Record of work done in the Chemical Department of the Owens College, 1857-1887 / by Sir Henry E. Roscoe.

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RECORD OF WORK DONE

IN THE

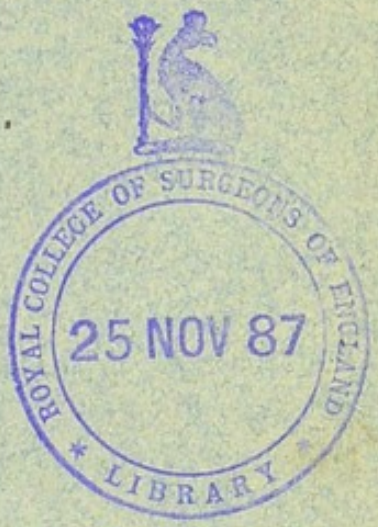
26

CHEMICAL DEPARTMENT

OF THE

OWENS COLLEGE,

1857—1887.



BY

SIR HENRY E. ROSCOE, B.A., PH.D., LL.D., F.R.S., M.P.

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RECORD OF WORK DONE

IN THE

CHEMICAL DEPARTMENT OF THE OWENS COLLEGE.

1857—1887.

Introduction.—Early History of the Chemical Department.—I have felt that I should wish to leave behind me some kind of connected record of the work done in the Chemical Department of the Owens College during the thirty years in which it has been under my direction, however imperfect that record may be.

In the first place I desire to recall the position of the College in 1857. The total number of Students was 34, and of these 15 worked in the Chemical Laboratory. The institution at that time had not gained in any degree the confidence of the public, it had for many years to fight a stiff battle, and it was only gradually that the idea could be generally grasped that Science could be made an efficient instrument of education, and that such an education

was not only compatible with, but absolutely necessary for, a successful manufacturing and industrial career. Nor was it an altogether easy task to convince the Trustees of the College that a mere repetition on an insignificant scale of the old university idea of a mainly classical training could not be expected to succeed in Manchester, or to bring home to them that unless the institution was to sink down to the level of a school (as many advocated), or die out altogether, some new line had to be struck out, and that the only possible one was that of the encouragement and development of the teaching of Physical Science. The fact that the stipend of the Professor of Chemistry was fixed at one-half of that given to the other Chairs shows the feeling entertained by the Governing Body as to the relative importance of this subject and those of Classics and Mathematics. To make the above idea a reality, so far as Chemistry and the Allied Sciences are concerned, was my ambition, and after thirty years of work, I think it must be admitted that this has been, to some extent at least, realised, for at the present time there are I believe few engaged in this district in any large way of business in which Chemistry plays a part, who have not shown their appreciation of the value of Scientific Education by sending their sons or their managers to learn Chemistry at Owens College; whilst for many years past our Chemical Laboratories have been over-crowded, as shown in the following numbers, the Labora-

tories having been built to accommodate 100 workers :—

1881-2	108
1882-3	118
1883-4	111
1884-5	120
1885-6	118

Necessities for English Industrial Success.—For years I have been firmly convinced that the great blot in English Industrial life is a singular want of appreciation of one of the essential conditions of success, viz. a sound and thorough training in the scientific principles which underlie all practice, and I have felt certain that unless a more profound and intimate connection between Science and Practice is established, our continental rivals who practise with knowledge must in the long run out-bid our own manufacturers who hitherto have practised by rule of thumb. In what way could such a belief in the efficacy of Scientific Training be induced? Only by proving to the practical man that the youths trained in the Chemical School of Owens College were able not only to take a more intelligent part in the operations of the various manufactures than those who had not had such advantages, but that this education had given an insight into these processes such that those thus trained were able to effect improvements or even to make discoveries of importance.

LIST I.

Total number of Students in the Day Classes of the College 1857—1886, and number of Students in the Chemical Laboratory for each of those years.

Sessions.	Total in Day Classes including Chemical Laboratory.		No. in Chemical Laboratory.
1857—58 . . .	34		15
1858—59 . . .	40		23
1859—60 . . .	57		24
1860—61 . . .	69		21
1861—62 . . .	88		22
1862—63 . . .	108		34
1863—64 . . .	110		38
1864—65 . . .	128		49
1865—66 . . .	113		41
1866—67 . . .	113		37
1867—68 . . .	173		44
1868—69 . . .	210		57
1869—70 . . .	209		51
1870—71 . . .	264		60
1871—72 . . .	327		66
1872—73 . . .	337		66
1873—74 . . .	356		78
1874—75 . . .	375		71
1875—76 . . .	395	166*	77
1876—77 . . .	415	175*	98
1877—78 . . .	418	175*	77
1878—79 . . .	443	210*	81
1879—80 . . .	392	232*	87
1880—81 . . .	417	237*	91
1881—82 . . .	390	277*	108
1882—83 . . .	373	274*	118
1883—84 . . .	400	304*	111
1884—85 . . .	393	308*	120
1885—86 . . .	380	323*	118
1886—87 . . .	333	279*	101†
			1884

* Those marked with an asterisk are Medical Students.

† Up to December 1, 1886.

Plan of Laboratory Teaching.—Hence it became necessary to establish a thorough and systematic course of Theoretical and of Practical Instruction, and to make that system a reality. The gradual increase in the number of men studying Chemistry from the year 1857 onwards (see List I.) shows how far my efforts, seconded as they have always been by my colleagues, and by the able Demonstrators and Assistant-Lecturers (see List II.) with whom it has been my great good fortune to work, have succeeded. Nor has this result, like everything that is worth doing, been accomplished without the devotion of years of labour on the part of the Professor and his Assistants. The personal and individual attention of the Professor is the true secret of success; it is absolutely essential that he should know and take an interest in the work of every man in his laboratory, whether beginning or finishing his course. The Professor who merely condescends to walk through his laboratory once a day, but who does not give his time to showing each man in his turn how to manipulate, how to overcome some difficulty, or where he has made a mistake, but leaves all this to be done by the Demonstrator, is unfit for his office, and will assuredly not build up a school. It is in the Laboratory, and there alone, that Chemistry can be properly learnt, and it is by the peripatetic teaching of the professor and his demonstrators that the student benefits most.

LIST II.

PROFESSORS.

Appointed.		Resigned.
1857	Sir H. E. Roscoe, B.A., Ph.D., LL.D., F.R.S., M.P.	1886
1874	Carl Schorlemmer, F.R.S. (Organic Chemistry).	

DEMONSTRATORS, AND ASSISTANT LECTURERS.

1858	F. Guthrie, Ph.D., B.A., F.R.S. (deceased) . .	1859
1859	W. Dittmar, F.R.S.	1861
1861	C. Schorlemmer	1873
1869	T. E. Thorpe, Ph.D., F.R.S.	1870
1870	Francis Jones	1872
1872	Henry Arthur Smith, F.C.S.	1872
1873	C. Schorlemmer, F.R.S., Lecturer	1874
1873	Wm. Dittmar, F.R.S.	1875
1873	W. Carleton Williams, B.Sc., F.C.S.	1883
1873	Harry Grimshaw	1875
1875	M. M. Pattison Muir, F.C.S., F.R.S.E.	1877
1875	Oswald Wilkinson	1876
1875	Thomas Carnelley, D.Sc.	1880
1878	J. B. Hannay, F.C.S., F.R.S.E.	1879
1879	P. P. Bedson, D.Sc., F.C.S.	1882
1880	Watson Smith, F.C.S., F.I.C.	
1882	Harry Baker, F.C.S.	
1883	Arthur Smithells, B.Sc.	1885
1883	W. Bott, Ph.D.	1886
1885	Julius B. Cohen, Ph.D.	
1885	George H. Bailey, D.Sc., Ph.D.	

TECHNOLOGICAL CHEMISTRY.

1885	Watson Smith, F.C.S., F.I.C., Lecturer.	

METALLURGY.

1876	James Taylor, Honorary Demonstrator	1878
1885	W. H. Gardner, Lecturer.	

Lectures. — But I would by no means wish to depreciate the value of attendance on a thorough course of Experimental Lectures. By this means the principles and the important facts of the science are brought before the student in a consecutive and systematic manner, and illustrated by experiment, preparation, and diagram, in a way impossible for the pupil himself to make. The delivery of my lectures to both day and evening students has for thirty years been a uniform pleasure to me; the devising of new experimental illustration is always a matter of interest, and those who have attended these courses will acknowledge, as I have pleasure in doing, the long-continued services in this respect of our friend, Mr. Joseph Heywood. I have likewise of late years made it a practice to obtain short courses on special subjects from some of our Assistant Lecturers or from our Berkeley Fellows. Thus Dr. Bailey and Dr. Brauner have given lectures on Thermal Chemistry, Mr. Baker a practical course on Crystallography, Dr. Bott a similar course on Gas Analysis, and Dr. Cohen a set of lectures on Advanced Organic Chemistry. These have proved of signal value to and been fully appreciated by the senior men.

Elementary Laboratory Teaching.—My idea of elementary laboratory teaching is, that to be of any use it must inculcate method and accuracy both in theory and practice. The student must be put on a sound track, and made to understand what he is doing, and why he does it. Moreover, he must

gradually gain the power of exact observation, and of logical inference. All these faculties are exercised and developed in a properly organised and thorough course of qualitative chemical analysis. The objections which have been urged by some against this system as "mere test-tubing," indicate, to my mind, a want of knowledge of how to teach, and what can be taught, on the part of the critic; and I venture to assert, on the contrary, that no elementary course of practical scientific work is more useful, either in training the hand or the head, than a properly conducted course of qualitative analysis. This, however, presupposes that a training in the theory accompanies the practice of qualitative analysis, and that a course of lectures, in which the reactions and methods of separation are systematically explained and discussed, is attended as well as a general course on Theoretical Chemistry; such lectures have for several years past been most ably given by our Demonstrator, Mr. Harry Baker.

By degrees a system of work grew up amongst us, and this was arranged and published by my friend and our former Demonstrator, Mr. Francis Jones, under the title of the *Owens College Junior Course of Practical Chemistry*, and this little volume is, I have reason to know, largely used and much valued in other laboratories as well as in our own. Yet I would not have it supposed that our system is complete or even perfectly satisfactory; difficulties of all sorts accompany the teaching of a large

number (generally between 60 and 70) of beginners. It has, however, been our aim not to settle down into a stereotyped system, but constantly to make such changes, or to include such new processes, as might from time to time seem desirable, whilst preserving the general features of the course.

Recognition of the Value of Scientific Education.—The student on completing his course of qualitative analysis and of inorganic preparations at the end of his first session is only, however, on the threshold of his work. And here I may refer as a strong proof of the general public recognition of the value and meaning of a Scientific Education, to the fact of the growing willingness of parents and of young men themselves to devote such an amount of time to their studies as shall enable them to derive real benefit therefrom. In the earlier years the prevailing notion of the majority of manufacturers (though amongst them there were notable exceptions) was, that if his son stayed at college for six months he could be "put up" to all the necessary information to enable him to apply chemistry to his business. The fathers frequently used to come with a story of this kind: "I am a calico printer, or a dyer, or a brewer, and I want you to teach my son Chemistry so far, and only so far, as it is at once applicable to my trade," and when informed that Chemistry as a science must be taught before its applications could be understood, and that his son could not for two or three years at least begin to work upon the subjects

directly bearing on his trade, he too often replied that if that were the system he could not afford time for his son to learn on this plan, and that if he could not be taught at once to test his drugs, he should prefer to leave him in the works, where he and his father before him had made a great many commercial successes with no scientific knowledge, and where he saw no reason to doubt that his son would do the same. The change that has come over our manufacturers during the last five-and-twenty years has been remarkable, and now all are, I believe, fully awake to the necessities of their position, and are most desirous of improving the scientific knowledge not only of themselves and of their sons, but of their managers, foremen, and workpeople. That this is so may be proved by the fact that whereas, formerly, it was difficult to keep our students for more than one session, we now find our Senior Laboratory well stocked with men in their third, fourth, and even fifth years, working at advanced subjects and becoming "Chemists" in the highest and best sense of the word. And that our men are not only soundly and well-grounded in their science, but that many of them turn out accurate and even accomplished analysts is seen from the fact, amongst others, that, in the last three years, eighteen of our men have successfully passed the somewhat exigent practical examination for the Associateship of the Institute of Chemistry of Great Britain. The names of these gentlemen are found below.

LIST III.

ASSOCIATESHIP EXAMINATIONS OF THE INSTITUTE OF CHEMISTRY.

SUCCESSFUL CANDIDATES.

1884.

A. T. Mason.
D. Macnair.
A. W. Warrington.
H. C. Brown.

1885.

Arthur Harden.
H. G. Colman.
F. J. H. Coutts.
H. E. Brothers.
W. D. Radulowits.
Alfred Siebold.
Aug. Schloesser.

1886.

W. B. Hart.
Chas. A. Pauls, B.Sc.
G. J. Fowler, B.Sc.
C. W. Lowe.
W. L. Bunting.
T. Miniati.
Hy. Smith.

Advanced Course of Laboratory Work.—Having obtained a knowledge of the principles of the science, and a certain amount of facility in manipulation, and reliance on his own powers of experimentation and observation, the student on entering upon his second year's course commences Quantitative Analytical work. In this he learns by degrees what scientific accuracy means, how exact results can be obtained by careful work, and thus gains in confidence and certainty. Here, too, constant personal supervision on the part of the professor and of the demonstrators is absolutely requisite, as everything depends on the care with which the various operations are carried on, as working from receipts without superintendence is really valueless. The Course of Inorganic Quantitative work must likewise be systematic, a series of well-chosen examples of estimations and separations

being made by each pupil so as to give him practice in the best and most accurate methods for the determination of the more important elements and compounds contained in a variety of salts, minerals, &c. After much experience of the books on the subject we decided to print short directions of the methods found best, and these were collected by Mr. Watson Smith, and have been found most useful. One main object of this course is to give the pupil reliance on his own power of exact work, to make him aware of the sources of experimental error, and to enable him to estimate their amount. This can be accomplished as well by accurate volumetric as well as by gravimetric work, and hence this branch is one much encouraged. All the analyses thus made by the pupil are carefully entered up in a general log-book, so that at any time reference can be made to the extent, accuracy, and reliability of his work.

On this firm foundation of a competent theoretical knowledge of Inorganic Chemistry, and of a thorough practical acquaintance with Qualitative and Quantitative Inorganic Analysis, and on this alone, can, I have always been convinced, the proper and higher education of the Chemist, whether for purely scientific or for technical purposes be based, and upon this view I have for years consistently acted. Thus I have always set my face against the pupil "practising" the rough and ready methods used in works before he has learnt to appreciate the exacter processes, and it has been my constant

endeavour to supplant the often crude and incorrect trade tests by a more precise, though perhaps somewhat more lengthy system. Having, however, once obtained a satisfactory judgment as to the capability of the several methods, the student can occupy himself, according to his taste or necessities, with the determination and valuation of pure and impure products according to the most approved commercial processes.

Organic Chemistry.—Whilst thus gaining a practical acquaintance with Quantitative Methods, the pupil is attending a course of lectures on more advanced theoretical Inorganic Chemistry, and begins the study of the Carbon Compounds.

The history of the growth of the department of Organic Chemistry in the Owens College is of interest. When, in 1859, Mr. Dittmar, F.R.S. (now Professor at Anderson's College in Glasgow), resigning my private assistantship, was appointed to the sole Demonstratorship in the Laboratory *vice* Dr. Guthrie (whose death Science has recently had to deplore), Mr. C. Schorlemmer, a young chemist of Darmstadt, was recommended by Mr. Dittmar as my private assistant. In due course Schorlemmer showed his mettle, succeeding Mr. Dittmar as College Demonstrator in 1861, and whilst continuing to discharge the duties of Senior Demonstrator for no less than thirteen years, he won for himself by his original investigations the position of one of the first Organic Chemists of the day. During the growth

of our system of teaching, and whilst greater demands for a higher and more developed range of instruction arose, and whilst, at the same time, the boundaries of our science extended themselves enormously, it became plain that the work of properly professing the whole of the science had become too great for one individual, and at my request Mr. Schorlemmer was appointed Professor of Organic Chemistry in 1874. He was then, and is now, the only Professor of Organic Chemistry in the country; that is, in no other institution in the kingdom has it been thought worth while to encourage the study of the organic branch of our science, or to mark its great importance and extent by giving to it a distinct position, and there is no college or university in the country where so complete a course of lectures on Organic Chemistry is given as has been the case for years with us.

The arrangement of a systematic and extended course of laboratory instruction in Organic Chemistry is a matter of some difficulty which, however, we have now satisfactorily overcome. On entering upon their third session, students usually occupy themselves with Organic Analysis, Vapour Density, Fractional Distillation, &c., together with a series of Organic Preparations made in a systematic manner, and with special reference to the yield obtained. Dr. Julius Cohen, one of our demonstrators, has lately written a valuable series of examples of organic preparations suitable for

students, under the title of the *Owens College Course of Practical Organic Chemistry*. In each case references are found to the original memoir in which the first description of the preparation is given by its discoverer, and the consultation of those original communications by eminent Chemists of all countries is a matter of the greatest importance to the student of the science.

Results of the Teaching.—The results of our system of teaching began to be observable in the early years in the Honours in Chemistry, Inorganic and Organic, which our students gained, and continued year by year to gain, at the examinations of the London University (see List IV.), a list which I think will bear favourable comparison with similar ones from other colleges.

LIST IV.

HONOURS IN CHEMISTRY GAINED BY OWENS COLLEGE STUDENTS SINCE 1857.

MATRICULATION (LONDON).

Date.		
1859	Sims, T. H.....	3rd in Chemistry.
1859	Hurst, W. H.....	Prize of £10.
1860	Watts, W. M.....	7th in Chemistry.
1862	Dale, R. S.....	2nd in Chemistry.
1862	McDougall, A.....	4th in Chemistry.
1863	Dreschfeld, Julius....	3rd in Chemistry.
1863	Wright, C. R. A.....	Prize of £10.

PRELIMINARY SCIENCE (M.B.) (LONDON).

1865	Dreschfeld, Julius....	1st in Second Class in Chemistry.
1873	Meek, J. W.....	2nd in Third Class in Chemistry.
1874	Wilkinson, A. T.....	2nd in Second Class in Chemistry.
1876	Maguire, Robert.....	2nd in First Class in Chemistry.
1877	Barron, A.....	2nd in Second Class in Chemistry.
1883	Ashe, E. O.....	Bracketed 4th in Third Class in Inorganic Chem.
1884	Hancock, W. J.....	Bracketed 5th in Third Class in Inorganic Chem.

INTERMEDIATE SCIENCE (LONDON).

Date.		
1861	Watts, W. Marshall.	3rd in Chemistry and Natural Philosophy.
1863	McDougall, Arthur..	Alone in Second Class in Chem. and Nat. Philos.
1865	Smith, A. M.....	Alone in Third Class in Chem. and Nat. Philos.
1867	Bottomley, James....	2nd in Second Class in Chem. and Nat. Philos.
1867	Hopkinson, John....	Exhibition in Chemistry and Natural Philosophy. £40 for two years.
1867	Robinson, A.....	2nd in First Class in Chem. and Nat. Philos.
1868	Jekyll, W. R.....	4th in Second Class in Chem. and Nat. Philos.
1869	Routledge, R.....	2nd in First Class in Chem. and Nat. Philos.
1872	Napier, A. S.....	5th in Second Class in Chemistry.
1873	Hopkinson, Charles.	4th in Third Class in Chemistry.
1874	Smith, A. J.....	3rd in Second Class in Chemistry.
1875	Jackson, A. H.....	1st in Third Class in Chemistry.
1876	Higgin, W. H.....	1st in Second Class in Chemistry.
1877	Cross, C. F.....	Exhibition in Chemistry of £40 per annum, tenable for two years.
1880	Stroud, William.....	Exhibition in Chem. of £40, tenable for two years.
1881	Stroud, Henry.....	Alone in Second Class in Chemistry.
1884	O'Shea, L. T.....	Bracketed 5th in First Class in Inorganic Chem.
1884	Turpin, G. S.....	Exhibition in Chem. of £40, tenable for two years.

INTERMEDIATE MEDICINE (LONDON).

1856	Broadbent, W. H....	2nd in Chemistry, with Gold Medal.
1875	Wilkinson, A. T.....	Exhibition and Gold Medal in Inorganic Chem. &c.
1877	Hayle, Thos. H.....	1st in Third Class in Mat. Med. and Phar. Chem.
1878	Maguire, Robert.....	3rd in First Class in Chemistry.
1879	Dawson, A. G.....	1st in Second Class in Mat. Med. and Phar. Chem.
1880	Beverley, J. M.....	1st in Third Class in Mat. Med. and Phar. Chem.
1881	Thorburn, W.....	2nd in First Class in Organic Chemistry, with number of marks qualifying for a prize.
1882	Elliot, John.....	1st in Second Class in Organic Chemistry.
1884	Seville, C. F.....	1st in First Class in Organic Chemistry.

INTERMEDIATE SCIENCE AND PRELIMINARY SCIENCE (M.B.) (LONDON).

1864	Wright, C. R. A.....	Exhibition in Chemistry and Natural Philosophy. £40 for two years.
1868	Rayne, C. A.....	1st in Third Class in Chem. and Nat. Philos.
1869	Bott, H. S.....	Disqualified by age for Exhibition in Chemistry and Natural Philosophy.
1871	Carnelley, Thos.....	3rd in Third Class in Chemistry.
1872	Worthington, W. B.	6th in Second Class in Chemistry.
1873	Bedson, P. P.....	4th in First Class in Chemistry.
1874	Crow, J. K.....	4th in Third Class in Chemistry.
1877	Cross, C. F.....	Exhibition in Chem. of £40, tenable for two years.

1877 Marriot, Hyde..... 3rd in Third Class in Chemistry.
1879 Spiegel, A. K. A.... 1st in Third Class in Chemistry.
1879 Stevenson, John..... 3rd in Third Class in Chemistry.
1880 Gee, W. W. H..... 2nd in First Class in Chemistry, with marks qualifying for Exhibition.
1880 Irwin, Wilfred..... 1st in Third Class in Chemistry.
1880 Kimmins, C. W..... 16th in Third Class in Chemistry.
1880 Snape, H. L..... 10th in Third Class in Chemistry.
1881 Stroud, Henry..... 1st in Second Class in Inorganic Chemistry.
1883 Ashworth, Percy..... 1st in Third Class in Inorganic Chemistry.
1885 Horrocks, H..... 3rd in Second Class in Inorganic Chemistry.

B.Sc. DEGREE (LONDON).

1862 Watts, W. Marshall. 1st in Chemistry and Biology.
1864 McDougall, Arthur.. 2nd in First Class in Chemistry.
1865 Wright, C. R. A..... Alone in Second Class in Chemistry.
1867 Smith, A. M..... Alone in Second Class in Chemistry.
1867 Bottomley, Jas..... Disqualified by age for Scholarship in Chemistry.
1870 Routledge, Robt..... Disqualified by age for Scholarship in Chemistry.
1872 Carnelley, Thos..... 2nd in First Class in Chemistry, with number of marks qualifying for Scholarship.
1873 Napier, A. S..... Bracketed 1st in First Class in Chemistry.
1874 Bedson, P. P..... Scholarship in Chemistry. £50 per annum, tenable for two years.
1875 Cooper, F. A..... Bracketed 1st in Third Class in Chemistry.
1875 Smith, A. J..... Bracketed 1st in First Class in Chemistry.
1876 Crow, J. K..... Scholarship in Chemistry. £50 per annum, tenable for two years.
1877 Wills, W. L..... 1st in Second Class in Chemistry.
1878 Cross, C. F..... 2nd in Second Class in Chemistry.
1880 Young, Sydney..... Scholarship in Chemistry. £50 per annum, tenable for two years.
1882 Stroud, Wm..... Scholarship in Chemistry. £50 per annum, tenable for two years.
1883 Kimmins, C. W..... Bracketed 1st in Second Class in Chemistry.
1883 Stroud, Henry..... Scholarship in Chemistry. £50 per annum, tenable for two years.

D.Sc. DEGREE IN CHEMISTRY (LONDON).

1885 Bailey, G. H.
1878 Bedson, P. P.
1870 Bottomley, J.
1876 Carnelley, T.
1878 Crow, J. K.
1886 Kimmins, C. W.
1866 Watts, W. M.
1870 Wright, C. R. A.
1883 Young, Sydney.

FINAL B.Sc. HONOURS SCHOOL IN CHEMISTRY (VICTORIA UNIVERSITY).

1884 Gerland, C..... First Class in Chemistry.
1884 Warrington, A. W... Third Class in Chemistry.

1885 Colman, H. G..... First Class in Chemistry (Mercer Scholar).
1885 Harden, A..... First Class in Chemistry.
1885 Schloesser, A..... Third Class in Chemistry.
1886 Brown, R. J. ..... First Class in Chemistry (Mercer Scholar).
1886 Fowler, G. J..... First Class in Chemistry.
1886 Pauls, C. A..... First Class in Chemistry.
1886 Miller, J. P..... First Class in Chemistry.

CRACE-CALVERT SCHOLARS.

(This Scholarship was founded in memory of the late Dr. Crace-Calvert, F.R.S., by his widow for the purpose of assisting meritorious youths to pass from the Evening to the Day Classes.)

1876 Preston, R.
1878 Barnes, J.
1881 Hulme, J. E.
1884 Hall, John A.

Instruction in Applied Chemistry. — Having secured thorough and advanced teaching in both the Inorganic and Organic branches of the Science, it became necessary to see how far it was possible to introduce lectures and practical instruction in some special branches of Applied Chemistry. I have always held that the application can only be properly and thoroughly learnt in the factory or works, just as a trade cannot be taught in a school unless, indeed, the school becomes a shop ; but this is no reason why the scientific principles and details of the various industrial processes should not be brought before the pupil who is intended afterwards to conduct such processes. I am of opinion on the contrary, that provided a secure scientific basis is assured, such lectures given by a teacher who has had practical as well as theoretical experience are of great value to the technical student. For many years I gave a special course on some branch of Applied Chemistry, and Professor Schorlemmer one

on some other branch, but in 1880 Mr. Watson Smith, than whom it would be difficult to find a better qualified person, became Demonstrator and undertook the charge of this branch of the instruction, and in 1885 he was at my suggestion elected the Lecturer on Technological Chemistry.

Positions taken by Students.—The marked success that has attended our technological teaching, founded as it has been on a firm and extended knowledge of science, is seen from the results of our students' Technological examination under the City and Guilds of London Institute (List V.) for the last four years. In 1886 our students obtained a larger number and higher distinctions than fell to the lot of any other institution in the country, not excluding the Central Institute in South Kensington and other purely Technical Schools. This remarkable fact points to the evident conclusion that no high results can be obtained in the application without a thorough knowledge of the science itself, and is a proof not only of the high character of our technical teaching, but of the superior scientific training of our students. But this is not the only or the best proof of the quality of the teaching in our School of Applied Chemistry. This is rather to be found in the recognised positions which our students occupy in the industrial establishments in which Chemistry plays a part, and I think that it is not too much to say, that there are now few of these, in this district at least, in which one or more old pupils of the College may not be found

either as Professional Chemists or as Directors of the establishment. Nor must I forget to mention our Technological Certificate, only given after a rigorous series of examinations, and upon the conclusion of a long (four years) course of systematic study, not only of Chemistry, but of certain allied Sciences, and also of Mechanical Drawing. This certificate indicates in the holder a high degree of proficiency, and will, I believe, come to be a valued and popular mark of distinction for a Technical Chemist.

LIST V.

TECHNOLOGICAL CHEMISTRY EXAMINATIONS OF THE CITY AND GUILDS OF LONDON INSTITUTE.

HONOURS GAINED BY OWENS COLLEGE STUDENTS SINCE 1882.

1882.

ALKALI MANUFACTURE.

Wm. Ray..... 1st Prize, Ordinary Grade, £3 and Silver Medal.

1883.

TAR DISTILLING.

C. W. Duckworth ..... 1st Prize, Ordinary Grade, £3 and Silver Medal.

ALKALI MANUFACTURE.

D. S. Macnair..... 1st Prize, Honours, £5 and Silver Medal.
Wm. Ray..... 2nd Prize, Honours, £5 and Bronze Medal.

1884.

ALKALI MANUFACTURE.

A. Harden .. .. 1st Prize, Honours, £5 and Silver Medal.

GLASS MANUFACTURE.

Hugh Binney .. .. 2nd Prize, Honours, £5 and Bronze Medal.

TAR DISTILLING.

C. A. Kohn..... 1st Prize, Ordinary, £3 and Silver Medal.
H. C. Brown ..... 3rd Prize, Ordinary, £2 and Bronze Medal.
D. E. Jones ..... Honours, 1st Class.

1885.

ALKALI MANUFACTURE.

W. B. Hart ..... 1st Prize, Honours, £5 and Silver Medal.
J. P. Miller ..... 2nd Prize, Honours, £5 and Bronze Medal.
E. Reckitt..... Honours, 1st Class.
H. G. Colman..... Honours, 1st Class.

TAR DISTILLING.

*A. Harden ..... Honours, 1st Class.

ALKALI MANUFACTURE.

T. T. Best..... 1st Prize, Ordinary, £3 and Silver Medal.
G. J. Newman..... 2nd Prize, Ordinary, £3 and Bronze Medal.
J. A. Hall..... 3rd Prize, Ordinary, £2 and Bronze Medal.
A. W. Tangye..... 4th Prize, Ordinary, £1 and Bronze Medal.
C. Lowe ..... Ordinary, 1st Class.

1886.

ALKALI MANUFACTURE.

W. H. Bracher ..... 1st Prize, Honours, £5 and Silver Medal.
Joseph Lunt..... 2nd Prize, Honours, £5 and Bronze Medal.
T. T. Best..... 1st Class, Honours.
J. B. Miller ..... 1st Class, Honours.
H. W. Smith ..... 1st Class, Honours.
G. J. Fowler..... 2nd Class, Honours.
R. G. Winder ..... 2nd Class, Honours.
R. J. Brown..... 1st Class, Ordinary, £3 and Silver Medal.
C. A. Pauls ..... 1st Class, Ordinary.
C. T. Rhodes ..... 2nd Class, Ordinary.

FUEL.

Geo. Baxendale ..... 2nd Class, Ordinary.

COAL TAR PRODUCTS.

W. B. Hart ..... †1st Prize Ordinary, £3 and Silver Medal.
W. L. Bunting..... 3rd Prize, Ordinary, £2 and Bronze Medal.
J. P. Miller ..... 5th Prize, Ordinary, Bronze Medal.

BLEACHING, DYEING, AND CALICO PRINTING.

W. T. Entwisle ..... 1st Prize, Honours, £5 and Silver Medal.

WOOL DYEING.

E. Bentz ..... 1st Prize, Honours, £5 and Silver Medal.

RESULTS (1886).

20 Candidates, 16 Passed, 12 in the 1st Class, 7 of these taking 1st Class Honours. 8 take Medals and gain amongst them £28.

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* Mr. Harden's is the only 1st Class in Honours.

† This was the highest place taken in the country in the subject of Coal Tar.

The Training of Teachers.—Original Research.—But after all, the aim of a School of Chemistry is not limited to training Technologists, it must also train Teachers, and its highest function is to guide students to original scientific investigation, and fit them for extending the boundaries of the science. That this had to be done, if the tuition was to be in any degree successful, I had learnt (amongst much of other invaluable experience), from my dear and venerated teacher, Professor Bunsen ; and the names of T. H. Sims, William Dancer, William Marshall Watts, Arthur McDougall, and T. E. Thorpe are associated with original experimental investigations, which were published from our laboratory in the fifties and earlier sixties. The foundation of the Dalton Scholarship in 1856 for aiding Original Chemical Research, assisted most materially the progress of our school in early days, indeed, it has done so ever since. We have now a goodly list (see List VI.) of twenty-two Dalton Scholars, most of whom have made or are making for themselves distinguished careers, either as Teachers and Investigators, or as Industrial Chemists, and who, one and all, will I know, acknowledge that the first and most important step in that career was the original work done for the Dalton Scholarship.

Berkeley Fellowships.—These fellowships granted for original work by a generous anonymous donor have been of great value in stimulating chemical research amongst us.

LIST VI.

DALTON CHEMICAL SCHOLARS.

		Title of Research.
1856	Hobson, J. T.	On a New Series of Organo-Thionic Acids.
1860	Sims, J. H.	Contributions to the Knowledge of the Laws of Gas-Absorption.
1862	Dancer, Wm.	On the Mode of Preparation and Properties of Hypobromous Acid.
1863	*Watts, W. Marshall, B.Sc.	On the Absorption of Mixed Gases in Water.
1864	*McDougall, Arthur, B.Sc.	On a Mode of Measuring the Relative Sensitiveness of Photographic Papers.
1866	Thorpe, Thos. E.	On the Amount of Carbonic Acid contained in Sea Air.
1867	Darling, Wm. H.	Researches on Di-Methyl.
1870	Jekyll, Wm. Robt.	On the Action of Sulphuric Acid on Diallyl.
1871	Williams, W. C.	Contribution to our Knowledge of the Antimony Oxychlorides.
1872	*Carnelley, Thos., B.Sc.	On the Vanadates of Thallium.
	Grimshaw, H. (Extra Schol.)	On Ethyl-Amyl.
1874	Morgan, T. M.	On the Paraffins existing in Pennsylvanian Petroleum.
1875	*Bedson, P. P., B.Sc.	On some Compounds of Ether with Anhydrous Metallic Chlorides.
1876	*Crow, J. K., B.Sc.	On Hypovanadic Oxide (Vanadium Tetroxide) and its Compounds.
1877	Cross, C. F.	On Primary Normal Heptyl Alcohol and some of its Derivatives.
1878	Baker, Harry	On some Fluorine-Compounds of Vanadium.
1876	*Wills, W. L., B.Sc.	On the Atomic Weight of Tellurium.
1880	Kay, Wm. E.	On the Sulphides of Vanadium.
1882	Smithells, A., B.Sc.	On some Fluorine Compounds of Uranium.
1883	Dyson, Gibson	On some Compounds of Phenols with Amido-Bases.
1884	Bailey, G. H., B.Sc.	On some Vanadates of the Amines.
1885	Brierley, J. T.	On some New Vanadium Compounds.
1884	*Harden, A.	On the Action of Silicon Tetrachloride on the Aromatic Amido-Compounds.

BERKELEY FELLOWS.

1881	Bohuslav Brauner, Ph.D.	Königliche Adjunct in the University of Prague.
1881	Ludwig Claisen, Ph.D.	Privat-docent in the University of Bonn.
1884	Harry Baker, F.C.S.	Owens College.

* Became eligible for an additional year's income.

Teachers whom we have Trained.—That we have not laboured in this direction without result is seen by reference to List VII. which contains a list of about thirty men who are all occupying positions as Teachers of Chemistry of more or less importance; and that our men do their *alma mater* credit I think no one can doubt when we find the following names amongst them

THORPE, T. E., F.R.S.
Professor of Chemistry, Royal Normal School, S. Kensington.
CARNELLEY, THOMAS.
Professor of Chemistry, University College, Dundee.
SMITHELLS, ARTHUR.
Professor of Chemistry, Yorkshire College, Leeds.
WRIGHT, C. R. A., F.R.S.
Lecturer on Chemistry, St. Mary's Hospital, London.
WILLIAMS, W. C.
Professor of Chemistry, Firth College, Sheffield.
BEDSON, P. P.
Professor of Chemistry, Durham College of Science, Newcastle-on-Tyne.
WATTS, W. MARSHALL.
Science Master, Giggleswick.
JONES, FRANCIS.
Chemistry Master, Manchester Grammar School.

LIST VII.

ALPHABETICAL LIST OF THE NAMES AND POSITIONS OF STUDENTS OF THE OWENS COLLEGE, WHO OCCUPY POSITIONS AS TEACHERS OF THEIR SCIENCE.

F. W. Babbington.....	Demonstrator, University of Toronto.
G. H. Bailey, D.Sc.....	Assistant-Lecturer, Owens College.
Harry Baker.....	Assistant-Lecturer, Owens College.
P. P. Bedson, D.Sc., F.C.S...	P.ofessor, Durham College of Science, Newcastle-on-Tyne.
Ernest Bentz.....	Teacher of Dyeing, &c., Manchester Technical School.
B. Brauner, Ph.D.....	Professor, University of Prague.

C. A. Burghardt, Ph.D.	Lecturer in Mineralogy, Victoria University.
Thos. Carnelley, D.Sc.	Professor, University College, Dundee.
L. Claisen, Ph.D.	Privat-docent, Münich.
J. B. Cohen, Ph.D.	Assistant-Lecturer, Owens College.
G. Dyson, Ph.D.	Demonstrator, Normal School of Science, South Kensington.
Y. Hiraga	Professor in the Technical Institute of Tokio, Japan.
Francis Jones, F.C.S.	Chemical Master, Manchester Grammar School.
D. E. Jones, B.Sc.	Demonstrator, Aberystwith College.
C. A. Kohn, B.Sc., Ph.D.	Demonstrator, University College, Liverpool.
Joseph Lunt, B.Sc.	Demonstrator, Manchester Technical School.
D. S. Macnair	Science Master, Allan Glen Institution, Glasgow.
T. M. Morgan	Victoria College, Jersey.
M. M. P. Muir, M.A., F.C.S.	Fellow and Prælector in Chemistry, Caius College, Cambridge.
G. S Newth	Demonstrator, Normal School of Science, South Kensington.
L. T. O'Shea	Demonstrator, Firth College, Sheffield.
Wm. Ray	Demonstrator, Yorkshire College, Leeds, (Dyeing Department).
John Riley, F.C.S.	Lecturer on Calico Printing, Manchester Technical School.
S. Shaw	Demonstrator, Newcastle.
Watson Smith, F.C.S.	Lecturer on Technological Chemistry, Owens College.
Arthur Smithells, B.Sc.	Professor, Yorkshire College, Leeds.
H. Lloyd Snape, B.Sc.	Chemical Master, Manchester Technical School.
T. Takamatsu	Professor (Technological Chemistry), University of Tokio, Japan.
T. E. Thorpe, Ph.D., F.R.S.	Professor, Normal School of Science, South Kensington.
Wm. M. Watts, D.Sc.	Science Master, Giggleswick Grammar School.
Wm. C. Williams, F.C.S.	Professor, Firth College, Sheffield.
C. Alder Wright, D.Sc., F.R.S.	Lecturer, St. Mary's Hospital, London.
Sydney Young, D.Sc.	Lecturer in Chemistry, University College, Bristol.

Stimulus to Original Work to be given by the Professors.—The stimulus to Original Work must be given by the teacher, and it is he only whose head, hand, and heart are thus occupied, who can induce others to follow the same difficult though delightful path. The spirit of research must be felt

in the atmosphere of the laboratory. I do not say that either of the professors have done as much in this direction as they might have done, for this can be said of few, but they have at least set some example, and that example has been followed by many of their pupils.

Catalogue of Original Communications.—In my own case I was intensely interested in the investigations on the Chemical Action of Light, which I carried on in conjunction with Professor Bunsen, and for several years I spent the whole of the summer vacation working in the Heidelberg laboratory. During the course of the work of the subsequent sessions, a considerable number of original communications were published by myself or in conjunction with others. A list of these is found in the Appendix, Catalogue I. Concerning them it is not for me here to speak, except to say that it is, I suppose, chiefly to the opinion of the value of these researches entertained by my brother men of science that I owe most, if not all, the scientific honours which I have received.

Amongst those which I value most, I would place first that of the Royal Medal of the Royal Society awarded to me in 1873, for my researches on the Chemical Action of Light and on the metal Vanadium ; next my election in 1880 as one of the sixteen Honorary Members of the German Chemical Society; then the Honorary Degrees granted by the Universities of Dublin, Cambridge, Montreal and Heidel-

berg; then the Presidency of the Chemical Society of London (1881—1882), that of the Literary and Philosophical Society of Manchester (1882), that of the Society of Chemical Industry (1881), and lastly, though by no means least, the Presidentship Elect of the British Association for the Advancement of Science at its Manchester Meeting in the Jubilee year 1887.

I should wish specially to call attention to the large number of valuable papers published by Professor Schorlemmer, and to point out the important influence which his researches have exerted on the development of modern Organic Chemistry. A list of papers by Mr. Schorlemmer alone, and in conjunction with others, is found in Catalogue II. of the Appendix.

Students' Original Work.—Next, for the purpose of showing what Demonstrators and Students of the Department have done in the way of Original Work, I append in Catalogue III. an alphabetical list of those who have thus contributed during the period of their connection with our laboratory, together with the subject-matter of their research. And although we cannot pretend to compete in amount of work with the great German laboratories, I think I am not going too far when I say that in no laboratory in the kingdom has anything like this amount of sound original work been turned out. It is also satisfactory to know that all those who have thus made a new excursion, however short it may have

been, into the realms of undiscovered truth are now reaping the benefit of the training which they thus received, and are all, either as teachers of the science or as workers in its applications, occupying some influential, but all useful and honourable positions.

Owens College Chemical Society.—Amongst the various means of encouraging the study of our science at the College, I consider this Society to play a very important part. It is entirely under the government of the students; and amongst the memories which our men take away with them, none will, I think, have been more agreeable than those of the pleasant evenings spent in taking part in discussions or in listening to communications made by past or present students, or by some of their teachers, on a scientific topic of interest.

Literary Work.—Early in the course of my teaching, I found the necessity for a book explaining shortly and succinctly the principles and facts of the science. In those days, the only works one could put into the hands of students were either George Wilson's little text-book (in my experience quite inadequate), Fownes's *Manual* or Graham's or Miller's *Elements*, the latter, somewhat expensive works. In 1866, the first edition of my *Elementary Lessons* was published by Messrs. Macmillan. Since that date a large number of revised editions of this work in English have appeared, and it has become the standard school and college book of the country, no less that about 117,000 copies having been sold.

But the success attending the English sales of this little book, proving that it met an acknowledged want, was less remarkable than the demand which almost at once arose for translations into foreign languages, indeed, nothing has astonished me more during the whole course of my life, than the widespread popularity which this book has enjoyed. It may be of interest to note the several languages into which it has been translated :—

1. GERMAN. By Professor Schorlemmer. First edition in 1867. No less than eight editions, a total of about forty-two thousand copies have been published by Messrs. Vieweg of Brunswick. It is the text-book of widest circulation in the higher schools and universities of Germany.

2. RUSSIAN. An edition in Russian, with Preface by Professor Mendelejew, was published at St. Petersburg in 1868.

3. ITALIAN. In 1873 an edition in Italian was prepared by my friend Professor Silvestri of Catania, and published in Milan.

4. HUNGARIAN. In 1871 a Hungarian edition was published in Pesth.

5. POLISH. In 1874 a Polish edition appeared in Cracow.

6. SWEDISH. In 1878 a translation into this language was made by Professor Rindell, of Helsingfors.

7. MODERN GREEK. Professor Christomanos, of the University of Athens, made a translation in the above year.

8. JAPANESE. The late Mr. Hiraoka (a distinguished student of Owens College, since of the University of Tokio), has translated the book into Japanese ; and lastly,

9. URDOO. A translation into Urdoo by Dr. Amir Shah, of the University of Lahore, was published by order of the Punjaub University.

I need scarcely add that immediately on its publication, my little book had the honour of being pirated by an enterprising Yankee firm, but I am glad to think that the commercial success of the venture was

not great, as my friend Mr. Macmillan soon made arrangements for the sale of his books in the States, and the author received a regular, though small, and to his mind perhaps insufficient remuneration, for instructing the minds of our American cousins in the principles of the *belle science.*

The need in England of a series of books on simple Elementary Science had long been felt. No school-books existed in which the elementary facts and principles of the various sciences were given in a thorough but very simple manner. This need was supplied by the series of Science Primers published by Macmillan, under the joint editorship of Professors Huxley, Balfour Stewart, and myself. My *Primer of Chemistry* was the first one of the series to appear in 1871. Over 160,000 copies have been sold, and translations have appeared in Islandic, Japanese, Bengalee, Polish, German, and Italian.

Another publication which excited considerable interest is the *Lectures on Spectrum Analysis*, published in 1869. These were originally delivered in 1868 in the Hall of the Apothecaries' Company in London ; a second edition of this book was called for in 1870, a third in 1873, and a fourth edition has just appeared, in the preparation of which I have had the great benefit of the co-operation of my friend Professor Arthur Schuster.

By far the most serious piece of literary work emanating from the department is the publication of the *Treatise on Chemistry* (Macmillan), by myself

and my colleague Professor Schorlemmer. Our idea has been to give as full and complete an account of the present condition of chemical science as is consistent with due regard to space and cost. We have endeavoured to make this the standard handbook of the science, and the general approval which this work has met with both in this country, in America, and on the Continent, seems to show that we have, at least to some extent, succeeded in our intention. The German edition (Vieweg & Co.), which appeared simultaneously with the English, enjoys a wide circulation, and has become the standard work on the science in all the German Universities and Polytechnic Schools. The Inorganic portion of the work is complete in three volumes; a description of the subjects contained in the much more extensive domain of Organic Chemistry has already reached an equal amount, and is, I regret to say, not yet finished, though under Professor Schorlemmer's industrious hands its completion will I hope not be far distant.

I must not forget in this catalogue of literary effort, to mention the publication of two works of importance by Professor Schorlemmer. The first is the *Manual of the Chemistry of the Carbon Compounds* (Macmillan), one of the best of our shorter handbooks on Organic Chemistry, and a work which has had a large sale, both in England and particularly in Germany, and also an interesting historical sketch of the *Rise and Progress of Organic*

Chemistry (Cornish, Manchester), which fills an acknowledged *hiatus* in our English chemical literature, and has been recently translated into French by one of our former pupils, M. Claparède.

In concluding this part of my record I think I have shown that the two Professors of Chemistry have done what in them lies to make the name of the Owens College Chemical Department pretty well known all the world over, wherever our science is valued.

Victoria University Examinations.—One of the main objects of those who drew up the examination requirements of our new University, was to encourage and secure as much as possible the efficient training of specialists. We desired to train chemists, and the courses marked out by the University in their Honours School of Chemistry seem to me, after both consideration and trial, exactly to effect what is needed. Several of our students have already passed the stringent examinations for the degree of B.Sc. with Honours in Chemistry, with great credit, and many others are now in the several stages of preparation. I do not think that there is any other system of training in England better (if so well) qualified to turn out sound teachers of our science than this.

Importance of a Knowledge of German Laboratories.—But however we may value our own system, there can be no question that great advantages accrue to the men who have gone through this

course, but who finish their scientific education by a sojourn at one of the great German schools of Chemistry. The new life, the new atmosphere with which they are thus surrounded, is of the greatest possible value to them, both scientifically and socially. They go away boys, and they return men, with experience of other modes of life, and of other methods of work. I have therefore always advised my best students to enter for at least a year the laboratories of one of the German masters, either going to Bunsen, or Kekulé, or Baeyer, or Emil Fischer, or Victor Meyer or others, and I have never had cause to regret the advice I have thus given. On the contrary, those, and they are many, who have acted upon my recommendation have one and all expressed to me the greatest satisfaction with their foreign experiences, and their gratitude to the kind professors abroad who take so lively an interest in their progress and welfare. In a similar way we have almost every year had one or more foreign students of Chemistry from many countries who have come to England for somewhat similar purposes, and they too have expressed to me their sense of the value to them of their residence amongst us.

Society of Chemical Industry.—My connection with the foundation of this Society in 1881 will always remain a source of gratification, as it has done and will do much to bring about that union of Science and Practice which is of such national importance. The unparalleled rise of this Society, the number of

members now exceeding two thousand, including all the prominent leaders both in pure science and its applications, has plainly shown the want which is thus satisfied, whilst the results already accomplished have proved it to be one of the most important and useful societies in the country. Here I should wish to bear testimony to the ability with which Mr. Watson Smith discharges the difficult duties of Editor of the Journal, and to express my opinion that the connection of the Chemical Department with this Society has been, and will be, of very great value to the College.

Outside Lectures.—This record of work would be incomplete without mention of the Lectures on Elementary or on Advanced Science, which I have from time to time delivered outside the College. An idea which I entertained of the importance of interesting the masses of the population in science and scientific discovery, led me in 1866 to organise the Manchester Science Lectures for the People. These—carried on for eleven years—certainly were successful beyond my hopes, and the memory of these, given by such men as Huxley, Tyndall, Wallace, Huggins, and many other equally illustrious names, will I think not soon be forgotten by those who heard them. Nor is it too much to say that the Manchester Science Lectures formed the pattern upon which many other large towns founded similar courses, and that to these we owe much of the increase of the demand for scientific instruction now

so generally given in the Science Classes under the Department at South Kensington, and in our elementary schools.

Another kind of lecture activity of perhaps a higher, certainly of a more difficult character, are the Friday Evenings at the Royal Institution in Albemarle Street, in which the cry is always for something new. I have had the pleasure and honour of delivering many of these, and I think I may say that I have generally succeeded in satisfying that somewhat critical audience. The ones which were perhaps the most interesting was that delivered on March 1st, 1861, when I brought for the first time the results of Bunsen and Kirchhoff's discoveries before an English audience, and that on May 6th, 1864, when I photographed Mr. Faraday during the lecture by means of the magnesium light. I append (List VIII.) a list of the Friday Evenings given by me.

LIST VIII.

DISCOURSES DELIVERED AT THE ROYAL INSTITUTION BY HENRY E. ROSCOE.

Date.		Subject.
Friday Evenings.		
April 4, 1856	...	The Measurement of the Chemical Action of Light.
March 2, 1860	...	The Measurement of the Chemical Action of the Solar Rays.
March 1, 1861	...	Bunsen and Kirchhoff's Spectrum Observations.
May 22, 1863	...	The Direct Measurement of the Sun's Chemical Action.

Date.	Subject.
Friday Evenings.	
May 6, 1864 ...	The Metal Indium and Recent Discoveries on Spectrum Analysis.
June 1, 1866 ...	The Opalescence of the Atmosphere.
February 14, 1868	Vanadium, one of the Trivalent Group of Elements.
April 1, 1870 ...	The Artificial Production of Alizarine, the Colouring Principle of Madder.
June 2, 1876 ...	Recent Discoveries about Vanadium.
February 21, 1879	A new Chemical Industry, established by M. Camille Vincent.
May 27, 1881 ...	Indigo, and its Artificial Production.
April 16, 1886 ...	Recent Progress in the Coal Tar Industries.

During my time I have given experimental lectures in many of the large towns in the kingdom, and I have always been received with the greatest kindness and consideration, and have found that the labour was amply repaid by the feeling that something in this way was being done to diffuse a knowledge and taste for science amongst the people.

Conclusion.—In now closing this I fear somewhat egotistical record, I have only to recall the fact of my appointment in 1881 on the Royal Commission on Technical Instruction, and to acknowledge with thanks the kindness of the College Council in enabling me to take an active part in the work of the Commission. The experience which I thus gained of the relative positions of Scientific Education in this country and on the Continent, and the feeling, to which this knowledge gave rise, of the imperative necessity of some steps being taken to bring the

technical and scientific education here to a level with that enjoyed by other nations, led me, when the opportunity offered itself, to determine to throw my remaining energies into a more general field. But however much attention I may in future feel it necessary to give to the questions of educational and general politics, I can never take less interest than I have done in the progress of the special science to which I have devoted my life, and which I love so well.

HENRY E. ROSCOE.

MANCHESTER,
December 18, 1886.

APPENDIX.

CATALOGUE I.

LIST OF ORIGINAL COMMUNICATIONS MADE BY H. E. ROSCOE, 1857—1886.

1857 On the Influence of Light upon Chlorine, *Phil. Mag.* vol. xiv. p. 504.

1858 Some Chemical Facts respecting the Atmosphere of Dwelling-houses, *Chem. Soc. Journ.* x. 251.

1858 On the Measurement of the Chemical Action of the Solar Rays, *Roy. Inst. Proc.* iii. 210.

1861 On the Composition of the Aqueous Acids of Constant Boiling Point, pt. i. *Chem. Soc. Journ.* xiii. 146.

1862 On the Composition of the Aqueous Acids of Constant Boiling Point, pt. ii. *Chem. Soc. Journ.* xv. 270.

1862 On the Alleged Practice of Arsenic-eating in Styria, *Man. Phil. Soc. Mem.* 208.

1862 On Perchloric Acid and its Hydrates, *Roy. Soc. Proc.* xi. 493.

1862 Note on Perchloric Ether, *Chem. Soc. Journ.* xv. 213.

1862 On the Solar Spectrum and the Spectrum of the Chemical Elements, *Phil. Mag.* xxiii. 63.

1862 On the Application of the Spectroscope to the Manufacture of Steel by the Bessemer Process, *Man. Phil. Soc. Proc.* iii. 57.

1862 On the Existence of a Crystallizable Carbon Compound and Free Sulphur in the Alais Meteorite, *Man. Phil. Soc. Proc.* iii. 57.

1862 Note on the amount of Carbon Dioxide contained in the Air of Manchester, *Man. Phil. Soc. Proc.* iii. 219.

1862 On the Measurement of the Chemical Brightness of Various Portions of the Sun's Disk, *Roy. Soc. Proc.* xii. 648.

1863 On the Direct Measurement of the Sun's Chemical Action, *Roy. Inst. Proc.* iv. 128.

1864 On the Chemical Brightness of the Light Emitted by Burning Magnesium Wire, *Man. Phil. Soc.*

1864 On Photography by the Magnesium Light, *Man. Phil. Soc.*

1864 Note on the Existence of Lithium, Strontium, and Copper in the Bath Waters, *Brit. Assoc. Rep.* xxxiv. 41.
1866 On the Metal Indium and Recent Discoveries in Spectrum Analysis, *Roy. Inst. Proc.* iv. 284.
1865 On a Method of Meteorological Registration of the Chemical Action of Total Daylight, *Phil. Trans.* clv. 605.
1865 On a Mode of Preparing Sealed Bulbs containing Chlorine and Hydrogen, *Man. Phil. Soc.*
1866 The Opalescence of the Atmosphere, *Roy. Inst. Proc.* iv. 651.
1866 On the Isomorphism of Thallium Perchlorate with the Potassium and Ammonium Perchlorates, *Chem. Soc. Journ.* iv. 504.
1867 On the Chemical Intensity of Total Daylight at Kew and Parà (1865—1867), *Phil. Trans.* clvii. 555.
1868 Researches on Vanadium, pt. i. *Phil. Trans.* clviii. 1.
1869 Researches on Vanadium, pt. ii. *Phil. Trans.* clix. 679.
1870 Researches on Vanadium, pt. iii. *Phil. Trans.* clx. 317.
1869 On Vanadium, one of the Trivalent Group of Elements, *Roy. Inst. Proc.* v. 287.
1871 On Measurements of the Chemical Intensity of Total Daylight, made during the recent Total Eclipse of the Sun, by Capt. J. Herschell, *Man. Phil. Soc. Mem.* iv. 202.
1871 Spectrum Analysis in its Application to the Bessemer Process for the Manufacture of Steel, *Iron and Steel Inst. Journ.* ii. 38.
1872 A Study of Certain Tungsten Compounds, *Man. Phil. Soc. Mem.* v. 76.
1872 On the Artificial Production of Alizarine, the Colouring Principle of Madder. *Roy. Inst. Proc.* vi. 120.
1872 On a Self-recording Method of Measuring the Intensity of the Chemical Action of Total Daylight, *Phil. Trans.* clxiv. 655.
1872 Some Remarks on Dalton's First Table of Atomic Weights.
1874 On a New Uranium Chloride, *Chem. Soc. Journ.* xii. 933.
1877 On Two New Vanadium Minerals, *Chem. Soc. Journ.* ii. 444.
1878 Note on Metallic Niobium, and a New Niobium Chloride, *Chem. Soc. Journ.* ii. 272.
1878 Specific Gravity of the Vapours of Chlorides of Lead and Thallium, *Chem. Soc. Journ.* ii. 937.
1880 On the Absence of Potassium in Protagon, *Roy. Soc. Proc.* xxx. 365.
1882 A Study of Some of the Earth-Metals Contained in Samarskite, *Chem. Soc. Journ.* i. 277.
1882 Atomic Weight of Carbon, *Chem. Soc. Journ.* ii. 794.
1885 On the Spontaneous Polymerization of Volatile Hydrocarbons at the Ordinary Atmospheric Temperature, *Chem. Soc. Journ.* ii. 669.

ROSCOE AND OTHERS.

Roscoe and J. Baxendell.

1867 Note on the Relative Chemical Intensities of Direct Sunlight and Diffuse Daylight at Different Altitudes of the Sun, *Roy. Soc. Proc.* xv. 20.

Roscoe and R. W. Bunsen.

Photo-Chemical Researches—

1857 Part I.—Measurement of the Chemical Action of Light, *Phil. Trans.* 355.

1857 Part II.—Phenomena of Photo-Chemical Induction, *Phil. Trans.* 381.

1857 Part III.—Optical and Chemical Extinction of the Chemical Rays, *Phil. Trans.* 601.

1857 Part IV.—(1) Comparative and Absolute Measurement of the Chemical Rays.

(2) Chemical Action of Diffuse Daylight.

(3) Chemical Action of Direct Sunlight.

(4) The Photo-Chemical Action of the Sun compared with that of a Terrestrial Source of Light.

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1861 Exhibition of Products Illustrative of the Chemical Manufactures of the South Lancashire District, Exhibited in the Laboratory of the Owens College, Sept. 1861.

1861 On the Recent Progress and Present Condition of Manufacturing Chemistry in the South Lancashire District, *Brit. Assoc. Rep.* 108.

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1882 On the Spectrum of Terbium, *Chem. Soc. Journ.* i. 283.
1880 On a Comparison of the Spectra Obtained by Burning Diamond and Graphite, *Man. Phil. Soc. Proc.* xix. 46.

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1871 On the Measurement of the Chemical Intensity of Total Daylight made at Catania during the Total Eclipse of 22nd Dec. 1870, *Phil. Trans.* clxi. 467.
1877 On the Absorption Spectrum of Bromine and Iodine Monochloride, *Phil. Trans.* clxvii. 207.

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1862 On the Hydrides of the Alcohol Radicals existing in the Products of the Destructive Distillation of Cannel Coal, *Chem. Soc. Journ.* vol. xv. p. 419.
1862 On the Chemical Constitution of American Rock-oil, *Man. Phil. Soc. Proc.* iii. 81.
1863 On the Derivatives of Hydride of Heptyl, *Chem. Soc. Journ.* i. 216.
1863 On the Chemical Constitution of the so-called Alcohol Radicals, *Chem. Soc. Journ.* i. 425.
1864 On the Action of Chlorine upon Methyl, *Roy. Soc. Proc.* xiii. 225.
1864 On the Identity of Methyl and Hydride of Ethyl, *Chem. Soc. Journ.* ii. 262.
1865 Researches on the Hydrocarbons of the series $C_n H_{2n+2}$, *Roy. Soc. Proc.* xiv. 164, 464.
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1865 On American Petroleum, *Zeitsch. f. Chem.* i. 242.
1866 Note on the Hydrocarbons contained in Crude Benzol, *Chem. Soc. Journ.* iv. 356.
1866 Note on Ethyl Hexyl Ether, *Chem. Soc. Journ.* iv. 357.
1867 Note on Amyl Compounds derived from Petroleum, *Roy. Soc. Proc.* xv. 131.
1867 On Di-Isopropyl and Amyl Isopropyl, *Zeitsch f. Chem.* iii. 1.
1867 On the Action of Chlorine on Di-isopropyl, *Zeitsch f. Chem.* iii. 75.
1868 On the Conversion of the Isopropyl into the Normal Propyl Compounds, *Zeitsch f. Chem.* iv. 49.
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1869 On the Derivatives of Propane (Hydride of Propyl), *Roy. Soc. Proc.* xvii. 372.
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1869 On the Constitution of Hyposulphurous Acid, *Chem. Soc. Journ.* vii. 254.
1870 On the Derivatives of Hydride of Hexyl, *Deutsch Chem. Gesell. Ber.* iii. 615.
1871 Formation of Cetyl Alcohol by a singular reaction, *Roy. Soc. Proc.* xix. 22.
1872 The Chemistry of the Hydrocarbons, *Chem. Soc. Journ.* x. 425.
1872 Formula of the Lead-chamber Crystals, *Chem. Soc. Journ.* x. 627.
1872 On the Boiling Points of the Normal Paraffins, and some of their Derivatives, *Man. Phil. Soc. Mem.* v. 115.
1872 On the Normal Paraffins, Part I. *Phil. Trans.* clxii. 111.
1878 On the Normal Paraffins, Part II. *Phil. Trans.* clxix. 49.
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1873 On the Heptanes from Petroleum, *Chem. Soc. Journ.* xi. 319.
1873 An Improved Method for Preparing Marsh-gas, *Man. Phil. Soc. Proc.* xiii. 29.
1873 The Chemical Constitution of Bleaching Powder, *Man. Phil. Soc. Proc.* xiii. 49.
1874 Methyl-hexyl-carbinol, *Chem, Soc. Journ.* xii. 1029.
1875 Note on the Boiling-point of Methyl-hexyl-carbinol, *Chem. Soc. Journ.* xiii. 209.
1875 On Grove's method of Preparing Chlorides, *Chem. Soc. Journ.* xiii. 308.

1875 Remarks on T. M. Morgan's paper on the Paraffins in Pennsylvanian Petroleum, *Chem. Soc. Journ.* xiii. 306.
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1874 On Suberone, *Chem. Soc. Journ.* xii. 935.
1877 Transformation of Aurin into Rosaniline, *Chem. Soc. Journ.* ii. 121.
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1878 Isodulcite, *Chem. Soc. Journ.* ii. 969.
1879 Aurine, *Chem. Soc. Journ.* ii. 58, 925.
1879 Safranine, *Chem. Soc. Journ.* i. 682.
1879 Aurine, Part. II. *Chem. Soc. Journ.* i. 148.
1879 Suberic and Azelaic Acids, *Chem. Soc. Journ.* i. 683.
1879 Transformation of Aurine into Trimethylpararosaniline, *Chem. Soc. Journ.* i. 562.
1881 Suberone, *Chem. Soc. Journ.* i. 539.
1883 Phenates of Amido Bases, *Chem. Soc. Journ.* i. 185.

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1873 Oenanthylic Acid and Normal Heptyl Alcohol, *Chem. Soc. Journ.* xi. 1073.
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CATALOGUE III.

COMMUNICATIONS MADE BY DEMONSTRATORS AND STUDENTS WHILST AT OWENS COLLEGE.

BAILEY, G. H.

1884 On some Vanadates of the Amines, *Chem. Soc. Journ.* vol. i. p. 690.
1886 On a Method of Separation and Estimation of Zirconium, Pt. I. *Chem. Soc. Journ.* i. 149.
1886 On a Method of Separation and Estimation of Zirconium, Pt. II. *Chem. Soc. Journ.* i. 481.
1886 Notes on an Analysis of Koppite, *Chem. Soc. Journ.* i. 153.
1886 On a New Form of Thermostat.

BAKER, H.

1877 On some Thionates, *Man. Lit. Phil. Soc. Mem.* vi. 157.
1878 On some Fluorine Compounds of Vanadium, *Chem. Soc. Journ.* i. 388.
1879 A Study of certain Cases of Isomorphism, *Chem. Soc. Journ.* i. 760.
1880 On a Crystal of Diamond, *Chem. Soc. Journ.* i. 579.
1885 Orthovanadates of Sodium and their Analogues, *Chem. Soc. Journ.* i. 353.

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1879 Note on Magnesium Vanadates, *Chem. Soc. Journ.* i. 713.

BEDSON, P. P.

1875 On some Compounds of Ether with Anhydrous Metallic Chlorides, *Chem. Soc. Journ.*

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1879 On Acetylorthoamidobenzoic Acid, *Chem. Soc. Journ.* i. 752.

BRAUNER, B.

1882 Contributions to the Chemistry of the Rare Earth (Cerite) Metals, Pt. I. *Chem. Soc. Journ.* i. 68.
1883 Contributions to the Chemistry of the Rare Earth (Cerite) Metals, Pt. II. *Chem. Soc. Journ.* i. 278.
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BRIERLEY, J. T.

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1886 On some New Vanadium Compounds, *Chem. Soc. Journ.* i. 30.

BROTHERS (*see* Smith, Coutts, and Brothers).

CARNELLEY, THOS.

1872 On the Vanadates of Thallium.
1874 On a Colorimetric Method of Determining Iron in Water, *Man. Phil. Soc. Mem.* v. 346.
1874 Analysis of one of the Trifriu Mineral Waters.
1875 Note on the Effect of Passing the Mixed Vapours of Carbon Disulphide and Alcohol over Red Hot Copper, *Chem. Soc. Journ.* xiii. 523.
1876 On the Action of Water and Various Saline Solutions on Copper, *Chem. Soc. Journ.* ii. 1.
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1876 On High Melting Points, with Special Reference to those of Metallic Salts, Pt. I. *Chem. Soc. Journ.* i. 489.
1877 On High Melting Points, with Special Reference to those of Metallic Salts, Pt. II. and Pt. III. *Chem. Soc. Journ.* i. 365.
1878 On High Melting Points, with Special Reference to those of Metallic Salts, Pt. IV. *Chem. Soc. Journ.* i. 273.
1877 On the Oxidation of Ditolyl, *Chem. Soc. Journ.* ii. 653.

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1878 On Tetrabromide of Tin, *Chem. Soc. Journ.* i. 55.

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1878 Determination of High Boiling Points, *Chem. Soc. Journ.* i. 281.
1879 On the Boiling Points of certain Metals and Metallic Salts, *Chem. Soc. Journ.* i. 563.
1880 The Melting and Boiling Points of certain Inorganic Substances, *Chem. Soc. Journ.* i. 125.

(*See also* SHAW AND CARNELLEY).

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COHEN, J. B.

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1862 On the Mode of Preparation and Properties of Hypobromous Acid, *Chem. Soc. Journ.* xv. 477.

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1868 Researches on Di-Methyl, *Chem. Soc. Journ.* xxi. 496.

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1873 On Ethyl-Amyl.
1874 On Basic Calcium Chloride, *Man. Mem.* v. 279.

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1858 On the Action of Light upon Chloride of Silver, *Chem. Soc. Journ.* x. 74.
1859 Contributions to the Knowledge of the Amyl Group, *Chem Soc. Journ.* xi. 245.

HANNAY, J. B.

1878 Note on a New Manganese Reaction, *Chem. Soc. Journ.* i. 269.
1878 Action of Bromine on Sulphur, *Chem. Soc. Journ.* i. 284.
1878 New Process for the Volumetric Estimation of Cyanides, *Chem. Soc. Journ.* i. 245.
1878 On Silicious Fossilization, *Man. Phil. Soc. Mem.* vi. 234.
1878 On a New Calorimeter, *Man. Phil. Soc. Mem.* vi. 242.
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1879 On the Microrheometer, *Phil. Trans.* i. 275.

HARDEN, A.

1887 On the Action of Silicon Tetrachloride on the Aromatic Amido-Compounds.

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1879 On a New Series of Organo-Thionic Acids.

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1870 On the Action of Sulphuric Acid on Diallyl, *Man. Phil. Soc. Proc.* x. 9.

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1880 On the Sulphides of Vanadium, *Chem. Soc. Journ.* i. 728.

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1865 On a Mode of Measuring the Relative Sensitiveness of Photographic Papers, *Chem. Soc. Journ.* xviii. 183.

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1875 On the Paraffins Existing in Pennsylvanian Petroleum, *Chem. Soc. Journ.* xiii. 301.

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1875 Nitrosyl Tribromide and Sulphur Bromide, *Chem. Soc. Journ.* xiii. 844.
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1877 Note on Process for Estimating Bismuth Volumetrically, Pt. I. *Chem. Soc. Journ.* i. 658.
1877 On Solvent Action of Various Saline Solutions upon Lead, Pt. I. *Chem. Soc. Journ.* i. 660.
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1877 Detection of Small Quantities of Bismuth, *Chem. Soc. Journ.* ii. 45.
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(*See also* Suguira and Muir).

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Routledge. R.

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Sims, T. H.

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SMITH WATSON.

1880 On Analyses of the Ash of the Wood of Two Varieties of Eucalyptus, *Chem Soc. Journ.* i. 416.

1880 Certain Improvements in Chemical Apparatus, *Chem. Soc. Journ.* i. 490.

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1884 Note on the Behaviour of the Nitrogen in Coal during Distillation, *Chem. Soc. Journ.* 144.

1884 On the Recovery of By-products from Coal, *Journ. Iron and Steel Inst.* 486.

1885 On the By-products obtained in Simon-Carve's Coking Process, *Ibid.* 102.

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1883 On a Bye-Product of the Manufacture of Aurin, *Chem. Soc. Journ.* 358.

SMITH WATSON, AND DAVIS, G. W.

1880 On Pyrene, *Chem. Soc. Journ.* i. 413.

1882 On Molecular Compounds of Naphthalene and Benzene with Antimony Trichloride, *Chem. Soc. Journ.* i. 411.

1882 On Quinoline, *Chem. Soc. Journ.* 412.

SMITH WATSON, AND STAUB.

1884 On a Bye Product in the Manufacture of Aurin, Pt. II. *Chem. Soc. Journ.* 301.

1885 On Certain Derivatives of Iso-dinaphthyl, *Chem. Soc. Journ.* 104.

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1881 On Phenylnaphthalene, *Chem. Soc. Journ.* i. 546.

1881 On Sulphonic Acids derived from Iso-dinaphthyl, *Chem. Soc. Journ.* i. 551.

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SMITH WATSON AND W. B. SYME.

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1886 Examination of the Phenols in Blast-furnace Tar, *Chem. Soc. Journ.* i. 17.

SMITHELLS, ARTHUR.

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(*See also* Roscoe and Thorpe, and Schorlemner and Thorpe).

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1876 On Some Compounds of Antimony Pentachloride with Alcohol and Ether, *Chem. Soc. Journ.* ii. 463.

WILLS, W. L.

1879 On the Atomic Weight of Tellurium, *Chem. Soc. Journ.* i. 704.

YOUNG, SYDNEY.

1880 Note on Precipitation of Iron by Ammonium Succinate, *Chem. Soc. Journ.* 674.

1881 Note on Formation of an Alcoholic Fluoride, *Chem. Soc. Journ.* i. 489.

In concluding the Catalogue I may here remark that the January number (1887) of the *Journal of the Chemical Society* contains no less than seven original communications (exactly one half of the total number) made by past or present Students of the Owens College.

RICHARD CLAY AND SONS, LONDON AND BUNGAY.