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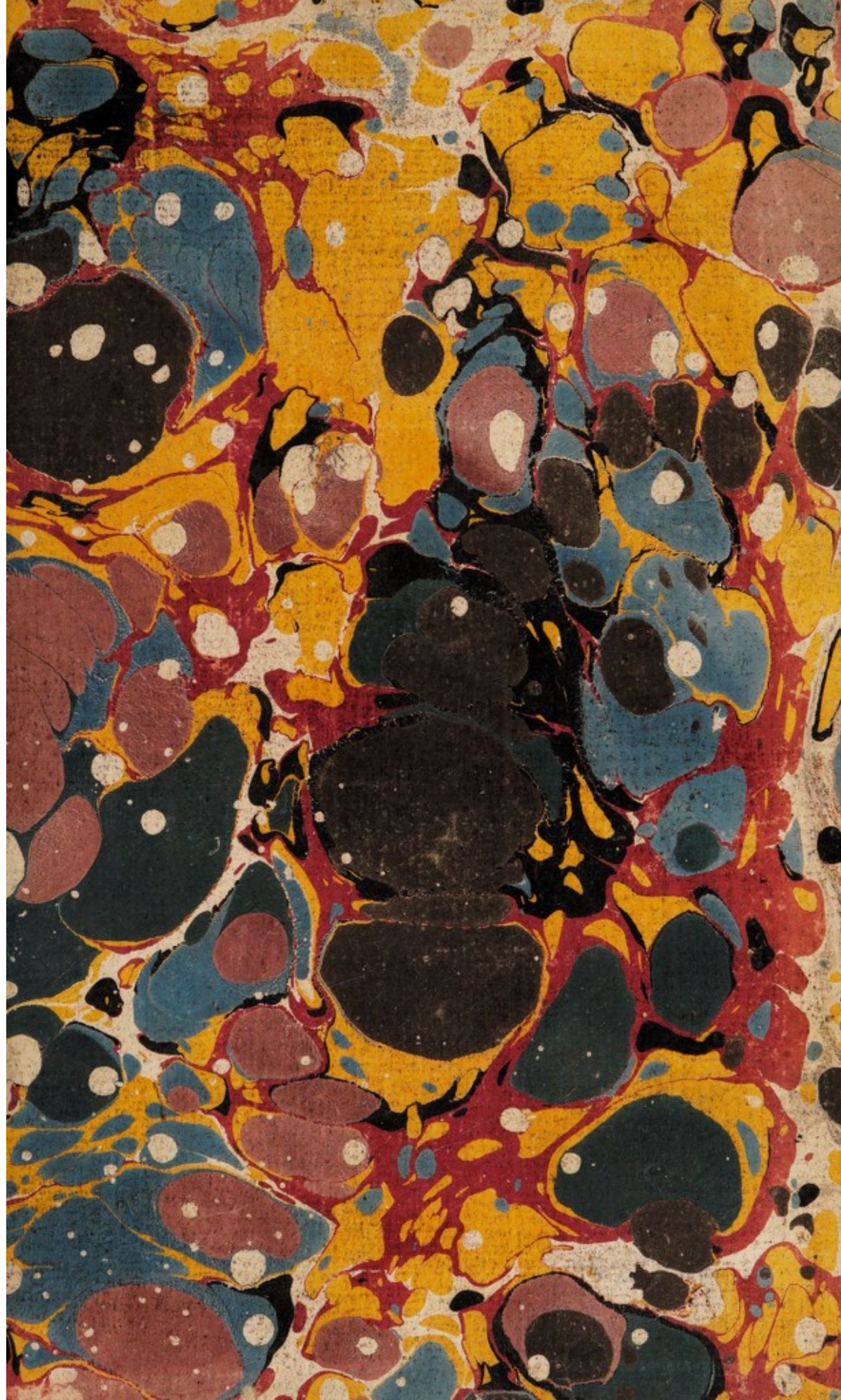


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Arthingworth.

AS A COURSE OF
CHEMICAL LECTURES

H. WATSON, D. D., F. R. S.

PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF CAMBRIDGE

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W. B. DENT

Revised

A
P L A N
OF A COURSE OF
CHEMICAL LECTURES,
BY
R. WATSON, D.D. F.R.S.
AND
REGIUS PROFESSOR OF DIVINITY
IN THE
UNIVERSITY OF CAMBRIDGE.

Rerum natura, sacra sua non simul tradit: Initiatos nos credimus, in vestibulo ejus hæremus. Illa Arcana non promiscuè nec omnibus patent; reduc̃ta et in inferiore sacrario clausa sunt. Ex quibus aliud hæc ætas, aliud quæ post nos subibit, adspiciet.

CAMBRIDGE,
Printed by J. ARCHDEACON Printer to the UNIVERSITY.


M. DCC. LXXI.



TO
THE MOST NOBLE
CHARLES WATSON WENTWORTH
MARQUIS OF ROCKINGHAM,
&c. &c. &c.

AS
A SINCERE TESTIMONY OF
RESPECT AND GRATITUDE
FOR THE STIPEND, WHICH THE AUTHOR,
THROUGH
HIS LORDSHIP'S RECOMMENDATION,
ENJOYED FROM THE CROWN AS
PROFESSOR OF CHEMISTRY
IN THE UNIVERSITY OF CAMBRIDGE,
THE
FOLLOWING PLAN OF CHEMICAL LECTURES
IS
MOST HUMBLY INSCRIBED AND DEDICATED
BY
HIS LORDSHIP'S
MUCH OBLIGED AND OBEDIENT SERVANT,

RICHARD WATSON.



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ADVERTISEMENT.

The following is the Plan of Lectures which I intended to have read during the Course of the present Term, had not the important Office to which I have had the honour of being unanimously elected, prevented me. I meant to have prefixed a Preface containing a short History of the Rise and Progress of Chemistry; an account of the recent Discoveries foreign and domestic which have been made in this Art; and of the present Desiderata in it; together with some animadversions on the commonly received doctrine of Chemical Elements; but I cannot, at this time and in my present situation, persuade myself to review what I have written upon these Subjects. I take my leave of Chemistry with some regret: from no part of Physics have I received equal entertainment, or equal instruction. I feel a satisfaction, however, in having been in some degree instrumental in acquiring for this Study the Protection of his Majesty, and in recommending it to the notice of this University.

Trinity College, Nov. 15, 1771.

INTRODUCTION.

HISTORY of Chemistry, and of Al-
chemy.

Of the Elements of Chemistry commonly
received — Earth, Air, Fire, Water.

Conjectures concerning the mutual con-
vertibility of Chemical Elements.

Of the solidity, fluidity, fixity, and vola-
tility of bodies in different degrees of heat.

Conjectures concerning the formation
and nature of the Atmosphere.

Calcination, Sublimation, Evaporation,
Distillation per ascensum, per retortam, per
descensum, explained and exemplified.

Of the different degrees of heat required
for the conducting of different operations :
the terms Venter equinus, Balneum Maris
vel Mariæ, Balneum vaporis, Capella vacua,

A

Bal-

Balneum cinerum, arenæ, limaturæ ferri,
explained.

The heat of boiling homogeneous fluids
in open vessels, shewn to be incapable of
Increase from an increase of fire.

The heat of boiling homogeneous fluids
shewn to be greater or less, within certain
limits, in proportion to the augmentation
or diminution of the pressure of the At-
mosphere, or other elastic fluid upon their
surface.

A fluid contained in a vessel exposed to
the action of boiling water for any length
of time, does not acquire the heat of boil-
ing water without it come in immediate
contact with it.

The heat of boiling oil ascertained, and
the use of a Balneum Olei illustrated.

The Structure and Use of Simple, Rever-
beratory, Melting, Cupelling and other Fur-
naces explained.

The nature of the Inflammable Principle,
Pabulum ignis, or Phlogiston, enquired in-
to from the Phænomena attending the
Combustion of Vegetable Oil, Animal Fat,
Vinous

Vinous Spirits, Charcoal, and Metallic Substances.

The Earth obtained from the Combustion of the Phlogiston of Metallic Substances converted into its primary Metallic Appearance by the Addition of Phlogiston; exemplified in the Reduction of the Flowers of Zinc by Charcoal, and of Minium by Charcoal, by Animal Fat, and by Iron Filings. — The Identity of Phlogiston inferred from the preceding Experiments.

Definition, and general Division of saline Substances into Acid, Alcaline, and Neutral Salts.

Acid Salts distinguished commonly from alkaline and neutral Salts by their Taste, by effervescing with calcareous Earths, and by changing the blue Colour of Syrup of Violets, and other blue vegetable Infusions into a red.

Alcaline Salts distinguished from neutral Salts by Taste, by effervescing with Acids, and by changing the blue Colour of Syrup of Violets into a green.

A neutral Salt made from a mixture of

an Acid and an Alkali. — The term Saturation explained.

The Vegetable fixed Alkali extracted from the ashes of Charcoal by Solution and Filtration; and from Tartar by Combustion—Pearl-ash—Pot-ash—Salt of Tartar.

Salt of Tartar rendered Liquid by exposure to the Air, improperly in that state called Oil of Tartar per Deliquium.

Quantity of Water attracted from the Air by a given quantity of Salt of Tartar, in a given time, estimated by experiment.

The Mineral fixed Alkali extracted from the ashes of the plant Kali, jointed Glasswort, marsh Samphire, or Salicornia of Linnæus, and from Sea Tangle, &c. by Solution and Filtration, and its difference from the Vegetable fixed Alkali shewn.

Volatile and fixed Alcalies distinguished from each other by the Smell, and by the different Colours produced in mixing them with a Solution of corrosive Sublimate. — Uncertainty of this Criterion remarked.

OF MINERALS.

Of the Pyrites and green Vitriol.

Natural History of the Pyrites.

Sulphureo-ferrugineous Pyritæ from the Chalk pits of Cherry-hinton analysed by Distillation—Sulphur,—Ferrugineous Residuum: Method of assaying any particular Species of the Pyrites for Sulphur.

Analysis of Sulphur by Combustion — Phlogiston — Volatile sulphureous Acid: Method of obtaining the acid of Sulphur at Battersea, and in other Places.

Iron-pyritæ defulphurated by roasting.

Green Vitriol extracted from the defulphurated Iron-pyritæ by Elixation and Crystallization: Method of assaying any particular Species of the Pyrites for green Vitriol.

Iron-filings, Sulphur, and Water kneaded together; Intumescence, - Incallescence, - Incension of the Mixture.

Conjectures concerning the Origin of subterraneous Fires and Volcanos founded upon the preceding Experiment.

Green Vitriol extracted from the Residuum of the preceding Experiment.

Of the weathering, or spontaneous Decomposition and simultaneous vitriolization, of the Pyrites.

Various Species of the Pyrites exhibited in a vitriolizing State.

Green Vitriol extracted from vitriolized Pyritæ.

Account of the principal green Vitriol Works in Great Britain.

Native green Vitriol - German - English.

Method of purifying green Vitriol from Copper, and of discovering whether it contains Copper.

Green Vitriol calcined to a white - yellow - and red Colour.

Calcined green Vitriol analysed by Distillation - vitriolic Acid - ferrugineous Residuum or Colcothar.

Of the vitriolic Acid and its Combination with Water, with fixed, and with volatile alkaline Salts.

The vitriolic Acid of the preceding process concentrated, or rectified by Distillation: Weak Acid, commonly called Spirit of Vitriol - Residuum, strong Acid, improperly called Oil of Vitriol.

Degree of Heat arising from the Mixture of Oil of Vitriol and Water observed by a Thermometer: Proportions producing a Maximum of Heat ascertained by Experiment.

Quantity of Water attracted from the Air by a given Quantity of Oil of Vitriol, in a given time, estimated by Experiment: Use of Oil of Vitriol as an Hygrometer.

Specific Gravity of Oil of Vitriol determined.

Equal Bulks of Oil of Vitriol and Water mixed together: specific Gravity of the Mixture not equal to the mean specific Gravity of the two Fluids.

Dr. Hook's Experiment, concerning the Penetration of Dimensions in the Mixture of Oil of Vitriol and Water, considered.

Vitriolic Acid not absorbed into the Pores of Water, as Muffchenbroek and others have supposed.

Acid of Vitriol combined with the fixed alkaline Salt of Tartar - Tartarus vitriolatus made after Tachenius's Manner, - General Properties of vitriolated Tartar.

Sir Isaac Newton's Theory concerning chemical Attraction stated and explained - Geoffroy's, Gellert's and other Tables of Affinity explained.

Acid of Vitriol combined with the fixed alkaline Salt of Kelp - Glauber's Sal Mirabilis, - General Properties of Glauber's Salt.

Acid of Vitriol combined with volatile Alkali - Sal ammoniacus secretus Glauberi; general Properties of this Salt.

Of the Combination of the vitriolic Acid with Earths.

Acid of Vitriol combined with Earth of Sal catharticus amarus - History of Epsom Salts. Acid

Acid of Vitriol combined with argillaceous Earths - Alum.

Natural History of aluminous Ores.

Schistus aluminosus crude, and calcined, from Yorkshire and Lancashire.

Account of the principal Alum Works in England.

Method of assaying aluminous Mineræ.

Alum calcined - Alumen ustum.

Alumen ustum dissolved in Water and crytallized.

Analysis of Alum by Distillation - Vitriolic Acid - Residuum.

Analysis of Alum by Precipitation with fixed alkaline Salt of Tartar - Vitriolated Tartar - Earth of Alum.

Account of the Experiments of Marggraf and Macquer upon the Earth of Alum.

Nature of argillaceous Earths - Conjectures concerning the Identity of argillaceous and vitrifiable Earths.

Acid of Vitriol combined with vitrifiable Earth.

Acid

Acid of Vitriol combined with calcareous Earth.

Natural History of Plaster-Stone, Alabaster, Gypsum, Selenites.

Specimens of Plaster-Stone from Montmartre near Paris, from Cornwall, Derbyshire, Westmoreland, &c.

Specimens of Rhomboidal Selenites from Shotover Hill in Oxfordshire, of striated Gypsum from Derbyshire, of Gypsum phosphorescens from Bononia, &c.

Gypseous Earth analysed by boiling it with Salt of Tartar - vitriolated Tartar and calcareous Earth obtained therefrom.

History of the Discovery of the Bononian Phosphorus. - Experiments therewith.

Artificial Bononian Phosphorus made from calcined Oyster Shells and Flowers of Sulphur after Mr. Canton's Method - Account of his Experiments therewith.

*Of the Combination of the vitriolic Acid with
Phlogiston, Spirits of Wine, and Oils.*

Acid of Vitriol combined with Phlogiston - Sulphur.

Natural History of Sulphur.

Sulphur nativum, pellucidum et opacum, from Solfatara near Naples.

Sulphur nativum pulverulentum Aquis efflorescens, from the Baths of Aix-la-Chapelle.

Account of the different Methods of preparing crude Sulphur in Germany, Saxony, &c.

Sulphur purified by Sublimation - Flowers of Sulphur - Sulphur Slag.

Sulphur crytallized.

Spirit of Sulphur per Campanam - Various ways of obtaining it.

Acid of Vitriol changed into a volatile fulphureous Acid, by the addition of Phlogiston in a State of Diffipation.

Volatile fulphureous Acid combined with the fixed alkaline Salt of Tartar - Stahl's fulphureous Salt.

Sulphureous Salt of Stahl changed into vitriolated Tartar by simple Exposure to the Air, or by the addition of Oil of Vitriol.

Sulphur united with fixed alkaline Salt by Fusion - Hepar Sulphuris.

Hepar Sulphuris changed into vitriolated Tartar by the Diffipation of the Phlogiston, Analysis of Sulphur.

Vitriolated Tartar changed into Hepar Sulphuris by the addition of Phlogiston - Synthesis of Sulphur.

The Proportion of the constituent Parts of Sulphur deduced from the two preceding Experiments of Stahl.

Hepar Sulphuris digested in rectified Spirits of Wine - Tinctura Sulphuris.

Sulphur rendered soluble in Water, by boiling it with fixed alkaline Lixivia, or with lime Water.

Sulphur precipitated from the preceding
So-

Solutions by weak Spirits of Vitriol - Lac Sulphuris - Sulphur præcipitatum.

Sulphur united with volatile alkaline Spirits by distilling it with Sal Ammoniac and Lime - Tinctura Sulphuris volatilis.

Action of Water and Acids upon Sulphur examined.

Remarks upon M. le Comte de Lauragais' Method of uniting Sulphur with Spirits of Wine.

Sulphur dissolved in Oil of Turpentine. Balsamum Sulphuris terebinthinatum.

Sulphur dissolved in Oil of Olives - Balsamum Sulphuris simplex.

History of the Discovery of Homberg's Pyrophorus.

Various Pyrophori made from Alum, Glauber's Salt, &c. calcined in conjunction with Matters containing Phlogiston.

Oil of Vitriol mixed with rectified Spirits of Wine - Phænomena attending the Commixtion - the Mixture distilled - Æther of Frobenius - Sulphureous Acid - Oil
of

of Spirits of Wine - Artificial Refin - Sulphur - Caput mortuum.

Specific Gravity of Æther determined.

Cold produced by the Evaporation of Æther - of Spirits of Wine - of alkaline Salts, &c.

Application of this principle of producing cold by Evaporation, to the cooling of Liquors, &c. in hot Climates.

Phænomena attending the Combustion of Æther.

Miscibility of Æther with Water, in certain Proportions, proved.

The Characteristics of Æther, as distinguished from Spirits of Wine, and from Essential Oils.

Oil of Vitriol mixed with Oil of Turpentine - Artificial Refin resulting therefrom: Proportions of the Ingredients which, cæteris paribus, produce the most solid Refin.

The preceding artificial Refin distilled - Sulphureous Acid - Oil - Sulphur - Caput mortuum.

Of

Of Nitre.

Account of the different Methods of making Nitre in the East Indies, and in Europe.

Of the medium quantity of Nitre annually imported into Great Britain from the East Indies, and exported to various parts of Europe.

Crude Nitre extracted from nitrous Earths.

Crude East India Nitre purified from Sea Salt, and calcareous Earth.

Nitre from America.

Account of the attempts to make Nitre in England.

Analysis of the Mother Water of Nitre.

History of the medicinal Application of Magnesia alba.

Nitre analysed by distilling it with calcined Vitriol - Acid of Nitre or Aqua Fortis - Residuum.

Re-

Residuum of the preceding Process analysed - vitriolated Tartar - ferrugineous Earth.

Acid of Nitre procured by distilling Nitre with Sand, Clay, Alum, &c.

Fuming Acid of Nitre procured by distilling Nitre with Oil of Vitriol - Residuum examined.

Fuming Acid of Nitre purified by distilling it with Nitre. Test of the Purity of Acid of Nitre.

Fuming Acid of Nitre mixed with Water - Change of Colour observed - Degree of Heat ascertained.

Fuming Acid of Nitre mixed with Snow, and with powdered Ice - Degree of Cold ascertained.

Fuming Acid of Nitre mixed with the Crystals of Kelp - Degree of Heat observed.

Diluted Acid of Nitre mixed with Crystals of Kelp - Degree of Cold observed.

Fuming Acid of Nitre simple, and combined with Oil of Vitriol mixed with various

rious Oils - Inflammation produced thereby
- Residua.

Enumeration of the various Oils which
have been observed to take fire, to efferve-
sce without taking fire, and which nei-
ther effervesce nor take fire, when mixed
with the fuming Acid of Nitre.

Acid of Nitre dulcified with rectified
Spirits of Wine, by Distillation and Di-
gestion.

Nitrous Æther made by spontaneous
Distillation, and by Digestion.

Nitre alcalised by Fusion.

Nitre alcalised by Charcoal - Clyffus of
Nitre.

Volatile Alkali in a concrete form sepa-
rated from the Clyffus of Nitre.

Nitre detonated with Tartar in various
proportions - white Flux - black Flux.

Nitre deflagrated with Sulphur - Sal
Polychrestus - Sal Prunellæ.

Pulvis fulminans made from Nitre, Salt
of Tartar, and Sulphur. - Explosion of
Pulvis fulminans.

History of the Invention of Gunpowder.

Gunpowder made from Nitre, Sulphur, and Charcoal - Account of the different Proportions of the Ingredients used in different Countries, and in different Works in England. - Best Proportions ascertained.

Method of extracting Nitre from damaged Gunpowder at Woolwich, &c.

Gunpowder decomposed. - The three constituent Parts exhibited separate. - Method of detecting Frauds used in the Composition of Gunpowder explained.

Acid of Nitre combined with calcareous Earth - Calcareous Nitre - Phosphorus Balduini.

Acid of Nitre combined with argillaceous Earth - Aluminous Nitre.

Acid of Nitre combined with the vegetable fixed Alkali - Regenerated Nitre.

Acid of Nitre combined with the mineral fixed Alkali - Quadrangular or cubic Nitre.

Acid of Nitre combined with volatile Alkali - Nitrous fal Ammoniac.

Of

Of the Use of Nitre in Agriculture.

The Use of Snow in fertilizing the ground, shewn not to depend upon the Nitre it is generally supposed to contain.

Of Sea Salt.

Natural History of Sea Salt - Sal marinus, fontanus, fossilis.

History of the Discovery of fossil Salt in England.

Account of the Method of preparing Sea Salt in different Parts of the World.

Of the different antiseptic Powers of Sea Salt according to the different Processes by which it is prepared.

Of the Bittern of Sea Salt.

Of the Method by which Epsom Salts, common Glauber Salts, and Magnesia, are extracted from the Bittern of Sea Salt at Lymington, and other Places.

Method of distinguishing the genuine Sal mirabilis Glauberi from the counterfeit of the Shops.

Analysis of Sea-water, attempted.

Comte Marfigli's Artificial Sea Water.

M. de Francheville's Opinion, concerning the Saltnefs of the Sea, examined.

Mr. Boyle's Opinion, concerning the uniform Saltnefs of the Sea at different Depths, examined.

Account of various Attempts to edulcorate Sea Water.

Of Mr. Irving's late Attempt.

Of the tests of the purity of distilled Sea Water.

Of the phosphoric Quality of Sea Water in particular Places, and at particular Times in the fame Place.

Mr. Canton's Experiments concerning the Cause of the Luminoufnefs of Sea Water.

Account of other Opinions concerning the fame Subject.

Sea Salt diffolved and cryftallized.

Decrepitation and Fufion of Sea Salt.

Sea

Sea Salt analysed by distilling it with
Acid of Vitriol after Glauber's Manner -
Fuming Spirit of Salt - Refiduum.

The Refiduum of the preceding Process
analysed, and the fixt alkaline Basis of Sea
Salt obtained therefrom after Marggraf's
Method.

Glauber's fuming Spirit of Salt purified
by distilling it with Sea Salt.

Sea Salt distilled with Vitriol, Clay, &c.
- Acid of Sea Salt - Refidua.

Acid of Sea Salt separated from its alca-
line Basis by Acid of Nitre.

Acid of Sea Salt combined with calcare-
ous Earth - Phosphorus Hombergi.

Acid of Sea Salt combined with argilla-
ceous Earth - Muriatic Alum.

Acid of Sea Salt combined with Earth of
Sal catharticus amarus.

Acid of Sea Salt combined with fixed
Alkali of Tartar - Sal Febrifugus Sylvii.

Acid of Sea Salt combined with Alkali
of Kelp - Sea Salt regenerated.

Acid of Sea Salt combined with volatile Alkali - Artificial Sal Ammoniac.

Acid of Sea Salt dulcified by Distillation with Spirits of Wine.

Marine Æther made after the Marquis de Courtanvaux's Manner.

Aqua regia made by mixing together Acid of Sea Salt and Acid of Nitre.

Aqua regia made by dissolving Sea Salt or Sal Ammoniac in Acid of Nitre - its Difference from the preceding Aqua regia, remarked.

Of Sea Salt as a Condiment, and as a Manure.

Of Sal Ammoniac.

Natural History of Sal Ammoniac.

Method of making Sal Ammoniac in Egypt.

Method of making Sal Ammoniac in Europe.

Sal Ammoniacus glebosus from Solfa-terra.

Sal

Sal Ammoniac purified by Sublimation.

Sal Ammoniac purified by Cryftalliza-
tion.

SalAmmoniac diffolved in Spirits of Wine.

Sal Ammoniac deflagrated with Nitre.

Sal Ammoniac analysed by distilling it with the Acid of Vitriol, and of Nitre - Marine Acid - Residua.

Sal Ammoniac analysed by distilling it with fixed Alkali - Volatile Alkali - Residuum.

The volatile alkaline Spirit of Sal Ammoniac procured by distilling it with Quicklime - Caustic Spirit of Sal Ammoniac.

The Residuum of the Process examined
- Oleum Calcis.

Volatile Alcaline Salt Spirit procured by
distilling Sal Ammoniac with Chalk - Mild
Spirit.

Caustic Spirit of Sal Ammoniac mixed with Acids, with Spirits of Wine, Lime Water, calcareous Nitre, &c.

Mild Spirit of Sal Ammoniac mixed with
B 4 Acids,

Acids, with Spirits of Wine, Lime Water, calcareous Nitre, &c.

Eau de Luce made.

Degree of Cold, produced during the Solution of Sal Ammoniac in Water, observed by a Thermometer.

Equal quantities of Water of different Temperatures saturated with Sal Ammoniac, and the Degrees of Cold severally produced during the Saturation, remarked.

Of the greatest possible Degree of Cold which can be produced in Water by the Solution of Sal Ammoniac.

Of the Use of Sal Ammoniac in various Arts.

Of Borax.

Natural History of Tincal or Crude Borax.

Borax vitrified.

Glass of Borax dissolved in Water, and crystallized.

Sal Sedativus Hombergi separated from
Borax

Borax by the Acids of Vitriol, Nitre, Sea Salt, and Vinegar, and procured by Sublimation and Cryftallization.

The Refidua examined, and the mineral fixt Alkali feparated therefrom.

Borax regenerated by combining together Sal Sedative and Mineral Alkali.

Sal Sedative diffolved in Spirits of Wine, the green Colour of the Flame obferved.

Of Copper fupposed to be contained in Borax.

Account of the Attempts to make Artificial Borax in England.

Of the mechanic Ufes of Borax.

Of Mineral Earths, crude and calcined.

Diffillation of Siliceous, Calcareous, Argillaceous, and Gypfeous Earths.

Account of the Experiments lately made at Paris by M. Darcet, and others, concerning the Infufibility and Volatility of Diamonds in a great Degree of Heat.

Vitri-

Vitrification of a Mixture of Earths, separately unvitriifiable in a given Degree of Heat.

Glass made from a Mixture of Alkaline Salts and powdered Flints.

History of the Invention of Glass.

Of the Method of making and polishing plate Glass in France, &c.

Siliceous Earths rendered soluble in Water by means of Alkalies - Liquor Silicum.

Of European and Asiatic Porcelane, and their specific Difference.

Account of the Methods of making the white and yellow Staffordshire Ware.

Calcareous Earths converted into Lime by Calcination.

Calcareous Earths converted into Lime by Solution and Precipitation.

Lime converted into calcareous Earth.

Dr. Black's Theory of Lime explained.

The Quantity of fixed Air contained in Alkalies, and calcareous Earths, and separable

ble by Solution, estimated by the Honourable Hen. Cavendish.

The loss of Weight sustained by calcareous Earths during Calcination estimated by Experiment, and shewn to correspond with the quantity of fixed Air, separated therefrom by Solution.

Of the Solubility of Lime in Water.

Of the Pellicle of Lime Water, and of the excess of its Weight above the Weight of the Lime dissolved.

Is the smallest Quantity of Lime wholly soluble in the largest Quantity of Water, without undergoing a fresh Calcination?

Of Marle.

Of the Use of Lime, Marle, &c. in Agriculture.

Of Arsenic.

Natural History of white Pyrites, Orpiment, Realgar, Cobalt Ores, and other mineral Substances affording Arsenic.

Method

Method of procuring Arsenic in Saxony, called from its powdery Appearance, Farina Arsenicalis.

Farina Arsenicalis purified, and changed into white crystalline Arsenic, by being mixed with Pot-ash and sublimed.

Farina Arsenicalis mixed with the Sulphur of fulphureous Pyrites, and changed into yellow or red crystalline Arsenic by Sublimation.

Arsenic dissolved in Oil of Olives, in Oil of Turpentine, in a Solution of fixed Alkali, in rectified Spirits of Wine, in Aqua Fortis, in Acid of Sea Salt, in Aqua Regia, in Oil of Vitriol, in Vinegar, and in Water.

Arsenic and Nitre distilled together - Acid of Nitre - Residuum.

Macquer's neutral arsenical Salt extracted from the Residuum.

Nitre and Arsenic fused together in open Vessels - Fume - Residuum called Nitre fixed by Arsenic.

Arsenic combined with Phlogiston, and sublimed into a metallic Appearance, commonly called Regulus of Arsenic.

OF METALLIC SUBSTANCES in general.

Of Mercury in a fluid State.

Natural History of Mercury and of Cinnabar.

Mercury extracted from Earths or Stones with which it is mixed, by simple Lotion, and by Distillation without Addition.

Mercury extracted from Minerals, in which it is mineralised, by Distillation with Addition.

Method of assaying mercurial Minerals, and of discovering whether any particular Mineral contains Mercury.

Methods of purifying Mercury.

Mercury changed into a black Powder by long continued Trituration.

Mercury changed into a red Powder by Cal-

Calcination - Mercurius calcinatus - Mercurius præcipitatus per se.

Mercury boiled with Water.

Mercury revived, from the Powders obtained by Trituration, and Calcination, by simple Distillation.

Account of Boerhaave's Experiments relative to the unchangeableness of Mercury, by the Processes of Digestion, and Distillation.

Account of Professor Braunius's Experiments, relative to the Conversion of Mercury into a solid malleable Metal, at Petersburg, by an artificial Cold resulting from the Solution of Snow in the fuming Spirit of Nitre.

Of the Degree of Heat of boiling Mercury, and of the Limits within which Mercury may be used as a Thermometer.

Mercury triturated with Turpentine, with Lard, with Sugar, &c. - Mercurial Plaisters, Ointments, Pills.

Mercury dissolved in Acid of Nitre - The Solution diluted with distilled Water, Aqua mercurialis.

The

The Solution of Mercury in Acid of Nitre cryftallized.

The fame infpiffated - Calx Mercurii.

The infpiffated Mafs, or cryftallized Salt, calcined to a red Colour - Mercurius præcipitatus ruber.

Mercurius præcipitatus ruber dulcified by Spirit of Wine - Mercurius corallinus - Arcanum corallinum.

Mercury precipitated from its Solution in Acid of Nitre by Copper.

Mercury corroded into a faline Mafs by Oil of Vitriol.

The preceding faline Mafs partly diffolved, principally changed into an infipid, indiffoluble, yellow Powder, by frequent Ablution in warm Water - Mercurius emeticus flavus - Mercurii Præcipitatum flavum - Turpethum minerale.

Mercury precipitated, from the Washings of Turpeth mineral, by Alcalies.

Washings of Turpeth mineral infpiffated, and deliquiated - Oleum Mercurii.

Mer-

Mercury united by Sublimation with the Acid of Sea Salt; Corrosive Sublimate made from a Mixture of unwashed Turpeth mineral and Sea Salt.

Corrosive Sublimate made from Crystals of Mercury in the nitrous Acid and Sea Salt.

Corrosive Sublimate made from crude Mercury, Nitre, calcined Vitriol, and Sea Salt.

Corrosive Sublimate rendered mild and insipid, by Trituration with a sufficient Quantity of crude Mercury and subsequent Sublimations - *Mercurius dulcis sublimatus* - *Calomelas* - *Aquila alba* - *Panacæa mercurialis* - *Draco mitigatus*, &c.

Specific Gravities of corrosive Sublimate and Calomel, determined.

Corrosive Sublimate dissolved in Water, and crystallized.

Corrosive Sublimate dissolved in Spirits of Wine.

Mercury precipitated from a Solution of corrosive Sublimate in Water by fixed Alkalies - *Mercurius præcipitatus fuscus* - by

volatile Alkali - Mercurius præcipitatus dulcis - by Lime Water - Aqua Phagedenica.

Mercury precipitated from its Solution in Acid of Nitre by the Acid of Sea Salt, or by any neutral Salt containing the Acid of Sea Salt - Mercurius præcipitatus albus.

Mercury precipitated from its Solution in Acid of Nitre by the Acid of Vitriol, or any neutral Salt containing the Acid of Vitriol - Turpeth mineral.

Mercury dissolved in the vegetable Acids, native, and fermented, and in fixed, and volatile Alcalies, after Marggraf's Method.

Account of M. le Comte de la Garaye's Tincture of Mercury in Spirits of Wine.

Mercury united with Sulphur by Trituration, and by Fusion - Æthiops Mineral.

A Mixture of Sulphur and Mercury sublimed - Factitious Cinnabar.

Factitious Cinnabar levigated - Vermillion.

Method of discovering whether Vermillion be adulterated with red Lead.

Mercury revived by distilling Cinnabar with Iron-filings.

Mercury united with volatile Tincture of Sulphur, and with Hepar sulphuris.

OF SEMIMETALS.

Of Antimony, and Regulus of Antimony.

Natural History of Antimony, and other Ores of Regulus of Antimony.

Crude Antimony separated from earthy and stony Impurities by Eliquation, or Distillation per Descensum - Morfuli restaurantes Kunckelii.

Crude Antimony digested with Aqua regia, Solution of the metallic, and Separation of the sulphureous Part effected thereby.

Crude

Crude Antimony calcined to an ash-coloured Calx.

Calcined Antimony vitrified.

Glass of Antimony digested with Aqua regia, Sulphur sometimes separated thereby - Differences observable in the fusibility, colour, pellucidity, and solubility of Glass of Antimony in Wines, and other Menstruums, according to the different Degrees of Calcination used in preparing it.

Regulus of Antimony prepared, by fusing the Calx, or Glass of Antimony with Charcoal, Soap, or other phlogistic Matters.

Regulus of Antimony prepared, by fusing crude Antimony with Iron, with Lead, with Copper, &c.

Regulus of Antimony prepared, by fusing crude Antimony with Tartar and Nitre.

Chief mechanic Uses of Regulus of Antimony noticed.

Regulus of Antimony volatilized by a strong Fire - Flowers of Regulus of Antimony.

Method of reducing Flowers of Regulus of Antimony.

Action of Acids upon Regulus of Antimony, examined.

Regulus of Antimony combined with the marine Acid by distilling Antimony and corrosive Sublimate together - *Caufticum Antimoniale*, or Butter of Antimony.

Regulus of Antimony precipitated from the marine Acid, by diluting Butter of Antimony with Water - *Pulvis Algaroth* - *Mercurius vitæ*.

Regulus of Antimony precipitated from the Water used in the preceding Process, commonly called *Spiritus vitrioli philosophicus* by an Alkali.

Bezoard Mineral prepared, by repeated Abstractions of the Acid of Nitre from Butter of Antimony - *Spiritus Bezoardicus*.

Antimony and Nitre mixed together in the Proportion of 2 to 1, and deflagrated - *Crocus Antimonii mitior*.

Antimony and Nitre mixed together in equal Parts, and deflagrated - *Crocus Antimo-*

timonii - Hepar Antimonii - edulcorated,
Crocus metallorum.

Antimony and Nitre mixed together in
the Proportion of 1 to 2, deflagrated and
edulcorated - Emeticum mite Antimonii.

Antimony and Nitre mixed together in
the Proportion of 1 to 3, deflagrated and
edulcorated - Calx Antimonii - Antimo-
nium diaphoreticum dulce.

Different chemical Properties of the pre-
ceding, and other fimilar Combinations of
Nitre and Antimony, explained; general
Account of their medical Powers deduced
therefrom.

Washings of Diaphoretic Antimony con-
sidered - Materia perlata, or Boerhaave's
Sulphur fixatum stibii precipitated there-
from.

Regulus of Antimony reduced to a Calx,
fimilar to Diaphoretic Antimony, by De-
flagration with Nitre, called Cerusse of An-
timony.

Antimony combined with fixed Alkali by
boiling them together - Kermes Mineral

spontaneously precipitated from the Solution.

Tinctura Antimonii made by digesting Hepar Antimonii in Spirits of Wine.

Vinum Antimoniale sive Emeticum, made by digesting Crocus Antimonii, or Glafs of Antimony in Mountain Wine.

Tartarus emeticus made by boiling Glafs, or Crocus of Antimony with Cream of Tartar.

Tartarus emeticus made, after Macquer's Manner, by combining Pulvis Algaroth and Cream of Tartar.

Of the medical Virtues of Antimonial preparations in general, and the Cause of the variable and uncertain Effects of particular Preparations explained.

Of Zaffre and Regulus of Cobalt.

Method of making Zaffre in Saxony.

The Zaffre of the Shops dissolved in all the mineral Acids.

The Difference of the Colour of the Solution

lution of Zaffre in weak and strong Acid of Sea Salt observed.

The tawny Colour of Zaffre dissolved in weak Spirit of Salt, changed into a green by heating the Solution.

Zaffre changed into a blue Glas by Vitrification, called Smalt.

Method of preparing from the blue Glas of Zaffre, an impalpable Powder, called in that State azure, enamel blue, Powder blue.

Of Lapis Lazuli, and the pigment called Ultramarine blue prepared therefrom, and its Difference from the azure prepared from Zaffre.

Regulus of Cobalt procured from Zaffre or Smalts, when melted in Conjunction with Matters containing Phlogiston.

General Properties of Regulus of Cobalt enumerated.

Account of the manufacturing of Smalts in England.

Orpiment and Quicklime digested together with Water - *Liquor vini probatorius*.

Use of the preceding Liquor in detecting Adulterations of Wine by Saccharum Saturni, shewn from the different Colours of the Precipitates attending its Mixture with genuine and adulterated Wine.

Experiments with the aforefaid Liquor as a fympathetic Ink,

Of Nickel.

Nickel not foluble in Acid of Vitriol, with difficulty in Acid of Sea Salt, readily by Acid of Nitre into a green Colour.

Nickel precipitated from Acid of Nitre by a fixed Alkali into a greenish Powder.

Nickel compared with Regulus of Cobalt.

Experiments with fympathetic Inks from Solutions of Nickel and Cobalt.

Of Bismuth.

Natural History of Bismuth.

Bismuth fublimed into yellowish Flowers by a strong Fire,

Bif-

Bismuth changed into an ash-coloured Powder by Calcination.

Calx of Bismuth vitrified.

Vitrified Calx of Bismuth reduced by the Addition of Phlogiston.

Bismuth dissolved in Acid of Nitre.

Solution of Bismuth in Acid of Nitre crystallized.

Bismuth precipitated from its Solution in Acid of Nitre by the Affusion of Water, - Magistery of Bismuth, - Blanc de fard.

Bismuth precipitated from the Washings of the Magistery by a fixed Alkali.

Bismuth and Mercury melted together - Amalgam.

Bismuth, Lead, and Mercury, melted together - Method of falsifying Quicksilver - Method of detecting the Adulteration of Quicksilver.

Bismuth not miscible by Fusion with Nickel.

Of Zinc.

Natural History of Lapis Calaminaris, Black Jack, and other Ores of Zinc.

Zinc procured by distilling Lapis Calaminaris with Charcoal.

Account of the Method of making English Zinc at the Copper Works near Bristol, and its difference from Indian Zinc shewn.

Zinc calcined in a gentle Fire, inflamed in a strong Fire - Flowers of Zinc, or Lana Philosophorum separated during the Combustion of Zinc.

Flowers of Zinc vitrified.

Flowers of Zinc reduced in close Vessels.

Flowers of Zinc dissolved in all the Acids.

Zinc deflagrated with Nitre.

Zinc dissolved in Acid of Vitriol - Nature of the black Flocculi separated during the Solution.

Solu-

Solution of Zinc in Acid of Vitriol crystallized - white Vitriol.

Method of discovering whether white Vitriol contains Copper.

Difference between English and Goslarian white Vitriol.

Zinc dissolved in Acid of Nitre.

Solution of Zinc in Acid of Nitre crystallized.

Zinc dissolved in the concentrated Acid of Sea Salt, and in the aqueous Acid of Vitriol - Inflammable Air separated during the Solution in each Menstruum.

The Quantity, and specific Gravity of the inflammable Air separated from Zinc by Solution, estimated by the Hon. Henry Cavendish.

Zinc not acted upon by Sulphur, or Liver of Sulphur - Purified thereby from all other metallic Substances.

Zinc not miscible by Fusion with Bismuth,

OF METALS.

Of Lead.

Natural History of Lead Ores.

Account of the two different Methods of extracting Lead from its Ore, as practised in Derbyshire.

Lead extracted from its Ore - Method of assaying simple Lead Ores.

Lead in Fusion partly volatilized, chiefly converted into a gray Calx, called Plumbum ustum, or calcined Lead.

Plumbum ustum melted in a strong Fire - Litharge.

Account of the Method of making red Lead from Plumbum ustum, as practised in Derbyshire.

Account of the Method of making red Lead from Litharge, as practised in Flintshire.

Re-

Remarks concerning the quantity, and cause of the Increase of Weight, gained by the Conversion of Lead into Minium.

Glasses of Lead made from Minium simple, and mixed with vitrifiable Earth in different Proportions.

Artificial Ores, perfectly resembling some kinds of natural Ores of Lead, made from an Union of Lead and Sulphur.

Of black Lead or Wadd.

Method of distinguishing the factitious from the true black Lead.

Black Lead exposed to a strong Fire in close Vessels - Fixity remarked.

Black Lead exposed to a strong Fire in open Vessels - Loss of Weight remarked.

Calcined black Lead attracted by the Magnet.

Lead corroded into a white Calx by the Vapour of Vinegar, called Cerusse or white Lead.

Account of the Method of Manufacturing white Lead at Holywell, and other Places,

Places, and of the increase of Weight gained by the Lead.

White Lead, Minium, or Litharge, dissolved in distilled Vinegar, and crytallized - Sugar of Lead.

Crude Lead, white Lead, Minium, or Litharge dissolved in Oil of Olives - Common Diachylon Plaster.

Method of discovering whether Oil of Olives be adulterated, by means of Lead, with Rapefeed, or other expressed Oils.

Lead separated, from its Solution in Oils, by Vinegar.

Lead dissolved in Acid of Nitre, and crytallized.

Lead precipitated from Acid of Nitre by Acid of Vitriol, or any neutral Salt containing Acid of Vitriol; by Acid of Sea Salt, or any neutral Salt containing Acid of Sea Salt.

Lead distilled to Dryness with Oil of Vitriol - Sulphureous Acid - Sulphur - Saline Residuum.

Sulphur procured instantaneously by
pour-

pouring Oil of Vitriol upon Lead in Fusion, and collecting the Vapour.

Lead or Minium distilled with Sal Ammoniac - Volatile Alcaline Spirit - Volatile Alcaline Salt - Residuum, or a Combination of the Acid of Sea Salt with Lead, called Plumbum corneum.

Plumbum corneum fused.

Plumbum corneum dissolved in Water, and crytallized.

Lead and Mercury melted together in different Proportions - Amalgams of various Consistencies.

Of Copper.

Natural History of Copper.

Account of the Processes used in extracting Copper from its Ore, at Ecton, Macclesfield, Cheadle, &c.

Regulus and Scoria of the first, second, third, and fourth Fusion of Copper Ore examined, and the Reason of their Differences explained.

Copper

Copper combined with Sulphur by Stratification and Cementation - *Æs uftum*.

Copper combined with Sulphur by Fusion - Artificial Ore of Copper.

Copper combined with Arfenic by Fusion - white Copper.

Of Chinese white Copper, improperly called Tutenag, and its Difference from the preceding white Copper shewn.

Copper changed into Brass, by cementing and fusing Copper in conjunction with calcined Calamine and Charcoal.

Copper changed into Brass, by substituting, in the preceding Process, calcined black Jack for Calamine.

Brass changed into Copper, by dissipating the Zinc or metallic Part of the Calamine, in a strong Fire.

The Increase of Weight, gained by the Copper in being changed into Brass, estimated.

Copper melted with Zinc - Pinchbeck.

Difference between Pinchbeck and Brass observed, and the Reason explained.

Copper

Copper melted with Tin in various Proportions - Bell metal - Bronze, &c.

Equal Parts of Copper and Tin melted together, their mutual Penetration and Increase of specific Gravity observed.

Copper dissolved in Oil of Vitriol.

Solution of Copper in Oil of Vitriol crystallized - Blue Vitriol.

Copper precipitated from a Solution of blue Vitriol by Iron - Cuprum præcipitatum, called Ziment Copper.

Account of the Cement or Ziment Waters at Newfol in Hungary, Arklow in Ireland, in Anglesea, &c. and of the Methods of procuring Copper from them.

Copper dissolved in Acid of Nitre, and crystallized.

Copper precipitated from Acid of Nitre by Chalk - Verditer Blue.

Copper dissolved in Acid of Sea Salt, and crystallized.

Crytals of Copper, in the Acids of Sea Salt, and Nitre, when dissolved in Spirits of
D Wine,

Wine, communicate a green Colour to the Flame.

Copper dissolved in Oils, in vegetable Acids, in fixed, and volatile Alcalies, in neutral Salts, &c.

Account of the Method of making Verdigrise at Montpellier, and in England.

Various mechanical Applications of Verdigrise enumerated.

Verdigrise dissolved, in Part, in distilled Vinegar.

Solution of Verdigrise in distilled Vinegar crystallized, improperly called Viride *Æris* distillatum.

Crytals of Verdigrise distilled - Concentrated Acid of Vinegar, called Acetum Radicatum - Cupreous Residuum.

Acetum Radicatum mixed with rectified Spirits of Wine, and acetous *Æther* made after the Manner of M. le Comte de Lauragais.

Of Iron.

Natural History of Iron.

Account of the Processes used in extracting Iron from its Ores in different Parts of England and Wales; and of the Attempts to make Pig Iron by Coke and charred Peat.

Method of converting Pig Iron into Bar Iron.

Of the Tenacity of Iron Wire.

Iron converted into Steel.

Steel converted into Iron.

Steel hardened, and rendered brittle and elastic.

Of Tempering of Steel.

Iron deprived of its Phlogiston by various Ways - Different kinds of Crocus Martis.

Natural History of Ochres.

Red and yellow Ochres converted into Iron by the Addition of Phlogiston.

Iron deprived of its Phlogiston by Deflagration with Nitre.

Iron combined with Sulphur.

Iron dissolved in Acid of Vitriol - Sal Martis.

Iron dissolved in Acid of Sea Salt.

The inflammable Air arising from Iron during the two preceding Solutions collected and inflamed.

Of fulminating Damps in Mines.

Method of freeing the Coal-pits at Whitehaven from inflammable Air described.

Iron dissolved in Acid of Nitre, elastic but not an inflammable Air produced thereby.

History of the Discovery of the Method of making Prussian Blue.

Prussian Blue made by precipitating a Solution of green Vitriol with an Alkali saturated with Phlogiston.

The

The colouring Matter of Prussian Blue extracted by an Alkali.

Iron precipitated from any of its acid Solvents into a blue Powder by a fixed Alkali, saturated with the colouring Matter of Prussian Blue.

Iron precipitated from any of its acid Solvents into a black Powder by a Decoction of Galls or other astringent Vegetables.

Nature of Ink and of the black Dye, and the Difference between them explained.

Beccher's Experimentum ferriferum considered.

Iron shewn to exist in common Sand, in coloured Clays, in the Ashes of Vegetables, in the Ashes obtained from the Blood, Urine, and Flesh of Animals.

Vegetable Ashes melted into a green or blue Glass, according to the Violence of the Fire.

Iron filings or Colcothar of Vitriol mixed with Sal Ammoniac and sublimed - Flores Martiales - Residuum.

Residuum deliquiated - Lixivium Martis - Oleum Ferri.

Flowers of iron digested with Spirits of Wine - Tinctura Florum martialium.

Iron precipitated from its Solution in Acid of Nitre by fixed Alkali - Sthal's alkaline Tincture of Iron.

Iron combined with Cream of Tartar by grinding them together - Rotuli Martiales - Mars solubilis; by boiling, Tartarus Chalybeatus, Tinctura Styptica Helvetii.

Iron dissolved in Rhenish Wine - Vinum Chalybeatum.

Of Tin.

Natural History of Tin.

Of the Processes of stamping, buddling, and trunking used in Cornwall for preparing Tin Ore for Fusion.

Of the Magnetiren used in some Parts of Germany.

Tin melted and granulated.

Tin

Tin rendered hard and sonorous by being melted in Conjunction with Regulus of Antimony, with Zinc, with Bismuth, &c.

Of Pewter and its different Kinds.

Of different metallic Mixtures which melting with less Heat than the Metals to which they are applied, constitute Solders of various Kinds.

Method of manufacturing Tin Plates in England and Germany, and of tinning Copper Vessels.

Tin calcined singly and in Conjunction with Lead - Putty.

Calces of Lead and Tin melted with calcined Flints, or other vitrifiable Earths, and alkaline Salts, in various Proportions - white Enamels.

White Enamels converted into different Colours, by the Addition of metallic Calces, and applied upon English and Indian Porcelain.

Pastes and artificial precious Stones made, and their Difference from coloured Enamels explained.

Tin amalgamated with Quicksilver, and the Amalgam mixed with Sulphur and Sal Ammoniac, and sublimed - Residuum called Aurum mosaicum or musicum.

Tin dissolved in Aqua regia - Different Consistences of the Solutions.

Tin dissolved in Acid of Nitre.

Use of the preceding Solutions of Tin in precipitating the colouring Matter of Cochineal.

Woollen and Linen boiled in Cochineal precipitated by Tin - Reason of the different Dyes explained by Macquer.

Inflammable Air separated from Tin during its Solution in Acid of Vitriol and Acid of Sea Salt.

Account of Marggraf's Experiments upon the Solubility of Tin in vegetable Acids native, and fermented.

Tin amalgamated with Quicksilver, and the Amalgam distilled with corrosive Sublimate - Liquor fumans Libavii - Butter of Tin - Revivified Mercury.

Look-

Looking Glafs silvered by amalgamating Mercury and Tin.

Tin, Bismuth, and Lead melted together, and mixed with Mercury - Method of silvering concave Glafs Vessels with the Mixture.

Of Silver.

Natural History of Silver.

Account of the Method of separating native Silver from the Stones or Earths in which it is imbedded, by Amalgamation with Mercury; as practised at Potosi and other Spanish Silver Mines in America, and at Kungsborg in Norway.

Account of the Method of separating Silver when mineralised with sulphurated Lead, as practised in Flintshire, and in Northumberland.

Cardiganshire lead Ores assayed for Silver.

Silver purified from Semimetals, and imperfect Metals, by Cupellation with Lead.

Silver

Silver purified from such minute Portions of Copper as escape Cupellation, by Fusion with Nitre and Borax.

Silver separated from $\frac{1}{3}$, or any less Part of its Weight of Gold by Solution in Acid of Nitre - Quartation or Departure.

Silver recovered from its Solution in Acid of Nitre by precipitation with Copper.

Solution of Silver in Acid of Nitre crystallized.

Crystals of Silver melted - Lunar Caustic.

Silver precipitated from Acid of Nitre, by Acid of Vitriol, or by any neutral Salt containing Acid of Vitriol.

Silver distilled to Dryness with Acid of Vitriol - Sulphureous Acid - Saline Residuum.

Saline Residuum dissolved in Water, and crystallized.

Silver precipitated from Acid of Nitre, by Acid of Sea Salt, or by any neutral Salt containing it - Luna Cornea.

Marg-

Marggraf's Method of obtaining Silver absolutely pure by the Reduction of Luna Cornea.

Silver precipitated from its Solution in Acid of Nitre by fixed Alkali.

Precipitated Silver dissolved in vegetable Acids, in volatile, and phlogisticated fixed Alcalies, according to Marggraf's Method.

Pure Silver made harder by being melted with Copper in the Proportion of 37 to 3 - Standard Silver of England.

Silver precipitated from Acid of Nitre, largely diluted with Water, by means of Mercury - Arbor Dianæ.

Silver combined with Sulphur into an artificial Ore resembling the *Minera Argenti vitrea*.

Of Gold.

Natural History of Gold.

Method of separating native Gold from Sands, Earths, &c. by Amalgamation with Quicksilver.

Method

Method of extracting Gold when mineralized, or when so mixed with Sulphur by means of other Metals as to escape the Action of Quicksilver and Aqua regia.

Gold soluble in Aqua regia, but not in Acid of Nitre.

Silver soluble in Acid of Nitre, but not in Aqua regia.

Method of purifying Gold from all metallic Substances by Solution in Aqua regia, and Precipitation with green Vitriol.

Method of separating a minute Portion of Gold from a large Quantity of Silver, by melting the Mixture with Sulphur, as practised at Rammelsberg.

Gold precipitated from its Solution in Aqua regia made with Acid of Nitre and Acid of Sea Salt, by volatile Alkali - Aurum fulminans.

Aurum fulminans deprived of its fulminative Power by Oil of Vitriol, by Fusion with Sulphur, by fixed Alkali, and in part by Ablution with Water.

Gold precipitated from its Solution in
Aqua

Aqua regia, when largely diluted with Water, by Plates of Tin, or by a Solution of Tin in the same Menstruum - Purple Magiftery of Caffius.

Glaſs changed into an artificial Ruby by being melted with Caffius' purple Magiftery.

Gold extracted from its Solution in Aqua regia, and kept ſuſpended in Æther.

Method of ſeparating Gold from gilt Copper.

Gold precipitated from its Solution in Aqua regia by fixed Alkali.

Precipitated Gold diſſolved by the ſame Menſtruums as precipitated Silver.

Gold diſtilled to Dryneſs with the Acid of Vitriol, with the Acid of Sea Salt, and with the Acid of Nitre - Inſoluble in theſe Menſtruums.

Gold diſſolved in Hepar Sulphuris.

Pure Gold hardened by being melted with Copper, or with an Admixture of Copper and Silver, in the Proportion of 22 to 2 - Standard Gold of England.

Gold

Gold amalgamated with Mercury -
Methods of gilding and separating Gold
from gilt Works.

OF MINERAL WATERS in general, and their various Im- pregnations.

Different Methods of assaying mineral
Waters, and their Imperfections.

Of Thermæ or hot mineral Waters, and
the different Conjectures concerning the
Cause of their Heat.

Accounts of Dr. Brownrigg's Experi-
ments on the fixed Air contained in Spa
Water.

M. Lane's Experiments concerning the
Suspension of Iron in Water, by means of
fixed Air discharged either from ferment-
ing, or effervescing Mixtures.

Of

Of Bituminous Substances.

Natural History of Bituminous Substances.

Newcastle Coal distilled - Phlegm - Acid - Air - Oil - Caput mortuum.

Air discharged from Newcastle Coal by Distillation, collected, and shewn to be inflammable, and to retain its elasticity and inflammability for several Days.

Peat from the Isle of Ely distilled - Phlegm - Acid - Oil - Alkali - Caput mortuum.

Amber dissolved in Spirits of Wine.

Amber precipitated from its Solution in Spirits of Wine by Water.

Amber distilled - Phlegm - Acid Spirit - Volatile acid Salt - Oil - Caput mortuum.

Method of rectifying Oil of Amber.

Method of purifying Salt of Amber.

Amber Varnish made by different Methods.

OF VEGETABLES.

Of vegetable Juices spontaneously extravasated, or exuding upon Incision.

Of liquid Resins, or Balsams.

Venice Turpentine distilled without Addition with the Heat of boiling Water - Acidulated Phlegm - Colourless essential Oil, commonly called Æthereal Spirit of Turpentine - Resinous Residuum.

The Residuum of the preceding Process distilled with a Degree of Heat exceeding that of boiling Water - Acid - Yellow Oil - Residuum called Colophony.

Colophony distilled to Dryness - Acid - Reddish Oil, called by some, Balsam of Turpentine - Caput mortuum.

Common Turpentine distilled with Water - Essential Oil, vulgarly called Spirit of Tur-

Turpentine - Refiduum - Terebinthina
cocta or common Rosin.

Turpentine dissolved in Spirits of Wine,
and precipitated therefrom by Water.

Of Tar and Pitch, and the Method of
procuring them.

Tar dissolved in Part in Water.

Of Lamp Black, and the Method of ob-
taining it.

Balsam of Capivi distilled Balneo Arenæ
- Acid - Yellow Oil - Blue or green Oil -
Caput mortuum.

Of Balsam of Gilead, Balsam of Peru,
Balsam of Tolu, liquid Amber, &c.

Of solid Resins.

Benzoine dissolved in Spirits of Wine,
and precipitated therefrom by Water -
Virgins Milk.

Acid Phlegm and essential Salt, com-
monly called Flowers of Benzoine, obtain-
ed from Benzoine by Sublimation.

E

Essen-

Essential Salt obtained from Benzoin by
Eluxation with Water and Crystallization.

Flowers of Benzoin dissolved in Water,
and in Spirits of Wine.

The Residuum from the Sublimation
of the Flowers of Benzoin distilled - Acid
- Oil of different Consistences - Caput
mortuum.

Elemi - Mastic - Copal - Dragon's
Blood, and other solid Resins dissolved in
Spirits of Wine and Oils.

Different Kinds of Varnishes made, and
applied upon Wood and Metals.

Of Camphor.

Native Camphor.

Rough Camphor refined by Sublimation.

Rough Camphor refined by Solution in
Spirits of Wine.

Camphorated Spirits of Wine inflamed.

Camphor dissolved in Acid of Nitre, and
in Acid of Vitriol.

Camphor

Camphor separated from Spirits of Wine, and from mineral Acids by the Addition of Water.

Of Gums.

Gum Arabic, Gum Tragacanth, Gums from Pear Trees, Plumb Trees, Apricot Trees, &c. dissolved in Water - Mucilages.

Gums dissolved in Water, and precipitated therefrom by Spirits of Wine.

Gums distinguished from Resins principally by their Solubility in Water, and Insolubility in Spirits of Wine, and by their being neither fusible, nor inflammable in Fire.

Gum Arabic distilled - Acid - Oil - Volatile Alkali - Caput mortuum.

Of Gummy Resins.

Gum Ammoniac dissolved in Spirits of Wine.

Gum Ammoniac dissolved in Water.

Of Asa foetida, Myrrh, Frankincense, and other gummy Resins.

OF VEGETABLE JUICES obtained by Trituration, and Ex- pression.

Of essential Salts of Plants.

Native aqueous Juices expressed and clarified.

Native aqueous Juices evaporated and crystallized - Essential Salts.

Of neutral Salts contained in Vegetables.

History of Sugar, and of the Method of preparing it.

Brown or gray Muscovade - Melasses, or Treacle.

Method of refining Sugar.

Sugar dissolved in Water and crystallized - Saccharum candum, et crystallinum.

Sugar dissolved in rectified Spirits of Wine, and crystallized.

Refined

Refined Sugar distilled - Acid - Oil -
Air - Caput mortuum.

Of saccharine Juices obtainable from Maple Trees, Birch Trees, Sycamore Trees, &c. by tapping; from Fruits and Roots of various Kinds, by Solution in Spirits of Wine; from the spontaneous Exudations of the *Fraxinus rotundioris Folio*, and other Trees producing Manna; and from various Flowers affording Honey to the Bee.

Native Juices of Vegetables inspissated to different Consistences - Liquid or solid Extracts by Expression.

Of Aloes, Opium, Acacia vera, and other solid Extracts by Expression.

Of expressed Oils.

Oils obtained by Expression from Linseed, Mustard Seed, ripe Olives, Almonds, Walnuts, &c.

Expressed Oils distinguished principally from essential Oils, in not being soluble in Spirits of Wine, nor volatile in the heat of

boiling Water, and in having scarce either taste or smell.

Method of impregnating expressed Oils with the odorous Principle of Violets, Lilies, Roses, &c. - Various Perfumes.

Oil of Olives distilled - Phlegmatic Acid - Oil - fixed Oil - Caput mortuum.

Of the Rancidity of expressed Oils.

Expressed Oils suspended in Water by means of Mucilages - Emulsions - Milky Juices of Plants.

Of the Combination of Oils with fixed Alkali.

Fixed Alkali deprived of its fixed Air by Quicklime - Caustic Alkali - Soap Leys.

Soap Leys inspissated - Cauterium potentiale, lapis infernalis.

Oil of Olives, Oil of Turpentine, Train Oil, Tallow, &c. dissolved in Soap Leys - Soaps of various Kinds.

Solution of Soap in distilled Water, and in Spirits of Wine,

So-

Solution of Soap in Water decomposed by Acids, and by earthy, or metallic neutral Salts.

Method of analyzing Vegetables further explained, by Infusion, and Decoction in various Menstruums.

Carduus Benedictus infused in cold Water.

Carduus Benedictus boiled in Water.

Peruvian Bark infused in cold Water.

Peruvian Bark boiled in Water.

Jalap digested with Spirits of Wine -
Tincture of Jalap - Residuum.

The Refiduum of the preceding Process boiled with Water and inspissated - Aqueous Extract of Jalap.

Refin of Jalap precipitated from Tincture of Jalap by Water.

Method of obtaining the refinous and gummy Parts of Vegetables, and of making spirituous, aqueous, and mixt Extracts.

Aqueous Decoction of red Saunders.

Spirituous Decoction of red Saunders.

Aqueous Decoction of Brazil Wood.

Spirituous Decoction of Brazil Wood.

Aqueous Decoction of Alkanet Root.

Spirituous Decoction of Alkanet Root.

Red Saunders digested in Oil of Turpentine.

Alkanet Root digested in Oil of Turpentine.

Archel boiled in Water, in Oils, in Acids, in Spirits of Wine, in fixed Alcalies, and in volatile Alcalies.

The colouring Matter of some Vegetables
pre-

precipitated by Alum, Solutions of Tin, &c.
- Lakes.

Various Experiments relative to the production, change, and recovery of Colours, by different saline Additions to coloured vegetable Infusions.

Of Dying in general.

Method of analyzing Vegetables by Distillation, exemplified in various Instances, and various Degrees of Heat.

Mint, Thyme, Rosemary, Lavender, or other aromatic Plants distilled with a Heat less than that of boiling Water and without Addition - Spiritus rector, or odorous Principle.

The same Plants distilled with the Addition of Water, and with the heat of boiling Water

Water - Effential Oils - Aromatic or simple distilled Waters.

Of the different weights, colours, and consistences, of effential Oils.

Effential Oils by Expression from Oranges, Citrons, &c.

Method of obtaining them in Italy.

Effential Oils soluble in Spirits of Wine.

Rosemary Tops, Lavender Flowers, &c. distilled with Spirits of Wine - Spirit of Rosemary, Spirit of Lavender, &c. more commonly called Hungary Water, Lavender Water, &c.

Effential Oil of Rosemary, and of Lavender, precipitated from Hungary Water and Lavender Water, by the Affusion of Water.

Of distilled spirituous Waters.

Rosemary, &c. after the Extraction of their effential Oil, distilled to Dryness - Phlegm - Acid - Empyreumatic Oil - Caput mortuum.

Method of making Charcoal explained.

Char-

Charcoal not acted upon by Water, Acids, Alcalies, vinous Spirits, or Oils.

Charcoal decomposed by burning - Phlogiston - Residuum.

Quantity of Residuum from a given Weight of Charcoal estimated.

Fixed alkaline Salt and Earth obtained from the Residuum.

Of the Method of manufacturing and depurating Pot-ash.

Of the difference between the mineral fixed Alkali, or Natron of the Antients, and the vegetable fixed Alkali.

Analysis of Woods.

Oak distilled B. M. - Phlegm - Residuum.

Residuum distilled - Phlegm - Acid - Air - Oil lighter and heavier than the Acid - Caput mortuum.

Air from Oak not destructive of Flame, but inflammable after passing through Water,

ter, and through fixed alkaline Lixivia, and retaining its inflammability for several Days.

Of the different quantities of Charcoal, of liquid Contents, and of fixed Air obtained from equal Weights of Oak, Box, Hazel, Willow, and other Woods by Distillation.

Of the best kinds of Charcoal requisite for the making of Gunpowder, fluxing of Metals, &c.

Volatile Alkali disengaged from the Acid of Oak by fixed Alkali.

Acid of Box-wood rectified.

Rectified Acid of Box saturated with vegetable and mineral fixed Alkalies - Nature of neutral Salts from the distilled Acids of Vegetables.

Analysis of the Tetradynamia of Linnaeus.

Mustard Seed, Pepper Wort, &c. distilled with the heat of boiling Water - Phlegm sapid and odorous, but neither manifestly acid nor alkaline.

Mustard

Mustard Seed, &c. distilled with a degree of Heat superior to that of boiling Water - Volatile Alkali, Acid, Air, Oil, Caput mortuum.

Of Soot.

Wood Soot distilled - Acid - Volatile Alkali - Empyreumatic Oil - Sal Ammoniac - Caput mortuum, yielding fixed Alkali.

Of Wax.

Wax distilled - Acid - Oil - Congealed Oil - Caput mortuum.

Congealed Oil or Butter of Wax rectified - Acid - Yellow Oil - Fat brown Residuum.

Methods of bleaching yellow Wax, and of colouring bleached Wax.

OF FERMENTATION in general.

Of the vinous Fermentation.

History and Use of Malting as preparatory to the Fermentation of farinaceous Seeds.

Equal Weights of Barley, Rye, Wheat, Oats, Beans, Pease, converted into Malt, and after Decoction for the same time in equal Quantities of Water exposed to Fermentation - Ale of different Sorts.

The medium heat of fermenting Wort estimated by the Thermometer, and shewn to be equal to the medium heat of an Animal Body.

The Air generated during the vinous Fermentation shewn to be deleterious to Animal Life and to Flame.

The

The specific gravity of Air generated by vinous Fermentation proved by the Hon. Henry Cavendish to be greater than that of common Air, and to be equal to that separable from Marble by Solution, or about 511 Times lighter than Water, when common Air is supposed 800 Times lighter.

Equal Weights of Raisins, refined Sugar, brown Sugar, Treacle mixed with equal Quantities of Water and fermented - Wines of different Kinds.

Ale distilled - Malt Spirits - Residuum.

Wine distilled - Brandy - Residuum.

Potatoes fermented and distilled - Potatoe Brandy.

Of the Methods of making Malt Spirits, Brandies, Rums, Arracks, and the Origin of their different Odours and Flavours explained.

Malt Spirits, Brandy, &c. distilled - Alcohol, or rectified Spirits of Wine - Acidulated Phlegm.

Of the Identity of Alcohol from whatever fermented Liquor it is distilled.

Of proof Spirit.

Usual Methods of estimating the Strength of Brandies, Rums, &c. and their Imperfections.

Alcohol and Water mixed together, the Bulk of the Mixture shewn to be considerably less than the Sum of the separate Bulks.

Method of judging accurately concerning the Strength of spirituous Liquors pointed out.

Of the Arrack or Cosmos prepared by the Calmuck Tartars from Mares Milk.

Method of obtaining white and red Tartar.

Tartar purified - Cream or Crystals of Tartar.

Tartar distilled - Acid - Air - Oil - Volatile Alkali - Caput mortuum.

Fixed alkaline Salt extracted from the Caput mortuum of distilled Tartar without burning it.

Crystals of Tartar combined with absorbent Earths.

Crystals

Cryſtals of Tartar combined with the fixed Alkali of Tartar - Sal vegetabilis, Tartarus tartarifatus.

Cryſtals of Tartar combined with the fixed Alkali - Sal Polychreſtus de Saignette - Rochelle Salt.

Cryſtals of Tartar combined with volatile Alkali.

Of the acetous Fermentation, or the ſpontaneous Conversion of Ales and Wines into Alegars and Vinegars.

Method of making Vinegars, and of diſcovering whether they are adulterated with Oil of Vitriol.

Vinegar diſtilled - Phlegm - Acid - Extract.

Method of discovering whether Vinegar be depraved by Lead.

Extract of Vinegar distilled - Acid - Em-pyreumatic Oil - Volatile alkaline Salt, and Spirit - Caput mortuum.

Vinegar concentrated by freezing the phlegmatic Part.

Distilled Vinegar combined with absorbent Earth.

Distilled Vinegar combined with the fixed Alkali of Tartar - Sal Diureticus - Terra foliata Tartari.

Distilled Vinegar combined with the mineral fixed Alkali, and crystallized.

Distilled Vinegar combined with volatile Alkali - Spiritus Mindereri - Acetous Sal Ammoniac.

Combinations of the Acid of Tartar with the vegetable and fixed Alcalies, decomposed by the Acid of Vinegar.

Difference between the Acid of Tartar, and that of Vinegar.

*Of the putrefactive Fermentation of
Vegetables.*

O F A N I M A L S.

General Analysis of animal Fluids exemplified in the Analysis of Milk, Blood, Urine, and Whites of Eggs.

Of Milk.

Cows Milk distilled Balneo Mariæ -
Phlegm transparent, colourless, insipid -
Unctuous saline Residuum.

Asses Milk distilled Balneo Mariæ -
Phlegm - Residuum.

Proportion of Phlegm separable from
equal Weights of Cows Milk and Asses
Milk by Distillation B. M. ascertained.

Equal Weights of Cows Milk, Goats Milk, Woman's Milk, Affes Milk evaporated to Dryness - Proportion of the Residuum, and of the saline and earthy Matter contained in them.

Residuum from the Distillation of Milk B. M. distilled - Acid - Empyreumatic Oil - Volatile Alkali - Caput mortuum, containing fixed Alkali.

Milk spontaneously separated into Cream and Skim-Milk.

Cream resolved into Butter - Curd - Whey.

Skim-Milk resolved into Whey - Curd - Butter.

Butter distilled - Acid - Oil - Caput mortuum.

Curd distilled - Alkali volatile in a fluid and concrete Form - Fetid Oil - Caput mortuum.

Whey evaporated and crystallized - Sugar of Milk - Sea Salt.

Milk not coagulable by the Heat of boiling Water.

Milk

Milk coagulable by Acids, by Alcalies, by vinous Spirits, by some neutral Salts earthy and metallic.

Of Blood.

Blood examined by a Microscope - Transparent Fluid - Red Globules of various Sizes.

Blood warm from the Vein distilled Balneo Mariæ - colourless, insipid Phlegm - Residuum.

Of the Quantity of Phlegm contained in the Blood of different Animals, and separable therefrom by the Heat of boiling Water.

Phlegm, impregnated with volatile Alkali, obtained from Blood by the Heat of a boiling fixed alkaline Lixivium.

Blood exsiccated by the Heat of the Sun.

Blood exsiccated by the Heat of the Sun, or by Distillation B. M. not subject to Putrefaction.

Exsiccated Blood distilled - Volatile alkaline

caline Spirit and Salt - Air - Empyreumatic Oil - Caput mortuum.

Blood spontaneously resolved, by Exposure to the Air, into a fluid and coagulated Part - Serum - Craffamentum.

Account of Mr. Hewson's Experiments, relative to the Cause of the spontaneous Coagulation of Blood when taken out of an animal Body.

Blood prevented from spontaneous Coagulation by Sea Salt, and other neutral Salts.

The Craffamentum resolved, by Ablution, into a white fibrous Part, called by some the coagulable Lymph, not soluble in Water, and a red colouring Part, called the red Globules, reckoned soluble in Water.

The fibrous Part or coagulable Lymph distilled.

The red globular Part distilled.

The Serum coagulated by boiling Water, by Acids, and by vinous Spirits.

Of Urine.

Fresh Urine gives no Marks of containing either acid or alkaline Salts.

Fresh Human Urine distilled B. M. - Colourless Phlegm with an urinous Smell - Residuum.

Residuum distilled - Volatile Alkali in a fluid and concrete Form - Oil - Sal Ammoniac - Caput mortuum, yielding Sea Salt by Elixation, and fixed Alkali by Calcination.

Horses Urine distilled - Phlegm - Volatile alkaline Spirit - Oil - Caput mortuum, yielding fixed Alkali without Calcination, and Sea Salt by Elixation.

Human Urine evaporated and crystallized - Fusible, essential, native, microcosmic, phosphoric Salt of Urine - Sal Ammoniac - Sea Salt.

Horses Urine, evaporated to a due Consistency, does not yield a fusible Salt, but a

portion of Sea Salt and a Magma incapable of Cryftallization.

Earth from the Exficcation of human Urine rendered white by Calcination - Its habitude to Fire and Menftruums examined.

Account of Marggraf's Experiments on the fufible Salt of Urine.

Volatile Alkali feparated from fresh Urine by fixed Alkali and by Lime.

Of Eggs.

Whites of Eggs coagulated nearly by the fame degree of Heat which coagulates the Serum of Blood.

Whites of Eggs coagulable by Acids and by Spirits of Wine - their Ufe in Clarification.

Whites of Eggs diftilled B. M. Phlegm - Refiduum.

Refiduum diftilled - Volatile Alkali concrete and fluid - Emphyreumatic Oil - Caput mortuum.

Oil expreffed from the Yolks of Eggs.

Of

Of the essential Oil, volatile Acid, and
expressed Oil of Ants.

Of Coral, &c.

Volatile Alkali procured from Coral and
Sponges by Distillation.

Of Brains and Spermaceti.

Contents of a human Cranium distilled
- Phlegm - Volatile Alkali - Fetid Oil -
Caput mortuum.

Of Fat.

Suet distilled - Acid - Congealed Oil -
Caput mortuum.

Of Bones and Horns.

Horns rendered soft and flexible by boil-
ing in Water.

Ox Horn, Tortoise Shell, &c. dissolved in Acid of Nitre.

Bones softened, and in part dissolved, by Digestion in Acids.

Earth of Bones precipitated from Acids by Alcalies.

Gelatinous and saline Part extracted from Hartshorn by boiling in Water - Method of making Glue - Portable Soop - Isinglass - Size, &c.

Inert Earth remaining after the Extraction of Gelly of Hartshorn - Cornu Cervi philosophice Calcinatum.

Hartshorn distilled - Phlegm - Volatile alkaline Salt and Spirit - Air - Empyreumatic Oil - Caput mortuum.

Method of preparing volatile alkaline Salt and Spirit from Bullocks Bones, &c.

Animal Oil dissolved in Spirits of Wine.

Animal Oil rectified, Oleum Animale Dippelii.

History of Putrefaction.

Caustic volatile Alkali rendered mild by the Air discharged from putrescent Bodies.

Volatile Alkali separated with the Heat of boiling Water from putrid Blood, Pigeons Dung, and putrid Urine.

History of Kunckel's Phosphorus.

Phosphorus made by distilling evaporated Urine.

Phosphorus made by distilling the Extract of Urine with Plumbum corneum and Charcoal, according to Marggraf's Method.

Phosphorus made by distilling fusible Salt of Urine and Charcoal together.

Method of rectifying Phosphorus.

Several Experiments with Phosphorus.

Of other Vegetables which yield a Phosphorus by Distillation.

Analysis of the Fæces Alvinæ.

The

The following Tables of Salts were drawn up and printed some years ago; I intended to have made large Additions to them, and to have accompanied them with a Copper-plate, exhibiting the different Figures of all the crystallizable Salts hitherto known. I would not however suppress them in their present State, thinking that they might not be unserviceable to a Student in Chemistry.

Tabula Salium in genere.

Sales sunt {	
Acidi	Minerales { Vitreolicus, Nitrosus, Marinus vel Mariaticus.
	Sal acidus succini
	Vegetabiles { Nativi vel essentiales, Acetosus, { fermentati, Tartareus, { Empyreumatici vel stillatitii.
	Sal acidus Benzoes, &c.
Alcalini	Animales { Phosphoricus, Ex formicis, &c. distillatione educti.
	Fixi { Mineralis, sive Natron. Vegetabilis, sive lixiviosus. Volatiles — Igne vel Putrefactione a substantiis Animalibus, Vegetabilibus, et Fossilibus quam plurimis, separati.
Neutri	Ab Acido quovis conjuncto cum Basi { Alcalina, Terrea, Metallica.

Tabula Salium neutrorum, Basi Alcalinâ.

Acidum

conjunctum cum

efficit Salem Neutrum,

Alcali

quem vocant

Vitriolicum

Minerali
Vegetabili
Volatili

Salem mirabilem Glauberi.

Tartarum vitriolatum, nitrum vitriolatum, Salem de duobus, &c.
Salem ammoniacum secretum Glauberi.

Nitrosum

Minerali
Vegetabili
Volatili

Nitrum cubicum.

Nitrum commune.
Nitrum flammans vel Ammoniacum.

Marinum

Minerali
Vegetabili
Volatili

Salem communem regeneratum, fossilem, fontanum.

Salem febrifugum vel digestivum Sylvii.
Salem Ammoniacum vulgarem.

Acetosum

Minerali
Vegetabili
Volatili

Salem crystallisantem, nomine non dotatum.

Salem diureticum, et improprie Tartarum regeneratum, Terram foliatam Tartar.
Spiritus Mindereri.

Tartareum

Minerali
Vegetabili
Volatili

Salem Repullentem, Rochelle Salt, Sel de Seignette.

Tartarum solubilem, Tartarum tartarifatum, Salem vegetabilem.
Tartarum solubilem Ammoniacum.

Vegetabilum
Nativa, et Stillatitia
vel Emphyreumatica

Minerali
Vegetabili
Volatili

Sales crystallisantes varios, nominibus non insignitos, Chemicis haud penitus exploratos.

Phosphoricum

Minerali
Vegetabili
Volatili

Sales figuræ variae, igne boracis instar liquefcentes, non crepitantes.

Salem microscopium, nativum vel subtillem Urinae.

Formicarum

Minerali
Vegetabili
Volatili

Salem aëre deliquescentem.

Salem distillatione non concrefcentem.

Acidum

Tabula Salium neutrorum, Basi Terreâ.

Acidum

conjunctum cum

efficit Salem Neutrum

nuncupatum

Vitriolicum

Calcareæ
Argillaceæ
Vitrescenti, ab Alcali dejecta
Magnetisæ
Aluminis

Selinitem, Phosphorum Bononiensem, Gypsum.
Alumen.
Alumen forsan.
Salem catharticum amarum, vulgo Epsom Salts.
Alumen regeneratum.

Nitrosolum

Calcareæ
Argillaceæ
Vitrescenti, ab Alcali dejecta
Magnetisæ
Aluminis

Nitrum calcareum, Phosphorum Balduni.
Alumen nitrosolum.
Salem flavum crystallisantem nitro similem, sed in aëre deliquescentem.
Massam salinam Alumine magis stipticam in igne fortiori acidum profus dimittentem.

Marinum

Calcareæ
Argillaceæ
Vitrescenti, ab Alcali dejecta
Magnetisæ
Aluminis

Salem improprie dictum Ammoniacum fixum, oleum Calcis, Phosphorum Hombergi.
Alumen marinum.
Massam deliquescentem, vix crystallisationem admittentem.
Massam Salinam.

Acetosolum

Calcareæ
Argillaceæ
Vitrescenti, ab Alcali dejecta
Magnetisæ
Aluminis

Salem crystallisantem, aëre non deliquescentem.
Alumen acetosolum.
Massam viscosam, dum calida manet, sed brevi deliquescentem.

Tartareum < Calcareæ

> Salem solubilem crystallisantem.

Acidum

Tabula Salium neutrorum, Basi Metallicâ, quorum usus in Artibus et Medicinâ est præcipuus.

conjunctum cum Subf. Metall.		efficit Salem Neutrum nuncupatum
Vitriolicum	Ferro	Vitriolum, vel Cuperosum viride.
	Cupro	Vitriolum, vel Cuperosum coeruleum.
	Zinco	Vitriolum album, Gollariense.
	Mercurio	Turpethum minerale.
Nitrosum	Argento	Crysallos lunares, ex quibus Lapis dictus infernalis conficitur.
	Cupro	Massam vel Crysallos, in Spiritu vini solubiles.
	Plumbo	Crysallos plumbi, figure pyramidalis.
	Mercurio	Crysallos Mercurii, unde calx Mercurii, Mercurius præcipitatus ruber, Arcan. Corall.
	Bismutho	Magisterium Bismuthi.
Marinum	Argento	Lunam corneam.
	Cupro	Massam vel Crysallos, in Spiritu vini solubiles.
	Ferro	Massam unde tinctura Martis in spiritu salis conficitur.
	Plumbo	Plumbum corneum.
	Stanno	Butyrum Stanni, et liquorem fumantem Libavii.
	Mercurio	Sublimatum corrosivum, Præcipitatum Album, Sublimatum dulce, Panaceam Mercurialem.
	Regulo Antim.	Butyrum Antimoni.
Acetosum	Plumbo	Cernisam et Saccharum Saturni.
	Cupro	Viride aeris et viride aeris distillatum.
	Ferro	Tincturas martiales acetosas.
Tartareum	Ferro	Rotulas Martiales, Tartarum Chalybeatum.
	Regulo Antim.	Tartarum emeticum.

Acidum

GEOFFROY's TABLE

I	2	3	4	5	6	7	8
Acids in General	Acid of Sea Salt	Acid of Nitre	Acid of Vitriol	Abforbent Earths	Fixed Alcaline Salts	Volatile Alcaline Salts	Metalline Substances
Fixed Alcaline Salts	Tin	Iron	Phlogiston	Acid of Vitriol	Acid of Vitriol	Acid of Vitriol	Acid of Sea Salt
Volatile Alcaline Salts	Regulus of Antimony	Copper	Fixed Alcaline Salts	Acid of Nitre	Acid of Nitre	Acid of Nitre	Acid of Vitriol
Abforbent Earths	Copper	Lead	Volatile Alcaline Salts	Acid of Sea Salt	Acid of Sea Salt	Acid of Sea Salt	Acid of Nitre
Metalline Substances	Silver	Mercury	Abforbent Earths		Distilled Vinegar		Distilled Vinegar
	Mercury	Silver	Iron		Sulphur		
			Copper				
			Silver				
	Gold						

of AFFINITIES.

9	10	11	12	13	14	15	16
Sulphur	Mercury	Lead	Copper	Silver	Iron	Regulus of Antimony	Water
Fixed Alcaline Salts	Gold	Silver	Mercury	Lead	Regulus of Antimony	Iron	Spirits of Wine
Iron	Silver	Copper	Calamine	Copper	Silver, Copper, Lead	Silver, Copper, Lead	Neutral Salts
Copper	Lead						
Lead	Copper						
Silver	Zinc						
Regulus of Antimony	Regulus of Antimony						
Mercury							
Gold							

from the Author
to
G. Hume

ANALYSIS

OF THE

SUBJECTS OF CHEMISTRY

AND

GENERAL DIVISION

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AN
E S S A Y
ON THE
SUBJECTS OF CHEMISTRY,
AND THEIR
GENERAL DIVISION.

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AN

E. S. A. Y.

ON THE

SUBJECT OF CHEMISTRY

AND

GENERAL DIVISION

R. WATSON, A.M., M.A.

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AN
ESSAY
ON THE
SUBJECTS OF CHEMISTRY, &c.

ALL terrestrial existencies may, in one view or other, be considered as the subjects of Chemistry: they are usually divided into three distinct classes, called the three kingdoms of nature; the first includes Minerals, the second Vegetables, the third Animals. Natural History, in an extended sense, comprehends the knowledge of whatever relates to terrestrial existencies, exclusive of the moral actions of man, which constitute the basis of civil history; and of

A the

the physical actions of bodies one upon another, which are the foundation of natural philosophy.

Mineralogy is that part of natural history which treats of whatever is found upon the surface, or dug out of the bowels of the earth, except animal and vegetable substances: some have excepted water also, and denominated that branch of science which explains the properties of water, Hydrology. And indeed, many Chemists have thought proper to consider water, as not appertaining to any of the three kingdoms of nature; but it hath no better right to be distinguished from a solid, elastic, diaphanous mineral, than a melted metal hath to be distinguished from the same metal when concentered into a solid form: in their different states of fluidity and solidity they will have different properties; but should not, from such accidental changes as are effected by minute variations of heat, be referred to different classes: had water been called melted ice, no one would have scrupled to consider it as belonging to the mineral kingdom.

The reducing quicksilver into a solid, malleable metal, by a due degree of cold,
was

was an important discovery in physics: we learn from thence to consider all fluid bodies such as water, oils, spirits, æthers, and probably the air itself, as convertible into solids without the introduction of any frigorific particles, but simply by a diminution of heat; and all solid bodies, as convertible into fluids, without suffering any other change in their constitution, except what arises from the volatilization of such of their principles, as cannot sustain the degree of heat requisite to render the rest fluid.

Mineralogy is principally employed in arranging similar bodies under the same, and dissimilar bodies under different denominations. It judges of similarity two ways; either from the similarity of the external appearance, or from the similarity of the internal constitution. The knowledge of the similarity of the internal constitution of bodies is acquired, chiefly by regarding the changes produced in them by the action of fire, or the action of menstruums; that of the external appearance by regarding the colour, configuration of the superficial parts, consistency, and weight. From the knowledge of the constituent parts of bodies is derived their œco-

nomical application, their use in medicine, agriculture, metallurgy, and other arts: from the similarity of the external appearance, is derived a suspicion concerning the identity of the internal constitution; a suspicion, serviceable in suggesting conjectures to philosophic minds, relative to the generation, transmutation, and destruction of natural bodies.

Most Mineralists have contented themselves with classing the various species of Fossils according to their most obvious qualities, and have thereby referred things very heterogeneous to the same genus. In the animal and vegetable kingdoms, the external appearance is of essential use in helping us to reduce them into genera and species: indeed, when from a resemblance in one or two particular parts of a plant or an animal; as from the figure of the leaves, or the number of stamina; from the shape of the hoof, or the number of teeth, we venture to arrange them under the same general denomination, great confusion will arise, if we suppose that general denomination, to infer a resemblance more extensive than the idea from whence it was derived: nature often admitting a similarity in some particulars

culars coexistent with the greatest dissimilarity in others: it is not probable however, that Linnæus in classing the productions of nature ever entertained such a supposition, and he seems therefore to have been uncandidly censured. But when the whole external appearance of a plant, or an animal is taken into consideration, it is far easier to refer it to a particular class, than from a chemical enquiry into its internal constitution. In fact, the internal constitution depends, in a great measure, upon the same principle from which the external figure is formed. From the configuration of the vascular system, through which nutrition is conveyed to every part of a plant or an animal, is derived the external figure; and from the same configuration the internal properties seem to arise: for plants become acescent or alcalescent, sweet or bitter, poisonous or salubrious according to their different natures, tho' they be planted in the same soil, and fed with the same food, that being changed and elaborated, by processes which we can neither understand nor imitate, into different fluids by the different organizations; and, I had almost said, digestive powers of different plants.

plants. The case is quite otherwise with respect to minerals, the external appearances conveying to us little real knowledge; they may be the same in different bodies, or different in the same body.

Sir Isaac Newton has proved, that the colours of natural bodies depend upon the thickness and density of the component parts, and consequently that minute changes in either of these qualities will make very considerable changes in the colour: this Philosophy is confirmed by, and serves at the same time to explain many appearances in Chemistry. Crystals of quicksilver in Aqua Fortis are white, yellow, or red, according to the degree of heat to which they have been exposed; whilst on the other hand, the same quicksilver corroded into a saline mass by Oil of Vitriol, remains perfectly white in all degrees of heat, but by the affusion of water is changed at once into a vivid yellow, which is of different shades according as the water is hot or cold, or as the Mass hath been more or less freed from its adhering acid by calcination. Iron and lead, and most other metals undergo similar changes of colour from calcination and precipitation, so that nothing
seems

seems more uncertain than the classing of bodies from a respect to their colour. This uncertainty of colour, according as the heat is various, is much felt and complained of by Enamellers, and the makers of artificial gems.

The configuration also of the superficial parts is a very uncertain characteristic of the specific nature of a Mineral: Metallurgists are sensible of this, they are obliged in many cases to have recourse to fire, before they can pronounce concerning the metal contained in an ore, whether it be lead or silver, iron or antimony. We have a notable instance of this uncertainty in what is called the stellated regulus of antimony; the crystallization on the surface resembling the radiations of a star, the scales of a fish, branches of trees, fibrillæ of feathers and other matters, according to certain diversities of circumstances attending the process. I do not deny but that a definite degree of liquidity in the Regulus and Scoria, a definite quantity and quality of the Scoria, and a proper precision in some other matters, would ever produce a definite arrangement of the superficial parts; but it is certain that a small variation

tion in any of these, will make a great change in the outward and inward appearance of the Regulus, without affecting in any sensible manner its internal composition. Another instance will shew the imperfection of this external method of classification still more obviously: In several portions of water let there be dissolved nitre, sea salt, alum, borax, sugar, saccharum saturni, corrosive sublimate, &c. or any combinations of these salts, the several solutions will still be equally colourless and transparent, and by a sufficient degree of cold suddenly applied would be concreted into solid bodies, not to be distinguished from one another by their colours, figures, consistencies, nor (so the experiment might be managed) specific gravities.

By these instances from Chemistry we can apprehend, how there may be a perfect similarity in the external appearances of bodies, when their internal constitutions are wholly different, and a dissimilarity, when they are wholly the same. The Minerals produced by nature are analogous to these of art, and hence we may infer the great confusion and obscurity which must necessarily attend a natural History of Minerals,

nerals, when it is founded only on the external appearance.

Sensible at last of this imperfection, the composers of systems of Mineralogy have availed themselves of the assistance of Chemistry, and have endeavoured to class Minerals according to their internal properties. This method is perfect in its kind; and in particular instances deserves greater or less attention, according as the analysis of Minerals is more or less complete: in many cases however it is too general and abstracted for common use. For instance, all earths or stones which by a certain assignable degree of heat, and with a certain quantity of saline additions, are convertible into glass, may be called vitrifiable earths; all earths or stones which in the same degree of heat, and with the same quantity of saline additions, or without them, are not convertible into glass, but into quick lime, may be called calcareous earths; and all earths or stones which under similar circumstances remain unaltered in their properties, may, with respect to the other two kinds, be called refractory earths. This is all we can learn from Chemistry relative to the comparative na-

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tures of earths, when exposed to a given degree of heat; and hence fish shells, chalk, limestones, and marbles would be included in the same class: but to answer the purposes of common life, it will be necessary to make a more particular division of them, which can only be done after the generic idea hath been established, by contemplating the external appearances; in which view the colour or figure, or both together, would be principally respected; as in fact we see they are in the distinction of the Italian Antico's, as Marmore Nero, Giallo, Rosso di san guisto; di Fiorenza, Pæfino; Alberino di Monte Gallicano, &c. all of which are convertible into quicklime, but from their different colours, superficial contextures, and capabilities of receiving different polishes, they have become of different values in a commercial light, and therefore are not improperly distinguished in a system of Mineralogy. In like manner, tho' a chemical examination by fire would probably refer diamonds, emeralds, rubies, topazes, and other stones generally denominated precious, to the class of flints; yet since men have annexed a fanciful value to these pebbles

bles from their pellucidity, colour, hardness, and other external attributes, it would be a great defect in a mineral system not to have them particularly specified and described.

But to discriminate common limestones, or common flints into different species, from a minute variation of the figure or the colour; to class pyrites, or combinations of sulphur and iron, under the specific denominations of spherical, hemispherical, pyramidal, cubical, &c.; to divide, as is usually done, the ores of the same metallic substance into a great variety of kinds, when an assay will give no difference either in the quantity or quality of the metal contained in them, or of the matter by which they are mineralised, seems to be a multiplicatio entium præter necessitatem, and tends rather to obscure and circumscribe, than to elucidate and extend our knowledge of nature.

Upon the whole, the great outlines and general divisions of mineral productions may most usefully be made from a chemical investigation of their constituent parts, and where it is expedient for commercial purposes to be more particular, an atten-

tion to the external appearance will be proper for that end. A Mineralist who considers gypseous alabasters, plaster stone, lamellated gypsums, rhomboidal felinites, spatum Bononiense, and a great many other bodies as proper to be distinguished from one another, and who is able to ascribe any particular body to its proper species from considering its external appearance, is possessed of a particular kind and degree of knowledge: He who besides being acquainted with the external appearances, is able to prove that all these different bodies are composed of a calcareous earth, united to the vitriolic acid; and thus make several species of things coalesce together, and unite, as it were, under one general conception, hath a knowledge of these bodies different in kind, and superior in degree. By this sort of knowledge the memory is much relieved, and the mind, ever grasping after universal truths, is gratified with the acquisition of general ideas. These two very different kinds of knowledge belong to every part of Mineralogy, in different views each of them is of indispensable use, and a perfect system of Mineralogy should include them both.

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If it be asked what are the discriminative characteristics of Minerals, Vegetables, and Animals as opposed to one another, I plainly answer that I do not know any either from natural History or Chemistry which can wholly be relied on.

Systematic distinctions, and specific divisions of things, are useful in enlarging the comprehension of the mind; by methodizing the objects they seem to extend the boundaries of knowledge: but having no real foundation in nature, they should not be depended on too far; they often perplex or impede the progress of a curious enquirer. This prepossession in favour of systematic arrangements, operates more forcibly upon us as the ideas to which it is usually annexed become the more abstracted. The strongest analogies are overlooked, the plainest reasonings thought fallacious, and decisive experiments inconclusive, when their tendency is to subvert a distinction, of which we had wrongly supposed nature herself the author. Every one thinks that he knows what an animal is, and how it is contradistinguished from a vegetable, and would be offended at having his knowledge questioned thereupon.

A dog or a horse he is truly persuaded, are beings as clearly distinguished from an herb or a tree, as light is from darkness; yet as in these, so in the productions of nature, the transition from one to the other is effected by imperceptible gradations.

The loco-motive powers which appertain to most animals, whether they proceed from the Cartesian mechanism, or from sensation, are so manifest in quadrupeds, birds, fishes, and insects, that in our first and superficial enquiries into nature, we are apt to consider the possession or want of these powers, as making a decisive and essential difference between animal and vegetable bodies; and it is not without a certain degree of regret, as it were, that we find ourselves obliged to predicate animality concerning a great variety of beings, which are destitute of every power of progressive motion. If at the same time we happen to have entertained some preconceived opinions, no matter whence they have been derived, concerning the usual shapes of animals, (tho' they are far more different from one another than some of them are from vegetables) our repugnancy to the admitting a being of the outward

ward form of a shrub, into the class of animals, is much increased. Hence have proceeded most of the objections which have been made to the fine discoveries of Peyssonel, Jussieu, Ellis and others, relative to the animal nature of corals, madrepores, millepores, corallines, sponges, and a numerous tribe of bodies which the very ingenious labours of Marfigli had formerly removed from the mineral kingdom, where they had been placed by Woodward and other Mineralists, and allotted to that of vegetables.

If rejecting spontaneous motion and figure as very inadequate tests of animality, we adopt perception in their stead; no doubt, he would be esteemed a visionary in Philosophy who should extend that faculty to vegetables; and yet there are several chemical, physical, and metaphysical reasons which seem to render the supposition not altogether indefensible.

The greater the quantity of perception existing in the universal system of creation, the greater is the quantity of happiness produced; and the greater the quantity of happiness produced, the greater is the goodness of the Deity in the estimation of Beings

Beings with our capacities. The latter part of this proposition needs no proof; and the former is liable but to one objection, and that grounded upon a false supposition. If, it may be urged, all the species of percipient beings be not accommodated with objects congruous to their faculties of perception, and productive of more pleasure than pain to the whole species taken collectively, then the animation of that matter of which they consist is an introduction of evil, and no test of benevolence. This may be granted; but in all the species of beings which come within the observation of our senses, the supposition of their not being furnished with objects suited to their wellbeing is evidently not true, and therefore ought, from analogy, to be rejected with reference to such as by their magnitude, their minuteness, or their dullness of perception escape our examination.

That animals should feed one upon another, is a law of nature full of wisdom and goodness, life and happiness being indefinitely multiplied thereby. For a given quantity of what are called vegetables, annually produced upon a globe of a given diameter,

diameter, being sufficient but for the support of a given number of herbaceous animals, whose place in the universe not admitting their immortality, it hath been wisely contrived that their bodies, which from their structure must perish, should in ceasing to live, become the instruments of supporting life in beings, which could not by any other means have had an existence, at least upon this globe; and of the other parts of the universe we know nothing except from analogy, and from that we must conclude that the $\tau\acute{o}\ \pi\acute{\alpha}\nu$, be it finite or infinite, is as full of life as this particular part with which we are connected. Nay, animated matter, containing as it were the concentrated virtue of many vegetables, serves for the support of life, and the consequent communication of happiness in a far more ample manner than vegetables themselves; animal substances in equal weights furnishing more nutriment than vegetable. It is by death, a seeming imperfection in his workmanship, that the Deity preserves vegetable life, supports the animal kingdom, daily regulates and renews the œconomy of nature, and continues this wonderful system of things in

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full youth and vigour, nor interrupted by disease, nor enfeebled by old age.

No objection therefore to the animality of vegetables can be brought from any considerations respecting their daily destruction; for the destruction of animals by other animals, the *bellum omnium in omnia*, is an universal law of nature, derived from the same benevolence to which we attribute creation itself. If then every part of the vegetable kingdom hath a degree of perceptivity, however small, there will be a gain of happiness to the whole system, the aggregate may be of a value not to be overlooked by him, to whom the existence of all things is equally possible, and from whom all created existences are equally distant in perfection.

Wherever there is a vascular system, containing a moving nutritive succus, there is life; and wherever there is life there may be, for ought we can prove to the contrary, a more or less acute perception, a greater or less capacity for the reception of happiness: the quantity, indeed, of which after we have descended below a certain degree of sensibility, will, (according to our method of estimating things, which is ever
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partial and relative to ourselves) be small in each individual; yet is the existence of it in the nature of things possible, from the analogy of nature probable: and who can tell whether in a system of nature, confessedly contrived for the production of the greatest possible good, it may not also be necessary?

It should be well weighed by the Metaphysicians, whether they can exclude vegetables from the possession of the faculty of perception, by any other than comparative arguments; and whether the same kind of comparative reasoning will not equally exclude from animality those animals which are provided with the fewest and the obtusest senses, when compared with such as are furnished with the most and the acuteest. The perception of a man (tho' it may be doubted whether there are not several animals which have all the senses more acute) seems to be indefinitely greater when compared with that of corallines, sea-pens, and oysters, than the perception of these, which are allowed to be animals, doth when compared with the signs of perception manifested by a variety of what are called vegetables. Spunges

open and shut their mamillæ, corals and sea-pens protrude or draw back their suckers, shell-fish open or keep close their shells in search of food or avoidance of injury; it is from these and similar muscular motions that we judge the beings to which they belong to have perception, that is, to be animals. Now in the vegetable kingdom, we may observe the muscular motions of many plants to be, to the full, as definite and distinguishable as those of the class of animals just mentioned. The plants called *Heliotropæ* turn daily round with the sun; by constantly presenting their surfaces to that luminary, they seem as desirous of absorbing a nutriment from its rays, as a bed of muscles doth from the water, by opening their shells upon the afflux of the tide. The *Flores Solares* are as uniform in their opening and shutting as animals are in their times of feeding and digesting; some in these motions do not observe the seasons of the year, but expand and shut up their flowers at the same hour in all seasons; others, like a variety of insects which appear, or not, according to the heat of the weather or climate, open later in the day, or do not open at all, when
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they are removed from a southern to a more northern latitude. Trefoil, woodforrel, mountain ebony, wild fenna, the African marigold, &c. are so regular in folding up their leaves before rainy weather, that they seem to have a kind of instinct or foresight similar to that of ants; which however deserts many of them as soon as they have propagated their kind, by shedding their pollen. Young trees, in a thick forest, are found to incline themselves towards that part through which the light penetrates, as plants are observed to do in a darkened chamber towards a stream of light let in through an orifice, and as the ears of corn do towards the south. The roots of plants are known to turn away with a kind of abhorrence from whatever they meet with which is hurtful to them, and to desert their ordinary direction, and to tend with a kind of natural and irresistible impulse toward collections of water placed within their reach: many plants experience convulsions of their stamina upon being slightly touched. Whatever can produce any effect upon an animal organ, as the impact of external bodies, heat and cold, the vapour of burning sulphur,

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of volatile alcali, want of air, &c. are found to act also upon the plants called sensitive. But not to insist upon any more instances, the muscular motions of the *Dionæa Muscipula* lately brought into Europe from America, seem far superior in quickness to those of a variety of animals. Now to refer the muscular motions of shell fish, and zoophytes, to an internal principle of volition, to make them indicative of the perceptivity of the being; and to attribute the more notable ones of vegetables, to certain mechanical dilatations, and contractions of parts occasioned by external impulse, is to err against that rule of philosophizing which assigns the same causes for effects of the same kind. The motions in both cases are equally accommodated to the preservation of the being to which they belong, are equally distinct and uniform, and should be equally derived from mechanism, or equally admitted as criterions of perception.

I am sensible that these and other similar motions of vegetables, may by some be considered as analogous to the automatic or involuntary motions of animals; but as it is not yet determined amongst the Physiologists, whether the motion of the heart,
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the peristaltic motion of the bowels, the contractions observable upon external impulse in the muscles of animals deprived of their heads and hearts, be attributable to an irritability unaccompanied with perceptivity, or to an uneasy sensation, there seems to be no reason for entering into so obscure a disquisition; especially since irritability, if admitted as the cause of the motions of vegetables, must, a fortiori, be admitted as the cause of the less exquisite and discernible motions of beings universally referred to the animal kingdom.

Physical observations concerning the generation, nutrition, organization, life, health, sickness, and death of plants, help us as little towards the establishing a discriminative characteristic between them and animals, as metaphysical speculations relative to the quantity of happiness, or degrees of perceptivity.

The eastern practice of fecundating the female palm tree by shaking over it the dust of the male, which Herodotus mentions in his account of the country about Babylon, and of which Dr. Hasselquist in the year 1750 was an eye witness, was not unknown to Aristotle and Pliny: but the
Ancients

Ancients seem not to have carried the sexual system beyond that single instance, which was of so remarkable a kind that it was hardly possible for them to overlook it; at present there are few Botanists in Europe who do not admit its universality. It seems generally agreed, that a communication of sexes in order to produce their like belongs to vegetables as well as to animals. The disputes subsisting among the Anatomists concerning the manner in which conception is accomplished, whether every animal be produced *ab ovo* *femellæ*, or a *vermiculo in semine maris*, are exactly similar to those amongst Botanists concerning the manner in which the *farina fœcundans* contributes to the rendering the seed prolific: but however these doubts may be determined, they affect not the present enquiry, since it is allowed on all hands, that as the eggs of oviparous animals, tho' they arrive at their full magnitude, are incapable of being vivified by incubation, unless the female hath had commerce with the male: so the dates of female palm trees, and the fruits of other plants, tho' they ripen, and arrive at maturity, will not grow unless they have been

been fœcundated by the pollen of the male.

In like manner notwithstanding the diversity of opinion which hath long subsisted, and in a matter so little capable of being enlightened by experiment, probably ever will subsist, concerning the *modus agendi* by which nature elaborates the nutritive fluid, administers it to the fœtus in the womb, and produces an extension of parts; yet since a placenta and an umbilical chord are by all thought essential to the effecting these ends; and since the cotyledons of plants, which include the corculum or first principle of the future plant, with which they communicate by means of tubes branched out into infinite ramifications, are wholly analogous to the placenta and umbilical chord of animals, we have great reason to suppose that the embryo plant and the embryo animal are nourished and dilated in their dimensions after the same way. This analogy might be extended and confirmed by observing that the lobes, within which the fœcundated germ is placed, are by putrefaction converted into a milky fluid, well adapted as an aliment to the tender state of the plant.

Expiration and inspiration, a kind of larynx and lungs, perspiration, imbibition, arteries, veins, lacteals, an organized body, and probably a circulating fluid appertain to vegetables as well as to animals. Life belongs alike to both kingdoms, and seems to depend upon the same principle in both: stop the motion of the fluids in an animal limb by a strong ligature, the limb mortifies beyond the ligature, and drops off; a branch of a tree under like circumstances, grows dry, and rots away. Health and sickness are only other terms for tendencies to prolong or to abridge the period of life, and therefore must belong to both vegetables and animals, as being both possessed of life. An east wind, in our climate, by its lack of moisture, is prejudicial to both; both are subject to be frost bitten, and to consequent mortifications; both languish in excessive heats; both experience extravasations of juices from repletion, and pinings from inanition; both can suffer amputation of limbs without being deprived of life, and in a similar manner both form a callus; both are liable to contracting diseases by infection; both are strengthened by air and motion: Alpine plants, and
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such as are exposed to frequent agitation from winds, being far firmer and longer lived than those which grow in shady groves, or hot houses; both are incapable of assimilating to their proper substance all kinds of food; for fruits are found to taste of the soil, just as the urine, and milk, and flesh, and bones of animals, often give indications of the particular pabulum with which they have been fed: both die of old age, from excess of hunger or thirst, from external injuries, from intemperature of weather, or poisoned food.

Seeds of various kinds retain their vegetative powers for many years: the vivification of the ova, from which the insects occasioning the smut in corn, and the infusoria animalcula observable in water after the maceration of plants probably proceed, may be esteemed a similar phenomenon. It is not yet clearly decided amongst Naturalists, whether the seeds of mushrooms, of mucors, and of the whole class of Fungi be not in a tepid, humid matrix changed into vermicular animals, which lose in a little time their power of spontaneous motion, coalesce together, and grow up into these very singular plants:

the quickness of their increase, and the irresistible force with which the least mouldiness propagates itself, and destroys the texture of the bodies upon which it fixes, seem to point towards an animal nature.

Different vegetables require different soils, as different animals do different food for their support and well being: aquatics pine away in dry sandy grounds, and plants which love rocks and barren situations, where they imbibe their chief nutriment from the air, become diseased and putrid in rich bogs and swamps.

There are aquatic animals which become immoveable and lifeless when the rivulets in which they subsisted happen to be dried up, but which recover their life and loco-motive powers upon the descent of rain: in this circumstance they are analogous to the class of mosses among vegetables, which, tho' they appear to be dried up, and ready to crumble into dust during the heats of summer, yet recover their verdure and vegetable life in winter, or, upon being put into a humid soil.

Trembley, Bonnet, and Spallanzani have vastly amplified our views of nature; they have discovered to us divers species of
animals,

animals, which may be cut into a variety of pieces without losing their animal life, each piece growing up into a perfect animal of the same kind: the multiplication of vegetables by the planting of branches, suckers, or joints of roots is a similar effect. The reproduction of the legs of craw-fish, lobsters, crabs, of the horns and heads of snails, legs of lizards, of the bony legs and tails of salamanders, when by accident or design they have been deprived of them; and the great difference in the time of the reproduction, according to the season of the year in which the limb is lost, are wonders in the animal kingdom, but wholly analogous to the repululation of trees after lopping.

All plants, except those of the classes *Monæcia* and *Diæcia*, are hermaphrodites; that is, they have the male and female organs of generation within the same empalement. Shell-fish, and such other animals as resemble vegetables in not being able to move far in search of mates, with which they might propagate their kind, are hermaphrodites also: Reaumur hath proved that vine fretters do not want an union of sexes for the multiplication of their kind.

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From the conjunction of animals of different species are produced hybrides, which in many cases cannot propagate: Botanists have tried the experiment, and by fœcundating female flowers with the male dust of another species, have produced hybridous plants, of an intermediate shape, the seeds of which are barren and effete.

Trees shed their leaves as birds do their feathers, and hirsute animals their hair. At particular seasons the juices of vegetables move with fullness and vigour; at others they are less plentiful, and seem to stagnate; and in this they resemble dormice, bats, frogs, and numberless other animals of cold blood, which lie torpid and destitute of every sign of life during the winter time; the action of the lungs and of the heart being, if any, imperceptibly weak and languid.

Few, if any animals can exist without a reciprocal succession of sleep and vigilance, and the younger the animal, the greater is its propensity to sleep: the same alternatives seem necessary for the health of several vegetables; a great variety of plants fold up their leaves, and seemingly compose themselves to rest, in the night time,
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and this disposition for sleep is more remarkable in young plants than in old ones; nor does it, as might be suspected, depend upon the influence of light or heat, since plants in hot houses, where the heat is kept at the same degree, fold up their leaves at a stated time in the evening, and expand them in the morning, whether the light be let in upon them or not. It may deserve to be enquired, whether by a relaxation of fibres these plants become subject to a more copious perspiration during sleep than in their state of vigilance, as Sanctorius hath proved to be the case in animals.

There is a great diversity, but a regular succession in the times, in which animals of different species feel the *œstrum*, by which they are stimulated to the propagation of their respective kinds: an order equally determined, is observable in the times of accomplishing the *sponsalia* of plants. The periods of incubation in oviparous, and of gestation in viviparous animals are not more various in different species, nor probably more definite in the same, than the periods requisite for the germination and maturation of different seeds. By the influence of heat
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and cold, abundance and scarcity of nourishment, the seasons of propagating may be somewhat accelerated or retarded in animals as well as in vegetables: the effects of a cold ungenial spring are as remarkable in the retardation of the procreative intercourses of birds and beasts, as in the stoppage of the leafing of trees, or the flowering of shrubs. In a word, there are so many circumstances in which the anatomy and physiology of some plants agree with those of some animals, that few, I believe, can be mentioned in which they disagree.

When it is considered that animals are either mediately or immediately wholly nourished from vegetables, it might be expected, a priori, that the products obtainable by a chemical analysis from the two kingdoms should be different rather in quantity than quality, and that we could not from thence discover any criteria by which they might be distinguished from one another: this observation is confirmed by experiment. Animals, it is true, in general yield a greater proportion of a volatile alkaline, than of an acid salt by distillation; vegetables on the contrary abound in acid, and yield not any volatile
alkali,

alkali, unless with the last degree of heat, or when they have undergone putrefaction: in saying this, I am aware that I differ from the opinion commonly received. Mustard seed, water cresses, horse-radish, and other plants of the tetradynamia class are generally said to contain a volatile alkali already formed, and to yield it with the heat of boiling water; from none of these however could I ever obtain B. M. a phlegm which would give a precipitation with corrosive sublimate, the most indubitable test of a fluid's containing even the minutest portion of volatile alkali; the pungent smell seems to have been mistaken here, as Sir John Pringle hath well observed the fœtor to have been in the putrefaction of many animal substances, as proceeding from a volatile alkali; and which may, perhaps, be with greater truth attributed to a volatile oil, a small portion of which is sometimes procurable from pepperwort, by the heat of boiling water impregnated with sea salt. However, as some animals, and some parts of most animals yield a portion of acid, and as most vegetables, by a strong fire in close vessels, or when converted into soot, afford a volatile

alkali, altogether similar to that obtained from animal substances, we cannot from these circumstances establish any distinctive mark between the two kingdoms.

With respect to Minerals indeed, Chemists think that they have found out an infallible and universal Criterion, by which they may be distinguished from every animal or vegetable substance. All bodies from which we can obtain an oil by distillation, or otherwise, are supposed to belong to such substances as have enjoyed an organic life; no mineral, it is said, containing any: this is a sensible distinction, and yet it is not perhaps in extreme cases wholly to be relied upon. When a vegetable or animal is distilled in close vessels, the stronger the fire is, the more oil is obtained; what first passes into the recipient is more clear and limpid than what comes over towards the end of the operation; it may be presumed however, that what remains adherent to the coal in the retort, and which no violence of fire can separate, is not essentially different from the last portions which are distilled; yet this, be it fixed oil or phlogiston, is no wise different from what enters into the composition of
metallic

metallic substances, and of minerals, perhaps, of all kinds. Zinc burns with a flame resembling that of charcoal; lead and tin burn like rotten wood; iron and other metals may be burnt to ashes in the open air, but like charcoal cannot be decomposed in close vessels; spirits of wine burn like sulphur, charcoal and metallic substances without producing any foot; yet from spirits of wine an oil may be obtained: Why should the phlogiston of metals be thought of a nature wholly different from the oil which so obstinately adheres to charcoal, or from that which seems to enter into the composition of vinous spirits?

Naturalists, as well as Chemists, have perhaps too precipitately embraced the opinion, that Minerals may be certainly and readily distinguished from the other two kingdoms. A vascular system, a nutritive fucus, and a power of producing its like, constitute the abstract idea both of a vegetable and an animal, as contradistinguished from a mineral: this idea is clear and definite in itself; but to determine how far the coexistence of these qualities is in the nature of things necessary, or where any of them ceases to exist, is a question of vast

difficulty when applied to particular cases. Stones dug out of quarries, ores out of mines, in general, minerals separated from their matrices are like the dead branches or limbs of vegetables or animals, incapable of receiving increase, except from an external incrustation; but whether the matrices themselves increase, or that being in some cases granted; whether they receive their augmentation from an external apposition, or an internal assimilation and extension of parts, cannot readily be decided either way. In the Cretan labyrinth it hath been observed, that the names of travellers, which have been cut in the rock in former ages, are now in alto relievo, and that the older the dates are, the greater is the protuberance, resembling the callus formed by incisions in trees: In the mines of Chremnitz in Hungary, which have been wrought for above one thousand years, the antient roads which had been cut through the rocks are left to grow up; and it is remarked, that they approach one another in a horizontal, and not in a perpendicular direction; the same phænomenon may be observed in the marble quarries in Italy, as is mentioned
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by Baglivy in his treatise upon the vegetation of stones; but whether these, and many similar appearances are to be attributed to the pressure of the superincumbent strata, or to a kind of vegetable growth, is a doubtful point. Rock crystals, amethysts, and various precious stones have been thought by De Boot and others to grow like mushrooms; certain it is, that they often contain in them several heterogeneous particles; a circumstance which proves them to have been once in a fluid state, and induces a suspicion that in their formation they may resemble the gums and resins extravasated from various species of vegetables. The vegetation of stones hath been admitted by many, and some have contended that minerals as well as animals and vegetables spring from seed, the greatest rock being nothing but the expansion of the parts of a minute grain of sand.

Salts dissolved in water consist of indefinitely small *moleculæ*, which, as far as microscopes can inform us, are similar in figure to the large crystals which become visible to the naked eye, and which are formed, as it were, from the expansion of one particle: it will be easily understood, how

how conformable this mineral crystallization is to the opinion of those, who attribute the growth of animals and vegetables to the accretion of organic particles of the same kind. The concentrick crusts of which stalactites consist, are not either in their appearance, or their formation, perhaps, unlike the circles annually produced by the stagnation of the sap in the bolls and branches of trees. The native gold and silver tufts, which appear to burst through the hardest rocks, and which from their great resemblance to trees, have been called by some arborescent, seem to indicate a kind of vegetation in their formation.

Supposing, however, that we pay no attention to any of these circumstances, yet cannot we form any judgement concerning the internal state of the earth. The greatest depths to which Miners have penetrated even in mountainous countries, which may be considered as excrescencies from the true surface of the earth, or the level of the sea, have scarcely ever equalled one sixteen thousandth part of its diameter; a distance altogether insufficient for the forming any probable conjecture about the

the inward constitution of the globe. The strata of stones, and veins of minerals, which are met with upon the surface, can give us as little information concerning the internal structure of the earth from which these are probably derived, as the contemplation of the scales of a fish, the feathers of a bird, or the Epidermis of a man, would concerning the bones and muscles, the veins and arteries, the circulation of the blood, and the several secretions of an animal body. Many minerals seem in their formation to have been antecedent, others subsequent to the universal deluge; a great part of the matter constituting the outward shell of the earth, the only part which we can examine, hath been subservient to vegetable or animal life. All the strata of limestones, chalks, marbles, all gypsums, spars, alabasters, &c. are confessedly of animal origin. The strata of pit-coal, and of all bituminous fossils, of some species of flates, whatever may be thought of argillaceous strata in general, the mould every where covering the surface of the earth, and other substances are supposed probably enough, to have arisen from the destruction of vegetables, so that I know
not

not whether it would be a very extravagant conjecture which should suppose that all matter is, or hath been organized, enlivened, animated.

Hence may it appear probable, with reverence yet, and conscious ignorance be it spoken, that the One, Eternal, Incomprehensible God hath established an uninterrupted concatenation in all his works, which he hath submitted to our view. Different individuals hath he mingled together into the same species; different species into the same genus; different genera into the same kingdom; and different kingdoms he hath distinguished, perhaps, but by lines of division too minute for our observation. This strong analogy by which men and minerals, and all intermediate existencies are bound together in a common chain, and thence, it would seem, naturally subjected to a common fate, may appear humiliating to such as have been wont to entertain high notions of the physical dignity of human nature: but it cannot offend nor disquiet those, who feel within themselves faculties essential to the constitution of moral agency, and who from thence become capable at least of retribution

tribution of punishment or reward in another state.

In the number of our senses, and in the modifications of the intellectual faculties which spring therefrom, we have a great resemblance to many animals which inhabit this planet as well as we. The genus to which man belongs includes a great many subordinate species; or, to speak in a manner more conformable to nature, and more consonant to the account we have of its origin, the human species from the diversities of climate and of food, from changes introduced by disease, and continued, perhaps, by propagation, and from other causes which are unknown to us, hath been branched out into a great many varieties: these, however, are as much distinguished in shape and intellect from one another, as they are from animals which have sprung from a different stock. Anatomists, whether they consider the brain as an instrumental, or an efficient cause of intelligence, are agreed in acknowledging a great resemblance between the contents of the human cranium and those of quadrupeds; and Putius hath proved, contrary to the opinion embraced

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by Pliny, and commonly received, that we have not that medullary substance in a greater proportion than other animals. Nor are we characterised by a circumstance generally esteemed essentially necessary to the support of the human foetus, and exclusively appertaining to our species: nations are mentioned to whom it doth not belong, and whatever degree of credit may be given to that narration, it is certain that a great many species of animals have been discovered to which it doth. Notwithstanding this analogy by which we are to be classed with the rest of the animals around us, yet hath it pleased Him who called forth from nothing both us and them, and thankful we ought to be for the preference, to place us at the top of the scale, to make us, as it were, the first term of a series, descending indefinitely by imperceptible gradations, to particularize that class of animals to which we belong, by rendering it capable of forming a moral character. This capability, it is true, is various according to the opportunities of, and capacities for receiving instruction in different species, and in different individuals of the same species: the Orang-outang

outang of the woods of Java, the apron-bellied Caffre of the Cape, the woolly-headed Negro of Africa, the beardless Savage of America, the dwarfish Inhabitant of the Frigid Zone, the moon-eyed Albino, and the enlightened European, are as different from one another in this circumstance as in outward form: yet wherever it exists even in the smallest degree, there ariseth a proportionable imputability of conduct, a kind of title to the natural or covenanted good, a reasonable subjection to the natural or positive evil, which God hath annexed as sanctions to the laws which he hath thought fit to prescribe for the regulation of the moral conduct of mankind.

RICHARDI WATSON, A.M.

COLL. SACRO-SANCTÆ TRIN. SOC.

ET

CHEMIÆ PROFESSORIS

IN ACADEMIA CANTABRIGIENSI,

INSTITUTIONUM CHEMICARUM

IN PRÆLECTIONIBUS ACADEMICIS

EXPLICATARUM,

PARS METALLURGICA.

CANTABRIGIÆ,

Typis Academicis Excudebat J. ARCHDEACON.

M.DCC.LXVIII.

REPORT

RICHARD D. WATSON, M.D.

CONDUCTED BY THE
FACULTY OF THE
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IN THE YEAR 1880

INSTITUTIONAL MEDICINE

IN THE
FACULTY OF THE
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REPORT

PARS METALLURGICA

CHICAGO, ILL., 1880

CHICAGO

THE UNIVERSITY OF CHICAGO

CHICAGO

P R Æ F A T I O.

MIRUM profecto et incredibile dictu est, quam late per universas Europæ regiones sese dilataverit Philosophia Naturalis, ex quo Peripateticorum atque Aristotelis Auctoritatem fregerit Baconus. Hinc æque singulorum, ac Societatum et Academiarum Laboribus Commentariisque, adeo jam diffusa est undique et disseminata, ut ingentes ejus Auctus et Progressus Cogitatione vix quisquam poterit complecti.

Jacebat interea *Chemia* parcius et infrequentius culta, fanis plerisque suspecta, et, Alchemicorum propter deliramenta, ab ipsa Legum nostrarum auctoritate improbata. At ut aliis rebus humanis ita etiam et Artium scientiis accidit, quæ nec in imo gradu neque in fastigio moram patiuntur.

P R Æ F A T I O.

Chemiam, quam haud ita pridem fuisse audivimus domi squalidam, fuligine infuscatam, et præ hominum ei deditorum pauperie pene ridiculam, foris per trivia misere vagantem, inhianti passim popello præstigias suas venditantem, a nemine fere non conculcatam et despectui habitam, nostris tandem temporibus sese alacrius erigentem, focillatam demum a Principibus, et a Philosophis ubique excultam auspicato fatis admiramur. Eò quidem jam perducta est, ut quæ inter præcipuas plane doctrinas reponatur omnino digna sit, cum nec in Principiorum perspicuitate nec in Conclusionum pondere, sive philosophicos seu civiles respicias usus, ulli scientiarum cedat.

Chemia genere *duplex* est; corpora vel *resolvit* vel *componit*. Resolutio corporum iisdem, quibus ipsa eorum varietas specifica, terminis definitur; singulorum
rum

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rum absoluta esse habetur cum ad *Elementa* vel principia homogenea, five plura sint five pauciora, perducatur. — Compositio corporum, Geometriæ instar est infinita.

Partium Animalium figuram, nexum, et motum Anatomici; Vegetabilium fabricam Botanici; Fossilium situs atque habitus externos Mineralogici; non formas rerum sed mixtiones Chemici, perscrutantur.

Actiones Medicamentorum in corpora animalium tractat *Therapeutice*. Chemia autem quippe quæ resolvat mixta, resoluta conjungat, et varia quæ inde exoriantur phænomena dignoscat Therapeutices fit quasi anima : at cum infinitas simul aliorum corporum naturas retegat, et actiones mutuas investiget, ad universam potius Physicem, quam ad solam medicinam, tanquam ad suum ac proprium finem refertur.

P R Æ F A T I O.

Mechanica tum Phyfices tum Chæmiæ fanioris fundamenta feliciter pofuit *Newtonus*; cum de mutuis corporum Attractionibus, vel, ut Chemici loquuntur Affinitatibus, ex quibus omnis eorum Refolutio et Compositio pendet, in quæftionibus quibusdam fuo de re optica libello adjectis quam fagaciffime difceptavit: fundamento jam pofito molem extruxere paululum Recentiores, felici admodum folertia; nec Ædificio Adminiculum nec forma deeft: Faftigium Operi quod infinitum eft, nulla ingeniorum fagacitas, nulla temporum diuturnitas unquam imponet.

In *Theoreticam* et *Praëcticam* commode dividi poteft Chæmia: hæc quæ Encheiræfes docet, Opificum eft; illa quæ veritatem exquirat, Philofophorum. Veritatis indagatio omnis eft Philofophiæ finis, hæc autem veritas inter phyficos cognitione rerum experimentis eruenda continetur.

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tinetur. Chemia quoque infinitam pro-
pemodum experimentorum, cum multis
ante seculis tum nostra etiam ætate insti-
tutorum, copiam complectitur, atque iis-
dem universa nititur.

Notiora tanquam ignota proferre, de-
peculari aliena, antiqua undique corrasa
tanquam nova ac propria venditare, ho-
minis est otio abutentis: At simulata a
finceris distinguere, dubia secernere a
certis, indigestis nexum quendam conci-
liare et ordinem, obscuriora illuminare,
infinitis modum statuere, arduum fane
sed nec inutile nec inhonestum est. Quod
si magno cum discentium commodo,
in aliis philosophiæ naturalis partibus
absolutum hocce vidimus, quid obstat
quo minus in Chemia quoque industriæ
aliquid periclitemur? Hac mente Provin-
ciam mihi ab Alma Matre demandatam,
Regis Ornatissimi munificentia insigni-
tam simul ac ditatam, quantum in me
fuerit colui, et colam.

P R Æ F A T I O.

Lectores nihil hic reperient præter *Corporum Metallicorum Affectiones* cum alienis tum meis quibusdam experimentis enucleatas; quas in seriem Propositionum, brevem quidem at Lectionibus publicis explicandam et illustrandam redegi.

Opusculum hoc Tyronum gratia, currente calamo conscriptum, utcunque imperfectum et provectorum notitia indignum, iis qui Chemiam a limine tantum salutant, vix erit inutile. Et cum nollem id extra Academiæ pomœrium evagari aut publici fieri juris, erroris si quid aut incuria fuderit, aut ab ipsius operis obscuritate et difficultate irrepperit, id solita pro sua humanitate condonent oro, qui hic loci Chemiæ operam navarunt: iisque mei adversum ipsos studii, pietatis erga Academiam hoc quaecunque Testimonium, omni cum cultu et observantia, dico atque dedico.

C A P. I.

Definitiones.

1 **C**ORPORA quæ ponderis decrementum in igne fortissimo non patiuntur *Fixa* vocantur, quæ patiuntur *Volatilia*; idque magis aut minus prout majori aut minori negotio partes eorum igne dissipantur.

2 *Partes volatiles* corporis, quæ fluidæ sunt et ignis vi in auras agantur, *evaporari* dicuntur; cum in vase clauso stillatim condensentur, *distillari*; *Solidæ* vero, cum fursum evectæ in forma solida condensentur, *sublimari* dicuntur: atque hæ vel *Sublimata* vel *Flores* vocantur, prout massam compactam, vel pulverem friabilem efficiunt.

3 Fluidum quodvis, solido affusum et ab eo distillatione separatum, dicitur ab eo *abstrahi*.

4 Cum partes aquosæ fluidi cujusvis compositi ab eo separantur, sive distillatione, sive corporum aquam vel phlegma absorbentium interventu, sive congelatione, fluidum remansens *dephlegmari* vel *concentrari* dicitur.

5 Corpora, quæ vel culinari vel solari igne, sive ipsa ignis vi, sive aqua postea affundenda

(ut fit in lapidibus calcareis) in Pulverem *fragilem, friabilem*, terræ similem fatiscunt, *calcinari* dicuntur: Pulvis iste *Calx* appellatur præsertim si corpora sint ex regno minerali de-sumpta. Corpora quoque, cùm in hujusmodi Pulverem Acidis corrosa dejiciantur, nonnunquam dici solent *in Calcem redigi*.

6 Corpora *via humida dissolvi* dicuntur, cum partes eorum fluido cuivis ita adjunguntur, ut unum quasi cum eo corpus visu homogeneum constituent, in eo suspensæ maneant, nec tamen id opacum vel turbidum reddunt.

7 Corpora ficca, quæ aeri exposita fiunt fluida, *deliquescere* vel *Deliquium pati* dicuntur.

8 Fluidum, quo corpora dissolvuntur, *Solvens* aut *Menstruum* vocatur.

9 Menstruum, cum de corpore solvendo nihil amplius in se recipere et sustinere potest, *saturari* dicitur.

10 Separatio corporis a menstruo quo solutum est, five spontanea sit five coacta, et five sursum five deorsum fiat, *Præcipitatio humida* dicitur; atque Materia ad imum dejecta, vel ad summum evecta, *Magisterium* vel *Præcipitatum* vocatur.

11 Cum partes corporis solidi adeo a se invicem vi ignis expandente separantur ut fiant fluidæ, corpus *fusum* vel *liquatum* esse dicitur.

12 Corpora heterogenea, quæ igne fusa, diversa particularum gravitate in duas partes interea separantur, *Præcipitationem siccam* vel *fusoriam* subire dicuntur. Pars illa quæ gravitate sua majori imum petit, *Regulus*, altera huic super incumbens *Scoria* appellatur.

13 *Eliquatio* est cum eo ignis gradu in quo altera Mineræ compositæ pars solida seu refractaria manet, altera fluit et ab illa separetur.

C A P. II.

De Substantiis metallicis in genere.

1 SUBstantiæ metallicæ, arte metallurgica e mineris, eductæ et fusione purgatæ, sunt corpora omnium longè ponderosissima et (nisi subtilius partes dividantur) opacissima, aqua non solubilia, igne fusilia, at calore atmosphæ-ræ terrestris, (Mercurio excepto) non fluida, fulgore et nitore peculiari insignia. Hæ in duas classes, alteram Metallorum, alteram Semi-metallorum distribui solent.

2 Metalla, quæ hætenus cognita sunt, sex vulgo numerantur; Aurum, Argentum, Plumbum, Cuprum, Ferrum, et Stannum.

3 Semi-metalla habentur Platina (quæ metallis potius annumerari debeat) argentum vi-

vum, Regulus Antimonii, Bismuthum, Zincum, Regulus Cobalti, et Nickel. Ad hæc ab omnibus fere, at temere forsan, adjungitur Regulus Arsenici.

4 Metalla a Semi-metallis majori sua malleabilitate præcipue distinguuntur.

5 Metalla fere dividuntur in duos ordines, metalla perfecta seu nobilia, et metalla imperfecta seu ignobilia. *Perfecta* habentur Aurum et Argentum; quibus adjungi debet Platina. Reliqua *imperfecta* esse deprehenduntur.

6 *Metalla perfecta* sunt, quæ in igne violentissimo et fixa manent, et calcinationem nullam patiuntur: *imperfecta*, quæ in igne et calcinationem patiuntur et partium dissipationem.

7 Omnes substantiæ metallicæ, exceptis forsan Auro, Platina, Argento et Argento vivo, si in igne aperto comburantur in calces convertuntur, quæ difficilius aut facilius vitrificationem admittunt prout calcinationem magis minusve perfectam subierint.

8 Calces et vitra metallicæ, cum Carbone, Oleo, Sevo aliisve substantiis Phlogiston debito statu in se continentibus, præsertim in vase clauso, igni exposita in formam suam pristinam metallicam reducuntur, modo calcinationem nimiam non perpeffæ sunt; ipsa operatio vocatur *Reductio*.—Annon omnes Substantiæ Metallicæ

tallicæ constant ex terra vitrescente et substantia inflammabili? Quod si Phlogiston sit uniforme quiddam sibi ubicunque reperiatur simile, quæri potest 1^{mo} num terræ metallicæ ab aliis omnibus terris vitrescentibus genere discrepant: et proinde, num Arte Chemica substantiæ Metallicæ generari queant: 2^o utrum substantiarum Metallicarum differentia oriatur a specifica quadam terrarum differentia; an a diversa proportionem et nexu quibus eadem terra cum Phlogisto conjungitur; an ab interpositione aliorum quorundam corporum: et proinde possint necne in se invicem transmutari?

9 Substantiæ Metallicæ, fusione inter se mixtæ, raro magnitudinem illam habent quæ oriri debeat a magnitudinibus partium componentium simul sumptis. In quibusdam vero, ut in mixtura Stanni et Cupri decrementum magnitudinis et incrementum gravitatis specificæ sunt admodum notabilia. In aliis, ut cum Stannum et Zincum una colliquantur, tantum est magnitudinis incrementum, ut gravitas specifica sive densitas mixturæ minor sit gravitate specifica corporis levioris. In mixtura Cupri et Bismuthi ea fere deprehenditur densitas quæ secundum regulas communes hydrostaticas expectari debeat.

10 Quædam substantiæ Metallicæ Ex. Gr.
Aurum,

Aurum, Argentum, Cuprum, Plumbum, Stannum et Zincum, igne fusæ adeo magnitudine augeri, et specifica gravitate diminui dicuntur, ut frustulum solidum ejusdem materiæ, cuilibet earundem cum fluidæ sint injectum, submergatur et in fundum subsidat; ut fit in Sevo, Cera et Resinis liquefactis: Aliæ, ut Bismuthum Antimonium et præcipuè Ferrum, adeo diminui dicuntur magnitudine, ut solidum frustulum iis innatet, quemadmodum sulphur solidum sulphuri liquato aut Glacies aquæ innatat.

11 Plurimæ, fortasse omnes, Substantiæ Metallicæ igne satis fusæ et lentius postea frigefactæ, partium quandam regularem dispositionem vel *Crystallisationem* in superficie visibilem, sed in diversis generibus diversam, acquirere dicuntur.

12 Omnes Substantiæ Metallicæ calore dilatantur, frigore contrahuntur. Hæc magnitudinis mutatio, Pyrometro mensurata, minor esse observatur in Regulo Antimonii, et major in Zinco, quam in alia quavis Substantia Metallica.

13 Omnes Substantiæ Metallicæ citius et calefcunt et refrigescunt quam aut Spiritus vini, aut Olea, aut alia ulla corpora: et hinc Thermometris et Pyrometris conficiendis adprimè aptæ sunt.

14 Sub-

14 Substantiæ Metallicæ, nec in directa nec in reciproca ratione densitatis, cohærentiæ, duritiei, nec in ratione quavis ex his quocunque modo composito, nec denique secundum ullam generalem legem huc usque repertam, calorem vel acquirunt vel amittunt.

15 Corpora Metallica fusa omne cum salibus et terris etiam metallicis respuunt connubium, superficiem convexam habent; præterquam quod si fusa sint in vasis metallicis ab horum lateribus partes contiguæ ^tatrahuntur quasi, et superficiæ convexitas destruitur. Si cum sulphure liquifiant, omnia (præter Aurum et Zincum) in mineras, iis quæ e fodinis eruuntur similes, et ab iis vix distinguendas, convertuntur: cum Arsenico, omnia per fusionem uniuntur, et ab eo fragilia redduntur.

16 Metalla quædam, uti Ferrum, Cuprum et Argentum, quæ ignem ut fluant fortissimum postulant, sulphure addito citò liquefcunt: dum alia quædam, uti Plumbum et Stannum, per se satis fusilia, cum Sulphure conjuncta fiunt admodum refractaria.

C A P. III.

De Argento vivo sive Mercurio.

1 *M*ercurius est corpus metallicum tactu frigidum, omnium (Auro et Platina exceptis) ponderosissimum; eo propemodum caloris gradu quo aqua ebullit aut etiam minori, volatile; corpora, nisi metallica, non maffaciens; Atmosphæræ terrestris calore fluidum.

2 Mercurius frigore artificiali, a mistura spiritus nitri fumantis cum nive orto, in solidum mutari potest.

3 Mercurius frigore in solidum constructus est metallum eximio nitore splendens; mallei patiens; duritie et sono quem reddit plumbo perfimile.

4 Magnitudo Mercurii frigore fixi minor esse dicitur parte circiter 10^3 quam magnitudo ejusdem Mercurii ad ebullitionem calefacti.

5 Mercurius, cum jamjam sit vel in calore ebulliturus, vel in frigore fluiditatem suam amissurus, celeriter ascendere et descendere observatur.

6 Mercurius purgatissimus, diu multumque agitato, converti potest aliqua ex parte, forsan omnis, in pollinem nigerrimum saporis acris, metallici

metallici ænei, qui igne valido, nullâ re additâ, distillatus fit *Mercurius vivus* vel *currens*.

7 Mercurius, in igne mitiori vase clauso diutius detentus, in pollinem nigrum antecedenti similem mutatur: in igne fortiori digestus quasi calcinatur in pulverem primo cineraceum, deinde flavescentem, tandem rubrum; qui improprie vocatur, *Mercurius præcipitatus per se*.

8 Mercurius calcinatus vel præcipitatus per se, ipso Mercurio ponderosior est et in igne fixior. Adaucto nihilominus calore dissipatur; remanente perparva quantitate pulveris fusci, qui vitro ustorio in vitrum fuscum mutatur: dum mercurius qui calcinationem non passus est, ab eo calore, nullo restante residuo, in auras pellitur.

9 Mercurius quingenties amplius distillatus, singulis vicibus semper quiddam pulveris rubri in retorta reliquit; at aliam non subiit mutationem.

10 Mercurius præcipitatus per se, in igne culinari, nullo addito Phlogisto, maxima ex parte reviviscit. Residuum igne fortissimo fixum est: fustum cum Borace, in massam friabilem vitrescentem vertitur; cum Plumbo cupellatum, prorsus evanescit.

11 Acidum Nitri mercurium facile dissolvit. Solutio evaporata, præbet Cryсталlos albas, a-

cerrimas, longas, nonnunquam et tentues nitro
similes: inspissata, in massam vertitur albam,
salinam, admodum causticam, quæ æque ac
cristalli igni in patella exposita fit pulvis, pri-
mo albus, deinde flavus, tandem dum calidus
manet purpureus, sed frigescens ruberrimus;
qui vocatur *Mercurius præcipitatus ruber*.

12 Acidum Vitrioli Mercurium vix dissolvit,
nisi sit ebulliens et concentratum. Si distille-
tur, odorem sulphureum a Mercurio acquirit,
et Mercurius simul corrosus fit massa salina,
alba, quæ in igne violentiori colorem non mu-
tat, aere non deliquescit, et aquam calidam af-
fundendo partim in ea dissolvitur, partim mu-
tatur in pulverem flavedinis eximiæ, qui fervi-
da aqua sæpius ablutus fit insipidus; et vocatur
Mercurius emeticus flavus, vel *Turpethum mi-
nerale*.

13 Acidum marinum in Mercurium non a-
git viâ humidâ; at in vapores resolutum, et ei
per sublimationem variis modis conjunctum,
salem crystallinum semipellucidum constituit;
qui vocatur *Mercurius sublimatus corrosivus*, tunc
viribus rodendi maximis pollens, cum propor-
tio Acidi, respectu habito ad Mercurium, fit
maxima.

14 Mercurius sublimatus, maximè corrosi-
vus, cum ea quantitate Mercurii crudi tritus
quæ

quæ sufficiat Acido marino perfectè saturando, et sublimatus fit opacus, aqua non solubilis, vis rodentis expers, et *Mercurius dulcis sublimatus* nuncupatur.

15 Acida vitriolica et marina iis qui Propositionibus 12^a et 13^a explicantur modis cum Mercurio uniuntur. Quòd si Acida hæc vel Solutio salis cujuslibet medii, in quo alterutrum continetur, in Mercurium Acido nitri solutum infundantur, Mercurius sese iis adjunget et pulveris albi forma præcipitabitur. Pulvis hic, si cum Acido vitriolico conjungatur, fit *Turpethum minerale*; sin ab Acido marino præcipitatio fiat, *Mercurius præcipitatus albus* vocatur, sublimato corrosivo vel dulci accedens prout sit vel non sit edulcoratus.

16 Mercurius sublimatus corrosivus, aqua solutus, ab Alkali fixo in fundum præcipitatur in forma pulveris rubri: ab aqua calcis præcipitatus fit flavus: ab Alkali volatili albus: a mistura Alkali fixi et Alkali volatilis paribus quantitativibus albor nihil inquinatur.

17 Spiritus vini rectificatus, et ebulliens, suum pene pondus Sublimati corrosivi; ad gradum 16^m Thermometri Reaumeri aut 68^m Fahrenheitii calefactus, tres octavas ponderis sui partes, dissolvit.

18 Spiritus vini rectificatus, ad gradum 68^m

Thermometri Fahrenheitiani calefactus, et Sale Ammoniaco faturatus, Sublimati corrosivi tres quartas ponderis sui partes dissolvit: et proinde vis ejus solvendi Sublimatum corrosivum Salis Ammoniaci additione duplicatur.

19 Aqua, cum ebulliat, dimidium suum pondus de sublimato corrosivo; si ad quinquagesimum tantum gradum Ther. Fahren. calefiat, vix partem sui ponderis vigesimam, dissolvit.

20 Aqua, Sale Ammoniaco saturata et ad prædictum gradum calefacta, Sublimati corrosivi duas tertias partes ponderis sui dissolvit: et proinde majorem habet vim solvendi hunc saltem quam aqua simplex in proportionem fere, 40 : 3.

21 Si Mercurius cum Sulphure teratur, aut cum Sulphure liquato misceatur, pulverem fuscum, cito in nigrum abeuntem, constituit; qui vocatur *Æthiops mineralis*. Hic autem sublimatione fit massa rubra, friabilis, striata, quæ *Cinnabaris factitia* nuncupatur; a Cinnabari nativa, quando debita sulphuris portio adhibita fuerit, vix distinguenda.

22 Si Cinnabaris factitia, aut nativa, misceatur cum Alkali fixo, Calce viva, Limatura ferri, aliisque rebus, quibus major cum Sulphure competit affinitas, quam ipse habet Mercurius,
et

et distilletur, *Mercurius* obtinebitur *purgatus*. Aliquid etiam Sulphuris quod ab Acidis præcipitari potest a cinnabari, ea cum Alkali fixo decoquenda, extrahitur.

23 *Mercurius* *Plumbum*, *Stannum* et *Aurum* facillime penetrat et friabilia reddit; et cum omnibus quidem Substantiis Metallicis (*Nickel* et *Regulo Cobalti* forsan exceptis) quanquam cum *Ferro*, *Antimonio* et *Ære* paullò difficilior, vel trituratione frigida aut calida, vel fusione, coit, *Mixtura* inde proveniens vulgò *Amalgama* rectius *Malagma* dicitur: quod est mollius, friabilius, fluidius, aut spissius pro diversa quantitate *Mercurii* in eo conficiendo adhibiti.

24 *Amalgama Mercurii* et *Argenti*: gravitatem habet specificam majorem gravitate specifica ipsius *Mercurii*.

25 *Acida vegetabilia* et *Sales alcalini* eâdem fere methodo in *Mercurium*, quàm in *Aurum* et *Argentum*, agunt.

C A P. IV.

De Antimonio et ejus Regulo.

1 *Antimonium crudum*, est Minera a terreis et lapideis recrementis Eliquatione purgata, striis nitentibus tanquam aciculis ordinatim ferè dispositis distinctum, atque ex Sulphure et parte metallica, quæ *Regulus antimonii* appellatur, paribus plerumque quantitibus conflatum.

2 *Antimonium crudum*, igne mitiori ustulatum, album copiosè emittit fumum; quem *Florum* nomine colligere licet. Residuum gradatim mutatur in Calcem cineream; quæ, igne fortiori fusa, vitrum facit hyacinthini aut fulvi coloris, durum, volatile, eò pellucidius quò perfectior fuerat Calcinatio et tenuior Liquefactio.

3 Vitrum antimonii, cum aqua regia digestum, colorem ei rubescentem impertit: Acidis vegetabilium aut Vinis infusum, abrasione quadam suæ substantiæ vim ipsis emeticam conciliat; quæ tamen repetitis infusionibus languescere quidem et exhauriri dicitur.

4 Vitrum Antimonii, vel *Antimonium crudum*, tum lapides tum metallica omnia corpora (Auro et Platina exceptis) fusione dissolvit,

vit, et volatilia reddit : et hinc a quibusdam vocatur *Lupus vorax*, *Balneum Solis*, &c.

5 Vitrum vel Calx Antimonii, cum Carbone, Sapone, aliâve substantia Phlogiston continente fusa, reducitur in Regulum; qui, si partium debita fiat refrigeratio, stellæ speciem in superficie plerumque exhibet.

6 Regulus Antimonii est Semi-metallum durum admodum et fragile, quod a Zinco et Bismutho tum specie externâ (quâ nec cærulescit, ut Zincum, nec flavescit, ut Bismuthum,) tum fusilitate difficiliori distinguitur.

7 Regulus Antimonii, in igne aperto mitiori, fatiscit in Calcem vitrescentem; at in vasis clausis, valido igne fusus, prorsus volatilis est; et Flores exhibet spiculorum splendentium instar, aqua ægrius solubiles, igne vix volatiles, et in Regulum difficillimè reducendos.

8 *Regulus Antimonii confici potest*, vel Calcis reductione, ut in propositione 5^a explicatum est; vel Præcipitatione sicca, qua nimirum interventu alterius corporis sulphur a parte regulina separatur; vel solutione humida partis metallicæ Antimonii crudi in Aqua Regia facta et Calcis inde dejiciendæ reductione.

9 Regulus Antimonii, cum Ferro, Stanno et Zinco fusus, mixturas metallicas constituit quæ minorem habent gravitatem specificam; cum
Argento,

Argento, Cupro, Plumbo, et Bismutho, quæ majorem quam secundum regulas communes habere debent.

10 Reguli Antimonii cum acido nitri concocti aliquid dissolvitur, at maxima ex parte in pulverem album corroditur: si cum Acido vitriolico distilletur corroditur quoque; Acidum autem fit sulphureum, et Sulphur sæpe sublimatur. In Acido marino difficulter solvitur, facillime in Aqua Regia.

11 Si Regulus Antimonii, vel Antimonium crudum, cum sublimato mercurii corrosivo trituratione probè misceatur et distilletur, Acidum marinum in sublimato Mercurium deferens, Regulo Antimonii sese adjunget, et cum eo elevabitur, et in Excipulum transibit, vel collo Retortæ, pinguedinis glacialis aut Butyri specie, adhærebit: unde *Butyrum Antimonii* nuncupatur. Aucto deinde igne, Mercurius vivus purissimus ascendet, et in Recipiens decurret. Denique, si Antimonium crudum adhibeatur, Cinnabaris sublimata in collo Retortæ invenietur.

12 Butyrum Antimonii aere deliquescit, et pulverem album deponit: repetitis distillationibus fit ex parte fluidum, et olei instar limpidum; ex parte, si rectè instituatur distillatio, sublimatur crystallorum forma, in aere volatiliū admodum et deliquescentium.

13 Butyrum Antimonii, aquam affundendo, lactescit; et ob Acidum debilitatum, vel propterea quod Sales perfecte medii aqua vix sunt solubiles, Regulus Antimonii in eo solutus maxima ex parte ad imum subfidet, specie pulveris albi; qui, cum aqua sæpius abluatur, insipidus fiet; et vocatur *Pulvis Algaroth*, vel (impropriè licet, cum nihil insit Mercurii) *Mercurius vitæ*; qui, si fusus sit, vitrum fucinei coloris evadet.

14 Liquor post pulveris Algaroth præcipitationem remanens Butyri aliquid in se retinet soluti, quod evaporatione crystallos, distillatione sale sublimatum in collo retortæ exhibet, aere non deliquescentem, spiritu vini solubilem, sali sedativo haud absimilem. Ipse liquor, sed nullo jure, nuncupatur *Spiritus vitrioli philosophicus*.

15 Si acidum nitri a Butyro Antimonii distillatione separetur, Aqua Regia nonnullis forsitan Reguli partibus inquinata obtinebitur, quæ vulgò dicitur *Spiritus Nitri bezoardicus*, a massa residua novi spiritus nitri abstractione subsequente calcinatione et ablutione conficitur pulveris; qui dicitur *Bezoardicum minerale*.

16 Sal Alkali fixum tum coctione tum fusionem ex Antimonio crudo sulphur ejus extrahit, et sic *Hepar Sulphuris* constituit; quod partem

regulinam Antimonii statim dissolvens hepar efficit Antimonii, colore hepatico vario, et aqua copiosius aut parcius solubile, pro diversis proportionibus quibus Alkali fixum et Antimonium una admisceantur. Ex Hepate Antimonii Pharmaceutici parant medicamentum quod vocant *Crocum metallorum*, nec non *Vinum antimoniale*, *Tartarum emeticum*, &c.

17 Sulphur, quod ab Hepate Antimonii aqua soluto per Acetum aut Acidum quodcunque præcipitetur, *Sulphur Antimonii auratum* nuncupatur. Quod vero spontanea præcipitatione, dum frigescit solutio, dejicitur, *Kermes mineralis* aut *Pulvis Carthusianorum* vocatur: Utrumque a sulphure communi discrepat portione Reguli Antimonii quæ in eo continetur; a se invicem vero distinguuntur, tum proportionem partis regulinæ ad partem sulphuream, quæ minor est in pulvere Carthusianorum quàm in sulphure aurato, tum quòd Kermes mineralis alcali aliquid fixi sibi adjunctum retinet.

18 Si Antimonium crudum nitro commisceatur et deflagretur, massa residua, diversis coloribus insignis, diversis medendi viribus valet; atque *Crocus Antimonii medicinalis* aut *Crocus Antimonii mitior*, *Antimonii Calx diaphoretica*, &c. nominatur; pro variis proportionibus quibus

bus Nitrum et Antimonium inter se misceantur. Si ea quantitas Nitri adhibeatur quæ toti Sulphuris Antimonii deflagratione destruendo satis sit, vis maxima emetica massæ residuæ comparabitur: sin minori aut majori proportione admisceantur, tum aut totum Sulphuris non erit absumptum, aut pars etiam Reguli Phlogisto suo privabitur. Utroque modo mitius fit medicamentum; quippe quòd vel ad Antimonii crudi, vel ad Calcis metallicæ, vires accedat.

19 Regulus Antimonii cum Sulphure liquatus in massam striatam crudo Antimonio similem frigore concrefcet,

C A P. V.

De Bismutho.

1 *Bismuthum* est Semi-metallum cæteris Metallicis Substantiis (Stanno excepto) minore ignis gradu fusile; inter Semi-metalla (Nickel excepto) fixissimum; ponderosum, fragile, ab aëre et aqua vix immutandum; Auri instar purum, non mineralisatum, semper repertum.

2 Bismuthum, in valido igne fufum, fumum
expirat inflammabilem; et, vel per fe, vel cum
C 2 additione,

additione, sublimari potest in Flores flavescen-
tes: In aperto et mitiori igne, mutatur facilli-
mè in Calcem cineream; quæ continuata flam-
mæ reverberatione flavescit, at vix nisi dum ca-
lida restat, rubescet. Calx in Vitrum liquefcit,
pellucidum, fuscum, terrarum vitrificationi et
usibus docimasticis apprimè accomodatum.

3 Acidum Nitri Bismuthum dissolvit magnâ
cum Effervescentia et vaporum eructatione.
Solutio, evaporata, præbet cryсталlos albas:
affusione aquæ puræ, Bismuthum partim in ea
suspenditur; partim ab ea dejicitur; et pulvis
sic dejectus vocatur *Magisterium Bismuthi*, *Blanc
d'Espagne*, vel *Blanc des perles*.

4 Acidum Salis marini, cum Bismutho coc-
tum, parum ejusdem dissolvit: Acidum Vitrioli
nihil, quod præcipitari potest; at colorem ru-
bescentem ab eo extrahit.

5 Si Acidum Vitrioli in Bismuthum fusum
infundatur, vel ab eo abstrahatur, sulphuris
aliquid colore fusco sublimatur, et odor arse-
nici, sentitur.

6 Acida Vegetabilia aliquid Bismuthi,
quod ab Alkali præcipitari potest, coctione
dissolvunt. Alcalia fixa Phlogisto imbuta, et
alcalia volatilia, in Bismuthum eodem fere mo-
do, quo in Argentum, agunt.

7 Bismuthum, cum Sulphure fusum, cum

eo coit et massam efformat striatam, Antimonio crudo quodammodo similem, et facile liquefcentem.

8 Bismuthum cum omnibus Metallicis Substantiis)Zinco et Nickel exceptis) sese fusione commiscet et fluxiliora reddit: Stannum dealbat, durius, magis sonorum, et fragilius simul efficiens.

9 Mercurius et Bismuthum, paribus ponderibus unà fusa, Amalgama solidum constituent. Idem dici potest de Mercurio et Plumbo. At Mercurius, Plumbum, et Bismuthum, paribus ponderibus, Amalgama efformant fluidum: ab hoc Bismuthum, sub specie pulveris grysei, brevi separatur; at Plumbum adeò tenuiter solutum restat, ut per Corium unà cum Mercurio transeat.

10 Aqua ebullit gradu caloris, in Thermometro Fahrenheitiano, 212°. Bismuthum liquefcit gradu 460°. Stannum liquefcit gradu 410°. At Mixtura, ex paribus quantitatibus stanni et bismuthi conflata, liquefcit gradu 280°.

11 Si Plumbum, Stannum, et Bismuthum unà fundantur paribus ponderibus, Massa mixta minori dicitur liquefcere ignis gradu quàm eo quo aqua ebullit.

C A P. VI.

De Zinco et Lapide calaminari.

1 **L**APIS Calaminaris tertiam vel maiorem ponderis sui partem, Florum specie nec sulphur nec arsenicum redolentium, ustulatione amittit. Si cum pulvere carbonum permisceatur, et igne vehementissimo vasis quantum fieri poterit clausis distilletur, Substantiam præbebit Metallicam, ex cæruleo albam; quæ *Zincum* appellatur.

2 *Zincum* est Semi-metallum: vel striatum, ut *Zincum Goslariense*; vel tessellis distinctum, ut *Indicum* et *Anglicanum*; durum; sonorum, malleo (dum frigidum est) aliquantum cedens; in pulverem trituratione non reducendum; in igne liquefcens simul ac rubet, at *Plumbo* difficilius; sæpius fusum, fit (*Stanni* instar) durius, fragilius, minùs fusile, et calcinationi minus obnoxium: ab aëre et aqua non multum mutatur.

3 *Zincum*, igne leniori fusum, mutatur in *Calcem*: at si violentior sit ignis, inflammatur cum strepitu, et odorem emittit arsenicalem; flamma lucidissima, viridis, ne minima fuligine inquinata, durat donec tota *Zinci* massa sit combusta

combusta et in Flores albos, levissimos, Gossypio similes, (quos *Lanam* nuncupant *Philosophicam*) sublimata.

4 Zinci Flores ab Acidis omnibus dissolvuntur; Phlogisti additione, in vasis clausis *reducuntur*; in igne fixi restant, et in vitrum coloris prafini tandem convertuntur.

5 Acida omnia mineralia, nec non Acetum faciliori negotio Zincum quam cætera Metallica Corpora dissolvunt: Si cum Oleo vitrioli distilletur Sulphur sublimatur, Residuum Arsenicum olet.

6 Zincum dum, ab Acido vitriolico aquoso, vel ab Acido marino concentrato, dissolvitur, Aerem, vel vaporem elasticum, fœtidum, inflammabilem copiose emittit; at nihil Sulphuris præbet.

7 Pondus totum Aeris inflammabilis qui, per solutionem Zinci in Acido vitriolico generatur, æquale circiter deprehenditur parti vicestimæ-quartæ ponderis ipsius Zinci.

8 Densitas aeris inflammabilis fere eadem est ex qualicunque metallo, vel qualicunque Acido fit genitus.

9 Aer inflammabilis, per Solutionem Zinci generatus, levior est aere communi (Thermometro denotante gradum 50 et Barometro 30 uncias) in proportionem circiter 11 : 1.

10 Zincum

10 Zincum in Acido vitriolico solutum, evaporatione concrefcit in Cryftallos, quæ vocantur *Vitriolum Album* vel *Goslariense*.

11 Zincum cum omnibus Metallicis Subftantiis (Bismutho excepto) fufione uniri poteft. Paullò difficilior coit cum Ferro; facilius cum Cupro; cum reliquis facillime.

12 Zincum ab omnibus Metallicis Corporibus diffinguitur; et ab iis depurgari poteft: eò quòd cum Sulphure aut Hepate Sulphuris colliquefactum, nullam ab iis mutationem patitur.

C A P. VII.

De Cobalto et ejus Regulo.

1 **S**I Cobaltum uftulatione in furno reverberarii ab arfenico liberetur, in pulverem poftea redigatur, et cum duplo vel triplo arenæ aut filicum calcinatorum et contuforum mifceatur, mixtura aquâ irrorata in maffam quafi lapideam brevi indurefcit, et *Zaffera* vocatur.

2 Omnia Acida mineralia Zafferræ venalis aliquid diffolvunt; acida vitrioli et nitri colorem fulvum aut rofeum ab ea extrahunt qui calore non mutatur; cum ab acido marino facta eftolutio color ejus dùm frigida manet, eft
fulvus

fulvus aut intense viridis prout acidum est aquâ dilutum necne; at dum calefcit solutio fulvus mutatur in viridem.

3 Zaffera in acido vitriolico soluta, forma pulveris cærulei præcipitatur ab alcali fixo phlogisto imbuto; si uberior alcali copia adhibeatur præcipitatum fit e cæruleo gryseum quod tamen affusione spiritus falis colorem cæruleum recuperat prorsus uti evenire solet cum cæruleum Berolinense a solutione vitrioli viridis dejectur.

4 Zaffera in acido vitriolico soluta gallarum decocto affundendo nigrescit.

5 Zaffera ab acido quovis præcipitata, cum oleo aut sevo mista et igne leniter calcinata fit pulvis niger qui magneti obsequitur.

6 Zaffera igne liquefcit in vitrum cæruleum, quod cum in pollinem subtilissimum reducitur vocatur *Smaltum* vel *Encaustum cæruleum*.

7 Si Zaffera aut smaltum cum substantia inflammabili una fundantur, odor arsenicalis sentitur, et substantia metallica in fundum præcipitatur quæ dicitur *Regulus Cobalti*.

8 *Regulus Cobalti* a reductione Zafferæ ab acidis præcipitatæ vel smalti proveniens est fragilis admodum et durus, coloris grysei, texturæ lævis at non granulata; a magnete promptissime atrahitur, calcinatione mutatur in pul-

verem nigrum qui ab igne vehementiori in vitrum cæruleum, ferri instar, liquefcit.

9 In Regulum Cobalti, acida vitrioli et falis marini vix agunt; solutio in acido nitri facta est rubra, in aqua regia viridis.

10 Regulus Cobalti per Alkali fixum commune ab aqua regia præcipitatur in pulverem rubescentem, per Alkali phlogisto imbutum in pulverem cæruleum.

C A P. VIII.

De Nickel.

1 **N**ICKEL est Semi-metallum ex gryseo rubens, cæteris minus fusile, in calcem viridem mutabile, quæ in igne etiam fortissimo vix liquefcet in vitrum.

2 Si Nickel et Bismuthum una fundantur et sub fusione admisceantur, Nickel conjunctionem cum Bismutho, prorsus aufugiens semper supernatat, et Bismuthum in imum subsidet.

3 Acidum vitriolicum sive concentratum, sit sive aqua dilutum Nickel non dissolvit: Acidum marinum paullo segnius in illud agit; Acidum nitri cum fumorum rubrorum eructatione violenter dissolvit, solutio viret, et ab Alkali volatilis affusione fit cærulea.

4 Dum

4 Dum Nickel ab acido nitri dissolvitur flocculi grysei ab eo separantur, qui in igne et sulphuris et arsenici dant indicia.

5 Nickel ab acido nitri per alcali fixum præcipitatur in pulverem subviridem.

C A P. IX.

De Plumbo sive Saturno.

1 **P**lumbum est Metallum imperfectum, minus quam cætera durum, elasticum, tenax, et sonorum; Stanno minus fusile: ab actione aeris et aquæ rubiginem quandam gryseam contrahit at difficilius corroditur quam Ferrum.

2 Filum Plumbi cylindricum cujus diameter decimæ partē unciae æqualis est sustinere potest pondus $29 \frac{1}{4}$ Librarum.

3 Plumbum in igne fluit antequam candescit; aucto calore effumat et ebullit; fusum in superficie tegitur pelliculâ cinereâ versicolore; quâ semotâ vel cum plumbo mixtâ, altera enascitur; et sic tandem tota massa in Calcem converti potest quæ vocatur *Plumbum ustum*. Hoc autem, Plumbo in hunc finem adhibito, levius est.

4 Plumbum ustum si subitam ignis violenti actionem

actionem patiatur, fit Olei instar fluidum, et in Scoriam convertitur vitrescentem, ex squamosis lamellis, flavescentibus aut rubescentibus, pro diverso ignis gradu, constantem et *Lithargyrus* vocatur. *Lithargyrus* æquè ac Plumbum ustum in igne mitiori diutiùs detentus, flammâ simul in superficiem ejus supernè reverberatâ, fit primo flavus, deinde aureus et Gallico idiomate a Pictoribus dicitur *Massicot*; tandem ruber, et vocatur *Minium*.

5 *Massicot* in igne calefactus fit e flavo ruber, frigescens iterum fit flavus.

6 Plumbum in Minium conversum licèt multum de substantiâ suâ Florum formâ deperdat, pondere plusquam decimâ parte augeatur; at Minium illud nihilominùs, *Reductione factâ*, pondus æquale ponderi Plumbi ex quo erat confectum minimè præbebit.

7 *Lithargyrus*, *Massicot*, *Minium* aliæve Plumbi Calces facilè liquefcunt in Vitrum coloris aurei.

8 *Lithargyrus* vel Vitrum Plumbi cum lapidibus, vel terris quibuscunque refractariis fusus, mirificè earum liquefactionem promovet; et Metallica corpora (Auro, Platinâ et Argento exceptis) in Scoriam vel Vitrum secum rapit; et hinc commodè adhibetur tùm ad Vitra conficienda pellucidissima, tùm ad Metalla perfecta

a Mineris et Metallicis imperfectis purganda.

9 Plumbum ab Acido Nitri aquâ diluto copiosè dissolvitur. Solutio evaporata in Crystallolos concrefcit, albas, pyramidales, sapore dulces, aufteras; quæ in vase clauso igni expofitæ crepitant at non inflammantur.

10 Plumbum in Acido Nitri folutum, inde præcipitatur ab Acidis tum Vitrioli tum Salis marini quibus fefe conjunget: cum Acido marino fic conjunctum Plumbum quod corneum vocant, cum Acido Vitrioli, Vitriolum Plumbi conflituit.

11 Si Plumbum fit cum Acido Vitriolico concoctum aliquanta ex parte diffolvitur; Diffillatione in vafis claufis inflitutâ, totum corroditur in maffam albam aquâ ex parte folubilem; vapor Sulphureus, qui inflammationem nonnunquam admittit, fub fine exit et Sulphur fimul fublimatur.

12 Si in Plumbum fufum Acidum Vitriolicum infundatur, Sulphur communi prorfus fimile flatim fublimatur.

13 Si Plumbum fit cum Acido marino coctum exigua ejus pars ab Acido diffolvitur. Solutio, debitâ factâ evaporatione, Crystallolos fiftit, albas, pellucas, Nitro haud abfimiles; vel cum adhuc calida fit in aquam frigidam infufa, præcipitatum præbet eximie album.

14 Acetum

14 Acetum longâ digestionem parum Plumbi dissolvit; at in vapores resolutum illud rodit in rubiginem squamosam, friabilem, insipidam, inodoram, quæ vocatur *Cerusa alba*.

15 *Cerusa alba*, vel *Lithargyrus* vel *Minium* si cum Aceto coquatur ab eo dissolvitur. Quælibet, harum solutionum usque ad Mellis ferè crassitiem evaporata, Salem præbet crystallinum, dulcem, stipticum, venenosum, dictum *Saccharum Saturni*. Quod distillatione spiritum ardentem præbet.

16 Olea Vegetabilium five Stillatitia five pressa Plumbum integrum vel Calces ejus quælibet, (copiosius autem Minium) in coctione dissolvunt. Solutiones ab Aceto possunt decomponi: et Olea pressa sic a Plumbo liberata Spiritu Vini fiunt solubilia.

17 Alcalia fixa per Calcem vivam acuata, parum Plumbi dissolvunt, multum rodunt.

18 Si Calx quælibet Plumbi vel Plumbum integrum cum Sulphure liquefiat, in Mineram, igne vix fusibilem at naturali Plumbi Minerae specie per similem mutabitur. Plumbum cum Arsenico fustum in Flores partim sublimatur, partim in Vitrum hyacinthinum mutatur.

19 Plumbum cum omnibus substantiis Metallicis (Ferro excepto) per fusionem commisceri potest.

20 Si Mixtura Metallica ex Plumbo et Stanno confecta fit fusa cum ferro, Stannum (connubium Plumbi respuens) sese Ferro adjunget.

21 Si Mixtura Metallica ex Ferro et Cupro vel ex Ferro et Argento conflata, fit fusa cum Plumbo, Cuprum vel Argentum Ferrum deferret, et cum Plumbo in massam coibit.

22 Si Mixtura Metallica ex Plumbo et Stanno confecta fit fusa cum mixturâ ex Ferro et Argento conflatâ Stannum (Plumbum deferens) sese Ferro adjunget; et Plumbum simul Argenti connubium petit, et massas (utcunque sub fusione agitantur) distinctas, cum frigescent, semper exhibebunt.

23 Plumbum scriptorium five Molibdæna, igne violentissimo occluso, ferè nihil; igne aperto decimam quartam partem ponderis amittit. Residuum ne particulam præbet Plumbi at Ferri Magneti obedientis multum.

24 Plumbum scriptorium, in pollinem comminutum, cum Sulphure liquato intime coit et massam vix a verâ Minerâ distinguendam constituit; nisi quòd in flammâ candelæ accenditur et fumum Sulphureum exspirat.

C A P. X.

De Cupro sive Venere.

1 **CUPRUM** est Metallum imperfectum; Auro, Argento, Plumbo et Stanno magis durum et elasticum, at in igne minus fusile; Plumbo et Stanno magis ductile et fixum: et omnium maximè sonorum.

2 Cuprum, diu candescens, tandem fluit; fusum, fit humidi admodum impatiens; in aperto igne violentiori si detineatur, Pondus ejus diminuitur, Superficies comburitur et in Crocum subrubrum convertitur, qui ab igne solari densato vitrum fit rubrum.

3 Ea est *Cupri tenacitas* ut filum cylindricum, cujus diameter æqualis est decimæ parti unciae sustineat pondo $299\frac{1}{4}$.

4 Cuprum ab omnibus Acidis, tùm mineralibus tùm vegetabilibus, dissolvitur, nec non ab Alkali fixo et volatili, a Salibus mediis, Oleis expressis et essentialibus; ab ipsis Aere et Aquâ eroditur et in Æruginem mutatur: frictu calefactum, odorem; manducatum, saporem nauseam moventem præbet.

5 Cuprum ab Acido Nitri facillimè dissolvitur; ab Acido marino difficiliùs, ab Acido triolico

triolico difficillimè, nisi acidum sit concentratum et ebulliens. Hæc Solutio crystallos dat, cæruleas, figura rhomboidales, in aere non deliquescentes, quæque *Vitriolum* constituunt quod a Mercatoribus *Romanum* aut *Cyprium*, vel *Cuperosum cæruleum* vocatur.

6 Ab aquis cæmentatoriis ut vocantur vel, quod eodem redit, a vitriolo cæruleo in aquâ soluto Cuprum purissimum præcipitatur additione ferri. Solutio virescit, acido ferrum fubeunte.

7 Si Cupri lamellæ sint alternatim stratae cum vinaceis exsiccatas (quæ cum vino generoso per fermentationem in acetum abeunte aliquot dies prius fuerint digestæ) erodentur, et superficies singularum viridi-cærulea quadam cooperietur efflorescentia, quæ *Ærugo* vel *Viride Æris* nuncupatur.

8 Cuprum vel Viride Æris venale (quod constat ex Cupro et Acido in proportionem circiter 5 : 7.) ab aceto stillatio solutum, dat per inspersionem crystallos virides, aëre ficco in pulverem fatiscentes, quæ apud Mercatores impropriè dicuntur *Viride Æris distillatum*.

9 Viride Æris distillatum, dimidium penè sui ponderis, Acidi admodum concentrati distillatione præbet, quod *Acetum radicum* vel *Spiritus Veneris* vocatur.

10 Spiritus Veneris est aliquantùm volatilis, odorem exhalat suffocantem; igne Spiritus quemadmodum Vini, est inflammabilis; crys-tallisationem admittit; et *Ætherem acetosum* distillatione cum Spiritu Vini exhibet.

11 Residuum ex Spiritu Veneris præparati-one in Cuprum reducitur per simplicem cum Borace fusionem.

12 Si Cupri limatura et Sublimatum Mer-curii corrosivum unà distillantur, Acidum ma-rinum Cuprum invadens, illud in massam re-finæ citrinæ vel rubræ similem mutabit.

13 Cuprum ab Oleis vel Spiritu Vini solu-tum, vel in integro etiam suo statu igne utcun-que combustum, colorem viridem flammæ im-pertit.

14 Cuprum calcinatum, præcipitatum, sul-phuratum, qualicunque demum modo para-tum, vel etiam integrum vitro mistum et sine additione fusum, colore viridi vitrum imbuit.

15 Si Cuprum sit cum Lapide Calaminari aliâve Zinci Minerâ, debitâ adhibitâ encheiresi colliquefactum, pondere, ad tertiam vel majo-rem ponderis totius partem, augebitur. Mix-tura Metallica flava conflabitur, quæ *Aurichal-cum* vocatur.

16 Aurichalcum frigescens Cupri malleabi-litatem habet; igne calefactum fit fragile; sed
levius,

levius, durius, fusilius, magis sonorum, scorificationi in igne mitiori, actioni aëris et aquæ ipso Cupro minus obnoxium deprehenditur.

17 Aurichalcum in igne diutius fufum mutatur in Cuprum; quippe Zincum five pars metallica Lapidis Calaminaris comburendo dissipatur.

18 Aurichalcum, cum Mercurio trituratione amalgamatum, mutatur in Zincum: quippe Cuprum, restante Zinco, Mercurio adjungitur.

19 Cuprum, cum Zinco liquatum in portione 4 : 1. vel secundum alias portiones, Mixturas varias Metallicas constituit, colore Auro perquam similes, at propter Zinci impuritatem plerumque fragiles; quæ vocantur *Metalla Principis Ruperti*, *Metalla aurea sophistica*, *Metalla Tombacina*, &c.

20 *Cuprum album* conficitur ex Cupro colliquefacto cum Arsenico per Nitrum fixo. Sæpius fufum pondere diminuitur parte circitèr septimâ, in Cuprum rubrum mutatur et sub fusione odorem efflat arsenicalem.

21 Si Cuprum et Stannum, quibus pauxillum Aurichalchi aut Bismuthi nonnunquam adjicitur, per fusionem commisceantur, Mixturam Metallicam constituent subflavam, duram, sonoram, fragilem, Aeris et Aquæ actioni ipso Cupro longe difficilior cedentem; quæ vo-

catur *Metallum tormentorum bellicorum, Campanarum, Æs Caldarium, Bronze, &c.* pro varia proportionē quibus Cuprum et Stannum unā liquantur.

22 Si æquales magnitudines Cupri et Stanni unā fundantur, Mixtura ex his conflata minor erit, parte plusquam quarta, quam cuprum et stannum simul sumpta; pondus tamen haud mutabitur et gravitas specifica fiet ipsâ Cupri gravitate specificâ major.

C A P. XI.

De Ferro sive Marte.

1 **FERRUM** est Metallum imperfectissimum; aëri et aquæ expositum, omnium facillime rubigine exeditur; cæteris, (Platinâ exceptâ) minùs fusile, et (excepto Cupro) magis sonorum; duritiæ et elasticitate omnia exsuperat; et unicum est quod a Magnete ^tatrahitur.

2 Ferri Filum cylindricum, cujus Diameter decimæ parti Unciæ equalis est, sustinere potest pondus 450 Librarum. Hinc Ferrum videtur omnium Metallorum esse tenacissimum. Nam tenacitas non videtur esse mensuranda ponderibus quibus disrumpantur fila metallica earundem

rumdem Diametrorum, ut affolet, sed quibus cohæſio datarum Quantitatum materiæ ſupera-
tur; vel ponderibus, quibus fila, cujus Diame-
tri ſunt in reciproca ſubduplicatâ ratione gra-
vitarum ſpecificarum, diſrumpuntur.

3 Ferrum, violentiori motu attritum, can-
deſcit; igni fortiori expoſitum, in ſuperficie
quodammodo vitreſcit; ad fuſionem accedens
ſcintillat, fumum vel flammam quaſi Sulphu-
ream emittit, et in calcem mutatur: at in
clauſo vaſe Calcinationem non patitur.

4 Si Ferrum excandescens follium continuo
flatu urgeatur, Calor ejus augebitur et li-
queſcet.

5 Ferrum ab Acido vitriolico aquoſo facilli-
mè diſſolvitur. Solutio hæc evaporata Salem
præbet, viridem, rhomboidalem, qui vocatur
Sal Martis, vitriolum vel *Cuperoſum viride*.

6 Ferrum duriffimum, ſub aqua vitriolica
per plures Annos ſubmerſum, fit, ut dicitur,
mollitie et Colore Molibdenæ perſimile.

7 Acidum nitroſum agit violentè in Fer-
rum; marinum paullò ſegniùs; utrumque cum
eo Salem deliqueſcentem efficit; qui, cùm
Acidum marinum adhibetur, in Spiritu Vini
eſt maximâ ex parte ſolubilis.

8 Acida omnia Vegetabilia, tùm nativa tum
fermentatione generata, nec non Sal Ammoni-
acus,

acus, Sales Alcalini, Aqua, et Aer, agunt in Ferrum et varia inde Pharmaceuticis suppeditantur medicamenta. Horum præcipua sunt 1° *Croci martiales* vel *Calces Ferri*, colore rubro aut flavescente tinctæ, sive parantur Calcinatione, Præcipitatione, vel simplici Actione Aquæ, vel Aquæ et Aeris conjuncta. 2° *Tincturæ martiales*, vel Ferrum variis modis in Spiritu Vini solutum. 3° *Flores martiales*, vel Ferrum cum Sale Ammoniaco sublimatum. 4° *Lixivium Martis*, vel Residuum a Sublimatione Ferri cum Sale Ammoniaco quod in liquorem deliquio redactum est. 5° *Vinum Chalybeatum*, vel Ferrum in vino Rhenano digestionem solutum. 6° *Rotuli martiales*, et *Tartarus Chalybeatus*, vel Ferrum cum Tartaro conjunctum, &c.

9 Limatura ferri aquâ madefacta sæpius et exsiccata, in Rubiginem tota convertitur, pondere augetur, et *Salem volatilem*, ut dicitur, distillatione exhibet.

10 Cum Ferrum in Acido vitriolico vel marino dissolvitur, vapor elasticus, foetens, sulphureus generatur; qui admotione Candelæ inflammatur.

11 Si partes æquales Scobis ferreæ et Sulphuris vulgaris in mortario triturentur, et in pastam aqua formentur, Mixtura, paucis elapsis

sis horis, incalescit, turgescit, vaporem sulphureum expirat, et si quantitas sit satis magna, flammam sponte concipit.

12 Ferrum candens cum Sulphure facillimè coit, et ab eo reducitur in Speciem Mineræ aere efflorescentis, Pyritæ martiali efflorescenti perfimilis.

13 Ferrum, uberiori Phlogisto imbutum, mutatur in *Chalybem*.

14 Chalybs, Phlogisto superabundanti privatus, mutatur in ferrum. Quæ? Utrum Phlogiston sit unicum Principium, ex cujus majore vel minore copiâ pendet inter Ferrum et Chalybem discrimen?

15 Chalybs, igne calefactus et aqua frigida subito immersus, fit durus admodum et fragilis; et sic a ferro distinguitur, æquè ac majori suâ gravitate specificâ, fusilitate in igne faciliore, elasticitate majori, Colore magis nigricante, et textura magis compacta, quæ ex granis exiguis, diversarum in diversis Generibus magnitudinum constat.

16 Chalybs expolitus, per diversam ignis actionem, diversos exhibet Colores. Primò flavescit, deinde flavet, rubescit, purpurascit, livescit, nigrescit, tandem aucto adhuc igne candescit.

17 Chalybs, igne candefactus, et immersione in aquam induratus, duritiem suam gradatim

tim amittit dum colores diversos prædictos suscipit; et ex hac coloris mutatione de duritie instrumentorum quæ singulis operibus conveniat judicium ferunt opifices.

18 Ferrum in Acidis solutum adfusionem decocti Gallarum (si solutio saturetur) nigrescit, et lente in fundum subsidet, specie nigri pulveris; qui ab acido maximâ ex parte iterum dissolvi potest.

19 Ferrum in Acido vitriolico solutum, inde præcipitari potest Alkali fixo quod phlogisto qualicumque saturetur idque sub formâ pulveris cærulei; qui a pictoribus nuncupatur *Cæruleum Bærolinense*.

20 In Cæruleum Bærolinense Acida non agunt: Alcalia fixa materiam colorantem ab eo extrahunt, et eâ saturari possint.

21 Alcalia fixa, cum Materia colorante Cærulei Bærolinensis saturata, cum Acidis non effervescent; colorem Cæruleum Vegetabilium non viridescent; et Ferrum, in Acido quocunque solutum, sub cæruleo colore præcipitant.

22 In omni ferè Arenâ, in Argillis coloratis, in Lapide Lazuli, in plerisque lapidibus pretiosis, in cunctorum ferè Vegetabilium cineribus, in Craffamento sanguinis, in Urinâ, et in carne Animalium, in cineres redactis,
vel

vel etiam leni calore exsiccatis, particulæ plurimæ reperiuntur quæ a Magnete attrahuntur.

23 In Offibus Animalium, in pinguedine, et parte sanguinis ferosâ, calcinatis, vel nullæ vel perpaucæ deprehenduntur particulæ Magneti obsequentes.

24 Particulæ quæ Magnetis Vim patiuntur plures reperiuntur in sanguine Hominum et Quadrupedum, quàm in Sanguine Piscium; et plures in Sanguine Piscium quam Volatilium: et, in genere, quò uberior sit Globulorum rubrorum in sanguine innatantium copia, eò major deprehenditur quantitas particularum, Magnetis actioni obedientium.

25 Particulæ, a cineribus magnete separatæ, Acidis dissolvi nequeunt.

26 Ferrum, cum Plumbo fusum, omne cum eo respuit consortium, et ei perpetuo supernatat: at aliis Metallicis Substantiis (zinco forsan, quod calorem debitum sustinere nequeat, excepto) facile per fusionem coit, et Mixturas varias Metallicas constituit: Hæ autem, si ejus cum Regulo Antimonii (ob Sulphur forsan, quo Regulus inquinatur) mixturam excipias, Magnetis attractionem patiuntur.

27 Ferrum cum Mercurio vix amalgamari potest, at sub eo nihilominus per aliquot Dies

F. submersum,

submersum, vel vapor Mercuriali expositum fit, ut dicitur, fragile et friabile.

28 Ferrum materia vitrescente per fusionem mixtum, minore ignis gradu viridem, majore cæruleum ei semper impertit colorem.

C A P. XII.

De Stanno sive Jove.

I STANNUM est metallum imperfectum, præ cæteris metallis levius et in igne fusilius; at Plumbo excepto, minima duritie, tenacitate, elasticitate, sono gaudens: Stridor quidam inter plicandum, ei, Zincum si excipias, est proprius; aëris et aquæ actioni parum profecto cedit.

2 Stanni filum cylindricum cujus diameter decimæ parti unciaæ æqualis est sustinere potest pondus 49 Librarum.

3 Stannum usque fere ad fusionem calefactum, vel post fusionem frigescens et in solidum tantum non condensatum, fit rigidum admodum et fragile, et si motu velociori in eo statu conquassetur in granula minuta, porosa erit divulsam. Plumbum et Aurichalchum similem subeant comminutionem, at Aurum et Argentum quæ fusioni proxima fiunt tenaciora,

ra, Granulationem ea methodo non admittunt.

4 Stannum fufum odorem exspirat arfenicalem, fcintillas emittit, et in calcem albescentem, difficillime reducendam, et in foco etiam speculi uftorii vix vitrificandam, citò calcinatur.

5 Stannum in igne fortiffimo diutius detentum dicitur partim in flores fublimari, partim in calcem rubefcentem redigi, partim in vitrum pellucidum coloris rubei mutari.

6 Stannum et Plumbum una fufa turgefcent, et lucida quafi combustionem citius in cineres exuruntur, quam fingula feorfim calcinata.

7 Si Calces ftanni et plumbi cum filice calcinato vel vitro pellucidiffimo contufo et fale alcalino fixo fimul fundantur, maffam vitrefcentem lacteam in arte fictili et encauftica utiliffimam constituent; cui fi calces aliorum metallorum conjungantur, encaufta varia diverfimode colorata conficientur.

8 Si ftannum cum Acido vitriolico concentrato ufque ad ficcitatem in vafis claufis diftilletur, multum exhibit vaporis fulphurei qui inflammationem nonnunquam admittit, et fulphur fimul in collo retortæ fublimatum invenietur. Quod fi acidum fit aqua dilutum vapor eft femper fere inflammabilis, et fulphur

præcedente ut videtur, minus flavum et in minori copia generatur.

9 Stannum in acido vitriolico aquoso copiose dissolvitur; solutio, debitâ factâ evaporatione crystallos præbet albas, tenues lanugini similes quas *Vitriolum Jovis* nominare liceat.

10 Stannum ab acido marino calefacto et concentrato promptius dissolvitur, et vapor inde inflammabilis sulphur et Arsenicum redolens producitur, cujus pondus æquale circiter deprehenditur parti quadragesimæ quartæ ponderis Stanni soluti.

11 Si Stannum cum Sublimato mercurii corrosivo distilletur, primo in excipulum cadent guttulæ quædam acidi marini, deinde prodibit liquor eximiè fumans, qui *Liquor fumans Libavii* dicitur, (in æthere marino conficiendo utilissimus) tandem in collum retortæ stannum cum acido marino conjunctum sub forma solida elevabitur.

12 Stannum ab acido nitri promptissime dissolvitur, vel potius ni cautè instituatur solutio in calcem corroditur: Ab aqua regia solutio ejus facillime absolvitur; hæc solutio est coloris et spissitudinis variæ, haud raro in solidum, juris instar gelati, concrescit.

13 Stannum in aqua regia solutum, sub leni evaporatione

evaporatione arsenici plerumque crystallos exhibet: quod ab imperfecta mineræ calcinatione provenire censendum est, cum datur stannum ab omni arsenico immune.

14 Stannum in acido nitri vel in aqua regia solutum, et cum purpurascentibus decoctionibus Ligni Brasiliæ, Cochinellæ, &c. mixtum, colores earum in usus tinctiles eximie exaltat.

15 Si Stannum, argentum vivum, sulphur, et sal ammoniacus accuratè admisceantur, ac in igne forti sublimantur, superiora vasorum petet quædam Cinnabaris, in imo remanebit massa levis, friabilis, coloris aurei, quæ vocatur *Aurum Musivum* vel *Musivum*, quod phlogisti additione in stannum reducatur.

16 Stannum in Aceto, vino Rhenano, et succis nativis acidis vegetabilium dissolvi potest.

17 Stannum cum omnibus metallicis corporibus facillime fusione commisceri potest; fragilia (ob arsenicum forsan quo inquinatur) reddit, et difficillime ab iis separatur.

17 Stannum cum plumbo colliquatum fit rigidius; fusum cum Bismutho, Zinco, Regulo Antimonii, &c. fit magis durum, album, et sonorum.

18 Stannum foliatum cum mercurio facillime in Amalgama coit, quo superficies posteriores speculorum planorum obduci solent.

19 Si

19 Si Stannum, Plumbum, et Bismuthum una fundantur, et cum Mercurio commisceantur, Amalgama constituent ad superficies concavas obtegendas apprime idoneum.

20 Stannum fustum cupri et ferri non tantum superficiei adhærescit, sed in intimiora penetrat, ut videre licet in ferreis instrumentis quibus opifices utuntur ad laminas ferreas stanno illinendas.

C A P. XIII.

De Argento sive Luna.

1 **A**rgentum est Metallum perfectum; ductilitate et fixitate Auro proximum; fluit cum primùm candescit, et paullo facilius quam Ferrum, Cuprum et Aurum: Aurum, Plumbum et Stannum duritie et elasticitate superat; omnibus Metallis, (Cupro excepto) magis sonorum est; actione aëris et aquæ prorsus immutabile, at a Sulphureorum halitu infuscatur.

2 Argentum, ut ait Kunckelius, igni vehementissimo furni vitriarii per mensem expositum, 64^a circiter ponderis parte diminutum deprehendebatur; spatio duorum mensium, ut ait Gastus Clavius, decrementum ponderis in eodem igne patiebatur æquale parti duodecimæ ponderis

ponderis totius; ut ait Hombergius, vitro ustorio expositum in fumum abiit, sed in Vitrum non fuit conversum.—Annon ponderum decrementa ignobili alicui Metallo quod cum Argento misceatur, potius quam defectui fixitatis in Argento ipso, attribui debeant?—Annon fumus, quem observavit Hombergius, ipsi Argento in Auras acto, potius quam Argento in partes dissimiles resolutio, referendus est?

3 Ea est *Argentī tenacitas*, ut filum Cylindricum, cujus Diameter æqualis est decimæ parti Unciæ, sustinere potest, pondus 270 Librarum.

4 Argentum non solvitur in Acido Salis marini, viâ humidâ, nec in Aquâ regiâ; difficillimè quidem in Oleo Vitrioli, etiam ebulliente; promptissimè verò in Acido Nitri solvitur. Solutio in Acido Nitri facta, si depuratum sit Argentum, est pellucida, excolor, amara, caustica.

5 Solutio Argenti, in Acido Nitri facta, Capillos, Cutem, Ossâ, cæteraque Animalium solida, nec non Achatem, Jaspidem, pluresque alios lapides fusco vel nigro colore tingit: evaporatione in Cryсталlos concrescit albas, quæ in igne fusæ colorem induunt nigrum et massam causticam constituunt quæ vulgò dicitur, *Luna caustica* vel *Lapis infernalis*; quæ vi minori, aut majori, causticâ pollet, prout Solutio est penitus, vel ex parte, saturata.

6 Argentum,

6 Argentum, ex solutione suâ in Acido Nitri præcipitatum, fit solubile, per Acidum vegetabile, vel nativum, vel ex fermentatione generatum: per Alkali volatile et Alkali fixum, quod conficitur calcinando Sale alcalino fixo, cum sanguine bovino: sed nec per Alkali fixum commune, vel causticum, vel Calcinatione cum Carbone vegetabili paratum, nec per Nitrum fixum detonatione cum carbone vegetabili aut animali. Hoc autem defectui salis alcalini volatilis quo alcali fixum sanguine bovino calcinatum imbuitur, attribui forsân potest.

7 Si in Solutionem Argenti Acido Nitri factam, infundatur Acidum Vitrioli, vel Salis marini, vel Solutio cujuslibet Salis, hoc vel illud Acidum continentis, Argentum deserit Acidum Nitri, et cum Acido vitrioli vel Salis marini conjunctum, Coaguli instar albi, in fundum subsidet.

8 Argentum, cum Acido marino conjunctum et igne fusum, fit Corpus admodum volatile; ex parte pellucidum et quasi corneum; et exindè *Luna cornea* appellatur: quæ in aquâ vix solvitur, et quinta circiter parte, accretione Acidi, Argento soluto ponderosior est.

9 Si Argentum sit cum Acido vitriolico usque ad ficcitatem distillatum, vapor prodit sulphureus, at nihil sulphuris sublimari observatur;

tur; ipsum Argentum in massam duram flavescentem, aquâ maximâ ex parte solubilem, et CrySTALLISATIONIS capacem convertitur.

10 Si in Argentum fusum Acidum vitriolicum infundatur, vapor prodit eximie sulphureus; at Sulphur non separatur.

11 Argentum ab omnibus Metallicis Substantiis (Auro et Platinâ, et perparvâ forsan Cupri Quantitate exceptis) Cupellatione liberatur. In Acido Nitri solutum, et inde ab Acido marino præcipitatum, fit reductione factâ, ab omni Corpore heterogeneo immune et purissimum habetur.

12 Argentum, cum Sulphure fusum, in Massam fragilem convertitur; colore et mollitie plumbi similem. Hâc fusione minima pars Auri a Massâ quâlibet Argenti separari potest.

13 Argentum, cum Cupro Colliquifactione conjunctum, fit magis durum et sonorum. Quod si cum Stanno vel Regulo Antimonii jungatur, pene omnem suam Malleabilitatem perdit.

14 Argentum purum ponitur æquale duodecim denariis. Si ejus pars duodecima sit Cuprum, vel aliud imperfectum metallum, dicitur constare ex undecim denariis; quale est Argentum ex quo *Ludovici* cuduntur. Argentum Anglice dictum *Sterling* constat ex unde-

cim denariis, unâ cum decimâ denarii parte; five Cuprum est ad Argentum ut 3 : 37, in Monetâ nostrâ.

15 Argentum vel sulphuratum, vel præcipitatum vel integrum, cum Vitro crySTALLINO fusione intime mixtum, vel Cæmentatione ut-cunque conjunctum, colorem flavum ei semper impertit.

C A P. XIV.

De Auro five Sole.

1 **A**URUM est Metallum perfectissimum, coloris inter fulvum et subflavum varii; cæteris metallis, plumbo et stanno exceptis minus elasticum, durum, et sonorum; plumbo, stanno, et argento minus fusile; fixitate, pondere, et ductili extensione omnia exsuperans; actione aëris et aquæ immutabile.

2 Aurum in igne vehementissimo furni vi-triarii per plures hebdomadas liquefactum, nullam aut calcinationem aut partium dissipationem patitur: ab igne solari condensato, in auras dissipatur, at nec in vitrum violacei coloris nec in partes dissimiles, ab illo etiam ignis gradu, converti videtur.

3 Aurum in igne candescens funditur, fu-
sum

sum colorem cæruleo-viridem induit, cæteris metallis mole magis augeri videtur; non satis fufum vel subito nimis refrigeratum, fit malleo paullò intraçtabilius, at a carbonum vaporibus fragile non redditur.

4 Auri filum cylindricum cujus diameter decimæ parti unciaæ æqualis est fufcinere potest pondo 500.

5 Aurum cum Borace fufum, fit folito pallidius, refufum cum nitro colorem fuum recuperat.

6 Pofito quod gravitas specifica aquæ diftillatæ et ad gradum 53^m Therm. Fahrenⁱ. calefactæ fit 1,000, gravitas specifica auri purgatiffimi haberi potest 19,376.

7 Auri reliquorumque metallorum etiam puriffimorum gravitates specifiche intra certos limites variæ erunt, propter et diverfam gravitatem abfolutam, et diverfam expansionem aquæ, quâ in diverfis locis et diverfâ cæli temperie ponderantur.

8 Aurum cum omnibus fubftantiis metallis per fufionem commifceatur.

9 Mixtura auri et ferri in minori fluit ignis gradu, quam ferrum ipfum, et inde fit idonea ad ferri fracturas ferruminandas.

10 Mixtura auri et cupri fufilior eft quam aut aurum aut cuprum, et inde utrique fit idoneum ferrumen.

11 Aurum cum Substantia quacunque Metallica colliquatum fit minus ductile ; ab Argento et Cupro malleabilitas ejus minimè diminuitur, maxime autem vel potius aufertur perparvis quantitatibus Plumbi aut Stanni, vel etiam si vaporibus solum, quos fusa emittunt, bilance non dignoscendis fit expositum.

12 Aurum ut moneta fiat, atque ut aliis usibus Oeconomicis inserviat, durius reddi solet mixturâ parvarum quantitatum aliorum metallorum Argenti præcipue et Cupri, vel amborum conjunctim.

13 Massa quælibet auri in partes viginti quatuor, quas Ceratia vocant, dividi semper concipitur ; et dicitur Aurum obryzum ; Aurum caraticum tria et vicenarium, ut Aurum Ducatorum ; Aurum caraticum duo et vicenarium, ut Aurum in Anglia dictum *Standard*, et sic deinceps, prout Aurum sit ab omni mixtura heterogenea illibatum, vel una, duabus, et sic deinceps partibus vigesimis quartis alterius alicujus metalli inquinatum.

14 Aurum, in integro suo et naturali statu, hucusque solubile non deprehenditur ab ullo acido simplici, sulphure, alcali fixo vel volatili : sed ab aqua regia, et hepate sulphuris dissolvi potest.

15 Aurum cum Argento colliquatum, ab
acido

acido marino, debita si adhibeatur Encheiresis, dissolvi dicitur.

16 Aurum in aqua regia solutum, et ex inde per Alkali fixum præcipitatum, ab omnibus acidis tum mineralibus tum vegetabilibus dissolvi potest, nec non a sale Alcalino volatili, et fixo, qui conficitur methodo in propositione 6^a de Argento explicata.

17 Aurum ab aqua regia per Alkali fixum aut volatile dejectum, et leni calore ficcatum, vocatur *Aurum fulminans*, eo quod sive ab igne sive affricu incalescat, cum magno fragore ~~in~~ in auras dissipatur: Hanc autem fulminandi vim, nisi Alkali volatile vel in confectione aquæ regię vel in præcipitatione adhibeatur, non acquirit.

18 Pondus Auri fulminantis majus est pondere auri soluti, parte circiter quarta.

19 Aurum fulminans cum displodatur, cavitates imprimit laminis metallicis non nimium crassis quibus imponitur, vel quibus superne premitur, et non deorsum tantum sed quaquaversum vires suas exerit.

20 Vis Elastica Auri fulminantis, dicitur esse ad vim elasticam pulveris pyrii ut 64 : 1.

21 Aurum fulminans in Sphærâ ferreâ exactissime obturatâ inclusum, ac igni expositum non disploditur; in simili casu pulveris pyrii

pyrii facta est explosio, et sphaera simul disrupta invenitur.

22 Aurum fulminans aqua saepius lavatum, cum oleo vitrioli tritum, cum sulphure fusum, vel ab alcali fixo lixatum vim suam fulminantem amittit.

23 Aurum nec per calcinationem cum vel sine additione, nec per solutionem in aqua regia, nec per sublimationem, nec per explosionem, nec per ullam aliam methodum hucusque repertam, in partes dissimiles resolvatur.

24 Aurum in aqua regia solutum cutem et plures substantias animales ac vegetabiles rubro vel purpureo colore tingit, debita facta evaporatione in crystallos concrescit rubras, et quacunque methodo, metallico suo aspectu sit privatum, et ad pulveris speciem redactum, colorem magis minusve rubicundum plerumque adipiscitur.

25 Aurum, metallorum densissimum, cum vitro puro crystallino colliquifactione confusum, vitri densitatem adaugendo, aptum illud reddit ad reflectendos radios minime refrangibiles, et semper vitrum praebet rubro colore pellucidum.

26 Aurum a menstruo suo extrahitur atque per aliquod tempus suspensum tenetur Oleis Essentialibus; facillime autem separatur Aethere

re vitriolico, et cum unicum sit metallum cui hæc proprietas competit, si cum cæteris vel minima quantitate commisceatur, hoc indicio deprehendi potest.

27 Aurum in aqua regia solutum inde præcipitari potest (si multa aqua diluatur solutio) vel laminis Stanni, vel solutione Stanni in eodem menstruo factâ, sub forma pulveris coccinei qui vulgo vocatur *Cassii purpureum Magisterium*.

28 Una Auri solutionis guttula, per aliquot aquæ uncias diffusa, Stanni interventu colorem purpureum toti aquæ conciliat, et sic ab omnibus Substantiis metallicis quibus admisceatur, facillime dignoscatur.

29 Hepar Sulphuris cum Auro liquatum illud facile et adeo penitus dissolvit, ut Aurum una cum Hepate filtrum permeans, in aqua suspensum maneat.

30 Aurum ab omnibus metallicis substantiis, Platina excepta, optime purgatur fusione cum Antimonio; ab omnibus præter Argentum et Platinam cupellatione cum plumbo; ab Argento solutione in aqua regia; a Platina et minutis portiunculis cupri aliorumve metallorum quæ Catini cinericii vim haud raro effugiunt, per præcipitationem ab aqua regia interventu vitrioli viridis.

C A P. XV.

De Platina sive Auro albo.

1 **P**LATINA est metallum perfectum; fixitate, ductilitate, et gravitate specifica auro vix secunda; cæteris metallis in igne longe minus fusilis, et ferro forsan excepto durior; colore argento obfuscatō similis.

2 Platina, in igne vehementissimo quem furni et crucibula optima sustinere possunt anteaquam in vitrum liqueſcunt, non funditur, sed pondere aliquantulum augmentatur: Hæc ponderis augmentatio, adhæſioni forsan ferri vel metalli cujuscumque imperfecti, quod per calcinationem pondere augetur, referri debet.

3 Platina, radiis solaribus condensatis in foco speculi concavi cujus diameter æqualis erat 22 unciis et focalis distantia 28 unciis, exposita ex parte in fumum erat acta, ex parte fusa in corpus album, splendescens, admodum malleabile.

4 Platina non solvitur ab acido vitriolico aquoso aut concentrato, frigido aut ebulliente; nec ab acido marino viâ aut humidâ aut siccâ; nec ab acido nitri communi aut fumante; nec a sulphure communi, nec ab antimonio crudo,
et

et hinc ab omnibus substantiis metallicis, auro excepto, distinguitur.

5 Platina ab aqua regia et hepate sulphuris, instar auri, dissolvi potest.

6 Platina in aqua regia soluta est coloris aurei, aut fusci in rubedinem vergentis, prout solutio est ex parte vel penitus saturata: Hæc solutio evaporatione concrescit in crystallos rubentes; solidis animalium partibus, lamellis vel solutioni stanni colorem rubrum aut purpureum, lavatione aquæ haud eximendum, non impertit; a sale ammoniaco ex parte præcipitatur Platina, sed nec a vitriolo viridi, nec ab Alkali fixo minerali; ab Oleis essentialibus, Æthere vitriolico, aut Spiritu Vini rectificato a menstruo suo non separatur, et hinc ab ipso auro distinguatur; minimaque hujus vel illius metalli portiuncula, in mixtura quavis metallica ex ambobus conflata, his præcipue similibusque indicibus facillime dignoscatur.

7 Platina ab aqua regia per Alkali volatile præcipitata, exsiccata et igni exposita non fulminat, et sic etiam ab auro discrepat.

8 Platina a menstruo suo præcipitata, cum vitro contuso mixta, et igni violentiori per longum tempus exposita, nec cum vitro fusionem conjungi, nec colorem ullum ei communicare videtur.

9 Platina cum omnibus substantiis metallicis per fusionem coit: si cum Aurichalci pari pondere fundatur, massa conflabitur dura quidem et fragilis, quæ polituram eximiam suscipit, et nitorem suum diu conservat.

10 Platina cum Plumbo aut Bismutho fusa, et cupello subjecta, igne vix vehementissimo ab istis metallis, adeo penitus liberari potest, ut fiat malleabilis.

11 Aurum cum Platina colliquatum, fit durius et in igne simul minus fusile, quod in mixtione sua cum aliis metallis non evenit.

12 Mercurius qui majorem habet Affinitatem cum Auro et Argento quam cum Plumbo, habet etiam majorem cum Platina; sed minorem cum Platina quam cum Auro.

13 Platina majorem habet Affinitatem cum plumbo quam cum ferro.

14 Platina Auri instar minorem habet Affinitatem cum aqua regia quam aut Zincum, aut Ferrum, aut Cuprum, aut Stannum, aut Argentum vivum.

