezing to that of boiling water: but he has made no experiments in favour of so bold an assumption.

Fortunately however our countryman, Mr. Dalton, has enabled us in great measure to supply the deficiency. From his very interesting experiments, published in the fifth volume of the Manchester memoirs, it appears that air condensed to one half, has its temperature raised 50°, a change capable of producing an expansion of one tenth of its bulk. This Mr. Dalton ascertained, by noting the velocity of the ascent of the mercury of the thermometer in a few seconds, and by comparing it with the velocity with which the thermometer was affected in the open air, at a known temperature differing from its own. Now, supposing that for each degree that the thermometer rises, the air must be condensed in some certain proportion, we may take that of 99 to 100 as near the truth; and then, in order to produce an elevation of 50°, we shall require, as will appear by involution, a condensation to $\frac{3}{5}$ only of the original bulk, instead of half; for we may allow that a little heat might have been lost, even in Mr. Dalton's experiment. Now a degree of heat increases the elasticity of the air $\frac{1}{500}$, very nearly, which is to be added to the $\frac{1}{100}$, produced immediately by the condensation. The moving force is therefore increased one fifth; and the effect is precisely the same as if the elasticity of the air were increased one fifth from any other cause. Consequently, since the velocity varies in the subduplicate ratio of the force (Syllabus, 294), we must add one tenth to the result of the calculation, and increase it from 950 feet in a second to 1045, at a mean temperature.

But this correction is only half enough for our purpose; for the mean velocity from observation is 1130 feet. It remains therefore to be considered, whether we choose to adopt, in addition to Mr. Laplace's suggestion, any of those that had before been made, or whether we may suppose that the production of heat could have been more than twice as great as Mr. Dalton's experiments indicated. At any rate, Mr. Laplace appears to deserve the highest credit, for having led us one step forward in the theory of sound, although there is still room for additional investigation and experiment; and the probability of the opinion which I have already stated, does not appear to be lessened by this collateral correction.

Note on Mr. COULOMB's *Experiments on Magnetism.*

We find in No. 3, Tome III, of the Bulletin de la Société Philomathique, an account of Mr. Coulomb's further experiments on magnetism. They appear to have been made with great precaution, and they tend to confirm the opinion already advanced in these Journals, (p. 135,) that the greater part, if not the whole, of the effect observed was owing to the presence of iron. For it appears that, according to the method employed in the purification of the metals examined, their apparent magnetic power was very materially different. Mr. Coulomb observes that, upon this foundation, we may make the action of the magnet, upon a needle thus suspended, a very useful instrument in chemical examinations; for he finds that the attractive force is directly as the quantity of iron in any mixture; and, according to its magnitude, we may estimate that quantity, when it is so small as wholly to elude all chemical tests. Y.

From the JOURNAL de PHYSIQUE, Prairial, An 10.

On the Change produced in Carbonic Acid Gas by the Electrical Spark. By THEODORE DE SAUSSURE.

Dr. Priestley observed, that an increase of volume was produced in carbonic acid gas by the electrical spark; and Mr. Monge, finding that inflammable gas was generated in the process, attributed the effect to the decomposition of the moisture dissolved by the carbonic acid.

Mr. Saussure, in repeating the experiment, making use of wires of copper for transmitting the electrical spark, was able, during eighteen hours of labour, to increase the volume of 13 cubic inches of carbonic acid gas, confined over mercury, $\frac{1}{10}$ of a cubic inch. On examining the products of the operation, he found that about a cubic inch of carbonic acid had disappeared, and that a quantity of inflammable gas, somewhat greater, had been produced. 100 parts, by measure, of this gas, burnt with about a third of its volume of oxygene, gave no perceptible quantity of water; and produced 77 parts of carbonic acid. Hence evidently it was not, as has been generally suspected, hydrogene gas, but the gaseous oxide of carbone. In another experiment, in which the carbonic acid gas was mixed with hydrogene gas, it was converted, in a much shorter time, by electrical sparks, into gaseous oxide of carbon, at the same time that water was produced.

The theory of the partial decomposition of carbonic acid by the electrical spark, is extremely simple; and, as Mr. Saussure has stated, in the case when pure carbonic acid gas is employed and copper wires are used, the metal is oxidated at the expense of the acid, which, losing a portion of its oxygene, becomes gaseous oxide of carbon. In the other case, the partial deoxygenation is chiefly effected by the hydrogene, which is converted into water, whilst the carbonic acid assumes the form of gaseous oxide. D.

Lectures delivered in the Theatre of the Royal Institution.

DR. YOUNG's *Lectures on Hydrodynamics.*

The remainder of this part of the course was devoted to optics. In the eleventh lecture, Dr. Young observed that simple opaque and transparent bodies, probably differ only in the quantity of light which they intercept: for a cube of water of 1000 feet would be opaque, and leaf gold is semitransparent: and, even in white metals, we cannot prove that no light at all penetrates into their substance. The refraction and reflection of light were shown, by the progress of a pencil of the light of a lamp, thrown into parallel directions by a lens. The mode of determining the shades of colour, very judiciously adopted by Scopoli in his Entomologia Carniolica, was exhibited and explained: dividing a circle into eight sectors, of different colours, he causes it to revolve so rapidly as to exhibit the appearance of a single one, which may be identified by describing the primitive colours of the sectors.

The twelfth lecture was upon the theory of optics. The prismatic spectrum was exhibited, for want of the solar light, by means of a lamp and a lens; and the properties of reflecting and refracting surfaces were shown, by well known experiments on the places of images, and the interchange of conjugate foci.

In the thirteenth and fourteenth lectures, the construction of optical instruments was explained. The principles of telescopes were illustrated by a model, in which screens of gauze were interposed at the places of the intermediate images, so as to render those images visible in all directions, at the same time that enough light was transmitted through the interstices of the threads, to allow the ultimate image to be seen through the eye glass: and lamps of different colours being employed to form an object, it was easy to distinguish the erect or inverted position of the image. The position of the image on the retina of an ox's eye was also exhibited; and the different parts of the eye demonstrated by dissection.

On Monday the 10th of May, the solar microscope was exhibited. The microscope could not be placed immediately in either of the windows under the gallery of the theatre, which were left for the purpose of admitting the light; a large square tube was therefore fitted into one of them, with a double joint; and the microscope was fixed in a similar manner at its extremity, so as to throw the image on the wall next the apparatus room. The first objects were the rings of colours, formed by a thin plate of air intervening between a plane and a convex glass, described with great accuracy by Newton, but hitherto little known. They afford, however, by means of the apparatus for opaque objects in the solar microscope, a picture equally brilliant and instructive. The rings of colours in the transmitted light, although less conspicuous, were still easily made visible. Dr. Young was assisted by Dr. Shaw in procuring animalcules for the occasion; and Mr. Rudge had the goodness to furnish him with a large number of sliders, filled with various subjects of natural history.

The nature of vision, and of other optical phenomena, occupied the sixteenth lecture. After explaining the functions of the eye, and the nature of the changes which it appears to undergo, Dr. Young briefly enumerated the arguments which are already before the public, in favour of supposing the form of the crystalline lens to be changed, when the eye is accommodated to the distinct vision of objects at a small distance; and observed, that it would be necessary to answer these arguments, before any thing could be safely concluded in favour of a different opinion; that Mr. Home had only opposed to them a single observation on the eye of a person who had been deprived of the lens; and that, even here, the change was at most so slight as scarcely to require discussion, but that it appeared to vary so much in different experiments, as scarcely to leave a doubt that it was accidental. The cornea must unquestionably have been very convex, and most probably irregularly convex, and then, either a slight pressure of the eyelids, or a small change in the position of the object with respect to the axis, might easily have produced the apparent change of refractive power: and, in order to be convinced how great an effect external pressure will produce, we need only to look at a minute luminous object, and then apply the finger to the eyelid, and the object will immediately appear distorted. Dr. Young remarked, that short sighted people only are called myopic; although we should at first naturally imagine, that a partial closing of the eyelids might be of equal use to those who are too longsighted; but that the difference probably depends on the magnitude of the pupil, which is generally much larger in a short sighted person, especially when he looks at a distant object, and that such an eye is therefore more in need of an artificial diminution of the magnitude of the pencils of rays

On Monday the 17th of May, Dr. Young delivered the concluding lecture; its subject was the nature of light and colours. By the help of the solar microscope, the colours of thin plates were again exhibited: the properties of solar phosphori were shown, by means of an exellent specimen of the Bolognan stone, lately brought by a young gentleman from Italy; and the circulation of the blood in the tail of a newt was displayed. Dr. Young observed, that besides the various cases of the production of colours which had already been explained by the combination of undulations, he had lately discovered two classes of colours hitherto unknown, one of them apparently analogous to the colours of halos, and the other somewhat similar to the colours of thin plates, but depending on the mixture of two mediums of different density; that both of these new orders of colours were easily referable to the general law first published in the syllabus, but perfectly unintelligible upon every other supposition; and that, if any physical arguments could be said to approach to the nature of mathematical demonstration, it must be such arguments as these, where a general law is shown, by the nicest evidence of the senses, to coincide with the whole detail of the dimensions of the substances employed, and to be applicable with equal ease to established facts and to subsequent observations.

DR. YOUNG'S *Physical Lectures.*

The seventh lecture, on Friday the 5th of March, was upon geography. The astronomical divisions of the earth were illustrated by the globe: some of the uses of the globe were exemplified; and the general situations and levels of the Continent were exhibited in Arrowsmith's globular projection of the two hemispheres, a line being drawn on it from Cape Finisterre to Kamtschatka, in such a direction as not to cross any rivers. The different opinions respecting the theory of the earth were enumerated; and the preference was given to that system which supposes the principal strata of the earth to have been deposited from water, and yet does not wholly exclude the frequent cooperation of fire. The experiments of Dr. Maskelyne, and of Mr. Cavendish, for ascertaining the earth's density were described; and it was inferred, that the mountain Schehallien must be either composed of unusually dense stony matter, or rich in metallic ores.

In the eighth lecture, the tides were considered. It was observed, that Laplace has endeavoured to confute the common opinion, that the primary spring tides are a few days after the time of new and full moon, and has supposed, that this interval is only occasioned by the time occupied by the principal tide of the ocean in travelling to our parts. The observations of Dr. Maskelyne, at St. Helena, were adduced, as favouring Laplace's idea. The combination of two tides was illustrated by the harmonic sliders, already mentioned in the account of the lectures on sound; and it was remarked, that the same harmonic curves which have long been assumed, in considering the laws of the propagation of sound, are such as actually express the state of the tides of the sea. The lecture concluded with a short history of astronomy, chiefly abridged from Laplace, and accompanied by an extract from Priestley's Biographical Chart; exhibited on a large scale.

The ninth lecture was occupied by the detail of the general properties of matter; a subject which is often mixed with the doctrines of elementary mechanics, but which is there perfectly unnecessary, and cannot indeed be fully examined, without a previous knowledge of many of the phenomena of nature. In speaking of its divisibility, Dr. Young observed, that there appeared to be a partial limitation to its actual minuteness in all coloured bodies: for that, if we adopt the opinion of Newton, in deriving the cause of colours from the dimensions of the colouring particles, we can never suppose these particles to be less than the millionth of an inch, except in bodies perfectly black; although indeed, there might be reason to think the particles of carmine capable of producing colour when reduced to one thirtieth of this thickness; but that, in such cases, we must necessarily suppose the particle to be surrounded with a little atmosphere of some medium capable of extending the limits of its operation. With respect to the ultimate density of matter, it was remarked, that although it might be very reasonable to believe it much greater than the apparent density of any bodies known to us, yet that we had no positive proof that there could exist a body much denser than platina; none of the planetary bodies appearing to be denser than the earth; and the mean specific gravity of the earth being only one fourth of that of platina. Some phenomena of the colours of thin plates, as observed by Newton, and by Professor Robison, were adduced, in illustration of the nature of repulsion and cohesion; and some arguments were advanced, in favour of Newton's conjectures concerning the immediate cause of gravitation, and of other natural powers, and in opposition to the opinions of Boscovich and his followers.

The subject was pursued in the tenth lecture: experiments were made on cohesion and capillary attraction. Dr. Young observed, that the form of a detached globule of mercury, or water, is principally dependent on the cohesion of the superficial particles, and that, upon a rough calculation, this cohesion of the circumference is nearly equal to the weight of the spheroid, when its diameters are in the proportion of 5 to 6. Count Rumford's experiments on the heat produced by friction were described; and the result was considered as almost fully decisive, against the opinion of the French chemists respecting the nature of heat. Experiments were made on the reflection of invisible heat, and of cold, by means of a single mirror, and both the effects were very distinctly sensible.

In the eleventh lecture, these experiments were repeated with two mirrors. The heat of a mass of iron not visibly ignited, was sufficient to produce an elevation of 30° in a mercurial thermometer, in the corresponding focus; and the apparent reflection of cold was ascertained by means of an air thermometer: the alternation was made by interposing a screen, not between the ice and the thermometer, but so as only to intercept the reflection from the mirror; and the effect, though not great in quantity, was perfectly decisive with respect to its dependence on the action of the mirrors. Some account of the history of these experiments was given. The reflection of cold is first found in the Essays of the Academy del Cimento, translated by Waller in 1684, p. 103. The ninth experiment, of reflected cold, is thus related. "We were willing to try, if a concave glass, set before a mass of 500lbs. of ice, made any sensible repercussion of cold, upon a very nice thermometer of 400 degrees, placed in its focus. The truth is, it immediately began to subside; but, by reason of the nearness of the ice, it was doubtful whether the direct or reflected rays of cold were more efficacious: upon this account, we thought of covering the glass, and (whatever may be the cause) the spirit of wine did indeed presently begin to rise: for all this, we dare not be positive but there might be some other cause thereof, besides the want of the reflection from the glass, since we were deficient in making all the trials necessary to clear the experiment." An experiment on the reflection of heat is also thus related by Buffon, Hist. Nat. Suppl. 1774. v. I. p. 46. "I collected, by means of a burning mirror, a strong heat without any light, by interposing a plate of iron between it and the fire, part of the heat being reflected into the focus of the mirror." Dr. Young advanced an explanation of these facts, nearly similar to that of Prevost; and observed, that the reflection of heat at an angle equal to that of its incidence, furnishes a strong argument against considering radiant heat as a stream of a continuous repulsive fluid; for that a stream of any fluid, as of water or air, when surrounded by the same medium, either glides along the surface on which it falls, or is irregularly dispersed in all directions, but is never reflected at an angle equal to that of its incidence. Dr. Herschel's important experiments on the refraction of heat were related; and it was observed, that they had been repeated with success by several other persons. The expansive powers of heat, and the properties of Prince Rupert's drops, and the Bolognan jars, were exhibited and explained. In addition to Count Rumford's experiments, those of Mr Davy were mentioned, where ice was converted by friction into water, while the surrounding air was at the temperature of the freezing point. Many of the phenomena of heat were illustrated by experiments on the sounds of chords, and of tuning forks. On the whole, Dr. Young observed that, there appears to be sufficient reason to induce us to abandon the too hasty theories of the moderns, and to return to the good old doctrines of our forefathers.

The twelfth and thirteenth lectures were employed in the consideration of electricity. The nature of induced electricity was shown by several small electrometers, placed at different parts of a long insulated conductor, in the neighbourhood of an electrified body. It was observed, that the scale of an electrometer may easily be so placed that its equal divisions may represent the exact proportions of the force; for, provided that the repulsive force of a neighbouring sphere act always in a horizontal line, the force will be as the portion of a horizontal scale cut off by the thread or wire supporting the ball of the electrometer. In order to account for the well-known fact, that when a shock passes through a conducting circle, its extremities are more sensibly affected than its intermediate parts, Dr. Young supposed, that the fluid naturally belonging to the conductor is often displaced at each extremity by induction, and that the restoration of the equilibrium produces a greater change in the state of the extremities, than the smaller current which passes through the whole substance.

The lecture of the 30th of April was on magnetism. The position of the magnetic needle was illustrated by an insulated wire supporting two pith balls, which was held in the neighbourhood of the insulated conductors of Nairne's electrical machine; the opposite states of the conductors enabling their extremities to represent the north and south poles of a magnet; and the induced electricity of the wire causing it to assume a position exactly similar to that of a needle held near a magnet. The experiment of the reversion of the temporary magnetism of a bar of iron depending on its position, was performed with perfect success; and a chart of the variation of the compass was exhibited. The variation at present, in London, was stated to be 24° west.

The fifteenth lecture was occupied by a summary of the science of meteorology. Considerable use was made of the observations of Mr. Prevost, on the heat received from the sun; but it was remarked, that some of them had been anticipated by Thomas Simpson. The general phenomena of the trade winds and monsoons were described, and shown to agree well with theory. With respect to the supposed vesicular nature of vapour, Dr. Young observed, that he had carefully examined the globules visible on the surface of a heated fluid, and was persuaded that there was no probability of their being vesicular. In order to illustrate the effects attributed, with great justice, by Lord Stanhope, to the returning stroke of lightning, Dr. Young placed a large conductor near another which was continually discharging itself by sparks passing to a neighbouring ball, and, laying his hand on the large conductor, he felt, at every spark, a very sensible effect in the hand and arm; which, on a larger scale, would have been the same returning stroke that has sometimes proved fatal without any visible lightning.

The physical division of the course was concluded on the 14th of May, by a lecture upon the general philosophy of natural history, both with respect to vegetation and animal physiology, and to the Linnean classification of the different kingdoms of nature. Mr Knight's interesting experiments on the motion of the sap in trees were related; but it was observed, that there was some difficulty in reconciling his opinion, that the sap ascends through the wood only, and descends through the bark, with an experiment of Dr Hope, who found, that the bark of a willow, when the whole woody part had been removed from within it for a considerable length, still went on to deposite new layers both of wood and of bark. Dr. Young regretted the want of specimens, or figures, on a scale large enough for exhibition in a public lecture; but hoped that some means might be found, in a future year, to represent to the eye some such subjects of natural history as might be either particularly interesting in themselves, or might tend to illustrate the relations of the diversified forms of living beings, and of the general economy of the works of nature.

Dr. Young concluded his first course with an avowal of his sincere consciousness of its great imperfection, and of the utter insufficiency of the time in which he had been obliged to prepare it for arranging any single lecture in such a way as to satisfy himself: and also of his apprehensions that more than one season must elapse, before it would be possible to collect and digest the information, and to complete the apparatus, necessary for the illustration of so extensive a range of distinct departments of science.

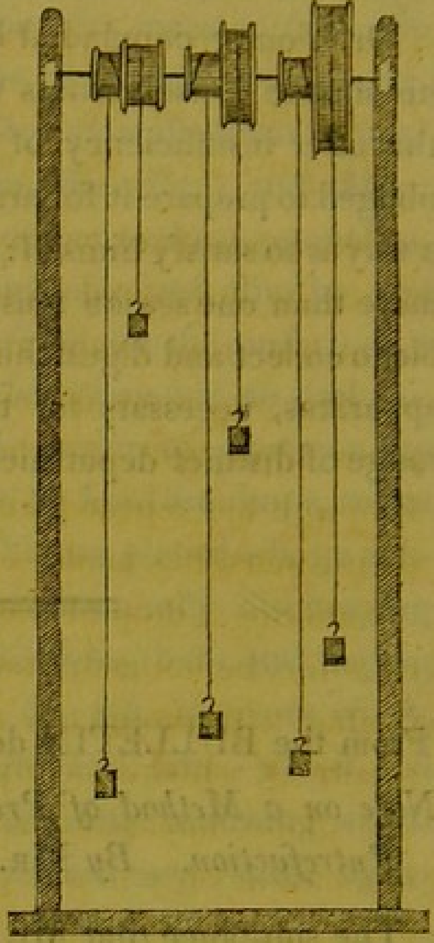
From the BULLETIN des SCIENCES, No. 3. Vol. III.

Note on a Method of Preserving Animal Substances from Putrefaction. By Mr. Chaussier.

The substance that Mr. Chaussier employs for preserving animal matters from putrefaction, is a solution of oxygenated muriate of mercury, kept constantly in a state of saturation. The preparations remain immersed in it for a certain number of days; and, after they are throughly impregnated with it, may be dried by exposure to light and air. After the process, they are no longer susceptible of being easily decomposed; they preserve their form, become possessed of a great degree of hardness, and are not subject to the attacks of insects. D.

A Description of Dr. Young's *Apparatus for illustrating the Doctrine of Preponderance.*

Although there can be no doubt of the truth of the mathematical conclusions, which have been deduced from the well known laws of motion, respecting the most advantageous employment of force in machines, yet they have, in general, been too little considered in practical works, and scarcely ever enforced by experimental illustration. The apparatus contrived for this purpose, has been mentioned in the account of the lectures on mechanics; its advantage is derived from the simplicity of its operation, and the facility of observing at once the several motions, which begin at the same time, and may easily be compared, as long as they continue. The dimensions of the double pulleys have already been stated. The ratio of the portions of the middle pulley, which is that of 5 to 2, is near enough to the maximum $(\sqrt{2}+1):1$; and the other ratios 3:2 and 4:1 are taken sufficiently different from this to show that the velocity of each is inferior to that of the middle pulley. The pulleys are all perforated in the axis, and move freely on a strong polished wire, supported by two short arms, projecting a little from two upright pieces about three feet in length, in order that the descending weights may proceed without interruption beyond the edge of the table. The other parts of the figure will be easily understood, from the account of the experiment, already published in the seventh number of these Journals, p. 105.



Y.

From the JOURNAL de PHYSIQUE. Messidor, An X.

Observations on the Evaporation of Water at a high Temperature. By MR. KLAPROTH.

Mr. Leidenfrost published a dissertation, in 1756*, in which he attempted to show, that drops of water thrown upon hot iron, evaporated more slowly in proportion as the heat was more intense; the highest point being taken at the white heat, and the lowest at a heat above 212°. Mr. Klaproth has repeated his experiments; and, in confirming their results, has made some new observations.

Suffering a drop of water to fall into an iron spoon heated white, he noticed, that at the moment the fluid came in contact with the metal, it divided itself into a number of spherules, which speedily united themselves, and, forming one globe, apparently rested in the bottom of the spoon, touching it only in one point. In observing minutely this globe, he found that it revolved rapidly round its axis, gradually became less, and at length dissappeared with a slight explosion. Another drop exhibited similar phenomena, but was lost in less time; and, in proportion as the spoon grew colder, the drops evaporated more speedily. The times of evaporation, in two experiments made with great care, were as follows.

Experiment I.

The first drop thrown into a spoon heated white, was in evaporating	40 seconds
The second	20
The third	6
The fourth	4
The fifth	2
The sixth	0

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* De Aquæ communis nonnullis Qualitatibus Tractatus.

Experiment II.

The first drop lasted	40 seconds
The second	14
The third	2
The fourth	1
The fifth	0

The intensity of the heat was greatest in the first experiment; and the degree at which the water evaporated most quickly was longer in being produced. Other experiments were made, but their results did not coincide more nearly, as it is impossible to measure exactly the temperature of the spoon; the inequalities of its surface also, and the presence of foreign bodies, must materially influence the appearances. Mr. Leidenfrost, indeed, had found before, that when the revolving globe, in the case of the white iron, was touched with a cold body, so as to be brought in contact with the spoon in many points, it instantly disappeared.

Mr. Klaproth caused seven drops of water to fall, one after the other, upon a spoon heated to the proper degree: these drops united themselves into a globe, which revolved as usual round its axis; it then became divided at the top, and a spot of foam appeared on its upper surface, whilst its edges seemed as if fringed. This phenomenon, truly beautiful, lasted 150 seconds; whilst the globe diminished, and at length, as the metal became colder, disappeared.

The results were similar in an experiment with ten drops; and the globe was not dissipated in less than 200 seconds. The process did not however succeed with a greater number; they united themselves into a globe, which began the rotatory motions, but they did not long continue; the inferior surface soon came in contact with the iron in more than one point, and the fluid disappeared with a hissing noise.

Cups of silver and of platina were employed, with similar effects; but the duration of the globe of water was longer when these metals were used white hot.

In the cup of silver, in the first experiment,

the first drop lasted	72 seconds
The second	20
The third	20
The fourth	0

In the second experiment, the first drop

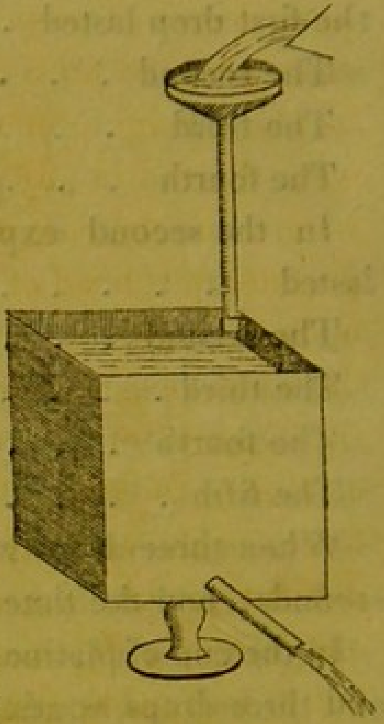
lasted	61
The second	30
The third	20
The fourth	6
The fifth	0

When three drops were employed, the globe lasted 240 seconds; and the time of evaporation was momentary.

In the cup of platina, the first drop continued 50 seconds; and three drops continued 90 seconds. D.

An Account of an Experiment on the Velocity of Water flowing through a Vertical Pipe.

It has been asserted by some writers on hydraulics, and Venturi describes a particular experiment in support of the assertion, that the discharge of water running out of the bottom of a cistern, through a descending pipe, is nearly the same as if the cistern were continued through the whole height, from the surface of the water to the orifice of the pipe, and the water were then discharged from the bottom of this cistern by a short pipe in any direction. The apparent difficulty of finding a cause adequate to the effect, on the one hand, and the authority of Venturi on the other, made it desirable that the experiment should be repeated; and an apparatus was constructed, in the house of the Royal Institution, for performing it in a simple and satisfactory manner. The cistern employed was a cube of nine inches: close to the bottom a cylindrical tube was inserted, in a horizontal direction, nine inches in length, and half an inch in diameter; another tube, of exactly the same dimensions, was provided with a flat funnel at its



upper end, and its lower end was fitted to slide in a collar placed in one of the upper angles of the cistern, so that it was supported in a vertical position. Water was poured into the funnel, as fast as it could be transmitted through the tube, and, as the surface of the fluid rose in the cistern, the vertical tube was drawn up, so that its lower orifice was barely immersed in the water. It was expected, that if the velocity of the water in the vertical tube were equal to the velocity corresponding to half its length, the water in the cistern would stand at the height of four inches and a half, or one half of that length, and that the pressure of this head of water would generate, in the water flowing through the horizontal tube, nearly the same velocity as the column of water would acquire in its descent through the vertical tube: the friction and resistance being in both cases the same.

But the result was far different, and it fully confirmed the truth of the received theory: for the water rose in the cistern to the height of eight inches, which was very nearly the length of the tube. It is true that the water had already some velocity when it entered the funnel; but most of this must have been lost by reflection from its sides and bottom; and the quantity of air bubbles, that were unavoidably carried down with the water, must have fully compensated the little that remained.

It appears therefore, that we are to consider this effect in a light somewhat different from that in which it was placed in the lectures on hydraulics. The water acquires all its velocity, in consequence of the pressure of the atmosphere acting jointly with its cohesion, in a very small space at the entrance of the tube: consequently, during the whole time of its descent it acquires no new motion, and the whole force of its gravitation must therefore be at liberty to act in any other way; hence the whole column produces the same degree of pressure as if it were at rest, and causes the atmosphere to press on the water above it in proportion to its whole height, in the same manner as if the pressure were derived in any other way from an equal column of water; and the case is reduced to a perfect analogy with the pressure of a head of water of this height, since the air acts upon the particles entering the tube in the same manner as the water does in more common cases. Had the result of the experiment been different, it would have been an exception to the general principle of the preservation of living force, or the equality of the potential ascent to the actual descent; for, the water moving with the velocity due to half the height only, would have been capable of ascending but to half the height. Y.

From the ANNALES de CHIMIE. No 127.

" *Observations sur quelques &c.*" *Observations on some Phenomena produced in Experiments made on the Combination of Iron with Silver, and with Lead. By* Mr. Guyton.

Gellert had formerly announced, that silver and iron might easily be made to enter into combination. But Mr. Guyton, from an experiment published in the Journal de Physique for August, 1778, concluded that the assertion was not well founded. In examining the subject very lately in a more minute manner, he has ascertained some new facts in relation to it, and to the action of iron upon lead, which lead to interesting conclusions.

He fused together equal parts of silver and iron: they gave a perfect globule, in which the metals had apparently separated from each other, according to their respective specific gravities, so that at first view there appeared to have been no combination between them. On examining the iron minutely, however, he found, that it was considerably altered in its properties. It was much harder than before, and very brittle; and that part of it which was farthest from the contact of the silver, dissolved in nitric acid, gave to muriatic acid a copious precipitate, which, when weighed, indicated a quantity of silver equal to $\frac{1}{30}$ of the mass of the iron.

Pieces of the silver most remote from the contact of the iron, when examined by solution in nitrous acid, and the test of prussiate of potash, gave no signs of the presence of iron; but they were evidently magnetic; and this circumstance, according to the observations of Mr. Coulomb, seems to denote that they contained a very minute portion of that metal.

In an experiment in which lead and iron were fused together, there was the same apparent separation in the parts of the globule; but the lead, examined in a part where it was far removed from the contact of the iron, gave, both by the test of magnetism and of the prussiate of soda, evident proofs that it contained iron.

Mr. Guyton is induced to believe, from those experiments, that there exists a true affinity between iron and silver, and iron and lead; and that, with regard to silver, the attraction is greatest on the part of iron. On account of the difference in the temperatures at which the three metals become fluid, it is impossible to combine them in large proportions; though their change of properties, after having been brought into contact in a state of fusion, sufficiently denotes their chemical action on each other. He thinks that the combination of iron with silver, may, on account of its extreme hardness, admit of useful applications.

" Suite à mon Essai, &c." A Continuation of an Essay upon Ether, containing some Researches on a new State of the Sulphuric Acid, and upon some of its Combinations. By MR. DABIT.

In this paper, Mr. Dabit gives an account of some experiments on the residuum of sulphuric ether, from which he is induced to believe, that he has discovered an acid of sulphur in a state of oxygenation intermediate between the sulphuric and sulphureous acids. As yet he has not obtained it in a free state; and he founds his conclusions upon the phenomena presented by its saline compounds.

In saturating the residuum of ether, mixed with water, with carbonate of lime, he obtained a solution which gave by evaporation, a salt that crystallized in parallelopipeds, having but little taste, and being soluble in 100 parts of cold water. This salt was decomposed by sulphuric acid. By the action of oxygene gas, or of nitrous acid, it was converted into sulphate of lime; and, by being heated with charcoal, it gave a sulphuret of lime.

When it was mixed with a solution of carbonate of potash, soda, or ammoniac, a double decomposition took place, and the stronger acid combined with the alkalies.

Mr. Dabit has noticed some of the properties of its alkaline combinations, which are extremely analogous to those of the sulphites. He proposes to call the acid the oxygenated sulphureous acid. But the application of the name will most probably be generally considered as premature; and new characters will be required to distinguish it from the sulphureous acid, before its existence as a peculiar body can be implicitly admitted. D.

From the JOURNAL de CHIMIE et de PHYSIQUE.

Par J. B. Van Mons.

" *Experiences, &c.*" *Experiments concerning the Action of certain Metals and Earths lately discovered on the Colouring Matter of Cochineal.* *By* M. Hermstadt.

1. The solution employed in these experiments was made by boiling two ounces of the cochineal of Mexico, in powder, for fifteen minutes, with seventy four ounces of distilled water. After having been filtrated, it was divided into portions of two ounces and a half, and one of these portions was used for each trial that was made upon its tinging property. A piece of cassimere that had been introduced into it, in its common state, came out of a lilac colour.

2. A quantity of a saturated solution of cobalt in nitric acid was poured into a portion of the solution of cochineal: the colour changed to reddish yellow; and the liquor, which was at first clear, gave, after twelve hours, a red precipitate. A piece of cassimer, after having been boiled for three minutes in a weak solution of nitrate of cobalt, was introduced into a warm portion of the decoction of cochineal: it became of a bright red colour; and, after having been washed and dried, its tint was a mordoré.

3. The decoction of cochineal was mixed with a solution of sulphate of cobalt; the liquor became deep coloured, and a violet precipitate was thrown down. A bit of stuff treated with sulphate of cobalt and the cochineal dye, became of a perfect violet.

4. A solution of uranium in sulphuric acid, gave, with the decoction, a precipitate nearly black. But a piece of stuff, after having been exposed to this substance, assumed in the cochineal dye a greyish green colour.

5. A solution of tungstic acid gave, with the dye, a clear violet; and a piece of stuff with which it was treated came out of the liquor of a bright poppy red.

6. With a solution of molybdic acid in water, the decoction gave a deep violet. Cassimer impregnated with the acid became sea green; and, when dried in the sunshine, greyish blue; and this colour, by the action of the dye, was converted into violet.

7. Arsenical acid produced in the colouring solution a yellowish red tint; but no deposit was formed. Cassimer boiled in a solution of the acid, and dyed, came out of a bright scarlet, inclining to yellow; this colour was rendered deeper during the process of drying, and by the application of a heated iron. When acidulated arseniate of soda was used as a preparative for the dye, the colour was a deep mordoré; and, when the alkaline arseniate, a lilac. With the arsenious acid dissolved in water, the colour was lilac, of a shade rather deep.

8. In comparing the effects of these metallic mordants, with the effects produced by the oxides of lead and tin,

Mr. Hermstadt observed, that the acetite of lead gave a good violet; and the muriate of tin, after it had been oxygenated by exposure to the air, a bright scarlet. He thinks, in consequence, that the muriate of tin may be substituted with advantage, in the common processes of dyeing, for the nitromuriate, provided it has been suffered to remain for a sufficient time in contact with the atmosphere.

9. The muriate of barytes, used as a mordant with cochineal, gave a dark colour, which, after washing, became violet. The nitrate and acetite of barytes produced different shades of poppy red.

10. Muriate of strontian gave a dark colour, which first appeared to border upon scarlet, but which, in dyeing, was converted into crimson. Nitrate of strontian gave a bright red brown; and acetite of strontian a vivid poppy colour.

Nothing is said in the extract quoted, of the different degrees of permanency in the colours produced. It would seem, from the experiments upon the earths, that the nature of the colour depends, in a great measure, upon the nature of the acid employed, which can hardly arise from any other cause than from its action upon the cloth. In all cases, indeed, where saline compounds are employed as mordants, it is probable that the base, whether earthy, alkaline, or metallic, always carries with it into combination a certain portion of the dissolving acid; and, on this supposition, we may account for the various modifications of colouring matters by mordants, the bases of which are very similar to each other.

" *Experiences, &c.*" *Experiments on the Colouring Properties of the Molybdic Acid, and on its use as a Mordant. By* M. D. JAEGER.

It has been often observed that solutions of the molybdic acid are capable, under particular circumstances, of assuming a blue colour. Mr. Hatchett, in his excellent paper upon the molybdate of lead, Phil. Trans. for 1796, has mentioned that a blue precipitate is produced by the action of muriate of tin upon a solution of molybdic acid in muriatic acid, saturated with potash; and, after this process, a blue colouring matter has been lately manufactured in Germany. In this extract, an account is given of different experiments on the applications of the molybdic acid to the purposes of dyeing.

Mr. Jaeger formed the molybdic acid by exposing the scaly molybdena of Saxony to heat and air; and he employed it as a material in dyes, in its state of combination with potash.

After trying the effects of various metallic solutions in combination with the molybdate of potash, he fixed upon the muriate of tin, as most promising with respect to useful application.

A solution of molybdate of potash in excess was boiled for half an hour with a saturated solution of tin, and suffered to rest for eight or ten days. After this time, it became of a fine deep blue, having deposited a considerable quantity of grey oxide of tin.

A piece of muslin introduced into this solution diluted with two parts of water, came out, after a quarter of an hour, of a pure and vivid blue.

A piece of white woollen cloth, after having been boiled for half an hour in it, became coloured of a fine deep blue. By these trials, the colouring matter of the lixivium was partly exhausted; and, in a new experiment made on it with woollen, the colour was much less intense. In all cases in which the metallic dye was used, the colour given to the cloth was uniform, and its union with the thread so intimate, that it had all the appearance of indigo.

Pieces of woollen cloth, dyed different shades of blue by the lixivium, were boiled for half an hour in an infusion of quercitron bark; they came out with different tints of green, but not so pure and uniform as could be desired. In another experiment, however, in which cloths dyed yellow with quercitron bark were boiled in the blue infusion mixed with the residual yellow dye, very beautiful tints, not inferior to those of the Saxon green, were produced.

The molybdate of potash gave, with acetite of alumine, and the colouring matter of logwood, a fine black dye, which resisted even the action of diluted sulphuric acid.

The blue lixivium, when evaporated at a low degree of heat, furnished a fine blue colour, extremely soluble in water, and which may be used as a pigment.

In general, the colours produced by the molybdic acid were very permanent, and unalterable by exposure to light and air.

"*Nouvelles Experiences, &c.*" *New Experiments on Artificial Cold. By* LOWITZ.

Mr. Lowitz concludes, from his various experiments on artificial cold, of which a particular account is to be published in the Transactions of the Academy of Petersbourg. 1. That the principal cause of the cold produced during the solution of salts in water, depends upon some agency of their water of crystallization; for salts deprived of this water, instead of producing cold, produce heat.

2. Amongst the liquid acids, the muriatic acid is most efficacious for forming freezing mixtures; the nitrous acid is next to it in order; and the sulphuric acid is least powerful.

3. The liquid acids produce cold only because they occasion a quick solution of the snow, or salt, of the freezing mixture.

4. Caustic potash and the muriate of lime, surpass very much, as cooling agents, the acids and the other saline substances.

5. The best proportion of the mixture of snow and muriate of lime, is two parts of the first to three parts of the last, mixed as accurately as possible.

6. Five pounds of muriate of lime are sufficient to freeze thirty five pounds of mercury.

7. The deliquescent salts are much more proper for producing cold than the efflorescent salts.

8. That the deliquescent salts may produce the highest possible degree of cold, it is necessary that they contain the greatest possible quantity of water of crystallization; and that they be used in fine powder.

9. The snow employed should be that which has newly fallen, light and dry; and the experiments should be made at the commencement of a frost, and not during a thaw.

10. It appears that the superiority of the deliquescent salts to the acids, is owing to the circumstance of their becoming fluid at the same time that they cause the snow to dissolve.

11. Caustic potash and muriate of lime possess, amongst other advantages, that of being easily restored, unaltered, to their solid state, after an experiment, by evaporation.

"*Composition &c.*" *An Account of a Composition for tinging Oak and Pear Wood of a Mahogany Colour; and of a durable Varnish for Wood. By* M. J. C. DANNEMAN, *Jun.*

This composition is very similar to that commonly used in this country. It is made by boiling together Brasil wood and Roman alum; and, before it is applied to the wood, a little potash is added to it.

The varnish is a solution of amber in oil of turpentine, mixed with a little linseed oil. D.

Description of Dr. Young's *Apparatus for exhibiting the Colours of thin Plates, by means of the Solar Microscope.*

The colours of thin plates were observed by Boyle and Hooke, and more accurately analysed by Newton: but little or nothing was added to the account that Newton gave of them, until some attempts were lately made to explain them, and to build at the same time on the explanation, the principal arguments in favour of a new system of light and colours. The phenomena themselves were very little known, except from Newton's description; it had happened but to few to observe them: and they had never been made conspicuous to a public audience in a form equally beautiful and interesting.

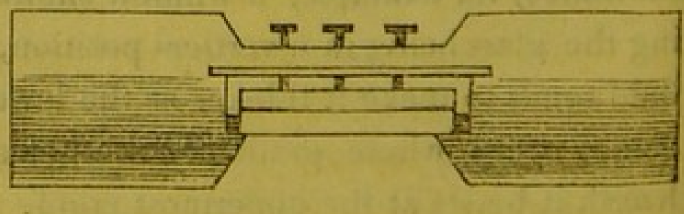
It appeared, however, that there would be little difficulty in applying the apparatus for representing opaque objects in the solar microscope, to the exhibition of these colours on a large scale: but several precautions were necessary, in order to obtain the most advantageous representation; and, these precautions having been completely successful, it may be of some utility to give a detached account of them.

The colours of thin substances must often have been seen in bubbles of water or of other fluids, and in the film produced by a drop of oil spreading on water; they were more particularly observed in the plates of talc, or of selenite, into which those substances readily divide. Sir Isaac Newton made his experiments principally on the colours of soap bubbles, and on those which are produced by the contact of two lenses. For inspecting the colours of soapy water, the most convenient method is that of Mr. Jordan. He dips a wine glass into a weak solution of soap, and then holds it in a horizontal position against an upright substance, for example, a window shutter; the film covering the glass being in a vertical position, the gravity of the fluid tends to make it thicker at the lower part, and it becomes every where gradually thinner and thinner, till at length it bursts at the uppermost point. The colours assume, in this case, the form of horizontal stripes, similar to the rings which are to be more particularly described.

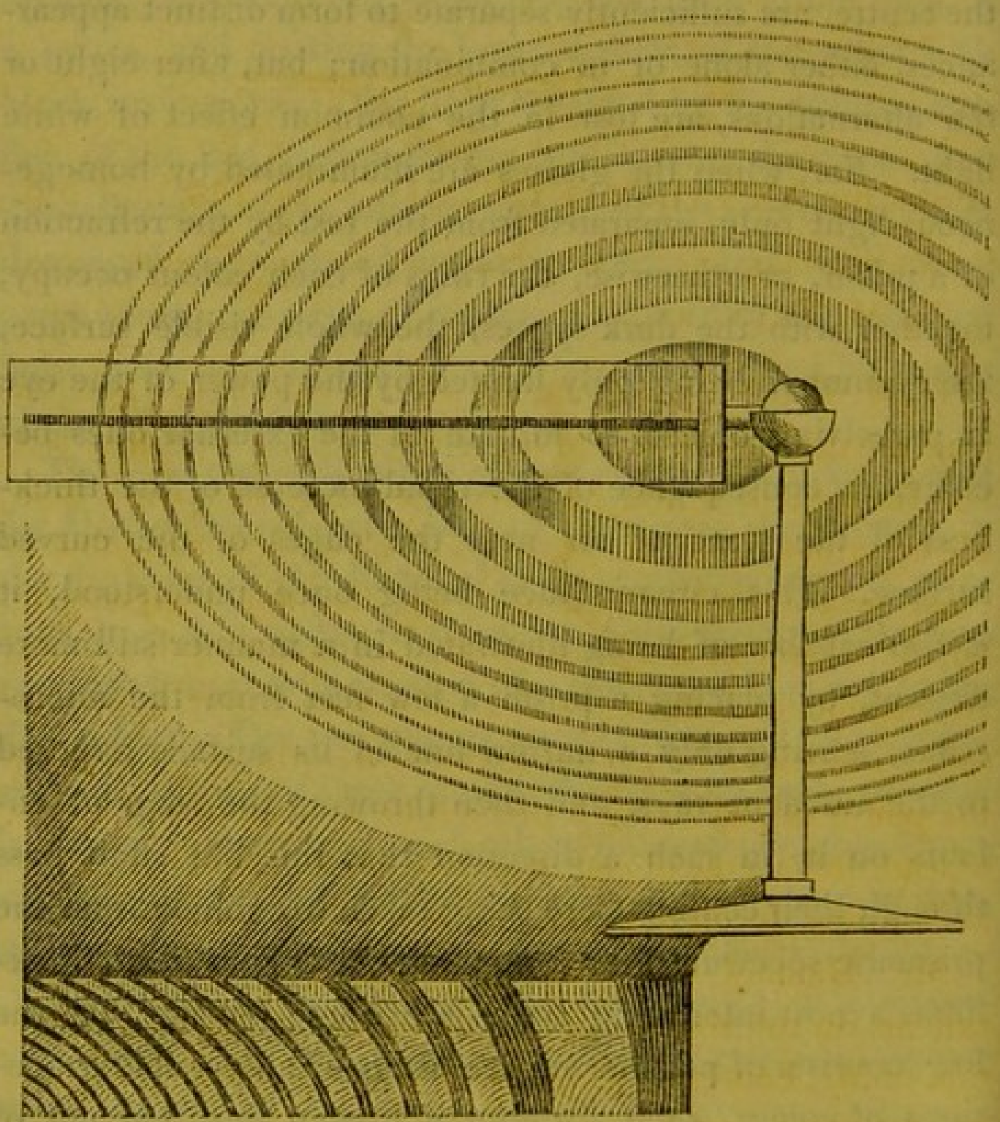
It has been observed by Newton, that the colours thus reflected from a plate of a denser medium, are more vivid than when a plate of a rarer medium is interposed between two denser mediums. But the cause of this apparent difference is probably, the quantity of foreign light that is generally present in the experiment, reflected as well from the upper surface of the superior medium as from the lower surface of the inferior, both these surfaces being often nearly parallel to the surfaces in contact. It becomes therefore desirable to remove this foreign light: this may be done effectually, by employing one glass in the form of a prism, and coating the lower surface of the other with black sealing wax: the light reflected by the oblique surface of the first, is thus thrown into another direction; and the reflection of the inferior surface of the second, is either destroyed or rendered imperceptible. And, with these precautions, the rings of colours produced in the reflected light, may be rendered a very beautiful object by means of the solar microscope.

The most perfectly plane glasses are those which are used for Hadley's quadrants: one of these may be ground in the direction of the diagonal of its transverse section, so as to make a thin wedge or prism; and the surface of the lens employed must be a portion of a sphere of from five to ten feet radius. The two glasses must be retained in their position by means of three screws; for, as soon as the pressure is removed, they repel each other with considerable force; and, for this reason, neither of them ought to be very thin, otherwise they will bend before they are sufficiently near.

For adjusting the glasses to the microscope, it is convenient to fix them in a cylinder of sufficient size to project beyond the glasses and their screws, in order that they may be readily turned so as to



reflect the light coming from the speculum into the direction of the axis of the microscope: it is obvious that, in this case, they must be somewhat inclined to the light, so that the focus of the whole image will never be equally perfect; and, instead of being circular, like the rings themselves, their images on the screen will be oval. In this manner, eight or ten alternations of colours may easily be observed; but their order and sequence is too complicated to be easily understood: for they are really composed of an infinite number of series of rings of different magnitude, each series being formed by each of the gradations of light in the prismatic spectrum, which, near the centre, are sufficiently separate to form distinct appearances, either alone or in combination; but, after eight or ten alternations, are lost in the common effect of white light. For, when the glasses are illuminated by homogeneous light only, separated from the rest by the refraction of a prism, or otherwise, the rings of each colour occupy, together with the dark spaces, the whole visible surface, their number being only limited by the power of the eye in perceiving objects so minute as the external ones become, in consequence of the rapid increase of the thickness of the plate of air near the edges of the curved surface. This circumstance being once understood, it is also capable of being illustrated in a manner still more elegant, by placing a prism a few feet from the microscope, leaving only a narrow line of its surface exposed to the incident rays, and then throwing the rings of colours on it, in such a direction that this line shall pass through their centre. Care being taken to exclude from the prismatic spectrum thus formed all extraneous light, it exhibits a most interesting analysis of these colours; for the line consists of portions of the rings of all possible gradations of colour, each forming a broken line, but not of the same dimensions; and, by the prismatic refraction, all these broken lines are separated and placed parallel to each other, on account of the different refrangibility of the light of which they consist. Thus the broken line of the extreme red, which consists of the longest portions, is least refracted: the other reds follow, and are placed in contact with the first, and with each other, but, on account of the different magnitude of the portions, somewhat obliquely. The dark spaces also are in contact, and form a separation between each portion of light. In the same manner, the green follows the red, with little or no visible yellow. The blue and violet are somewhat mixed: for these two colours are much less widely separated by thin plates than by the prism: for this reason, each portion of light formed by the contiguous lines of the different colours is bounded not by straight but by curved lines.



It is evident that, by drawing a line across this compound spectrum at any part, we may learn the component parts of the light constituting the rings at that part; for the prism only spreads the colours in a direction transverse to this spectrum: and it may be observed, that after the eighth or tenth alternation, the light transmitted at each point is so mixed, that we may easily understand how it appears white. In the figure here inserted, the red is expressed, as in heraldry, by vertical, and the green and violet by oblique hatches.

The colours of thin plates, as seen by transmission, are also easily exhibited in the solar microscope; but, since it is utterly impossible to exclude the very great proportion of the light which is not concerned in their formation, they never appear so brilliant as the colours seen by reflection. Y.

From the ANNALES de CHIMIE, Nos. 128, and 129.

"*Observations, &c.*" *Observations on the Zoonic Acid.* *By* M. THENARD.

1. M. Berthollet announced some years ago, that, during the distillation of animal substances, a peculiar acid was formed, to which he gave the name of zoonic acid. He describes it, 1st. As having a smell analogous to that of roast meat. 2nd. As liquid at the common temperature. 3d. As volatile at a heat below that of boiling water. 4th. As capable of forming soluble salts with barytes, potash, soda, strontian, lime, and ammoniac. 5th. As possessing the power of producing a precipitate in solutions of nitrate of lead, and acetite of mercury. 6th. As destructible by time; undergoing decomposition, and depositing charcoal.

Mr. Thenard was induced to make some new experiments on the zoonic acid, in consequence of the instigation of Mr. Fourcroy, who wished for a full investigation of its properties; and he prepared it after the manner pointed out by Mr. Berthollet.

2. He distilled, in a retort, at different times, and with much precaution, a considerable quantity of muscular flesh,

and collected the products in appropriated receivers. After he had separated the oil that they contained, they were boiled with lime, in consequence of which much ammoniac was disengaged. The excess of lime was precipitated by carbonic acid; and the liquor, after having been filtrated, was evaporated till it became thick. It was then distilled with phosphoric acid; when an acid fluid came over into the receiver, which had all the properties of the zoonic acid.

3. A quantity of this acid was saturated with potash, purified by means of alcohol. It gave, by evaporation, a scaly salt, of a very acrid taste; deliquescent, and decomposable by the sulphuric, nitric, and muriatic acids. Examined minutely, it seemed to possess all the properties of the acetite of potash. And, distilled with phosphoric acid, gave out a liquid exactly similar to the acetous acid, and of which the last portions only were capable of precipitating the acetite of mercury.

From this result, it appeared probable, that the zoonic acid was nothing more than acetous acid, combined with a particular animal substance. To ascertain the fact, with more certainty, Mr. Thenard caused pure zoonate of lime, formed by boiling lime with the product of the distillation of animal matter, to act upon a solution containing the nitrates and acetites of lead and mercury. Two zoonates of lead, and two of mercury, were formed; their colour was greyish white, and they had little taste or solubility.

In distilling these zoonates with phosphoric or sulphuric acid, supposing that the zoonic acid really existed, it ought to be evolved. But, in trying the experiment, it was found that this was not the case; the product which passed into the receiver did not redden tincture of turnsol: and the residuum was composed of the phosphates or sulphates of lead and mercury, and a peculiar animal matter.

This animal matter was of a brown colour. It was combustible, and but little soluble in water. The acids promoted its solution, and when they had dissolved it, provided they were not in too great excess, produced precipitates in the greater number of metallic solutions. And the oxygenated muriatic acid converted it into a yellow and thick oily matter.

After this experiment, the author thinks there can be no reason for supposing, that the zoonic acid is an acid sui generis: and that it must be considered as acetous acid, owing its peculiar properties to the animal substance which is held in solution by it, and which is capable of being easily separated from it.

M. Thenard concludes his memoir, by describing a curious fact relating to an unexpected production of nitric acid.

He had dissolved in water a portion of some animal matter, which had been separated from a solution of zoonate of lime, during its concentration by heat. After it had been suffered to rest for some time, it was examined, and was found to be possessed of no acid properties. It was then exposed to heat; as the evaporation went on it became extremely acid; and, on examination, he discovered that nitric acid had been produced.

In two experiments made on the remainder of the same substance, similar results were gained; but he twice attempted, without success, to produce a new quantity of it; though he has little doubt but that, by a minute attention to the process, the circumstances of its formation, might be ascertained.

"*Examen, &c.*" *Chemical Examination of the Juice of the Papaw.* *By* M. VAUQUELIN.

I. The existence of small quantities of a substance, analogous to albumen, in the juice of certain plants, was long ago noticed by Mr. Fourcroy. Scheele has partly described a production, in some respects similar to cheese, which is found in the leaves of vegetables; and Mr. Proust has lately shown, that the milky juice of almonds is chiefly composed of oil and caseous matter. Mr. Vauquelin, in submitting to an analysis the juice of the papaw (carica papaya), has discovered, that it is chiefly composed of a substance which has almost all the properties commonly attributed to animal matter, and which is for the most part, in its simple state, albuminous.

The specimens that he examined were procured from the Isle of France; they were of two kinds, the one consisted of the juice of the papaw, dried without any preparation; and the other of the juice, which had been preserved with an equal quantity of rum, and then evaporated.

II. The juice which had been dried without preparation, was of a reddish brown colour; its taste was slightly sweetish; in its common state it was brittle, but it became soft by exposure to moist air; when acted upon by a large quantity of water, a part of it was dissolved, and the insoluble portion had the appearance of a fatty matter; it melted upon burning coals, produced fumes, which smelt like those of common fat, and disappeared without leaving any residuum. The solution, when heated, gave a dense precipitate of white matter. It was coagulated by nitrous acid, and by alcohol; and it produced a copious deposition in a solution of gall nuts.

III. The juice which had been prepared by means of rum, appeared in the form of a soft extract; its colour was reddish; and its taste and smell were similar to that of boiled beef; it was almost wholly soluble in water; its solution was frothy like that of gum water; and it deposited by rest a small quantity of white matter. When nitric acid was poured into it, at first there was no change, but after twenty four hours a considerable white precipitate was produced. With alcohol it became clouded and white, and a white flaky matter was gradually separated from it. The watry infusion of gall nuts acted upon it in the same manner as if it had been a solution of glue, and there was a copious precipitation. It did not coagulate by heat. It produced yellow precipitates in the solutions of silver, lead, and mercury.

IV. Both specimens, when examined by destructive distillation, afforded products similar to those of animal matters; namely, oil, water, carbonate of ammoniac, and carbonated hydrogene, and the residuum was a light charcoal containing phosphate of lime.

From what has been said, it is evident that the juice inspissated by preparation with alcohol, approaches nearer to gelatine than to any other substance in its properties, and that it contains little albuminous matter; whereas the other specimen is extremely rich in it. This difference Mr. Vauquelin thinks may be accounted for, from the different circumstances of evaporation: for animal albumen when boiled with a large quantity of water, and then evaporated, undergoes a peculiar change, and gains some of the properties of gelatine*.

"Extrait, &c." Extract, from a Memoir by MR. EKEBERG, *on certain Properties of Yttria, as compared with those of Glucine; and upon two Substances in which he has found a new Metal.*

In the first part of this memoir, Mr. Ekeberg treats of the comparison of the properties of Yttria with those of Glucine. From which it results, that the first of these earths is insoluble in the caustic alkalies, and that the second, on the contrary, is easily soluble in them; a fact, which according to him, does not agree with what has been said on the same subject by Klaproth and Vauquelin; nevertheless we find, in a memoir of the last of these philosophers, Annales de Chimie, tome 36. p. 135. that "Yttria is not sensibly soluble in the alkalies; and that it differs in this respect from alumine and glucine."

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* The juice of the fruit of the papaw, and of all the other parts of the tree in its fresh state, is milky, and extremely acrid; it is used in the Indies as a remedy for the ringworm. The round fruit of the papaw, after being boiled, is used as an article of food: but it is previously soaked in salt and water to extract the acrid juice. This juice is possessed of the property of rendering tough meat tender. D.

One of the characters, which Mr. Ekeberg considers as the most proper for distinguishing yttria from glucine, is that of its being precipitated from its solutions by the prussiate of potash, which is not the case with glucine. Vauquelin has likewise made this remark, p. 158 of the memoir before quoted.

The swedish chemist has found, that glucine is precipitated from its solutions, by the succinates; and that yttria, in this respect, is wholly different from it. This is a new fact that Mr. Ekeberg has added to the history of these two earths, which is as yet very incomplete.

The difference of specific gravity, likewise, has appeared to him to be a good mark of distinction between glucine and yttria, when the two substances have been equally calcined. The specific gravity of yttria, according to him, is 4.842, whilst that of glucine is only 2.967. Mr. Vauquelin had likewise noticed this difference, and he was so much struck with it, that since the publication of his memoir, suspecting that yttria might be a metallic oxide, he heated it intensely with powder of charcoal; but no metal was produced, and he obtained only a mass, imperfectly fused, very hard, and which was of a specific gravity, nearly five times greater than that of water.

In repeating the analysis of the gadolinite, the mineral in which yttria is found, Mr. Ekeberg discovered, that 100 parts of it contained 4.5 of glucine, a fact which had not been noticed either by Klaproth or Vauquelin, nevertheless, when we consider the properties which he has attributed to this earth, it is impossible not to doubt but that it is truly glucine.

Mr. Ekeberg, guided by the discovery of Mr. Klaproth, separates iron from yttria, by means of the succinates, which precipitate the iron, but not the yttria, when they are dissolved together in an acid; but he remarks, that, to produce this effect, the iron must be perfectly oxidated; for unless that is the case, there remains a part of it which is not thrown down.

It results from the latest experiments of Mr. Ekeberg, that 100 parts of the gadolinite contain,

Yttria	55.5
Silex	23.0
Glucine	4.5
Oxide of iron	16.5
Loss	.5 only

He makes no mention of the quantity of the oxide of manganese, though he is nevertheless convinced of the existence of this substance in the stone. As yet he has not been able to discover the smallest trace of the presence of lime in the gadolinite, whence it appears, that the portion which Vauquelin found was only accidental, and that the pieces upon which Mr. Ekeberg operated were wholly free from it. But what is surprizing, is that Mr. Ekeberg had a loss of only .005; whereas Mr. Vauquelin has constantly had 12. Can this difference, which is truly extraordinary and remarkable, depend upon the difference of the specimens upon which they operated; or upon their different methods of operation?

In submitting to an analysis, different pieces of gadolinite, which had been given to him by Mr. Geyer, Mr. Ekeberg discovered in them a metallic substance, which in some was combined with the oxide of iron and manganese, and in others with yttria and iron. These minerals were found in the parish of Kimist, in Finland. He calls the first tantalite, and the second yttrotantalite, because the new metal[*], which they contain, is incapable of being combined with the acids.

Ever since the year 1746 the tantalite has been known in cabinets, under the name of oxide of tin (Zinn grauben). The mountain in which it is found is formed of white quartz, mixed with mica, and intersected by veins of red feltspar; the felt spar forms the bed of the mineral.

The tantalite usually appears in crystallized masses, of the

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[*] He has called it tantalicus in Latin, which the editor translates tantale. Following the analogy presented by the other names of the metals; the English word will be tantalium.

size of a hazel nut, having the appearance of oxide of tin. Their form approaches that of an octahedron; their surface is smooth, black, and sparkling; their fracture is compact and metallic, and, in some cases, of a blue or greyish tint. When powdered their colour is grey, approaching to brown. They give fire with steel. They are attracted by the magnet; and their specific gravity is 7.953.

The yttrotantalite is found in the same place, and in the same bed as the gadolinite. This bed is of pure feltspar, which forms the principal part of the quarry of Ytterby. It is sometimes accompanied by quartz and mica; but these substances are insulated, and do not form a true granite. Acccording to Mr. Ekeberg, the gadolinite and yttrotantalite should be sought for in those parts of the rock, where the feltspar is intersected vertically by veins of mica. The gadolinite is, in general, attached by one of its sides to a white and silvery mica, and surrounded in its other parts by feltspar.

The yttrotantalite seldom adheres to mica; it appears in small kidney formed pieces imbedded in veins of feltspar, divided by scales of black mica; the largest pieces discovered by Mr. Ekeberg were nearly of the size of a hazel nut. Its fracture is granular, and of a metallic grey; its hardness is not great, and, with some difficulty, it may be scratched with the knife; it is not acted upon by the magnet; its specific gravity is 5.13, but it retains always some little fragments of feltspar, and, in its pure state, consequently would be rather heavier.

The following are the principal properties attributed by Mr. Ekeberg to the new metal, which he has discovered in the two minerals just described. 1. It is not soluble in the acids in any of its states, or by any of the methods usually employed. 2. The alkalies act upon it, and dissolve it in considerable quantities*, and it is precipitated from them by the acids. 3. The oxide of this metal is

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* This most probably relates to it in the state in which it is found in the ore, when, as there is every reason to believe, from Mr. Ekeberg's experiments, it is an oxide. See Journal des Mines, No. 70. p. 257. D.

white, and does not change colour in the fire. 4. Its specific gravity is 6.5*. 5. It melts with the phosphate of soda, and with borax, without communicating to them any colour. 6. When heated with powder of charcoal it softens and collects into a mass; it then presents a metallic appearance, and its fracture is brilliant, and of a greyish black. 7. The acids oxidate it, and bring it back to the state of white powder.

The metallic brilliancy of the tantalium, reduced by charcoal, and its great specific gravity, have induced Mr. Ekeberg to class it amongst the metals; and he is convinced, that it is not the same with any metal hitherto described. The only substances at all analogous to it are tin, tungsten, and titanium. In fact, the oxides of tin, and of tungsten, are soluble in the fixed alkalies, and resist the action of certain of the acids. But the oxide of tin may be easily reduced, and furnishes a ductile metal: and the oxide of tungsten is soluble in ammoniac; is rendered yellow by the acids; and communicates a blue colour to borax, and microcosmic salt, which, as we have seen, is not the case with the tantalium. The oxide of titanium is soluble in the acids, after it has been acted upon by the alkalies; but it communicates a yellow colour to borax.

As the minerals, which contain the tantalium, are apparently very abundant in Sweden and Finland, chemists may indulge the hope that Mr. Ekeberg will, at a future time, more completely develope its properties; that the circumstances connected with its presence in bodies may be ascertained; and that the proper place for its arrangement amongst the classes of the metallic substances may be found. *N. V.*

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* i. e. of the oxide. D.

On the Colcothar, used for Polishing. By M. GUYTON.

On the 21st of July, 1802, M. Guyton communicated, to the mathematical and physical class of the French Institute, the results of some experiments relating to the use of colcothar, as a polishing material, from which he concludes, that in certain cases, different modifications of iron may be advantageously employed instead of this substance, which is, as is well known, a red oxide obtained from the decomposition of sulphate of iron.

For processes, in which a very fine grained substance is not needed, ochreous clays may be used, after having been heated red, or, what is better, the natural red ochres which are immediately produced from the decomposition of the sulphurets of iron, and which are plentifully found in nature.

To give to steel its last and finest polish, it has been heretofore always necessary to use colcothar or red oxide of iron, in its finest possible state of pulverization; and to reduce it to this state is a work of great labour, many different levigations being required.

The author has discovered a mode infinitely more simple than the common one, of producing a substance proper for the final process of the workman. The felt of hats is coloured black by the sulphate of iron, *(qu. tanno-gallate of iron?)* If a piece of hat be immersed for a few minutes in diluted sulphuric acid, the iron, according to him, is precipitated red, and in a minutely divided state. After being washed, dried, and moistened with oil, it is proper for use.

In common cases, for giving the most beautiful polish to hard substances, the levigated colcothar is applied to pieces of worn out hat, so that the new method is highly economical, as enabling us to use, by a very simple process, the last substance alone.

D.

From the JOURNAL des MINES. No. 70.

" *Sur les Oxides, &c.*" *On the Oxides of Mercury, and on Mercurial Salts. By* M. FOURCROY.

In a memoir, lately read before the physical and mathematical class of the French National Institute, and which is but the commencement of an extensive work, M. Fourcroy has announced several important facts relating to the oxides and salts of mercury.

He considers the black oxide of mercury as mercury in the first degree of oxydation, and he shows that 100 parts of it are composed of 96 parts of mercury and 4 of oxygene; that it is without taste; insoluble in water; capable of combining with the acids without effervescence; and reducible in a strong heat; and convertible into red oxide, by a low degree of heat,

The grey, yellow, and white oxides of mercury (as they have been called), are, according to him, not simple oxides, but slightly soluble salts: and he proves, that the red oxide of mercury is the only pure oxide in a higher state of oxygenation than the black, being composed of 92 parts of mercury and 8 of oxygene in 100; he considers it as uniform in its composition, whatever may have been the manner in which it was produced. " When triturated with mercury it gives oxygene to that metal, and both substances are converted into black oxide. When heated with zinc or tin, it imparts to them oxygene, and produces inflammation. Its taste is acrid and disagreeable; and it is soluble in water. This red oxide, when acted upon by oxygenated muriatic acid, combines with an additional quantity of oxygene; but in this state it is impossible to obtain it in a separate state, and free from acid.

In describing the different kinds of fulminating mercury, Mr. Fourcroy states, that in the process of digesting nitrate of mercury with alcohol, as discovered by Mr. Howard, under different circumstances, fulminating products, different from each other, are obtained; and on this theory, he explains some phenomena which had not been before well understood.

The first kind of fulminating mercury, formed from alcohol and nitrate of mercury, is produced in the case when the solution is but little heated. It is composed of oxide of mercury, nitric acid, and a peculiar vegetable matter; and it detonates very strongly.

The second kind is generated by means of a continued heat. It contains no nitric acid; but ammoniac, and more vegetable matter than the first; it detonates on hot coals; and gives a blue flame.

The third species is formed when the ebullition is carried on for so long as half an hour, or more; and it neither contains nitric acid, or ammoniac; but oxalic acid, and a very small quantity of the peculiar vegetable matter, produced from alcohol. It does not detonate either by percussion, or heat, but it decrepitates upon hot coals.

By means of these distinctions, M. Fourcroy reconciles the difference betwen the results obtained by Mr. Howard and M. Berthollet; and he considers the second species of fulminating mercury as that which has been described by M. Berthollet.

This part of the communication is concluded by the description of a particular detonating salt of mercury, discovered by the author himself. It is produced by the digestion of a strong solution of ammoniac upon the red oxide of mercury; the process is carried on for eight or ten days; by degrees the colour of the oxide changes to white, and at length it becomes covered with small scaly crystals. It then detonates loudly upon ignited coals, in a manner similar to fulminating gold. It decomposes spontaneously, and loses its fulminating property in three or four days. By a low degree of heat it is converted into red oxide of mercury and ammoniac. It is decomposed by the acids; and must evidently be placed in the same class of bodies as the ammoniacal fulminating gold and silver. D.

Miscellaneous Extracts from the eleventh and twelfth Volumes of GILBERT'S *Annals.*

Dr. Benzenberg, in an essay on the improvement of object glasses for telescopes, warmly recommends that the glass be suffered to cool in the pots without stirring, and that the mass be then divided in a horizontal direction, so that the variation of density may be regular, and then, by a proper form of the glasses, the errors of refraction may be corrected. The idea is not new, but it does not appear to have been carried into practice. Dr. Benzenberg considers achromatic telescopes as promising much more than reflectors, and thinks that they intercept much less light.

Mr. Sprenger of Jever gives an account of his method of administering galvanic electricity in cases of deafness. A small ball is applied to the external orifice of the ear, and a much larger one is held in the patient's hand; the communication is then formed and interrupted alternately by means of machinery, once in every second, for about four minutes daily, for a fortnight or more. He asserts that he has thus restored the sense of hearing to forty five persons, and to four of them that of smell also. All who were completely deaf experienced relief, almost without exception; but a partial deafness did not appear to receive the same benefit. The ear was filled with wool, to avoid taking cold. The degree of advantage obtained was estimated by an instrument invented by Professor Wolke, in which a hammer falls from a certain point of a quadrant, so as to strike an elastic plate with a velocity capable of precise determination. These experiments relate to a subject so important that they must not be passed unnoticed, however improbable it may appear that galvanic electricity should have any material advantage over electricity otherwise excited, and however we may be disposed to believe the report of other observers, that the relief is in general inconsiderable and only temporary.

Mr. Brandes, in the eighth number, has inserted a theory of the formation of the halos of 23 and 46 degrees. He imagines, that these are formed by vesicular vapours, containing an elastic fluid of greater refractive density than the air, and, from the observed dimensions of the halos, calculates what this density must be in order to produce them in the same manner as the common rainbows are produced by drops of rain. It is obvious that such an explanation is absolutely arbitrary, besides that the existence of such vesicles is by no means universally admitted.

We have also an account of a lunar rainbow seen by Professor Seyffer of Gottingen, in which the red, green, orange, and violet colours were very lively and distinct. The editor remarks that this phenomenon is not so rare as is sometimes supposed, for that Mr. Alfeld has collected accounts of 30 lunar rainbows which had been seen before 1750. The observation here noticed is only of consequence as it tends to destroy the opinion of the existence of a difference in the colours of the lunar and solar rainbows.

In the first number of the twelfth volume, Mr. Reinhold has published a continuation of his galvanic researches; and, from a comparison of various experiments, he considers himself authorised to conclude that "In every series of a battery, composed of two heterogeneous metals, the more oxidable metal is positively electrified at the end in contact with the less oxidable, and negatively at the other end, while the reverse happens to the less oxidable metal." And, quoting the position laid down in his former essay, "that the moist conductor is positively charged on the side of the positive pole of the battery, that is, on the side which affords oxygen, and negatively on the negative side," he infers that induced electricity operates throughout the battery, without any communicated electricity; hitherto, says Mr. Reinhold, I have found no phenomenon which is not satisfactorily explained by this theory. An experiment which appears the most to favour the opinion of induced electricity, is, that when the circuit of a battery is completed by means of a wire immersed in an acid, the parts of the wire nearest the oxygenating pole are dissolved much the most rapidly, but all the other experiments appear equally intelligible on the supposition of communicated electricity; and, indeed even in this experiment, it is easy to imagine that the current of the fluid may partially escape into the acid at one end, and return to the wire at the other. Y.

From the JOURNAL de PHYSIQUE, Fructidor, An 10.

Account of M. DELARIVE'*s Memoir on the Sounds produced by burning Hydrogen Gas.*

It is well known, that when a stream of hydrogen gas passes through a small tube, and is inflamed at its orifice, if a large tube be held over the flame so as partially to inclose it, an agreeable sound is frequently produced. The frequent failure of the experiment, and the impossibility of producing the same effect with other kinds of flame, left considerable obscurity with respect to the immediate cause of the sound. M. Delarive appears to have been very successful in his attempts to remove these difficulties. He supposes the continual production and condensation of aqueous vapour to cause a brisk vibratory motion, which must be able, in order to produce a sound, to harmonize with the dimensions of the tube, and is then regulated and equalised by the regular reflections from the tube, so as to constitute together a clear musical sound: he observes, that for this purpose there must be a great difference of temperature in the air and the tube near the flame; hence the failure of the vapour of ether, which produces too slight a degree of heat, and the difficulty of succeeding in a warm room, for want of a sufficient supply of cool air. This explanation is confirmed by a curious experiment on tubes with bulbs resembling that of a thermometer, in which a small particle of water or mercury is exposed to a considerable heat, so as to be wholly converted into vapour, while the upper part of the tube remains cool; in this case a sound is produced somewhat similar to that of hydrogen gas, but much fainter. Brugnatelli has obtained a sound from phosphorus burnt in a tube; and M. Delarive supposes that the phosphorous acid, in the form of a vapour, possesses a high degree of elasticity, and that it is condensed with sufficient rapidity for the production of the sonorous effects. Y.

" *Extrait, &c.*" *Extract of a Letter from* MR. PFAFF.]

This extract relates to some experiments of Mr. Ritter, on the relation of magnetism to certain chemical changes.

Mr. Darnim had observed, that when soft iron was attached to the poles of a magnet, they being previously wetted, the oxidation of the iron was strongest at the north pole of the magnet, that is, at the south pole of the iron itself.

Mr. Ritter, in making analogous experiments, has found that when pieces of iron wire are placed nearly in the magnetic meridian in cups full of water, oxide is formed at both their ends in about twelve hours, but greatest in quantity at that end turned towards the north.

Of two wires, he attached one to the south pole of a magnet, and suffered the other to remain free. They were then separately introduced into the legs of a tube filled with distilled water and bent in the form of a V. In five days the wire attached to the magnet began to oxidate, on the other there was no change till the eighth day. Magnetised wires of 3.3 inches long, and from two thirds to three fourths of an inch in breadth, when placed in cups of water, were most oxidated at the south of the needle; the phenomenon was similar with very thick wires and with the common horseshoe magnets the oxidation was always most vivid at the south pole, and most feeble at the north pole.

When magnetised wires were introduced into a mixture of water and nitric acid, the acid became more deeply coloured at the north pole. With a strong solution of nitric acid, the iron was more corroded at the south pole than at the north. And the same phenomenon was observed with regard to the muriatic and acetic acids. The north pole was less attacked than iron which had not been magnetised.

"Nouvelle Comete, &c." *Discovery of a Comet by* MECHAIN.

M. Mechain discovered this new comet on the 28th of August, about nine o'clock at night, in the constellation Serpentarius. It was rising rather quickly towards the north pole, passing along the right side of Serpentarius, and the opposite side of Hercules. It was sufficiently near to be seen by the naked eye.

M. Mechain made a report concerning it to the Institute on the 15th. and has assigned to it the following elements.

Mean time, ...	94° 24′ 6″.
Right ascension, ...	249° 18′.
Southern declination	6° 11′ 31″.

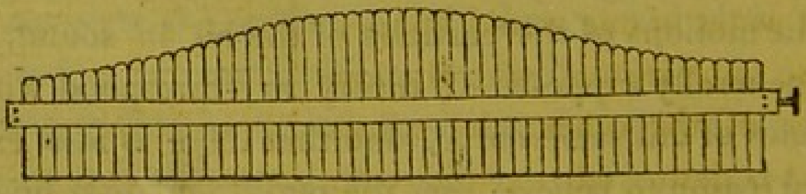
D.

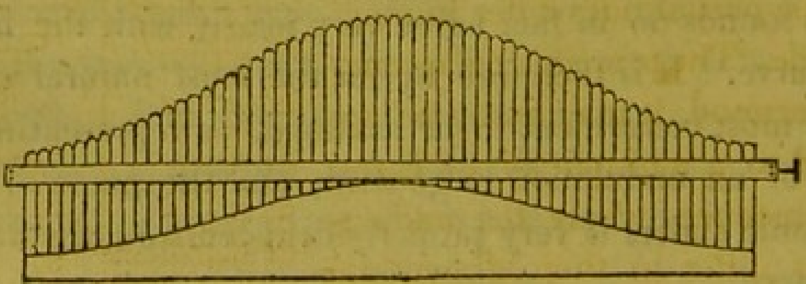
An Account of DR. YOUNG'S *Harmonic Sliders.*

The combination of undulations, however cautiously the world may adopt its application to the explanation of optical phenomena, is of acknowledged utility in illustrating the phenomena of musical consonances and dissonances, and of undeniable importance in accounting for many of the phenomena of the tides. Each tide is an undulation on a large scale; and, supposing the general form of the ocean, in consequence of the attraction of a distant body, to coincide with that of an oblong spheroid, as it is found by calculation to do, the section of the surface of each tide, if conceived to be unbent from the circular form and extended on a plane, would form the harmonic curve. (Young's Syllabus IV. 151. 155.) It is remarkable that the motions of the particles of the air in sound, have been generally supposed in theory to correspond with the ordinates of this same curve, and that there is also experimental reason to believe, that the purest and most homogeneous sounds do in fact agree very nearly with the law of this curve. It is therefore by far the most natural as well as the most convenient to be assumed, as representing the state of an undulation in general; and the name of these harmonic sliders is very properly deduced from the harmonic curve.

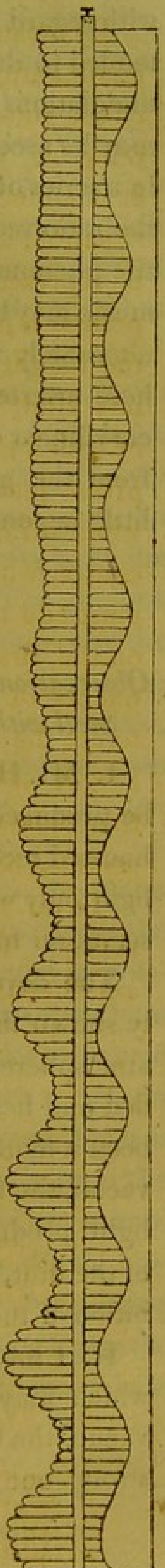
By means of this instrument, the process of nature, in the combinations of motion which take place in various cases of the junction of undulations, is rendered visible and intelligible, with great ease, in the most complicated cases. It is unnecessary to explain here, how accurately both the situations and motions of the particles of air, in sound, may be represented by the ordinates of the curve at different points: it is sufficient to consider them as merely indicating the height of the water constituting a tide, or a wave of any kind, which exists at once in its whole extent, and of which each point passes also in succession through any given place of observation. We have then to examine what will be the effect of two tides, produced by different causes, when united. In order to represent this effect, we must add to the elevations or depressions in consequence of the first tide, the elevations or depressions in consequence of the second, and subtract them when they counteract the effect of the first: or we may add the whole height of the second above any given point or line, and then subtract, from all the sums, the distance of the point assumed below the medium.

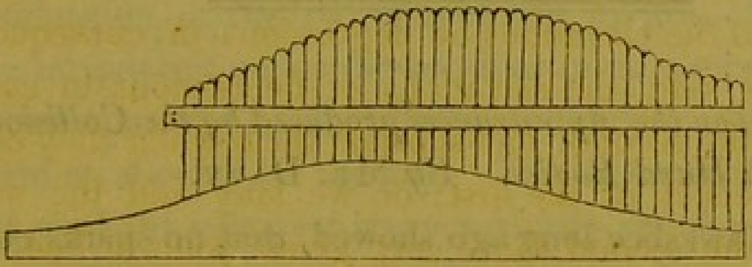
To do this mechanically is the object of the harmonic sliders. The surface of the first tide is represented by the curvilinear termination of a single board. The second tide

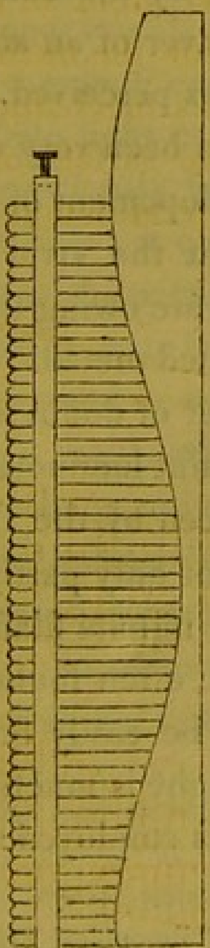




is also represented by the termination of another surface; but, in order that the height at each point may be added to the height of the first tide, the surface is cut transversely into a number of separate pieces or sliders, which are confined within a groove or frame, and tightened by a screw. Their lower ends are situated originally in a right line; but, by loosening the screw and moving the sliders, they may be made to assume any other form: thus they may be applied to the surface representing the first tide; and, if the similar parts of each correspond, the combination will represent a tide of twice the magnitude of the simple tides.







The more the corresponding parts are separated, the weaker will be the joint effect; and, when they are furthest removed, the whole tides, if equal, will be annihilated. Thus, when the general tide of the ocean arrives by two different channels at the same port, at such intervals of time that the high water of one would happen at the same instant with the low water of the other, the whole effect is destroyed, except so far as the partial tides differ in magnitude. The principle being once understood, it may easily be applied to a multiplicity of cases: for instance, where the undulations differ in their dimensions with regard to extent. Thus, the series of sliders being extended to three or four alternations, the effect of combining undulations in the ratio of 2 to 1 of 3 to 1, of 2 to 3, of 3 to 4, may be ascertained, by making a fixed surface, terminating in a series of curves, that bear to those of the sliding surface the ratio required: and, by making them differ but slightly, the phenomenon of the beating of an imperfect unison in music may be imitated, where the joint undulation becomes alternately redoubled and evanescent. In the last figure here inserted, the proportion is that of 17 to 18, and the curvilinear outline represents the progress of the joint sound from the greatest degree of intensity to the least, and a little beyond it. Y.

Observations on the Appearances produced by the Collision of Steel with Hard Bodies. By MR. DAVY.

I. Mr. Hawksbee long ago showed, that no sparks could be produced by the collision of flint and steel * in the exhausted receiver of an air pump, and that in this case a faint light only was perceived. And, since his time, the same observation has been very often made.

The developement of the theory of combustion has clearly shown that the vivid sparks obtained from steel in the atmosphere, are owing to the combination of the small abraded and heated metallic particles with oxygene. But it has been a matter of doubt whether, in the experiment made in vacuo, the faint luminous appearance is owing wholly to the light produced by the fracture and abrasion of the parts of the flint, or only partly to this cause, and partly to the ignition of the minute filaments separated from the steel.

II. I have often found, that when a fine and thin flint, which may be easily broken, is used for the collision in vacuo, the light is much more vivid than when a thick and strong one is employed: and with a strong flint, but just

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* Philosophical Transactions, Vol. XXIV, p. 2165.

sharp enough to give sparks with steel in the atmosphere, it is seldom that any light at all is produced in the exhausted receiver. These facts seem to show that the abraded particles of steel are not rendered at all luminous by collision, except in consequence of combustion; and the opinion is almost fully proved by the following experiment, which was made in the course of a lecture on the properties of light, in the theatre of the Royal institution, and which has been since often repeated.

III. A thin piece of iron pyrites * (sulphuret of iron) was inserted in a gunlock in the place of the flint. It gave by collision in the atmosphere very vivid sparks; which were chiefly white, from the combustion of the particles of the steel; but sometimes mixed with a few red sparks from the combustion of the particles of the pyrites. The gunlock was introduced under the receiver of an air pump, and the exhaustion was made till the mercury in the short gage stood at about $\frac{6}{10}$ of an inch. The lock was then snapped, but no light whatever was perceived; and the phenomenon was uniform, every precaution being taken to render the room dark, and to preserve the apparatus in order.

IV. It is well known that in common cases the finest steel wire does not burn with a white light or sparks in the atmosphere, unless it have been previously heated to a degree much above that of the red heat; it consequently at first view appears extraodinary, that the particles separated from the gunlock should be heated so as to burn vividly in air, and yet not so as to appear ignited in vacuo; for it is not easy to conceive that they emit light, which from the minuteness of their volume cannot be perceived; or to suppose that the opacity of the metallic substances, should hinder light generated at their points of contact from being visible. I had formerly supposed, in reasoning upon the phenomenon of the collision of flint and steel, that † heat

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* The etymology of the name of this substance shows that its property of giving fire by collision was very anciently known. It was used in the old gunlocks, with the revolving wheel, for inflaming the priming.

† Nicholson's Journal, 4to. Vol. III. p. 517.

and light might in common instances be only accidentally coexistent; and that in certain cases very high temperatures might be produced without causing the appearance of light. At present however I am inclined to believe, that the phenomena may be adequately accounted for upon principles that coincide with the common facts relating to the production and communication of heat.

Mr. Stodart* has shown, that when steel is gradually heated it begins to change colour at about 430° Fahrenheit. And this change of colour is occasioned by its combination with oxygene, and, as there is every reason to believe, must be connected with the evolution of heat. At about 600°, a temperature much below that of ignition, it oxidates rapidly, and becomes covered with a bluish grey coating. And though in these cases of oxidation the heat evolved at the surface of the metal is not sufficient to raise the temperature of steel wire, or a steel plate, so as to cause it to enter into the vivid combustion, yet in acting upon such a minute filament as that struck off in the gunlock, it may be sufficient to keep up the process of oxidation till it becomes so vivid as to occasion the strongest heat and light. Besides, the surface of this filament is very great as compared with its bulk, and the oxide produced upon it is less likely to form a coat which might defend the interior parts from the action of the air.

It would not be difficult to find many analogous instances, in which the progress of oxidation is dependent upon the mass of the combustible body, or rather upon the relation of this mass to surface; thus, a very thin and small bit of phosphorus will inflame spontaneously, and burn with the vivid light when wrapped up in filaments of fine cotton; whilst a thicker and larger piece will only shine with the feeble blue light: and though a large mass of zinc may be melted in the atmosphere without inflaming, a small and thin shaving will burn vividly long before it is heated to the temperature of fusion.

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* Nicholson's Journal, 4to. Vol. IV. p. 130.

V. In considering the general phenomena of the production of heat and light, by mechanical means, it is difficult to conceive that any considerable increase of temperature can be produced on a metallic surface by a single collision; for the conducting power of the metals is such as would speedily cause the heat to be communicated to the contiguous parts; and even in the case of the abrasion of minute particles, though the time required for their separation from the mass is to us imperceptible, yet it must be sufficient to enable them to give out to it a portion of their heat.

The bodies that become luminous by being struck or rubbed together in vacuo, or in gases that do not contain oxygene, or under water, such as fluate and carbonate of lime, silicious stones, glass, sugar, and many of the compound salts, are both electrics per se, and phosphorescent substances; so that the flashes they produce are most likely occasioned, partly by the electricity excited on their surfaces by the friction, and partly by their phosphorescence, which is generally occasioned by moderate degrees of heat. It is not however improbable that in some cases, by the collision of very hard stony bodies, which are bad conductors of heat, there may be an actual ignition of abraded particles; and the supposition is countenanced by various facts. Mr. T. Wedgwood found that a piece of window glass, when brought in contact with a revolving wheel of grit, became red hot at its point of friction, and gave off luminous particles which were capable of inflaming gunpowder and hydrogene gas*. And we are informed by a late voyager†, that the natives of Oonalashka light their fires by striking together two pieces of quartz, their surfaces being previously rubbed with native sulphur, over dry grass.

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* Phil. Trans. 1792, p. 45.

† Sauer's Account of Billings's Expedition to the northern parts of Russia, p. 159.

From the MANCHESTER MEMOIRS, Vol. V. p. 374.

Observations on the Law of the Expansion of Water at Temperatures below 42°; *extracted from a Paper on the power of Fluids to conduct Heat. By* JOHN DALTON.

My first attempt was to ascertain the precise degree of cold at which water ceases to be further condensed—and likewise how much it expands in cooling below that degree to the temperature of freezing, or 32°. For this purpose I took a thermometer tube, such as would have given a scale of 10 inches with mercury from 32° to 212°, and filled it with pure water. I then graduated it by an accurate mercurial thermometer, putting them together into a bason filled with water of various degrees of heat, and stirring it occasionally: As it is well known, that water does not expand in proportion to its heat, it does not therefore afford a thermometric scale of equal parts, like quicksilver.

From repeated trials agreeing in the result, I find, that the water thermometer is at the lowest point of the scale it is capable of, that is, water is of the greatest density at 42°½ of the mercurial thermometer. From 41° to 44° inclusively the variation is so small as to be just perceptible on the scale; but above or below those degrees, the expansion has an increasing ratio, and at 32° it amounts to ⅛th of an inch, or about $\frac{1}{160}$ part of the whole expansion from 42°½ to 212° or boiling heat.—During the investigation of this subject, my attention was arrested by the circumstance, that the expansion of water was the same for any number of degrees from the point of greatest condensation, no matter whether above or below it: thus, I found that 32°, which are 10°½ below the point of greatest density, agreed exactly with 53°, which are 10°½ above the said point; and so did all the intermediate degrees on both sides. Consequently when the water thermometer stood at 53°, it was impossible to say, without a knowledge of other circumstances, whether its temperature was really 53° or 32°. Recollecting some experiments of Dr. Blagden in the Philosophical Transactions, from which it appears that water was cooled down to 21° or 22° without freezing, I was curious to see how far this law of expansion would continue below the freezing point, previously to the congelation of the water, and therefore ventured to put the water thermometer into a mixture of snow and salt, about 25° below the freezing point, expecting the bulb to be burst when the sudden congelation took place. After taking it out of a mixture of snow and water, where it stood at 32° (that is 53° per scale) I immersed it into the cold mixture, when it rose, at first slowly, but increasing in velocity, it passed 60°, 70°, and was going up towards 80°, when I took it out to see if there was any ice in the bulb, but it remained perfectly transparent: I immersed it again and raised it to 75° per scale, when in an instant it darted up to 128°, and that moment taking it out, the bulb appeared white and opaque, the water within being frozen: Fortunately it was not burst; and the liquid which was raised thus to the top of the scale was not thrown out, though the tube was unsealed. Upon applying the hand, the ice was melted and the liquid resumed its station. This experiment was repeated and varied, at the expense of several thermometer bulbs, and it appeared that water may be cooled down in such circumstances, not only to 21°, but to 5° or 6°, without freezing, and that the law of expansion abovementioned obtains in every part of the scale from 42°½ to 10° or below; so that the density of water at 10° is equal to the density at 75°.

Account of a simple Method of estimating the Changes of Volume produced in Gases, by Alterations of Temperature, and of Atmospheric Pressure, in the course of Chemical Experiments. By MR. DAVY.

It often happens that changes of atmospherical pressure, and of temperature, take place in the course of experiments on elastic fluids; and a knowledge of the alterations they produce in their volume, is essential to the precision and accuracy of the results.

In cases when chemical changes are produced, it is impossible to gain this knowledge by direct observation; and, in considering quanties, it is always useful to estimate the volumes of gases at some standard, fixed upon in measures of the barometer* and thermometer.

It is demonstrated by very accurate experiments, that the volumes of elastic fluids are inversely as the weights compressing them. And, consequently, the changes produced upon gases, by known changes in the atmospherical pressure, may be ascertained in a very easy manner. With regard to the effects of temperature, however, it is much more difficult to form a just estimation by means of general laws. For though the excellent experiments of Mr. Dalton †, and those of Mr. Gay Lussac, show that all the different elastic fluids, taken at equal temperatures, expand equally by heat, yet we are still ignorant of the precise ex-

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* Lavoisier's Elements, p. 406, 2nd Edit.

† Manchester Memoirs, Vol. V. p. 599. Mr. Dalton says, "I have repeatedly found that 1000 parts of common air, of the temperature 55° and common pressure, expand to 1321 parts in the manometer; to which adding 4 parts for the corresponding expansion of glass, we have 325 parts increase upon 1000 from 55° to 212°; or for 157° of the thermometric scale. As for the expansion in the intermediate degrees, which Col. Roi's experiments show to be a *slowly diminishing* one above the temperature of 57°, but which de Morveau's, on the contrary, show to be a *rapidly increasing* one in the higher part of the scale; I am obliged to allow that Col. Roi is right, though it makes, in some degree, against an hypothesis I have formed relative to the subject; he has certainly, however, made the diminution too great from 72° downwards, owing to his not perceiving that he actually destroyed a portion of the elastic fluid he was operating upon (aqueous vapour) in reducing its temperature so low; if his air had been previously dried by sulphuric acid, &c. he would not have found so remarkable diminution below 72°. My experiments give for 77°½ above 55°, 167 parts; for the next 77°½ only 158 parts: and the expansion in every part of the scale seems to be a gradually diminishing one in ascending.

"The results of several experiments made upon hydrogenous gas, oxygenous gas, carbonic acid gas, and nitrous gas, which were all the kinds I tried, agreed with those on common air, not only in the total expansion, but in the gradual diminution of it in ascending: the small differences observed never exceeded pansion for increments of single degrees, or of the mode in which the power of expansion is affected by difference of pressure; or by its relations to aqueous vapour or uncombined moisture.

The calculations on this subject are consequently laborious and complicated; but it is very easy to avoid them, by recurring to comparative observations, which may be obtained in a very simple manner, by means of the manometer.

By making a given quantity of air, in contact with water at a known temperature and pressure, a standard, it is easy, in ascertaining the changes produced in it by alterations in the temperature and pressure, to determine, by the rule of proportion, the changes that have been produced from the same causes in any other quantity of gas, submitted to chemical operation; or to ascertain what would be its volume at the mean height of the barometer and thermometer.

In forming the manometer for the purpose of comparison, a glass tube may be used about sixteen inches long, and one third of an inch in diameter, closed at one end, and curved in such a manner that its open leg is parallel to its closed end, and nearly three inches long. Its capacity is determined, and its closed leg is graduated so as to form a scale of 200 parts. The standard volume of air is confined in it by a column of water, four inches long; and the height of this water is kept equal in both legs at the different times of observation, by means of a glass tube, moveable in a

6 or 8 parts on the whole 325: and differences to this amount will take place in common air, when not freed from aqueous vapour, which was the situation of all my factitious gases.

"Upon the whole therefore I see no sufficient reason why we may not conclude, that *all elastic fluids under the same pressure expand equally by heat* —and that *for any given expansion of mercury, the corresponding expansion of air is proportionally something less, the higher the temperature.*"

Mr. Gay Lussac makes the dilatation to be from 100 to 137.5 between 32° and 212°, which gives for each degree between these points $\frac{1}{483}$. See p. 197; and Annales de Chimie, No. 128, p. 137.

perforated cork inserted in the open end, and capable of elevating the column of water in it at least an inch and a half.

In employing the standard of comparison, for correcting the results of operations in which portions of elastic fluids are either absorbed or generated, it is only necessary to recur to the state of it at the beginning and end of the experiment. Thus, let n equal the quantity of elastic fluid existing after the experiment; m the volume of the standard air before the experiment; and v the volume after, as expressed in the scale of 200 parts.

Then $\frac{nm}{v} = x$, which is the volume the residual gas examined would occupy at a temperature and pressure such as existed at the commencement of the experiment.

By the same method may be estimated the volume a quantity would occupy at such temperatures and pressures, as had been at any time denoted upon the scale.

From the latest experiments that have been made [*], it is probable that at the same temperatures, and under the same pressures, equal volumes of the different elastic fluids, in contact with water, contain the same quantity of aqueous vapour; so that in cases when the gases examined in the comparative observations are equally saturated with water, the results must be perfectly accurate as to the relation of volume to the state of moisture; and, even supposing a difference in the degree of saturation, the error arising from this circumstance, at common temperatures, would be so small as to be inappreciable.

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[*] Those of Saussure and De Luc, and MM. Desormes and Clement.

Observations on different Methods of obtaining Gallic Acid. By MR. DAVY.

1. The discoverer of the gallic acid, the celebrated Scheele, first obtained it by suffering a solution of gallnuts* to remain long exposed to the atmosphere. In this case, the acid is deposited upon the sides of the vessel containing the solution, and upon the film which forms on the surface; but its crystals are of a greyish brown colour, being mixed with other vegetable matter.

2. When heat is very slowly applied to powdered gallnuts, gallic acid sublimes from them, a part of which, when the process is conducted with great care, appears in the form of small white crystals. This method was first employed by M. Deyeux†. I have often successfully made use of it. When the operation is carried on in close vessels, the first product is a limpid fluid, which has the properties of a solution of gallic acid in water, and of which the last portions are pale yellow. The crystals form in that part of the vessel where the heat is just sufficient to cause water to boil; and the process must be stopped at the moment that the crystals in the lower part of the vessel begin to melt. An Argand's lamp may be used for the application of the heat; and the silver still for caustic alkali is a proper apparatus for making the sublimation in. I have found it expedient to separate some tannin from the gallnuts, by infusing them in a small quantity of water before they are used, as, in this case, there is less empyreumatic oil produced in the distillation.

3. M. Fiedler‡ has lately recommended a new process for preparing the gallic acid. He mixes together a solution of gallnuts and pure alumine; and he asserts, that after some time, the alumine combines with the tannin and extractive matter of the gallnuts; and that the gallic acid remains free in the solution, and may be obtained in crystals by evaporation. I have employed M. Fiedler's me-

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* Crell's Annals. † Fourcroy. Connaissances Chimiques, tom. VII. p. 191.

‡ Van Mons's Journal, tom. I, p. 85.

thod, but without having perfect success in the results. After pure alumine and solution of gallnuts had been suffered to remain together in the cold for three days, being very often agitated, the filtrated liquor still gave a slight precipitate with gelatine. I boiled about half an ounce of pure alumine with a solution obtained from nearly an ounce of gallnuts; and, in this case, I obtained a liquor which gave no precipitate with a solution of isinglass, or muriate of tin; so that it contained neither tannin nor extractive matter; but it likewise contained very little gallic acid, for it gave only a very faint olive colour when mixed with a solution of oxygenated sulphate of iron. By boiling together a solution of gallnuts and carbonate of alumine, procured from the decomposition of alum by carbonate of potash, I obtained a clear liquor, free from tannin and extractive matter, which gave a deep black colour with oxygenated sulphate of iron; and which, when evaporated, furnished a mass of white, opaque crystals. I suspect, however, that these crystals contained, as well as gallic acid, a small portion of alumine; for, when dissolved in distilled water, they rendered cloudy a solution of ammoniac.

4. I have found that when carbonate of barytes is boiled for some time with a solution of gallnuts it affords a blue green liquor; which appears from the common tests to contain neither tannin nor extract. When diluted sulphuric acid is dropped into the green liquor, it becomes turbid, sulphate of barytes is deposited; and, after filtration, if the saturation of the earth be perfect, a colourless solution of gallic acid, apparently pure, is obtained. All the alkaline earths, whether pure or saturated with carbonic acid, have, as I have found by various experiments, a strong attraction for tannin; and are capable of combining with a certain quantity of extractive matter. When a pure earth is made to act upon gallic acid, a salt is formed, having an excess of base, and nearly insoluble; but when an earth, combined with carbonic acid, is exposed to the agency of gallic acid, the salt formed is soluble, and seems to possess an excess of acid.

5. Of the different methods that have been described, that of M. Deyeux, is undoubtedly the most simple, and least expensive. The process with carbonate of barytes may, however, be sometimes employed with advantage, particularly in cases when gallnuts have been previously lixiviated for the purpose of obtaining tannin. There is very little mucilage in gallnuts: in cases, however, when the presence of it is suspected in gallic acid, this substance may be freed from it by being dissolved in alcohol, and then evaporated. When, in processes of evaporation, gallic acid is coloured by being partially decomposed, a clear solution of it may be again obtained, by means of ether, which dissolves the acid without acting upon the colouring matter. This last process is, however, too expensive to be commonly applied; and it should be used only in cases when an acid is required absolutely pure. D.

From the JOURNAL de PHYSIQUE. Vendémiaire, An XI.

"Description d'une nouveau Procédé, &c." Description of a new Process for Refining Gold. By M. DARCET, *the Nephew.*

In the common process of refining, employed in France, the alloys made use of are composed of about four parts of silver to one of gold; they are fused, and exposed to the action of nitrate of potash, which is thrown upon the melted alloy in small quantities at a time, for the purpose of oxidating any imperfect metals that it may contain. The mass is then granulated, and acted upon by nitric acid, the process being assisted by heat. In this manner the silver is dissolved, and the gold remains, though, as Mr. Darcet says, not in a state of absolute purity, as it uniformly concontains from $\frac{3}{1000}$ to $\frac{5}{1000}$ of silver.

The improved method of refining, consists in boiling the gold, purified by the common process, in sulphuric acid for about an hour. By this agent, according to the author, it is wholly freed from the last portions of silver, and it appears in a state of perfect purity.

M. Darcet thinks it advisable to use only a small quantity of nitrate of potash in the first part of the operation. In England, I believe, the nitric acid is the only agent employed in parting silver from gold.

The experiments of Mr. Tennant seem to show, that a certain loss of gold must arise from the use of any quantity of nitre. He found that a considerable portion of finely divided gold, was acted upon, and dissolved in two or three hours, by being exposed in a red heat to a quantity of nitre; whilst, in the same time, and under the same circumstances, silver was much less acted upon[*].

"*Extrait d'une Lettre, &c.*" *Extract of a Letter from Professor* Proust *to* J. C. Delametherie, *concerning the Discovery of a new Metal.*

"I shall send you very soon some details concerning the *silenum*, a new metallic substance, which I have discovered in an ore of lead from Hungary. I have not yet procured it in its pure state; but I fear that it will be extremely difficult of reduction, as its oxygene adheres to it with a very considerable force. Like many other metals, it is capable of combining with oxygene, in two different quantities. At its maximum of oxidation, it is yellow, and the salts formed by it, when in this state, are likewise yellow. Its oxide, at the minimum of oxidation, and its salts, are green. It must be placed in the class with those metals which do not give oxygene to sulphurated hydrogene, so that it may be purified by the same methods as nickel, cobalt, iron, and manganese."

"*Analyse, &c.*" *Analysis of an Ore of Uranium. By* M. Sage.

The colour of this ore was not so dark as that of pechblende, and its lustre was less: it was compact, and hard; and the powder of it was not attracted by the magnet.

It gave out sulphureous acid when heated in contact

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[*] Phil. Trans. Vol. 87, p. 219.

with air, and lost about a fiftieth of its weight. After torrefaction, it became attractible.

It was mixed with muriate of ammoniac, and then exposed to a red heat. By two processes of this kind, and subsequent washing, it was freed from iron, which, in the state of muriate, was sublimed with the muriate of ammoniac, or rendered soluble in water, occasioning a loss of weight of $\frac{1}{5}$. The uranium thus purified, dissolved with effervescence in nitric acid, and nitromuriatic acid. Its solutions were of a yellow colour, and there remained $\frac{1}{50}$ of a white powder, which, when acted on by a strong heat, did not sublime, and became of a yellow brown. It gave a green colour to glass.

The oxide of uranium is reducible by phosphorus; and the reduction, says M. Sage, is connected with some remarkable phenomena. A piece of phosphorus was introduced into a solution of the muriate of uranium: when in a moment the phosphorus became brown*, in consequence of its surface being covered with a portion of reduced uranium. When nitrate of uranium, with excess of acid, was added to the muriate, the brown colour disappeared. The clear solution, treated with potash, became of an emerald green, and gave a green precipitate.

M. Sage succeeded in reducing, by a strong fire, the precipitate of uranium by the fixed alkalies. In this case it was mixed with fat, and exposed in a crucible to the most powerful heat of a furnace for half an hour. It appeared in the form of a button, composed of brilliant globules, agglutinated together.

From the general results of his experiments, the author concludes that, 100 parts of this sulphureted ore of uranium consist of

Uranium	78
Iron	20
Sulphur	2

D.

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* The regulus obtained by Klaproth was grey internally, and brown externally.

" Essai sur les Couleurs, &c." Essay on the Colours obtained from Metallic Oxides, capable of being fixed, by Fusion, upon Vitreous Substances. By ALEXANDER BRONGNIART, *Director of the Porcelain Manufactory at Sevres.*

ABSTRACT.

Of the Fluxes for Vitrifiable Colours.

It is well known that vitrifiable colours are composed of metallic oxides; and such only can be employed with advantage as contain oxygene in a state of intimate combination, and such as are not volatile.

The metallic oxides are infusible in their pure states; and though they can be made to adhere to vitreous substances by means of a very strong fire, yet, in this case, if we except the oxides of lead and bismuth, they afford only dull colours. And to be exhibited in their perfect forms, they require to be combined with some fusible compound.

The fluxes made use of in manufactories are the glasses of lead and flint, and of borax, either alone or mixed together. By means of these substances the colours are rendered capable of being applied at a moderate degree of heat, they become more brilliant, and are defended from the contact of air.

Such oxides as are easily altered by a violent or long continued heat, are mixed only with their solvents, and applied in a finely divided state; but the more permanent colouring oxides are melted with the flux into a compound, which is ground for application.

Of the Vitreous Bodies to which the Colours are Applied; and of the Methods of Application.

The vitreous bodies to which colouring oxides are applied in manufactories may be divided into three classes.

1. Enamel, soft porcelain, and all the vitreous bodies that contain any considerable quantity of lead.
2. Hard porcelain, or porcelain glazed with feldspar.
3. Glass free from lead.

Enamel, as is well known, is a glass, rendered opaque by the oxide of tin, and fusible by the oxide of lead. It is the oxide of lead which gives to it its characteristic properties. And the same rules for the laying on of colours that apply to one vitreous substance containing lead, will apply to all of them.

The flux for the colours which are to be applied to enamel, may be either the glass of lead and flint, or the glass of borax mixed with flint glass. Borax alone has been employed, but in this case the compound is applied by means of volatile oils. In the manufactory at Sevres the glass of lead is used, and gum water is the substance by means of which the colours are laid on. In consequence of the great fusibility of enamel, the oxides are readily made to adhere to it by means of a very small quantity of the flux.

Some of the colours used in enamel painting undergo alteration, in consequence of the action of the oxide of lead upon them; and, in general, they are much diluted by their intimate union with the surface of the softened enamel; so that the paintings require to be several times retouched and burned, in order that they may possess the desired strength and vividness.

The colours on enamel generally appear brilliant and soft, and are never liable to the inconvenience of scaling off.

Hard Porcelain, which is the second kind of ground for the metallic colours, is composed of a very white clay, called kaolin, and a silicious and calcareous solvent. The glaze of it is feldspar.

The colours applied to hard porcelain are of two kinds.

The colours of the first kind, which are employed for representing different objects, are baked in a much lower degree of heat than that required for forming the porcelain, and they are very numerous. Those of the second kind require the same fire as the porcelain itself; and they are laid on the whole surface.

The colours of the first kind are nearly the same as those used for enamel; but they are combined with more flux;

and this flux is composed of the glass containing lead and borax.

As the feldspar glaze, after its incorporation with the porcelain, is not fusible in the heat at which the colours are applied, there is very little dilution of them; and it is only when a painting is required to be highly finished, that any retouching of it is necessary.

The great inconvenience in these colours is their disposition to scale off when the fire is often applied; and this is particularly the case with the hardest species of porcelain: it may, however, be in some measure avoided, by softening the glaze of feldspar, by combining it with certain quantities of silicious or calcareous flux. Soda and potash cannot be employed as solvents, for the colours uniformly fly off, when they are made use of, and the alkalies, are volatilized.

The colours of the second kind, which are laid upon the general surface, and fused by the same fire as that which bakes the porcelain, are not numerous. For there are very few metallic oxides which can support such a heat without being either altered or volatilized. Whenever they are used it is with a flux of feldspar. During the process of incorporating with the glaze, they never crack, but uniformly become more brilliant.

The third kind of vitreous substances to which colours are applied, is *glass, free from lead.*

The art of painting on glass was much practised in former ages, and it is not as yet entirely lost; descriptions of processes relating to it may be found in different works, particularly in L'Origine de l'Art de la Peinture sur Verre; and Traité de l'Art de la Verrerie, by Neri and Kunkel. But these descriptions are not altogether accurate, and it is necessary, on this subject, to refer to direct experiment.

The materials and fluxes used for painting on glass, are, in general, the same as those applied to porcelain; but they vary in their proportions, and require particular methods of application.

For baking plates of coloured glass, the support commonly recommended is gypsum; but this substance is extremely prejudicial to some glass, particularly to such as contains too much alkali: for it renders it white, and causes it to crack, in all directions; and smooth plates of earth, or unglazed porcelain are, in all cases, to be preferred to it.

Of the Red, Purples, and Violets, procured from Gold.

The carmine red is formed by the purple powder of Cassius, which is mixed with about six parts of flux, and applied without being previously fused. The purple colour is changed to bright red during the process of baking. This red is very delicate, and is easily spoiled by too much heat, or by vapours from the fuel. A charcoal fire is better for baking it than a fire from wood.

The purple, which differs very little from the carmine; and all the tints that are obtained from its mixture with other colours, are very liable to change. And in cases when a permanent bright red is wanted, for hard porcelain, the rose coloured oxide of iron may be employed.

The carmine, for soft porcelain, is made from fulminating gold, slowly decomposed, and muriate of silver. There is no tin in it. From which it is evident, that the oxide of tin is not essential for producing the purple colour of the compounds of gold.

The violet colour, like the purple, is obtained from the oxide of gold. But, in this case, there is a greater quantity of lead in the flux, and it is of the same tint, before, and after baking.

On glass, the carmine and purple afford a dirty violet; but the violet itself appears very pure, though it is liable to change to blue, as the author has lately observed.

Of the Red, Rose, and Brown Colours, from Iron.

These colours are made of the red oxide of iron, obtained by nitric acid, and exposure to heat and air.

The flux is a mixture of borax, sand, and a small quantity of minium; and the effects are the same, whether it be fused, or mixed with the colours, which never change when they are properly applied to hard porcelain.

Their preparation is the same for soft porcelain, and for glass. On glass they are durable: but they change on enamel, and become extremely pale, or disappear altogether; which, as the author has proved by experiment, is owing to the lead it contains: and he thinks that the property of lead to render glass clear, is owing to its action upon the iron generally contained in that substance.

Of Yellows.

The yellows for hard and soft porcelain are the same; they are formed of oxide of lead, white oxide of antimony, and sand.

The oxide of tin is sometimes added, and when the colour is required to be very bright, and approaching to that of the marigold, some red oxide of iron is used; the very deep colour of which is modified by the oxide of lead.

The fabrication of these colours requires much caution, as the lead is sometimes revived, and occasions black spots. When they have been once produced they are permanent; though they will not bear the intense fire used for baking hard porcelain.

The yellows from lead and antimony, cannot be applied to glass, for they render it dull and opaque. The yellow employed by the ancient painters, contained silver, and it has been successfully imitated in the manufactory at Sevres; where muriate of silver, oxide of zinc, white clay, and the yellow oxide of iron are employed. The colour is applied simply ground, and without flux. The shades, when a large quantity of the tinging materials is used, are very deep, and approach towards orange.

Of Blues.

The oxide of cobalt, as is well known, is the substance that produces the vitrifiable blue. This oxide as M. Brongniart has observed, is volatile at a very high degree of heat:

to which circumstance we must attribute the bluish tint that white porcelain sometimes gains when placed in a furnace, near blue porcelain.

The oxide of cobalt, for hard porcelain, is fused with feldspar. Its solvent for soft porcelain is flint, potash, and lead.

The blue, from the oxide of cobalt is unalterable. It is the same for glass as for soft porcelain.

Of Greens.

Greens are made from the green oxide of copper, or from a mixture of blue and yellow. They are melted with the flux; and without this precaution, would become black; but they do not change after the first fusion, unless they be exposed to a violent fire.

The green grounds, made by strong heat, are formed of the oxides of cobalt, and nickel; but they incline to brown.

The bluish greens, which were formerly very much in esteem, can only be used on soft porcelain; there is potash in their composition, and, in consequence, they scale off from hard porcelain.

To give a fine green to glass, it is necessary to put a yellow on one side, and a blue on the other; or to use a mixture of a blue with the yellow oxide of iron. Mr. Brongniart has great hopes of being able to obtain a very beautiful green from the oxide of chrome. The chromate of lead has already furnished him with a good shade of this colour.

Of Bistres and Brown Reds.

They are procured from mixtures of different proportions of manganese, brown oxide of copper, and umber. They are fused with their solvents, and do not change on soft porcelain.

They may be employed upon glass.

The brown red grounds, that bear a strong heat, are made in a similar manner. Feldspar is the flux. There is no titanium in their composition, as has been asserted. M.

Brongniart has made some experiments on this substance, but has obtained from it only a light and dull yellow.

Of Blacks.

There is no metallic oxide which affords a fine black alone. Manganese produces the best. Iron gives an opaque dull black, which is liable to become red.

To form the most beautiful black, several metallic oxides are combined; the oxide of manganese, the brown oxide of copper, and a little of the oxide of cobalt.

Grey is obtained by omitting the oxide of copper.

In the manufactory of Sevres, the finest black is made by a mixture of blue, with the oxide of manganese and iron.

The blacks for opaque glasses are the same as those for porcelain. D.

Observations relating to the Progress of Galvanism.

I. *On the Formation of Galvanic Combinations, composed wholly of Animal Substances.*

Professor Aldini, the nephew of Galvani, who is at present in this country, has lately confirmed the experiments made long ago by Galvani, Volta, and other philosophers, on the production of muscular contractions, by combinations, consisting wholly of animal substances, and has elucidated them by various new facts.

Galvani prepared a frog, in such a manner, that the legs were connected with the body, only by means of the sciatic nerve; and, in this case, he found that muscular contractions were produced by bringing the muscles of the legs in contact with the upper part of the body *.

Volta having laid bare the muscles and the sciatic nerve in the leg of a frog, just separated from the animal, introduced them into two vessels filled with water, in such

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* Humboldt sur le Galvanisme, p.27.

a manner, that the muscles were in one glass, and the nerve in the other. He connected the two glasses together, by means of his fingers, when a strong contraction was produced in the limb[*].

Humboldt placed the prepared leg of a very vivacious frog upon a plate of glass, and made a contact between the sciatic nerve and the muscles of the foot, by means of a piece of muscular flesh. At the moment of the contact muscular action was produced, and the experiment was often repeated with success[†].

M. Aldini has succeeded in causing contractions in the limbs of frogs, not only by bringing their nerves and muscles in contact with each other, in various modes; but likewise by placing them in contact with the nerves and muscles of warm blooded animals, just deprived of life. One of the most singular of his experiments is this. Of two persons, one holds in his hand the lower muscles of the prepared leg of a frog, and the other touches with his fingers the spinal marrow of an animal recently killed. The unoccupied hands are moistened, and connected with each other; and the sciatic nerve in the leg of the frog brought in contact with the bared abdominal muscles of the warm blooded animal. At the moment that the circuit is completed, the leg is agitated by strong contractions.

In considering these curious phenomena, it is difficult to account for them, except on the supposition that the animal organs are capable, in certain cases, of exerting an action similar to the metals, in producing galvanic electricity. Living animal bodies, in fact, follow the metals and charcoal, in the order of their conducting powers; they are composed of solids, and fluids. And all analogies on the subject tend to prove, that to form galvanic combinations, nothing more is necessary than the contact of solids, and fluids possessed of different conducting powers, and capable of exerting chemical action on each other.

In most cases when muscular contractions are produced

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[*] Humboldt sur le Galvanisme, p. 29. [†] Ibid. p. 31

in animal organs, by the application of an arc, composed of two metals, or one metal and different fluids, the circulation of the electricity must be supposed to be determined by the action of the inorganic bodies. But when contractions are produced by a single metal, communicating with the organs only by means of water*, the impulse of the electricity must be attributed to the animal substances; for the arc being simple, and connected at both ends with a similar body, forms only one element of a galvanic combination, of which water is the efficient part; and it can act only as a simple conductor.

The galvanic power of the artificial animal combinations is evidently much feebler, and more transient than that of the metallic combinations; silver and zinc will produce contractions in the muscles of a frog, many hours after it has become insensible to the action of either of them separately used: and, in this case, the effect must be attributed simply to the passage of the electricity through the irritable parts; for it takes place whatever be the form of the application.

The muscles and nerves appear to be the exciting parts in animal combinations; but as yet their states of electricity, with regard to each other, have not been ascertained. By connecting a very feeble metallic combination with a very active animal combination, in two different ways, this problem might perhaps be solved. If, for instance, with an arc of copper and silver, connected with the nerves and muscles in the leg of a frog, by means of water, the action was much stronger when the copper was opposite to the muscle and the silver to the nerve, than in the contrary case; it

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* The experiment on the production of muscular contraction, by the application of two portions of water, in contact with a single metal, to the organs, was first made by Galvani, and confirmed by Aldini, and Humboldt. One form of it, which I have several times employed with success, is this. A piece of silver is made to connect together two glasses, filled with pure water; the leg of a frog, deprived of the skin, is suspended by a bit of silk, in such a way, that the foot and the sciatic nerve are nearly parallel. On bringing the muscle in contact with one portion of water, and the nerve in contact with the other, the contraction of the limb is produced. D.

would be reasonable to conclude, that the nerve bore the same relation to the muscle, as the copper to the silver, i. e. that the nerve was positive, and the muscle negative, &c.

All the facts that we are acquainted with on the subject of galvanism, tend to show, that the same substances which form simple galvanic combinations, are capable, when multiplied and alternated with each other, in the proper order, of forming a galvanic battery. In consequence, however, of the susceptibility of animal substances to undergo change, from the feebleness of the action, and other circumstances in the experiments just detailed; it is probable that it will be very difficult, if not impossible, to accumulate galvanic electricity by means of arrangements, composed of separate animal organs*. In the torpedo and gymnotus electricus, the electrical instrument is composed wholly of living matter, and its activity is related to the general functions of the animal: and, in the case of the galvanic action of the nerves and muscles of frogs, and warm blooded animals, the effect is apparently connected with some remains of vitality; which, as there is great reason to believe, would disappear during the time required for forming compound galvanic combinations.

II. *On the Production of Muscular Contractions in the parts of warm blooded Animals after Death, by the Galvanic Battery.*

MM. Vassali-Eandi, Giulio, and Rosi †, have succeeded in producing contractions in the heart, and arterial system, after death, by connecting them with the galvanic battery.

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* I attempted to form a Galvanic battery, by combining in a circle, upon a plate of glass, ten newly prepared legs of frogs, having the sciatic nerve bared, with drops of water; in the order of muscle, nerve, water; muscle, nerve, water, and so on: but no effect was produced on breaking or completing the circle, by means of one of the legs. When a silver wire was made part of the circle, contractions were produced in the two legs which were nearest to it; but the others were not affected. When a little nitrous acid was added to the water, four of the legs contracted strongly with the silver; but there was no effect with the animal substances alone. D.

† Journal de Physique. Vendémiaire, An XI.

The heart loses its susceptibility to the galvanic stimulus very soon, but the muscular organs, which are connected with large nerves, are capable of being made to contract for a considerable time.

By connecting the pectoral muscles with one end of the pile, and the par-vagum and sympathetic nerves, at their origin, with the other end, very powerful muscular action was produced, which caused the phenomena of expiration, and inspiration.

On the first view of these experiments, we might be induced to hope for some advantages in the application of galvanism in cases of drowning, strangling, &c.; but when we consider that the contractions of most of the muscles, the actions of which are subservient to the vital functions, cannot be produced without laying bare large nerves, our expectations will be but moderate.

III. *On the Galvanic Batteries said to be formed without the use of Humid Substances.*

In No. 9, An XI. of the Magasin Encyclopédique, may be found the following notice.

" M. Guyton, Member of the National Institute, and Director of the Polytechnic School, read, at the sitting of the National Institute of the 25th of August, a memoir entitled, Researches on the pile of Volta, by MM. Hachette, and Desormes, Professor in the Polytechnic School.

" This memoir contains two important facts, which may be expected to throw great light upon the theory of electricity. The first is, that an insulated electrical column, or Nairne's electrical machine, insulated, that is, communicating only with the air, is an inexhaustible source of electricity. The second fact is, that many dry and solid substances, such as pure starch, and the powder of different salts, are capable of occupying the place of the moist substance, in the pile of Volta, and that, in consequence of this discovery, piles may be formed by the mere arrangement of different substances, which are constant and almost unchangeable sources of the electrical fluid."

It is perhaps impossible to judge accurately of the nature of the researches of the French experimenters, from this short notice; and, consequently, any observations upon it may not be found applicable to the memoir itself. It may not however be improper to say that, there is little novelty in the first fact It is a new expression of a truth that has been generally admitted.

The second fact, the formation of a pile by means of solid substances only, would, if comfirmed, be of the greatest importance in its applications to the theory and operations of galvanic electricity: it would afford a strong argument in favour of Volta's theory of *electromotion;* and it would go far to overturn the opinion concerning the dependence of the circulation of galvanic electricity upon chemical changes.

For the purpose of examining the results of MM. Hachette and Desormes, I constructed a pile with double plates of copper, and zinc, and dry powder of starch in its common state; but when twelve plates had been put together, in the order of copper, zinc, starch, and so on, no effects whatever were perceived; the pile produced no sensation on the tongue, and wires from it occasioned no change in water.

On exposing a pile, composed of copper, zinc, and starch, to the atmosphere in a cold and damp cellar; it was found, after two days, to have gained a very slight degree of power. On moistening the starch with a very little water, the electrical action was evolved in the same manner as when wet cloths were employed. The phenomena were the same with a combination of silver and zinc; no effects could be produced from pure dry starch.

It would be unjust to decide concerning the experiments of the French chemists, till the details of them are made known; but, in the present state of our information, one should be inclined to conceive that they have been misled by the moisture, which, in common cases, adheres very strongly to starch, and to many saline substances.

On exposing a quantity of powdered starch to the gentle heat of a sand bath, a considerable quantity of water was speedily driven off from it. When dry, it was a perfect nonconductor of electricity; but after being exposed for some hours to a moist atmosphere, it had gained a slight degree of conducting power; which, as there is every reason to suppose, was the consequence of its having absorbed moisture.

The salts, the earthy substances, and the solid vegetable productions, when in a state of perfect dryness, are, in fact, all nonconductors, and, as such, it appears impossible that they can form elements of the pile of Volta. They have, however, many of them a very strong attraction for moisture, and, in common cases, when exposed to the atmosphere, are always more or less saturated with it. I found, some time ago, that powdered steatite, from the Lizard, in Cornwall, in its crude state, when used in a small galvanic pile, instead of the moistened cloth, enabled it to act, though very feebly. But after having been gently heated, it was no longer capable of producing the effect; and in its dry state, a single stratum of it, when placed in any part of an active pile, was sufficient to destroy the circulation of the electricity. D.

From the LITERATUR-ZEITUNG of JENA, No. 193. 23d of October, 1802.

Observations on the Experiments of HACHETTE *and* DESORMES. *By* RITTER.

The first of the facts mentioned in this essay, says Mr. Ritter, is not new, and the second, as far as it is true, is liable to some objections. The true fact is, that no "solid and" really "dry substance can supply the place of the moist substance in the pile of Volta, which therefore renders the construction of such piles as may serve for an inexhaustible and almost unalterable source of the electric fluid", absolutely impossible: that "pure starch produces no action whatever, nor starch mixed with any kind of salt, provided that it has been properly dried on a stove, or on a plate over a fire. The reason of the mistake is, that all bodies are hygrometers, even such as are apparently dry, unless they are immediately taken from a stove, and preserved, during the experiment, in a temperature higher than that of the surrounding atmosphere, for otherwise there is an immediate deposition of moisture on them from the air. Oiled linen, and leather, as they are found in the shops, placed alternately with zinc and copper, afford a degree of tension as great as if these substances were soaked in salt water: but in charging electric batteries from such a pile, hours, and even days are necessary, in order to produce as great an effect as is obtained almost instantaneously from a similar pile, replenished with salt water; and any continued action of such a pile, while the circle continues complete, is out of the question. It may easily be imagined that starch, though apparently dry, may be somewhat more powerful. But let those substances be carefully dried on a stove, and the pile will not have the slightest activity, I have already published an account of experiments of this kind made on 600 plates. I have also shown that a body, perfectly dry within, only requires to be moistened on each surface, in order to produce an action. I imitated this by coating 600 plates of glass, warmer than the surrounding substances, on each side with thin pasteboard, slightly moistened, and introduced them into the pile. The pile exhibited its tension, and charged the electric battery, notwithstanding the quantity of glass contained in it: but it had not the slightest effect when I built it with warm and dry glass, without a coating. The application is easy. These observations may serve to correct mistakes, which were likely to deceive us with brilliant prospects, and the more so, as even Volta himself has induced us to hope for the success of operations which appear to be impracticable.* Y.

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* These facts of M. Ritter, are given as applying to the subject of the foregoing paper; and the two sets of experiments, though made with views in some measure different, and under different circumstances, go towards establishing the same principles. D.

Account of a Memoir on Dew. By BENEDICT PRÉVOST. *Read to the Society of the Department of Lot, at Monsauban. Abridged from the Annales de Chimie, No.* 130, *Vendémiaire, An XI.*

It is well known that dew is often deposited on glass, when metals in its neighbourhood remain dry; Mr Prévost has however discovered some new and curious facts relative to this deposition. When thin plates of metal are fixed on pieces of glass, it sometimes happens that they are as much covered with dew as the glass itself: but more frequently they remain dry; and in this case they are also surrounded by a dry zone. But when the other side of the glass is exposed to dew, the part which is opposite to the metal remains perfectly dry. If the metal be again covered with glass, it will lose its effect in preventing the deposition.

These experiments may be very conveniently made on the glass of a window, when moisture is attaching itself to either of its surfaces; Mr. Prévost remarks that it often happens that dew is deposited externally, even when the air within is warmer than without. A plate of metal fixed internally on a window receives a larger quantity of moisture than the glass, while the space opposite to an external plate remains dry: and if the humidity is deposited from without, the place opposite the internal plate is also more moistened, while the external plate remains dry: and both these depositions may happen at once with the same result. A small plate fixed externally opposite to the middle of the internal plate, protects this part of the plate from receiving moisture, and a smaller piece of glass, fixed on the external plate, produces again a central spot of moisture on the internal one: and the same changes may be continued for a number of alternations, until the whole thickness becomes more than half an inch. Gilt paper, with its metallic surface exposed, acts as a metal, but when the paper only is exposed, it has no effect. When a plate of metal on which moisture would have been deposited, is fixed at a small distance from the glass, the moisture is transferred to the surface of the glass immediately under it, without affecting the metal: if this plate is varnished on the surface remote from the glass, the effect remains, but if on the side next the glass, it is destroyed. The oxidation of metals renders them also unfit for the experiment. When glasses partly filled with mercury, or even with water, are exposed to the dew, it is deposited only on the parts which are above the surface of the fluid. But in all cases when the humidity is too copious, the results are confused.

In order to reduce these facts to some general laws, Mr. Prévost observes, that, when the metal is placed on the warmer side of the glass, the humidity is deposited more copiously either on itself or on either surface of the glass in its neighbourhood: but that, when it is on the colder side, it neither receives humidity nor permits its deposition on the glass: that a coat of glass, or varnish, destroys the efficacy of the metal, but that an additional plate of metal restores it.

Mr. Prévost was at first disposed to attribute these phenomena to the effects of electricity, but he thinks it possible to explain them all by the action of heat only: for this purpose he assumes, first, that glass attracts humidity the more powerfully as its temperature is lower; secondly, that metals attract it but very little; thirdly, that glass exerts this attraction notwithstanding the interposition of other bodies; and fourthly, that metals give to glass, placed in their neighbourhood, the power of being heated by warm air, and being cooled by cold air, with greater rapidity; hence that the temperature of the glass approaches more nearly to that of the air on the side opposite to the metal, and attracts the humidity accordingly more or less, either to its own surface, or to that of the metal. We should indeed have expected a contrary effect; that the metal would rather have tended to communicate to the glass the temperature of the air on its own side: but granting that the assumptions of Mr. Prévost serve to generalise the facts with accuracy, their temporary utility is as great as if they were fundamentally probable. Y.

On the Preparation of Phosphuret of Lime.

M. Van Mons, in the seventh number of his Journal, describes a new method of preparing phosphuret of lime. He introduces into a glass matrass, carbonate of lime in powder, and heats the matrass strongly in a sand bath, till almost all the carbonic acid is expelled from the lime. The phosphorus is then introduced in small pieces at a time, and being preserved from the contact of the air, by the carbonic acid in the vessel, it combines, as the author asserts, with the lime, which is preserved in a state of dull ignition, and forms with it a perfect phosphuret.

In considering this process theoretically, I should conceive that a very considerable portion of the phosphorus would be volatilized by the heat before it could come in contact with uncombined lime; and a simpler method of operation can hardly be imagined than that originally employed by Dr. Pearson, for the production of this substance. I have seen a useful modification of it employed by Mr. Clayfield of Bristol. A green glass tube is made use of, closed at one end. The phosphorus is introduced into the bottom of the tube, which is filled with well burnt quick lime. The tube is placed across an open furnace in such a manner, that the middle of it may be ignited before the bottom becomes very hot. When this effect is produced the bottom itself is slowly brought in contact with the fire; and the phosphorus, in consequence is volatilized, and made to pass through the red hot lime, with which it immediately enters into combination.

When the lime is in sufficient quantity, none of the phosphorus is lost by passing into the atmosphere. By coating the bottom of the tube with a little moist clay, the process may be easily conducted in a common grate.

By the same mode of operating, Mr. Clayfield has been able to form the phosphurets of strontian and barytes. D.

From the JOURNAL de CHIMIE et de PHYSIQUE.

Par J. B. VAN MONS. No. 7.

"*Nouvelles Observations, &c.*" *New Observations on the Conversion of Fixed Oils into Wax. By* BRUGNATELLI.

M. Brugnatelli succeeded in converting olive oil into a substance analogous to wax, by mixing together two parts of olive oil, one part of alcohol, and another part of nitric acid. A great effervescence takes place in the process; some ether is formed by the action of the nitrous acid on the alcohol; and the waxlike substance, when the vessel is cold, appears in the form of a pale yellowish mass.

A similar substance may be obtained, by exposing olive oil to weak nitric acid at the time that is dissolving copper.

"*Extrait, &c.*" *Extract of a Letter from the* COUNSELLOR WESTRUMB, *concerning the Discovery of two New Principles in Sulphureted Waters.*

"For six years almost the whole of my time has been devoted to researches concerning the constituent principles of sulphureous waters. I have found a new and easy method of ascertaining the quantities of sulphureted hydrogene gas, and carbonic gas, which they contain; and I have discovered a principle, hitherto unknown, in these waters; namely, bitumen, in combination with sulphurated hydrogene, and hydrosulphuret of lime. I have communicated the detail of these new facts, to our common friend M. Wurzer. The Counsellor von Crell, and Professor Schaub, of Cassel, have seen the new products: which are found in the waters of Neuwdorf, Limmen, Rehberg, and Eylse. In this last place, there are found in a space, less than a thousand feet square, five sulphureous springs, different from one another; a spring of water, impregnated with carbonic gas*, and another of soft water."

"*Extrait, &c.*" *Extract of a Letter from* M.C. Gimbernat, *concerning the Discovery of a New Gas (Sulphureted Nitrogene Gas), in the Mineral Waters at Aix-la-Chapelle.*

Aix-la-Chapelle, 20th August, 1802.

"I have nearly finished my analysis of the sulphureous waters of Aix-la-Chapelle. I have ascertained that the sulphur in these waters is held in solution by nitrogene, and not by hydrogene, as has been generally supposed. They contain no sulphureted hydrogene.

"Sulphureted nitrogene gas is a substance, the existence of which had been heretofore only suspected. But it is found abundantly in the mineral waters in this country.

"Besides sulphureted nitrogene, these waters contain a great deal of pure nitrogene."

ROYAL SOCIETY.

The Society met for the first time in this session, on the 4th of November, when a paper on the humours of the eye, by Richard Chenevix, Esq. F.R.S. was read.

Mr. Chenevix has made his experiments chiefly upon the eyes of sheep. He describes the aqueous humour in these eyes as a clear transparent liquid, of the specific gravity of 10.090, water being taken as 10.000, at 60° Fahrenheit. It scarcely alters vegetable blues when fresh. It gives a slight coagulum by boiling, and precipitates tannin and the nitrate of silver. Mr. Chenevix considers it as composed of water, albumen, gelatine, and muriate of soda.

The crystalline humour in the eye of the sheep is of the specific gravity of 11.000. It is neither acid nor alka-

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* Query, carbonic acid gas? D.

line. It is almost wholly soluble in cold water. It gives an abundant precipitate with tannin; and is partly coagulated by heat. It contains no muriate of soda; and is composed, says Mr. Chenevix, of a larger portion of albumen and gelatine than the other humours, and of a smaller quantity of water.

The vitreous humour, freed from its capsules, was of the same specific gravity as the aqueous humour; and Mr. Chevenix could discover no difference in the chemical composition of these two bodies. Mr. Fourcroy mentions a phosphate as contained in the humours of the eye; but Mr. Chenevix could not, in any case, detect the presence of it, though he made use of delicate tests.

Mr. Chenevix had not an opportunity to make many experiments on the human eye, but as far as his researches have gone, they show that the chemical composition of the humours in it is similar to that of the humours in the eye of the sheep. The specific gravity of the aqueous, and vitreous humours, he found to be 10.053, and that of the crystalline 10.790.

There is a remarkable difference between the ratios of the specific gravities in the different humours of the human eyes, and in those of the humours in the eye of the sheep, as is evident from estimation. Mr. Chenevix considers the humours of the eye, as achromatic in their effect; and conceives, that in the human eye, which is less than that of the sheep, the smaller density of the crystalline humour is designed by nature for the purpose of preserving the achromatic property.

The composition of the humours in the eyes of birds, Mr. Chenevix found to be analogous to that of the humours in the eyes of sheep; but what is remarkable in them is, that the crystalline humour is of less specific gravity than the vitreous humour.

No particular precaution is necessary in taking the specific gravity of the aqueous and vitreous humours, but as the crystalline humour is not of uniform density throughout, it ought to be preserved entire for examination. Mr.

Chenevix found the weight of a very fresh sheep's crystalline to be 22 grains; and its whole specific gravity as before mentioned 11.000. But on paring it away towards the centre, till only 5½ grains remained, he found that their specific gravity was 22.151.

Mr. Chenevix concludes his paper by stating that, if any just analogies could be drawn between the properties of dead and living matter, some curious inferences might be obtained concerning the dependence of the formation of the cataract upon the coagulation of the albumen in the humours of the eye; and he seems to wish that some observations were made concerning the relations of this disease to a gouty habit; as in this habit the coagulation might be supposed to depend upon a superabundance of phosphoric acid in the secretions. D.

The Bakerian Lecture, by William Hyde Wollaston, M.D. F.R.S. was read on the 11th of November. It consisted of observations on the quantity of horizontal refraction, and the method of measuring the dip at sea.

Dr. Wollaston notices Mr. Monge's memoir on the "mirage" observed in Egypt, as containing facts which fully agree with his own theory formerly published. From his observations on the degree of refraction produced by the air near the surface of the Thames, it appears that the variations derived from changes of temperature and moisture in the atmosphere, are by no means easily calculable; but that a practical correction may be obtained, which for nautical uses may supersede the necessity of such a calculation. Dr. Wollaston first observed an image of an oar at a distance of about a mile, which was evidently caused by refraction, and placing his eye near the water, the lower part of distant objects was hidden, as if by a curvature of the surface. This was at a time when a continuation of hot weather had been succeeded by a colder day, and the water was sensibly warmer than the atmosphere above it. He afterwards procured a telescope, with a plane speculum placed obliquely before its object glass, and provided with a micrometer, for measuring the angular depression of the image of a distant oar, or other oblique object; this was sometimes greatest when the object glass was within an inch or two of the water, and sometimes when at the height of a foot or two. The greatest angle observed was somewhat more than nine minutes, when the air was at 50°, and the water at 63°; in general the dryness of the air lessened the effect, probably by producing evaporation, but sometimes the refraction was considerable notwithstanding the air was dry. Dr. Wollaston has observed but one instance which appeared to encourage the idea, that the solution of water in the atmosphere may diminish its refractive power.

In order to correct the error, to which nautical observations may be liable, from the depression of the apparent horizon, in consequence of such a refraction, or from its elevation in contrary circumstances, and at the same time to make a proper correction for the dip, Dr. Wollaston recommends, that the whole vertical angle between two opposite points of the horizon be measured by the back observation, either before or after taking an altitude; and that half its excess above 180° be taken for the dip: or if there be any doubt respecting the adjustment of the instrument, that it be reversed, so as to measure the angle below the horizon, and that one fourth of the difference of the two angles, thus determined, be taken as extremely near to the true dip. It is indeed possible that the refraction may be somewhat different at different parts of the surface, but Dr. Wollaston is of opinion that this can rarely happen, except in the neighbourhood of land. Y.

On the 18th of November, a paper, by James Smithson, Esq. F. R. S. on the chemical analysis of some calamines, was read.

Much uncertainty has hitherto prevailed on the subject of the composition of calamines, the author was induced to carry on his researches by the hopes of obtaining a more certain knowledge of these ores; and he considers his results as fully proving the necessity for new investigations, and that the opinions which had been adopted concerning them were far removed from the truth. Mr. Smithson's experiments were made upon four different kinds of calamine: the calamine of Bleyberg, that of Somersetshire, that of Derbyshire, and the electrical calamine.

The calamine from Bleyberg was white, and had a stalactitical form; its specific gravity was 3.584. It became yellow under the blowpipe; and when exposed to the heat of the interior blue flame was gradually dissipated. It dissolved with effervescence in sulphuric acid, muriatic acid, and acetous acid. It lost by heat rather more than $\frac{1}{4}$ of its weight. It afforded oxide of zinc, carbonic acid, and water, in the proportion of 714, 135, and 151; there was besides found in it a minute portion of the carbonates of lead and lime; but these the author considers as accidentally mixed with the ore, and not in combination with the other ingredients.

The calamine from Somersetshire, was of a mamillated form. Its colour was brown externally, and greenish yellow internally; its specific gravity was 4.336. It dissolved in sulphuric acid, with effervescence: and when analyzed, by means of reagents, afforded in 1000 parts, 352 of carbonic acid, and 648 of oxide of zinc.

The Derbyshire calamine was in small crystals, of a pale yellow colour; their specific gravity was 4.333. When analyzed, by solution in sulphuric acid, and the action of heat, 1000 parts of them were found to contain, of carbonic acid 348, of oxide of zinc 652.

The electrical calamine, which Mr. Smithson examined, was from Regbania, in Hungary. It was in the form of regular crystals; the specific gravity of which was 3.434. They became electrical by heat: and when exposed to the flame of the blowpipe decrepitated, and shone with a green light. The electrical calamine differs materially in composition from the other specimens, in being formed chiefly of quartz and oxide of zinc, which, according to the author, are in chemical union. 1000 parts of it gave 250 parts of quartz, 683 of oxide of zinc, and 44 of water; the loss being 23 parts.

From his series of experiments on the calamines, Mr. Smithson has been able to deduce, with a considerable degree of acuracy, the composition of sulphate of zinc; which, when free from combined water, he considers as composed of equal parts of sulphuric acid, and oxide of zinc.

In reasoning generally upon the constitution of the salts of zinc, Mr. Smithson offers some new observations in relation to affinity; and he thinks that the proximate constituent parts of bodies are not absolutely *united* in the remote relations to each other, usually indicated by analyses, but that they are universally very considerable parts of the compound, probably seldom less than .2. He applies this theory in accounting for the presence of water in the calamine of Bleyberg, in which there is not sufficient carbonic acid to saturate the oxide of zinc; and he considers this ore, as probably composed of a peculiar combination of water with the oxide of zinc, which he names hydrate of zinc, and of carbonateof zinc, to each other, in the proportions of 3 to 2.

All the calamines, when long exposed to the heat of the blowpipe, are dissipated, with the production of white flowers. This circumstance, the author thinks, ought not to be attributed to an immediate volatilization of the oxide of zinc; but rather to the deoxidation of this substance, by the charcoal and combustible matter of the flame, and the consequent immediate sublimation and combustion of the metallic zinc: to which combustion, the phosphorescence of calamines under the blowpipe may be owing.

The fibrous form of the flowers of zinc, produced during the action of the blowpipe upon calamine, Mr. Smithson attributes to the crystallization taking place during their mechanical suspension in the air: and he thinks that the fluid state is not at all necessary to the production of crystals; and that the only requisite for this operation is a freedom of motion in the masses which tend to unite, allowing them to obey that sort of polarity which occasions them to present to each other the parts adapted to mutual union. D.

Extract from a Memoir on the Sap of Vegetables. By M. VAUQUELIN*.

On the Sap of the Elm. Ulmus Campestris. Linn.

The sap of the elm, first examined by M. Vauquelin, was collected in the beginning of the month Floréal, 1796. Its colour was red brown, and its taste sweet, and mucilaginous. It did not redden the tincture of turnsole. Ammoniac, barytes, and lime, each produced a copious yellowish precipitate in it; with the oxalic acid, and the nitrate of silver, it gave a white precipitate. Diluted sulphuric acid caused it to effervesce, and to give an odour similar to that of acetic acid. By the oxygenated muriatic acid, its colour was destroyed, a yellow precipitate falling down. The hydrosulphuret of potash, and the sulphate of iron, did not alter it; when alcohol was poured into it, a flaky matter was thrown down.

A quantity of the sap was exposed to a low degree of heat. During its evaporation, a brown pellicle formed on the surface; brown flakes separated themselves from the mass of the fluid; and an earthy substance was deposited on the sides of the vessel. When about $\frac{1}{10}$ of the original quantity remained, the liquor was suffered to cool. It was then examined by means of the action of muriatic acid, carbonate of potash, and sulphuric acid, and was found to be composed of water, vegetable matter, carbonate of lime, and acetite of potash.

From the general results of his experiments, M. Vau-

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* This extract is made from an account of M. Vauquelin's work, published in the Annales de Chimie, Tom. 31, by M. Tassaert. The experiments, though made some years ago, have not been much noticed in this country. The subject to which they relate is highly interesting, and an investigation concerning it, in all its details, could not fail to throw considerable light upon the phenomena of vegetation. D.

quelin concludes, that 103900 parts of it contain about 924 parts of acetite of potash, 106 of vegetable matter, and 79 of carbonate of lime.

In a second series of experiments made upon sap, which was collected from the elm, in the same month as the other, but rather later, similar results were gained; the constituent parts of the solids dissolved in the sap were the same, but their relative proportions were different; the quantity of the vegetable matter being greater, and that of the acetite of potash, and carbonate of lime, less.

Sap examined in the month Prairial, was found still richer in vegetable matter, than the two specimens collected in Floréal, and it contained a much smaller quantity of saline matter.

This fact M. Vauquelin considers as of importance, and he proposes it as a problem, to be solved by new observations, whether the increase of vegetable matter, and the diminution of saline matter in the sap, during the progress of vegetation, may not be owing to a decomposition of the acids, contained in the carbonate of lime, and acetite of potash, by means of which hydrogene and carbon, the chief elements of vegetable matter, may be supplied?

In examining the bark of the elm, M. Vauquelin found much less carbonate of lime, and acetite of potash in proportion, than in the sap.

The sap of the elm, suffered to remain for a long time in a vessel, containing a little air, became very much altered, and gained alkaline properties. When analyzed it was found to be composed of carbonate of potash, of carbonate of lime, and vegetable matter; so that it appears that the acetous acid, of the acetite of potash, had been decomposed or converted into carbonic acid.

This interesting fact throws some light upon the causes of the diseases of elms, and enables us to account for the manner in which the carbonates of potash, and of lime are formed, which are found in the decayed or ulcerated parts of these trees.

Sap of the Beech. Fagus Silvestris. Linn.

The sap of the beech, employed in these experiments, was collected in the beginning of the month Floréal, 1796. Its colour was reddish yellow; its taste was analogous to that of the infusion of tan. It reddened, but very little, the tincture of turnsole. It was precipitated by ammoniac, carbonate of potash, and oxalic acid. The oxygenated muriatic acid produced in it a flaky precipitate, of a yellow colour. It was blackened by concentrated sulphuric acid, and a smell of acetous acid was produced. The hydrosulphuret of ammoniac did not alter it. The sulphate of iron gave a black precipitate with it. The solution of gelatine occasioned in it a copious white precipitate.

4580 parts of this sap, having been evaporated at a low heat, furnished about 105 parts of a brown extract, of which a part only was soluble in alcohol. It was deliquescent when exposed to the air. When mixed with lime it gave out ammoniac. By the action of sulphuric acid, acetous acid was produced from it.

From this examination, M. Vauquelin concludes, that this sap contains, 1st, free acid; 2d, a calcarious salt; 3d, an alkaline salt; 4th, gallic acid; 5th, tannin; 6th, a mucous and extractive matter.

In a second series of experiments made on the sap of the beech, obtained in the month Prairial, its colour was observed to be brown red, and its taste was like that of the infusion of tan which had fermented. Acted on by reagents it presented the same appearances as that before examined. During its evaporation a brown matter was deposited; which gave by distillation, an ammoniacal product. The tannin was separated from the liquor, when it had been in part evaporated by means of a solution of isinglass. The residual matter, treated by alcohol and carbonate of potash, was found to consist chiefly of extractive and mucous matter, and acetite of lime.

It results from all these observations, that the sap of the beech differs from that of the elm; 1, In containing no carbonate of lime; 2, In holding in solution free acetous acid, tannin, and gallic acid.

The presence of these last substances seem to show, that the bark of the beech might be employed with advantage in the process of tanning.

Sap of the Hornbeam. Carpinus Sylvestris. Linn.

The sap of the hornbeam, collected in the month Germinal, 1796, was transparent and white; its taste was mild, and sweetish; and its smell analogous to that of skimmed milk. It reddened tincture of turnsole. Barytes, and carbonate of potash produced white precipitates in it, which were soluble in muriatic acid. It was rendered brown by sulphuric acid, which disengaged from it acetous acid. With oxalic acid it gave a white precipitate. Nitrate of silver gave to the liquor a red colour.

From experiments made upon different quantities of this sap, M. Vauquelin concludes, that it contains sugar, acetite of potash, acetite of lime, mucilage, and colouring matter.

When the sap of the hornbeam was exposed to the action of the air, it underwent fermentation, and gave out carbonic acid; the oxygene in contact with it was absorbed; and, after three months, it was found strongly impregnated with an acid, which appeared to be the acetous acid.

Sap of the Birch. Betula Alba. Linn.

The sap of the birch examined was colourless. Its taste was sweetish. It reddened tincture of turnsole. Ammoniac produced no effect upon it. Barytes gave a precipitate, soluble in muriatic acid. Oxalic acid produced a white precipitate. The salts of iron, the hydrosulphurets, and the solution of glue, did not alter it.

39180 parts of this sap deposited, during evaporation, about 2 parts of a reddish brown powder; and gave, when dry, 340 parts of a brown substance, very agreeable to the taste, and entirely soluble in alcohol.

By adding yeast and a little water to a portion of the sweet matter, obtained by the evaporation of the sap of the birch, M. Vauquelin caused it to enter into fermentation, and after fifteen days, he obtained from it, by distillation, a fluid containing alcohol. After the alcohol had come over, the residuum urged by a stronger heat, furnished acetous acid.

M. Vauquelin has not as yet been able to procure crystallized sugar from the sap of the birch, and he is inclined to believe that the saccharine matter in this vegetable is not in the state of truly formed sugar.

The solid matter obtained by the evaporation of the juice of the birch, contains, as well as the saccharine principle, a peculiar colouring matter, precipitable by means of sulphate of alumine, and which tinges woollen cloth of a yellow brown colour.

Sap of the Chesnut.

This sap was collected in the month Prairial, the quantity was too small to be minutely examined. Its taste was slightly bitter. By evaporation it gave a brown extract, in which at the end of a month little needles of nitrate of potash had formed. The extractive matter was not sensibly soluble in alcohol. It produced a smell like that of animal matter, when thrown upon hot coals. The part of it which was soluble in water furnished nitrate of potash.

Sulphuric acid poured upon it produced the smell of acetous acid, and M. Vauquelin thinks that it contains, like most of the other saps, acetite of potash, and of lime. D.

On the utility of Prussiate of Copper as a Pigment. By CHARLES HATCHETT, ESQ. *F.R.S.*

The accidental discovery made by Diesbach of the pigment called Berlin or Prussian blue, about the year 1710, and which afterwards was published by Woodward in the Philosophical Transactions for 1724, was soon adopted by artists and manufacturers, so that in a short time, the great utility of this colour was completely established; it is therefore remarkable, that but little attention has been subsequently paid to the colorific properties of the other metallic prussiates.

The experiments made by Mr. Brown, with the prussic lixivium, on various metallic solutions, do not merit particular attention, as the results evidently show that a very large portion of the alkali remained unsaturated with prussic acid, and thus the effects appeared different when the lixivium was prepared with blood or with muscle *.

Bergman has however more accurately examined the properties of metallic precipitates (Opuscula. Tom. 2. p. 385), and especially notices the various colours of the prussiates; but neither he, nor any other chemist, as far as I am acquainted, has pointed out to artists the utility of prussiate of copper as a pigment. During some late experiments, I was much struck with the beauty of this precipitate, and was therefore induced to make several trials of it as a paint; the results exceeded my most sanguine expectations. I afterwards prepared a large quantity, which at my request several gentlemen (particularly B.West, Esq. P.R.A. John Trumbull, Esq. and Sir H. C. Englefield) were so obliging to try in oil, and in water, and I have had the satisfaction to learn, that in beauty and intensity, it surpasses every brown paint now in use, with the additional advantage, that, by reason of its purple tint, it forms with white, various shades of bloom or lilac colour, which do not appear liable to fade like those which are formed by means of lake.

The prussiates obtained from acetite, sulphate, nitrate, and muriate of copper, are all very beautiful, but the finest and deepest colour is afforded by the muriate. I have found also that prussiate of lime can be better depended upon for this purpose than prussiate of potash. The best mode therefore of forming this pigment, is to take green muriate of copper, diluted with about ten parts of distilled or rain water, and to pour in prussiate of lime until the whole is precipi-

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* Phil. Trans. 1724, p. 17.

tated; the prussiate of copper is then to be well washed with cold water on the filter, and to be dried without heat.

An Account of a Method of obtaining the Salts of Iron at the Minimum of Oxidation.

The sulphate, muriate, and acetite, of iron, at their minimum of oxidation, may be obtained in a very easy manner, by means of the artificial sulphuret of iron. When artificial sulphuret of iron is acted upon by muriatic acid, or sulphuric acid in a state of dilution, or acetous acid, the sulphureted hydrogene gas, disengaged during the process of solution, prevents any hyperoxygenated salt from being formed by the action of the atmosphere; and a clear fluid, in all cases, of a shade of green, is obtained, which, when freed by heat from any sulphureted hydrogene dissolved in it, gives a perfectly white precipitate with the alkaline prussiates, and is not found to alter the colour of solution of galls.

To form the least oxygenated nitrate of iron, by means of the artificial sulphuret, an acid of a specific gravity, not greater than 1.12 must be used, and the solution must be made without the assistance of heat. After having been freed from sulphureted hydrogene, by being boiled for a minute or two, and then filtrated, it is found similar in its colour and physical properties to the weakest solutions of the other oxygenated salts.

When the sulphate and muriate of iron, at the minimum of oxidation, are obtained in the solid form, by evaporation from their solutions, they appear in regular crystals, which in each salt are a different shade of a very pale green colour; their tastes are exactly similar, being astringent, and leaving in the mouththe sensation of sweetness.

The least oxygenated nitrate of iron cannot easily be procured pure in the crystallized state, for when the solution of it is heated for any length of time, a new arrangement of its principles takes place; portions of the acid and of the water of the solution are decomposed; in consequence of which ammoniac is formed; and an oxygenated nitrate of iron, with excess of base, is deposited.

Amongst the salts of iron, at the minimum of oxidation, I have found the muriate the most convenient, for exhibiting the experiments of Proust, and in eudiometrical processes with nitrous gas (page 32). It is more soluble in water than the sulphate, and very much more soluble in alcohol. D.

Observations on the late Transit of Mercury. By SIR H. C. ENGLEFIELD, BART. *F. R. S. In a Letter to* DR. YOUNG.

Dear Sir,

Although my observations on the appearances of Mercury on the Sun, in the late transit, are rather a series of negatives, than any thing else, yet they may perhaps merit a place in the Journals of the Royal Institution; and if you are of that opinion, I shall feel myself honoured by their insertion.

The day was uncommonly fine, and the sun more free from undulation than he often is at the low altitudes to which he attains in November. I viewed him with my seven feet achromatic of Dollond, with four inches aperture; I used powers of 120, 300, and 400. With all these the disc of Mercury was perfectly round, and exquisitely well defined; and there certainly was not a trace of any haziness, or ring round him, either dark or luminous. The power of 120 is very bright, and showed not only the spots of the sun, but the mottled and dotted appearance of the central parts of his disc, with such extreme distinctness, that had any thing like an atmosphere been visible, I am sure it could not have escaped my search after such appearances. When Mercury approached the sun's limb, at the moment preceding the internal contact, I very distinctly saw a protuberance or tail stretch from his disc, and join the sun's limb, giving him the exact appearance of a glass globe, with a short and small neck. This lasted about a second and a half. The interval between the interior and exterior contacts I observed 1′ 32″, but as the sun's limb was not free from undulation, I do not think the exterior contact could be ascertained within 2″ of the truth. By the interval I observed, the diameter of Mercury was exactly 9″.

I am, Dear Sir,
Your obliged and faithful
H. C. ENGLEFIELD.

ROYAL SOCIETY.

On the 25th of November, a paper was read, containing an account of the experiments of Professor Aldini, on Galvanism.

The author divides his subject into three parts; in the first he professes to examine the nature and properties of galvanism. In the second he treats of its power of restoring the vital functions. And in the third he considers its medical application.

In reasoning concerning the nature and properties of galvanism, M. Aldini brings forward several experiments, with the view of proving what had been often before asserted by different philosophers, and particularly by Galvani and Humboldt, namely, that the metals are not essential in producing muscular contractions in the limbs of animals; and that galvanic combinations are capable of being formed merely by animal substances.

In treating of the power of galvanism in restoring the vital functions, M. Aldini details several facts of the action of the pile of Volta upon warm blooded animals, and upon the human subject. In one experiment, in which the communication between the ends of the pile was made by means of the biceps muscle, and the spinal marrow, an hour and a quarter after death, contractions of the arm were produced sufficiently strong to elevate it 6 inches above the table.

With regard to the medical application of galvanism, M. Aldini professes great hopes of success, particularly in cases of drowning, or strangling: and he states that in these cases the effects may be produced without dissection, by making a connexion by means of water, holding in solution salt, between the end of the pile and one of the ears, and a hand, in the subject operated upon. He states, that he has already tried galvanism in disorders of the brain, with great success; and by means of it he asserts that he has cured two persons of melancholy madness.

In concluding his memoir, M. Aldini mentions, that he has several times observed a very sensible attraction between the nerves and muscles of animals in cases when, after having been separated from the body and possessing a certain degree of vitality, they are brought very near each other. D.

An account of a Journey to the summit of Whararai, a mountain in the Island of Owhyhee, by Mr. Archibald Menzies, Naturalist on board the Discovery, Captain Vancouver, was read on the 9th and 16th of December.

In January 1799, the Discovery being stationed in Karakakooa bay, Mr. Menzies was desirous of making a botanical excursion into the island of Owhyhee, in company with some other gentlemen of the expedition, and in particular of ascending a conical mountain in the neighbourhood, called Whararai. For this purpose he was furnished with a numerous company of attendants by the king of the island, under the command of one of the chiefs, who was made responsible for his safety, and for his perfect accommodation with provisions of all kinds, and who executed his task with as much fidelity, as the whole troop performed their labours with alacrity. Mr. Menzies had a portable barometer of a simple construction, by which he ascertained the height of different places as accurately as the time would allow. The island appeared to be in general in a state of high cultivation: the provisions for the journey consisted of live hogs, poultry, dried fish, yams, and cocoa nuts, in quantities that loaded more than twenty men. They left the sea side the 17th of January, after coming by water to the foot of the mountain, the barometer standing at 30.10, the thermometer at 81°, at noon. The road was through lava and other volcanic productions for about three miles: here the plantations of bread fruit trees began, and the country was fertile and pleasant; the night was passed in the uppermost village, consisting of a few scattered huts. Beyond this was a thick forest, skirted by fruitful plantations of bananas and plantains: about three miles within the forest, the elevation appeared to be 2600 feet above the sea. The thermometer was 59°, at noon. The natives constructed a number of small huts, which afforded shelter to the whole party for the night, at the upper extremity of the forest. Here the thermometer was at 58°, in the evening: the uniformity of temperature at heights considerably different, Mr. Menzies attributes to the shelter of the forest, and the evaporation from the trees. But the next morning the thermometer was at 43°. The summit of the mountain was rugged and barren; Mr. Menzies arrived at it in a few hours from the last station. It afforded a very extensive view of the island, although parts of it were hidden by clouds: its most conspicuous features were two other mountains, of which the summits are covered with perpetual snow, bearing E.N.E. and S.E. by E. of Whararai. On this hill there is a very deep crater of a volcano, with ashes and cinders appearing quite fresh: the natives consider it as the habitation of evil spirits, whom they attempt to pacify by offerings of various kinds. The party of travellers spent the whole of this and the following day on the mountain, and passed the night in caverns, thatched with plantain leaves, and strewed with grass and mats for the occasion. The sophora tetraptera was in flower, as a small shrub; in the lower parts of the island it becomes a tree, of which the natives make their spears, and which takes a fine polish. The dodonaea viscosa thrived on the summit of the hill; and a small shrubby geranium was found there. The height appeared to be 8000 feet above the sea. The thermometer was lower at sunset than at seven in the morning.

Mr. Menzies descended on the south east side of the hill, and arrived in the afternoon at a deep cavern, where he past the night. Hence he made a fruitless attempt to ascend the snow clad mountain, on the other side of the valley, in which the natives accompanied him with the greatest reluctance; the same cavern received him the following night. The centre of the island between the three mountains, is barren and uninhabited; it appears to be elevated about 5000 feet above the sea. Returning towards the shore, the party arrived the next evening at a village nine or ten miles from Karakakooa bay, surrounded by fields and plantations, in the highest possible state of cultivation; its elevation appeared to be about 2000 feet. Here they were entertained by an exhibition of much grace and great activity, in the performance of a female dancer belonging to a strolling party. The next day was the last of the excursion; and the natives were dismissed with rewards of knives, files, scissars, looking glasses, and tape, of which a small portion was surrendered by each to the king The barometer now stood at 30.12, and the thermometer at 74°. Y.

From the JOURNAL de PHYSIQUE. Brumaire, An XI.

"*Lettre, &c.*" *Letter from T. C. De Saussure, on the Supposed Decomposition of the Gaseous Oxide of Carbon, by Hydrogene Gas.*

MM. Clément and Desormes had announced, in the Annales de Chimie, tom. 39, and 43, that hydrogene gas was capable of decomposing the gaseous oxide of carbon, by being passed with it through an ignited glass tube, so as to produce from it charcoal. In this letter, M. De

Saussure has shown, that this effect does not take place, and that the black matter, which they supposed to be charcoal, was the partially reduced lead of the glass.

Dr. Priestley, long ago, published some very interesting experiments on the action of inflammable air upon heated glass tubes, containing the oxide of lead, and he uniformly found that these tubes were blackened. Mr. Saussure has proved that porcelain tubes, heated red, are not blackened by the mixture of gaseous oxide of carbon and hydrogene.

If that equilibrium of affinities indeed existed between hydrogene, oxygene, and carbon, which would produce, in the red heat, from gaseous oxide of carbon and hydrogene, charcoal and water, it would be very difficult to conceive how the decomposition of water, by red hot charcoal, could take place.

"Note, &c." Note on the Influence of Galvanism on the Fibrine of the Blood. By G. F. CIRCAUD.

In this note, M. Circaud states, that the fibrine recently procured from bullock's blood, by agitation, may be made to contract, by being connected with the galvanic battery, in the same manner as the muscles; but he does not enter upon any detail of his process.

M. Nesten, is said by the author to have proved, that the heart preserves its power of being made to contract by galvanic electricity, longer than any other organ. The contrary, however, is asserted by the Italian experimenters [*].

D.

Some Observations upon the Motions of small Pieces of Acetite of Potash, during their Solution, upon the surface of Water. By Mr. DAVY.

In dissolving some acetite of potash in distilled water, I accidentally observed that some of the small pieces of that light and scaly salt, which floated upon the surface of the

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[*] See page 288.

water, were agitated by very singular motions during the time of their solution; these motions were very irregular. The fragments sometimes revolved for a second or two, and then moved rapidly backwards and forwards in various directions.

The phenomenon was evidently connected with the rapidity of the process of dissolution, for as the water became saturated with salt the motion became gradually weaker, and at last ceased altogether. The thinnest film of oil, or of ether, wholly destroyed the effect, and in several cases it did not take place, when water that had been exposed to the atmosphere, and on which some dust had probably been deposited was employed, or when a vessel that had not been accurately cleaned was used.

Those pieces which were most irregular in their forms, underwent by far the most rapid motions, from which it would appear, that the phenomenon was, in some measure, owing to changes in their centre of gravity, during the solution. The projectile motions, probably, chiefly dedepended upon the continual descent of a current of solution of the salt in water from the agitated particle, in consequence of which, the surrounding water would press upon different parts of it with different degrees of force. I found, by means of a mercurial thermometer, that the solution of acetite of potash in water, is connected with an increase of temperature; and, it is not improbable that this circumstance may, in some measure, modify the effect.

Observations on M. Berthollet's *Memoirs on Charcoal, and on the Hydrocarbonates.*

In the fourth volume of the Memoirs of the National Institute of France, Mr. Berthollet has published three very elaborate papers upon charcoal, and its combinations with oxygene and with hydrogene. In these papers he has examined almost all the experiments made upon the subject by different philosophers, and, in comparing them with his own researches, he has drawn the following conclusions:

1. Whenever carbonic acid is produced by the combustion of charcoal in oxygene gas, water likewise is formed.

2. Common charcoal is a combination of carbon and hydrogene, with a little oxygene; and charcoal, that has been strongly calcined, is composed of carbon and a very little hydrogene.

3. Hydrogene, carbon, and oxygene, are capable of uniting together, so as to constitute an aëriform compound, which is highly inflammable.

4. It is necessary to distinguish the inflammable gases that contain carbon, into two kinds: the first kind is composed of hydrogene and carbon only; and the second is formed of hydrogene, carbon, and oxygene. The heavy hydrocarbonate, or the oil making gas of the Dutch chemists, and its modifications; the inflammable gases produced from alcohol and oil; and, probably, that from the decomposition of water by charcoal, are all of the first kind. To the second kind belong the gas produced from charcoal, by the action of heat; the gas produced by the detonation of the oil making gas with a little oxygene; the gas produced from sugar; and that formed by the action of charcoal upon the metallic oxides, and carbonate of barytes.

There are many varieties of these gases, and they are found to differ very much in their specific gravities.

The two kinds ought to be distinguished from each other by different names. The first may retain the name of carbonated hydrogene gas, and the second may be called oxycarbonated hydrogene gas.

5. The carbonated hydrogene gases become oxycarbonated, when they are made to combine with a little oxygene by detonation. The oxycarbonated gas may be likewise formed, when oxygene is brought in contact with carbon at a high temperature, as is the case in reduction of the oxide of zinc by charcoal; or when aëriform carbonic acid is exposed to ignited charcoal; the hydrogene,

in this case, being supplied by the water in the carbonic acid, and by the charcoal.

These conclusions of M. Berthollet are evidently in opposition with the opinions of Mr. Cruikshank on the gaseous oxide of carbon, and with those of MM. Guyton, Desormes and Clement; and this circumstance alone is sufficient to demonstrate the abstruse and complicated nature of the subject.

MM. Desormes and Clement have attempted to show, that charcoal, after calcination, contains no perceptible quantity of hydrogene, but their experiments have been ably controverted by M. Berthollet, Annales de Chimie, tome 42, p. 283, and they are in opposition even with the results of Mr. Cruikshank, who always obtained water during the combustion of the gaseous oxide of carbon, obtained from metallic oxides and charcoal.

One of the strongest arguments of M. Berthollet against the opinion, that the gaseous oxide of carbon is a compound of oxygene and carbon, is derived from its small specific gravity. M. Berthollet cannot conceive how carbonic acid by dissolving charcoal, a substance specifically heavier than itself, should become specifically lighter. But it is evident that the specific gravity must depend upon the force of attraction, which, in all cases, is influenced by the proportions of the combining bodies; and there is an analogous instance in the combinations of oxygene and nitrogene: oxygene gas is of greater specific gravity than nitrogene gas, and yet nitrous gas becomes specifically heavier during its conversion into nitrous oxide, by the abstraction of a portion of its oxygene.

Mr. Cruikshank obtained gaseous oxide of carbon from chalk, that had been exposed to a red heat, by means of dry iron filings, and dry tin; and in the combustion of this gas no perceptible quantity of water was deposited. This circumstance however M. Berthollet thinks does not prove the absence of that fluid, for he finds by calculation upon the quantity of hydrogene that the gas may be supposed to contain, that the water produced would be wholly dissolved by the carbonic acid.

Allowing that, from the circumstances of the experiment, hydrogene is always present in cases of the formation of the gaseous oxide of carbon, there are none of the facts of M. Berthollet which show that it is actually in combination with the other elements of this gas. It is not improbable that two combinations, one of hydrogene and carbon, and the other of carbon and oxygene, may be formed at the same time, and evolved in a state of intimate mixture. And, as the gaseous oxide is obtained of greater specific gravity, and more uniform in its properties, in proportion as it is formed by means of substances which can furnish to it more oxygene and carbon, and less hydrogene, there is no reason for supposing that this last substance is absolutely essential to its existence.

M. Hassenfratz had attempted to prove, by some experiments made upon the action of red hot charcoal upon oxygene gas, that there exists a combination of oxygene and carbon containing more oxygene than the gaseous oxide of carbon, and less than carbonic acid: But M. Berthollet has shown, from some researches, conducted with his usual correctness and sagacity, that such a combination cannot be produced, and that M. Hassenfratz was probably misled in his conclusions by the presence of nitrogene gas. D.

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4 Murhard's Litteratur der Mathematischen Wissenschaften, 2 bände, 8vo. Leipzig, 1798.
5 New London Review, vol 3. London, 1800.

Collections relative to Science.

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27 Historia et Commentationes Academiae Electoralis Scientiarum et Elegantiorum Literaturarum Theodoro-Palatinae, vol. 3, 4, 6, 4to. Manhemii, 1785-1790.
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30 Journal des Mines, tom. 1 to 11. Paris,
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32 Journal de Physique, de Chimie, d'Histoire Naturelle, et des Arts, tom. 48 to 54, 4to. Paris.

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36 Leske, Abhandlungen zur Naturgeschichte, Physik, und Oekonomie, band 1, theil 1, 4to. Leipzig, 1799.
37 Magasin Encyclopédique, V, VI, VII Année. 8vo. Paris, 1799, &c.
38 Mathematical Society Spitalfields, London (Articles of the), 8vo. London, 1793.
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CORRECTIONS.

Page 156, l. 32, for "arm", read "axis". Page 167, l. 28, for "twelfth", read "thirteenth". Page 168, l. 22, for "thirteenth", read "fourteenth". Page 192, l. 4, for "eighth", read "seventh". Page 198, l. 21, for "when the centre is...... neutral", read "when the centre is at a certain depth below the surface, the equilibrium becomes neutral, and if the oval be still heavier, it will be reversed".

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PROSPECTUS

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IT is an undoubted truth, that the successive improvements in the condition of man, from a state of ignorance and barbarism to that of the highest cultivation and refinement, are usually effected by the aid of machinery in procuring the necessaries, the comforts,

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* After mature deliberation upon all the terms in the European languages, which have been used to distinguish public bodies; such as schools, academies, colleges, universities, societies, corporations, &c. it was found, that every one is either appropriated to well known establishments, or less adapted to the views of the present society than the word INSTITUTION, already well known for near a century in the famous "*Instituto*" of Bologna.

and the elegances of life; and that the pre-eminence of any people in civilization, is, and ought ever to be estimated by the state of industry and mechanical improvement among them.

In proof of this great and striking truth, no other argument requires to be offered, than an immediate reference to the experience of all ages and places. The various nations of the earth, the provinces of each nation, the towns, and even the villages of the same province, differ from each other in their accommodations, and are in every respect more flourishing and populous, the greater their activity in establishing new channels of industry. Successful exertions give courage to the spirit of invention; the sciences flourish; and as the moral and physical powers of man increase, new methods of improvement become practicable, which in an earlier state of society, would have appeared altogether visionary.

Who among the Ancients would have listened to the extraordinary scheme of writing books with such rapidity, that one man by this new art should perform the work of twenty thousand amanuenses ?—What philosopher would have given credit to the daring project of navigating the widest oceans? or imagined the astonishing effects of gunpowder ?—or even suspected the useful and extended powers of the steam engine ?——discoveries which have changed the course of human affairs, and of which the future effects can scarcely yet be conjectured ! The men of those early ages, in the confidence of their own wisdom, might have derided them as impossible, or rejected them as unnecessary. But to those who enjoy the full effect of these and numerous other instances of successful invention, it surely becomes a duty to reason upon different principles, and to exert all means in their power to give effect to the progress of improvement. To point out the causes which impede this progress, and to invite the public to join in effectually removing them, is the purpose of the present address.

The slowness with which improvements of every kind make their way into common use, and especially such improvements as are most calculated to be of general utility, is very remarkable; and forms a striking contrast to the extreme avidity with which those unmeaning changes are adopted, which folly and caprice are continually bringing forth and sending into the world under the auspices of fashion. On the first view of the subject it appears very extraordinary, that any person should neglect, or refuse to avail himself of a proposed invention or contrivance, which is evidently calculated to facilitate his labour, and increase his comforts. But when we reflect on the power of habit, and consider how difficult it is for a person even to perceive the imperfections of instruments to which he has been accustomed from his early youth, our surprise will be very much diminished.

Many other circumstances are unfavourable to the introduction of improvements. The very proposal of any thing new carries with it something offensive ;—something that seems to imply superiority ; and even that kind of superiority precisely, to which mankind are least disposed to submit. There are few who do not feel ashamed, and mortified, at being obliged to learn any thing new, after they have for a long time been considered, and been accustomed to consider themselves, as proficients in the business in which they are engaged. Their awkwardness in their new apprenticeship, more especially when they are obliged to work with tools with which they are not acquainted, tends much to increase their dislike to the teacher, and his doctrines.

To these obstacles to the introduction of new improvements, we may add the innumerable mistakes, voluntary and involuntary, committed by workmen who are employed in any business which is new to them, and which perhaps they neither understand nor approve; and, what is still more to be feared, those alterations which workmen in general, and more especially those who pride themselves on their ingenuity, have an irresistible propensity to make when they are employed in executing any thing that is new. How many useful inventions have been brought into disrepute by alterations intended and announced as improvements! It must be allowed also, that some cause for suspicion naturally arises, to manufacturers, and to the world at large, from frequent instances of pretended inventions, destitute of all real value.

They who propose improvements are commonly suspected of being influenced by interested motives; and this suspicion, which is often but too well founded, occasions little attention to be paid to such proposals, by the public.

Not only suspicion, but jealousy and envy, have too often their share in obstructing the progress of improvement, and in preventing the adoption of plans calculated to promote the public good.

The most meritorious exertions in favour of the public prosperity are often viewed with suspicion; and the fair fame that is derived from those exertions, with jealousy and envy: and many, who have too much discernment not to perceive the merit of an undertaking evidently useful, and too much regard for their reputation not to appear to approve of it, are yet very far from wishing it success.

This melancholy truth is but too well

known, and has more effect in deterring sensible and well disposed persons from offering to the public their plans for useful improvements, than all the trouble and difficulty that would attend the execution of them.

These are the chief causes which prevent the advancement and reception of valuable inventions already made; and they operate also against the production of such as might be made by ingenious men, if they were not discouraged by such impediments. But there is another serious obstacle, which is produced even by the flourishing condition of society, resulting from those very improvements. From the subdivision of labour which naturally takes place where active industry and the security of property are established, it happens that almost every man becomes confined to some appropriate occupation; seldom regarding, or even knowing what may be the processes or operations to which the material of his trade may be subjected, before or after it passes through his hands: still less does he know what is performed in other branches of trade and manufacture. The acquisition of wealth almost totally engages the attention of individuals thus employed. Hence those vain pretensions to superior excellence, that scorn of improvement, because improvement supposes previous imperfection, and those earnest endeavours at secrecy and monopoly; in addition to which there is a natural fear of risque, which deters men from entering upon new undertakings, of which they are not qualified to form a judgment. It cannot, therefore, be wondered, that the generality of manufacturers should possess neither the knowledge, the inclination, nor the spirit to make improvements.

Among the various operators who take their stations in the great laboratory of civil society, there are others who cannot be classed either with manufacturers or merchants, though they perform a great and very essential part of the general work. These men are Philosophers, who have devoted themselves to the labour of observing, comparing, analysing, inventing. The movements of the universe, the relations and habitudes of men and of things, causes and effects, motives and consequences, are the powers on which they meditate for the developement of truth, by those remote analogies which escape the vulgar mind. It is the business of these philosophers to examine every operation of nature or of art, and to establish general theories for the direction and conducting of future processes. Invention seems to be peculiarly the province of the man of science; his ardour in the pursuit of truth is unremitted; discovery is his harvest; utility his reward. Yet it may be demanded whether his moral and intellectual habits are precisely such as may be calculated to produce useful practical improvements. Detached, as he usually is, from the ordinary pursuits of life, little if at all accustomed to contemplate the scheme of profit and loss,—will he descend from the sublime general theories of science, and enter into the detail of weight, measure, price, quality, or the individual properties of the materials, which must be precisely known before a chance of success can be gained? Does he know them? will he become an operative artist? or can he make advances of this nature, if he do not? Are his motives and his powers equal to this task? Surely they are not.—The practical knowledge, the stimulus of interest, and the capital of the manufacturer, are here wanting; while the manufacturer on his part, is equally in want of the general information, and accurate reasoning of the man of science.

There appear to be but three direct methods of diminishing or removing these difficulties: 1. To give premiums or prizes to the inventors. 2. To grant temporary monopolies. And, 3. To direct the public attention to the arts, by an institution for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements. The first already constitutes the object of a most respectable Society:* the second is already provided for by the law of the land; and the third is now offered to the consideration of the public.

The two chief purposes of the ROYAL INSTITUTION, being the speedy and general diffusion of the knowledge of all new and useful improvements, in whatever quarter of the world they may originate; and teaching the application of scientific discoveries, to the improvement of arts and manufactures in this country, and to the increase of domestic comfort and convenience; these objects will constantly be had in view, not only in the arrangement and execution of the plan, but also in the future management of the institution.

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* The Society for the Encouragement of Arts, Manufactures, and Commerce, instituted 1753.

In the execution of the plan, the Managers have purchased, with the approbation of the Proprietors, a very spacious and commodious house in Albemarle-street, where convenient and airy rooms will be prepared for the reception and public exhibition of all such new mechanical inventions and improvements, as shall be thought worthy of the public notice; and, more especially, of all such contrivances as tend to increase the conveniences and comforts of life, to promote domestic economy, to improve taste, or to advance useful industry.

The completest working models or constructions of the full size will be provided and exhibited in different parts of this public repository, of all such new mechanical inventions as are applicable to the common purposes of life.

Every consideration unites in shewing how highly important it must be to the progress of real improvements, to have some general collection of useful mechanical contrivances, constructed on the most approved principles, and kept constantly in actual use, to which application can be made as to a standard; in order to determine whether the failure of experiments be owing to errors in principle, or to the mistakes of workmen employed in the construction, or to those of the servants intrusted with the management of the machinery.

How useful also would such a repository be for furnishing models, and for giving instruction to artificers who may be employed in imitating them! Workmen must see what they are to imitate—bare description will not suffice to give them ideas so precise as to prevent error in the execution of the work.

But this is also the case with mankind in general, and even with the best informed; for, how great is that effort of the imagination, which is necessary to form an adequate idea of what we have not seen!—Descriptions, though they be illustrated by the best drawings, can give but very imperfect ideas of things: the impressions they leave are faint and transitory, and seldom excite that degree of ardour which ought to accompany the pursuit of interesting improvements. Something visible, and tangible, is necessary to fix the attention and determine the choice.

This tacit recommendation from a respectable Public Institution, where things judged worthy of public notice will be exposed to view, must evidently tend to produce the happiest effects. The manufacturer, as well as the consumer, will become instructed as to the real value of new objects presented to view. The Managers of such an Institution will be above all suspicion of interested motives; their situation in life places them out of the reach of the mean jealousy of interested competition; and if, contrary to all expectation, the effects of prejudice should, in some respect or other, be directed against their laudable exertions, a firm perseverance in their duties must at length remove that ignorance which alone can give them birth.

An Institution of this nature, is peculiarly calculated to produce that unity of pursuit between manufacturers and men of science, which is absolutely necessary for attaining perfection in the theory, as well as in the practice of all the arts of civilized life. The philosopher will behold and contemplate the prodigious number of truly scientific experiments, which are hourly performed in the workshops of ignorant men; and the artist, by being taught to seize the general outline and connexion of the manual operations by which he obtains his bread, may learn to simplify his often tedious processes, and give increased value to the product of his labours.

The collection and exhibition of models and machines, will be rendered more effectual in their consequences, by detailed accounts or descriptions, illustrated by correct drawings. Arrangements will be made, and correspondences established for obtaining the earliest and best information respecting every valuable improvement which may be made either at home or in foreign countries. Visitations of manufactories, careful examinations of the processes of the arts, regular investigations, with accurate reports and registers of those operations and proceedings which may constitute the objects of inquiry or information, will, no doubt, afford very interesting results. To this growing mass of instruction, the managers will add a library of all the best treatises on the subjects for which this Institution is established, as well as those publications of academies, and journals of repute, which exhibit the transactions of ingenious men in every part of the world.

In order to carry into effect the second object of the Institution, namely, that of *teaching the application of science to the useful purposes of life*, a lecture-room will be fitted up for philosophical lectures and experiments, and a complete laboratory and philosophical apparatus, with the necessary instruments for making chemical and philosophical experiments: and men of the first eminence in science will be engaged to officiate in this essential department.

It may appear necessary to give some statement or enumeration of the several views to which the attention and the powers of this Institution will be directed. Such an enumeration, if made with only a small degree of the precision to which it is entitled, would grasp at once the whole extent and disposition of national industry. That man must labour for his food, and defend himself from the inclemencies of the seasons, the attacks of ferocious animals, and the still more pernicious operations and influence of vice in his fellow-creatures, are the inevitable decrees of Providence! he must be nourished;—he must be clothed;—houses, towns, fortresses, roads, canals, carriages, ships, instruments of manufacture, weapons of offence and defence, the subdivision of labour, commercial intercourse, and political regulation—all these must be established. This rapid association of words and ideas, every one of which includes a science, for the supply and regulation of things in the highest degree important to man, may serve, in the present short outline, to lead the mind to some of those objects which, of necessity, must constitute the pursuits of an institution established for purposes so great and truly dignified.

But though the extent and importance of the various departments from which the Institution may derive the means of diffusing the knowledge of valuable improvements, and teaching the application of science to the advancement of manufactures, are too great to admit of any comprehensive enumeration; and though, from the intimate connection of all the several subjects of art, it is at present impossible to give an outline of that arrangement into which the communications of the several lecturers must ultimately be disposed;—it seems, nevertheless, expedient to state the leading topics; with a view to assist the meditations of those who may be disposed to enter more minutely into the plan of operations to be adopted by this Institution.

The machines and models will afford a perpetual source of instruction. The lectures will be more particularly useful to elucidate and apply those general principles which are only in part observable in particular structures. The firſt principles of mechanics will be exhibited, and explained in the simple engines called the mechanical powers; and to these will be referred the prodigious variety of tools, implements, and engines in common use, the curiosity and value of which, as well as the improvements they are capable of receiving, are but too frequently overlooked. Under this head will come the practical operations of various arts, and the mutual connection between the theory of mechanics, and the experimental knowledge of the materials; requisites, which do not often accompany each other, though of the utmost necessity. Under the division of General Mechanics, will be shewn the advantages we derive from those happy expedients which abridge the labour of man in the culture of the ground, the preparation of food and clothing, by mills, looms, and other engines, and the improvements still possible in the wonderful arts of writing and printing; the effects of which have already carried the intellectual operations of society to a height they could by no other means have attained.

The comprehensive science of modern chemistry, will be taught and elucidated in the same simple and perspicuous manner. The processes of the laboratory will be employed to disengage and exhibit those substances which, with regard to the present extent of our knowledge, are considered as the elements of other bodies. Their compounds will be shewn, and the history of their connection with the structure of the earth, and their application to useful purposes, will be explained. This elementary knowledge, so desirable, and even indispensable, to the intelligent manufacturer, will then be connected with the great operations of the arts and trade. The nature of soils, the effects of tillage, of manure, and of the air and water of the atmosphere, which are essential to the product of every article of consumption, will also present themselves as subjects of research and elucidation. From the first produce, or raw materials, we shall be led to the various processes they are made to undergo. The making of bread, the brewing of beer, wine, and other fermented liquors; the distillation of ardent spirit; the preservation of animal and vegetable foods; the extraction of starch, farina, sugar, and other valuable articles; the making of butter and cheese, and numerous other arts, afford proper subjects for investigation, and are, no doubt, susceptible of very beneficial improvements.

Among the more elaborate arts, may be classed those of tanning, dying, callico-printing, bleaching, the fabrication of pigments, crayons, inks, varnishes, and the like; in many of which, very rapid advances have been lately made.

The mineral products afford materials for arts, of the highest importance to human society. How much do our comforts, and how greatly does the extent of our powers in mechanical operations and commercial intercourse, depend upon the tenacity and hardness of steel, and its singular property of magnetism! The smelting of metallic ores, the casting and compounding of metals, the preparation of acids, and other useful salts; the indispensable articles of mortar, cements, bricks, pottery, glass, and enamel, will shew to what valuable purposes the crude minerals have been applied; and will bring to recollection, no inconsiderable number of beautiful inventions of our own time and country.

From the vast field of individual operations, or separate manufactories, the inquirer will be led to other works of more general consideration, which include not only the objects of mechanics and chemistry strictly taken, but likewise those of commercial operation, and political economy. Under this class of objects will be found, the structure of roads, and form of vehicles; the establishment of canals; the improvement of rivers, harbours, and coasts; the art of war

—its engines, materials, and edifices; and in particular, that first object of the civil and military engineer, the estimate of natural powers, or first movers, namely, animal strength, wind, water, steam, and other elastic and explosive substances. The methods of determining the magnitude of these forces will be shewn, with their application to mills and every other engine. The exhibition of working models, will particularly display the powers of hydraulic machines, and that strikingly useful apparatus, the steam-engine.

But above all, we shall find our contemplations urged to the phenomena of light and heat; those great powers which give life and energy to the universe!—powers which, by the wonderful process of combustion, are placed under the command of human beings, who, without their assistance, would not only be incapable of operating on the materials around them, but could scarcely support their own existence. If we could for a moment suppose the privation of fire and artificial light, it would follow as an immediate inference, that the greatest part of the globe would cease to be the habitation of man. Whether he could ensnare or overtake those animals, upon whose unprepared remains he would then be compelled to feed;—whether he might store the fruits of the earth for his winter supply;—what might be the physical and moral consequences of a state of such desolation, may, perhaps, be conjectured, but no estimate can shew its dreadful magnitude! But if it should be proved, as in fact it may, that in the applications of fire, the management of heat, the production of light, the salutary effects of clothing, the ventilation of our dwellings, the preparation of our food, and in every other art and manufacture;—we do not, even now, derive half the advantage from combustion, which might be obtained by a judicious application of the principles already known; it will readily be admitted, that these subjects must constitute a very principal part of the instructions to be conveyed in the Public Lectures of the Royal Institution.

Albemarle-street,
21*st Jan.* 1800.

APPENDIX.

The Bye-laws and Regulations of the Royal Institution, are to be framed, by a general Committee of Managers and Visitors, agreeably to the Provisions of the Charter.—In the mean while, it is thought advisable to select the following heads of information for the public.

The expence of forming this Institution has hitherto been defrayed by the Proprietors, and the Subscribers who have paid in their subscriptions; and from this fund, the extensive premises in Albemarle-street have been purchased by the Managers, with the approbation of the Proprietors, for the use of the Institution.

The funds of the Institution are to arise, 1. From the sum of Fifty Guineas, paid by each hereditary Subscriber. 2. From the sum of Ten Guineas paid by each Subscriber for life. 3. From the sum of Two Guineas paid by each annual Subscriber. 4. From the particular donations and legacies which may be made, for the laudable purpose of extending and improving so interesting and useful an Institution.

It will be a consideration also, whether an additional income may not be derived from such Non-Subscribers as may wish to attend the Philosophical Lectures, and who are recommended for that purpose by subscribers.

A Proprietor, or Subscriber of Fifty Guineas, is an Hereditary Governor of the Institution, and has a perpetual *transferable* share in the house of the Institution, and in all the property belonging to it; is to have a voice in the election of the Managers and Visitors of the Institution ; and is to have two *transferable* tickets of admission into the Establishment, and to all the Philosophical Lectures and Experiments.

A Subscriber for life, or Subscriber of Ten Guineas, is to have one ticket for life, (not transferable) of admission into the Establishment, and to all the Philosophical Lectures and Experiments.

An annual Subscriber, or Subscriber of Two Guineas per annum, is to have a ticket for one year, (not transferable) of admission into the Establishment, and to all the Philosophical Lectures and Experiments.

The three classes of Subscription, are alike open to Ladies and Gentlemen.

Of the privileges that are common to the Subscribers in general, are, 1. The privilege to have copies or drawings (made at their own expence) of any of the models in the repository; and for which purpose, workshops will be prepared, and workmen provided under the direction of the Managers, for executing such work properly, and at reasonable prices: and that mistakes may be prevented, all such drawings and copies will be examined by persons duly qualified, and expressly appointed, and marked with the seal or stamp of the Institution. 2. But, in case of other tradesmen and artificers being employed in executing any work after the models lodged in the repository, they will, in that case, on the recommendation of a Subscriber of either of the three classes, be allowed free access to such models as often as shall be necessary: and any workman or artificer so recommended, who shall be willing to furnish to buyers any article exhibited in the repository, that is in his own line of business, will be allowed to place a specimen of such article of his manufacture in the repository, with his name and place of abode attached to it, together with the price at which he can furnish it; such specimen having been examined, and approved, by the Managers.

The Management of the Institution is in a President, and nine Managers, chosen by, and from among the Proprietors of the Institution, three for three years, three for two years, and three for one year; capable however of being *re-elected.* The office of Manager to be executed without pay, emolument, or any species of pecuniary advantage whatever.

The Committee of Visitors, whose business is to assist in the framing the Bye-laws, to inspect the Institution annually in detail, and to examine and audit the accounts of the receipts and disbursements of the Institution, kept either by the Managers, or by their order, is composed also of nine persons chosen by and from the Proprietors of the Institution;

three for three years, three for two years, and three for one year; capable however of being *re-elected.* The office of Visitor to be executed without pay, emolument, or any species of pecuniary advantage whatever.

The offices of Treasurer, and Secretary, are likewise to be executed without pay, emolument, or any species of pecuniary advantage whatever.

The election of Managers and Visitors, is to take place annually on the 1st of May.

Sub-committees, in the different departments of science, are also to be appointed indiscriminately, from the three classes of subscribers, as occasion shall require.

That the Institution may open as speedily as possible, a temporary Lecture Room in the house of the Institution, in Albemarle-street, is fitting up, and the Professor of Natural

Philosophy and Chemistry has reason to believe, that early in the next month he shall be able to commence his first Lectures in the following order;

1. A course of Experimental Philosophy, comprehending the principles of Astronomy, Electricity, Magnetism, Mechanics, Hydrostatics, Pneumatics, and Optics.

In this course, all abstract and mathematical reasoning will be as much as possible avoided, the most interesting and pleasing experiments introduced, and the whole calculated to afford instruction and amusement to those who have not had leisure or opportunity to investigate such subjects, and to refresh the memories of those who have.

This course will begin on Tuesday, the at two o'clock, and be continued every Tuesday at the same hour until it be completed.

2. A course of Chemistry, in which the principles of this science, and the discoveries that have been made in its various branches, will be illustrated by interesting experiments; and its application to the different arts and manufactures, as well as to the common purposes of life, be pointed out.

This course will commence on Thursday, the at two o'clock, and be continued every Thursday, or twice a-week, if necessary to complete the course before the conclusion of the session.

Outlines of both these courses may be had of the Porter of the Institution.

3. A full and scientific course on Experimental Philosophy.

In this course, the propositions will first be demonstrated mathematically, then illustrated experimentally; and afterwards their application to the mechanic arts, as well as the common purposes of life, pointed out, and illustrated by drawings and models of machinery; and, whenever it can be done, the different operations themselves will be performed.

This course will commence on Monday, the at eight o'clock in the evening, and be continued three times a-week, Monday, Wednesday, and Friday, at the same hour, till the conclusion of the session.

The most approved works in Science will, from time to time, be purchased, and the valuable presents of Books, Philosophical Instruments, &c. which have already been made to the Institution, afford a fair expectation that the *Library* (which will at all times be open to subscribers of every denomination), and its *Philosophical Apparatus*, will, in a short time, be highly respectable. The most esteemed scientific Journals, Transactions, and other periodical publications of learned Societies, Institutions, and Academies, in every part of the world, will be regularly procured, and lodged in the library of the Institution, for the use of the Subscribers.

The following is the CHARTER *for* INCORPORATING *the* ROYAL INSTITUTION, *of which* THE KING *has been most graciously pleased to become the* PATRON.

GEORGE the THIRD by the Grace of God, King of Great Britain, France, and Ireland, Defender of the Faith, &c. to all to whom these presents shall come greeting. Whereas several of our loving subjects are desirous of forming a *Public Institution for diffusing the knowledge, and facilitating the general introduction of useful mechanical inventions and improvements*; *and for teaching by courses of philosophical lectures and experiments, the application of science to the purposes of life*; and (having subscribed considerable sums of money for that purpose) have humbly besought us to grant unto them and such others as shall be elected, as hereinafter is mentioned, our Royal Charter of Incorporation for the purposes aforesaid, know ye, that we being desirous to promote every useful improvement in arts and manufactures for the increase of the industry and happiness of all our loving subjects, have of our special grace, certain knowledge, and mere motion, given and granted, and we do hereby give and grant, that our right trusty and right well beloved cousins *George, Earl of Winchilsea and Nottingham*; *George, Earl of Morton, Knight of the most antient order of the Thistle*; *George, Earl of Egremont*; *and Frederick, Earl of Bessborough, of our Kingdom of Ireland; our right trusty and well beloved counsellors Thomas Pelham, and Sir Joseph Banks, Baronet, Knight of the most honourable order of the Bath*; *our trusty and well beloved Benjamin, Count of Rumford, of the holy Roman Empire; Sir John Cox Hippisley, Baronet*; *Richard Clarke, Esq. Chamberlain of our City of London; and Richard Joseph Sulivan, Esq.* and such others as shall be from time to time elected in manner hereafter directed, they, and their successors be and shall for ever hereafter be, by virtue of these presents, one body politic, by the name of the Proprietors of "THE ROYAL INSTITUTION OF GREAT BRITAIN," and them and their successors for the purposes aforesaid, we do hereby constitute and declare to be one body politic and corporate, and by the same name to have perpetual succession, and for ever hereafter to be persons able and capable in the law, and have power to purchase, receive, and possess any goods and chattels whatsoever, and (notwithstanding the statute of mortmain) to purchase, hold, and enjoy to them and their successors, any lands, tenements and hereditaments whatsoever, not exceeding at the time or times of purchasing such lands, tenements, and hereditaments respectively, the yearly value at a rack rent of *two thousand pounds* in the whole, without incurring the penalties or forfeitures of the statutes of mortmain, or any of them. And by the name aforesaid, to sue and be sued, plead and be impleaded, answer and be answered unto, defend and be defended, in all courts and pleas whatsoever of us, our heirs and successors, in all actions, suits, causes, and things whatsoever; and to act and do in all things relating to the said corporation, in as ample manner and form as any other our liege subjects, being persons able and capable in the law, or any other body politic or corporate in our kingdom of Great Britain may or can act or do. And also to have and use a common seal, and the same to change and alter from time to time as they shall think fit. And we do hereby declare and grant, that the said

Institution shall be under the direction and conduct of a Committee of nine Managers, and one Treasurer, and one Secretary, to be hereafter elected by and from among the Proprietors of the Institution. And that the said *Frederick*, *Earl of Bessborough*, *Benjamin*, *Count of Rumford*, and *Richard Clarke*, shall be Managers for three years, from the first day of May, one thousand seven hundred and ninety-nine, and until other persons shall be chosen in their respective rooms; and the said *George*, *Earl of Egremont*, *Sir Joseph Banks*, and *Richard Joseph Sulivan*, shall be Managers for two years, from the said first day of May, until other persons shall be chosen in their respective rooms; and that the said *Gorge*, *Earl of Morton*, *Thomas Pelham*, and *Sir John Cox Hippisley*, shall be Managers for one year, from the said first day of May, and until other persons shall be chosen in their respective rooms. And it is our further will and pleasure, that the several persons herein before named as Proprietors of the said Institution, and such other persons as shall from time to time be elected Proprietors in manner herein after directed, shall and may elect and choose annually out of their own body a President; and that on his being so elected and chosen, such

President shall become an ex-official Manager of the said Institution. And that such President for the time being, shall have full power from and among the Managers of the said Institution for the time being, to elect, and choose as many Vice Presidents, as to him shall seem meet and needful for the regular holding of the several meetings. And for the purpose of forwarding the general views of the said Institution, that the said *George, Earl of Winchilsea and Nottingham*, shall be the first President; and the said *George, Earl of Morton*, *George, Earl of Egremont*, and *Sir Joseph Banks*, shall be the first Vice Presidents; and that our trusty and well beloved *Thomas Bernard, Esq.* shall be the first Treasurer; and that *Samuel Glasse, Doctor in Divinity*, shall be the first Secretary for one year, from the said first day of May, and until other persons shall be chosen in their respective rooms. . And we do hereby further declare and grant, that for the purposes of inspecting and examining the Institution, and the receipts and payments thereof, and reporting thereon, and also of consenting to such bye-laws as are hereinafter mentioned, there shall be a Committee of nine Visitors, to be hereafter elected from among the Proprietors of the Institution ;

and that our right trusty and right entirely beloved cousin *Francis, Duke of Bridgewater*, the right reverend father in God *Shute, Bishop of Durham*, and our trusty and well beloved *Thomas Bernard, Esq.* shall be Visitors for three years, from the said first day of May, one thousand seven hundred and ninety-nine, and till other persons shall be chosen in their respective rooms. And that our right trusty and well beloved cousin *Henry, Viscount Palmerstown, of our kingdom of Ireland*, and our right trusty and well beloved *John, Lord Teignmouth*, of our said kingdom, and our trusty and well beloved *Rowland Burdon, Esq.* shall be Visitors for two years, from the said first day of May, and till other persons shall be chosen in their respective rooms. And that our right trusty and right well beloved cousin and counsellor *George John, Earl Spencer, Knight elect of the most noble order of the Garter*, our right trusty and well beloved *James, Lord Somerville*, and our trusty and well beloved *Samuel Thornton, Esq.* shall be Visitors for one year, from the said first day of May, and till other persons shall be chosen in their respective rooms. And we hereby further declare and grant that the said Managers, or any five or more of them, (with the consent of the said Visitors, or of any five or more of them, in writing under their hands) shall and may, according to the best of their judgment and discretion, make and establish such bye-laws as they shall deem to be useful and necessary for the regulation of the said Institution, and of the estates, goods, and business thereof, and for fixing and determining the manner as well of electing Proprietors, and Honorary Members of the said Institution, and likewise the Managers and Visitors of the said Institution in future, as also of electing, appointing, and removing such officers, attendants, and servants as shall be deemed necessary or useful for the said Institution, and with such salaries as shall be a reasonable compensation for their duty and attendance; and such bye-laws, from time to time, to vary, alter, or revoke, and to make such new and other bye-laws as they shall think most useful and expedient, so that the same be not repugnant to these presents, or to the laws and statutes of this our realm. Provided nevertheless, and our will is, that from and after the twenty-fifth day of March, one thousand eight hundred, no bye-law shall be made, altered, or repealed, except by the authority of six or more of the Managers, with the consent of six or more of the Visitors, for the time being, in writing under their respective hands, and confirmed by the Proprietors at large at one of their general meetings. And we do authorize and empower the said Proprietors, as soon as conveniently may be, after every annual election to be made by the Proprietors of three Managers in the room of those whose time of serving shall be expired, to proceed to election from among themselves of a President, a Treasurer, and Secretary for the ensuing year, subject to such bye-laws respecting the manner and time of such election, as shall be made and established as aforesaid; and also, (but subject to such bye-laws as aforesaid) to proceed to the election of a President, Treasurer, or Secretary, upon any vacancy that may happen by the death or resignation of the President, Treasurer, or Secretary. Provided that it shall be lawful (in case it shall be found expedient) by such bye-laws as aforesaid, to increase the number of Managers and Visitors of the said Institution, so nevertheless as that one-third part of the Managers, and one-third part of the Visitors be annually elected by the said Proprietors. And our further will and pleasure is, that the Managers for the time being of the said Corporation, shall cause fair and just accounts in writing to be kept of all receipts, and payments, and doings by them, their officers, and agents respectively, which shall be liable to the view and inspection of the said Committee of Visitors, and which accounts shall, on the twenty-fifth day of March, in every year, or within thirty days after, be examined, audited, and reported upon by the said Visitors, or the major part of them. And it is our further will and pleasure, at the humble suit and petition of our said loving subjects, that no Manager of the said Institution shall vote in any thing in which he has any immediate concern or interest; and that no person who is a Proprietor of the said Institution shall be capable of any place, office, or appointment under the said Institution, to which any salary, profit, or emolument is or shall be annexed. And that no such Proprietor shall be liable to any further call or demand in respect of the transactions or engagements of the said Corporation, after he shall have paid and advanced the whole of his original subscription as the qualification of a Proprietor. And we do further authorize and empower the said Committee of Managers, on such day as shall be fixed upon for their monthly meeting, (but subject nevertheless to such bye-laws as aforesaid, and also to such orders as the said Managers may make for the regulation of their own proceedings, and which we do hereby authorize them to make) from time to time to elect, and choose by ballot, such persons to be Proprietors of the Institution, as shall have been nominated by the executors or administrators of any deceased Proprietor, as hereinafter is mentioned, or shall have respectively paid, or secured to be paid to the funds of the Institution, in case of their election, the sum of Fifty Guineas, or such greater sum as shall at the time by the bye-laws of the Institution be fixed as the qualification of a Proprietor. And it is our further will and pleasure, that in case any Proprietor of the said Institution shall be desirous of parting with his right and interest in the property of the said Institution, and shall in writing under his hand notify the same unto the Managers of the Institution, then, and in such case, it shall be lawful for the said Managers, on such day as shall be fixed upon for their monthly meeting (but subject nevertheless to such bye-laws and orders as aforesaid), from time to time, by ballot, to elect and choose in the room of such

Proprietor, such proper person as shall have been nominated by such Proprietor, or shall have paid to the said funds of the said Institution, to be paid over to such Proprietor, the sum of Fifty Guineas, or such greater sum as shall at the time by the bye-laws of the Institution be fixed as the qualification of a Proprietor; and then, and in such case, the right and interest of such Proprietor so giving notice, shall cease and determine as to him and her, and shall from thenceforth become vested in such person as shall have been so elected in his or her room as aforesaid. And it is our further will and pleasure, that, in case of the death of any Proprietor, it shall be lawful for his or her executors or administrators, by writing under the hands of such executors or administrators, to nominate a person to be admitted or balloted for as a Proprietor, in the right of the Proprietor so dying; and in case such person so to be nominated shall be a lawfully born child of such deceased Proprietor, then such person shall be admitted as a Proprietor of the said Institution, and be entitled to all the rights and privileges of the original Proprietor thereof: but in case such person shall be other than a lawfully born child of such deceased Proprietor, then the said Managers shall proceed to determine by ballot whether such person shall be elected a Proprietor; and in case such person shall not thereupon be elected and admitted a Proprietor by the said Committee of Managers, then there shall be paid to the executors or administrators of such deceased Proprietor, by and out of the funds of the Institution, and in full of such Proprietor's right and interest, the sum of Fifty Guineas, or such greater sum as by such bye-laws as aforesaid shall be then fixed as the qualification of a Proprietor. And we do hereby further authorize and empower the said Committee of Managers to elect and appoint such and so many Honorary Members of the said Institution as to them shall seem meet, and with such privileges, and subject to such restrictions and regulations, as by such bye-laws as aforesaid shall be fixed and established. And we do hereby further grant, that it shall and may be lawful for any person or persons to give, devise, grant, bargain, sell, assign, transfer, demise, and convey any lands, tenements, and hereditaments whatsoever, not exceeding the aforesaid value of two thousand pounds a year in the whole, to or for the use and benefit of the Proprietors of the said Institution, and their successors, without license of alienation in mortmain. And also that it shall and may be lawful for the Managers of the said Institution, or the major part of them, with the consent of the Visitors of the said Institution, or any five of them, in writing under their hands (but subject to any restrictions or regulations to be contained in such bye-laws as aforesaid) for a valuable consideration, to sell, grant, demise, exchange, and dispose of any lands, tenements, and hereditaments, belonging to the said Corporation. And moreover we will, and hereby for us, our heirs and successors, ordain, constitute and appoint, that if any abuse or difference shall hereafter happen in or concerning the government or affairs of the said Institution, or the management or conduct thereof; then, and so often we, for ourselves, our heirs and successors, authorize, constitute, and appoint the Lord High Chancellor of Great Britain, or Keeper of the Great Seal of Great Britain for the time being, the Lord High Treasurer, or in case of the vacancy of that office, the Chancellor of our Exchequer for the time being; the Lord President of our Privy Council for the time being; the Keeper of our Privy Seal, and our principal Secretaries of State for the time being; or any three or more of them, to reform every such abuse, and to settle and adjust every such difference. In witness whereof we have caused these our Letters to be made Patent.

Witness Ourself at Westminster, the thirteenth day of January, in the fortieth year of our reign.

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January 1800.

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