This photograph was selected for comparison with those of Mr. I'Anson because the rays are plainly shown, while the shadow of the mica sheet, which was between the coins and the photographic plate, can also be plainly seen. It will be noticed that the rays are most numerous between the coins.

FERNANDO SANFORD.

Stanford University. Cal., February 19.

[The photograph referred to by Mr. Sanford is similar to one which illustrated Mr. I'Anson's letter (p. 270), the chief difference being that a greater number of rays are shown in the space separating the two coins.—ED. NATURE.]

Laboratory Use of Acetylene.

IN your issue of September 3, 1896, appeared a short letter stating that acetylene was in use in our laboratory for blowpipe work, and further stating that we hoped to introduce the gas on to the benches. From one or two inquiries received since then, it would seem that the fact of our now having succeeded in doing this will be of interest, as, indeed, it should be to any one possessing or contemplating the erection of a laboratory in the country where ordinary gas is costly or not obtainable. We use an ordinary Bunsen of special dimensions, the aperture of the jet being very small, and the tube (also of small diameter) is provided with a cap to protect the burner from dust when not in use. The generator is a modified form of one of those at present in the market, and gives between seven and eight inches water pressure. With six inches pressure a perfectly non-sooty flame of good size can be obtained, and a "quarter Bunsen flame" under as little as three and a half inches. If turned lower than this, the flame becomes luminous, the draught becoming insufficient. The flame is steady, noiseless, and, unless turned too low, evinces no tendency to strike down. The consumption of gas averages one cubic foot per burner per hour. The flame possesses, of course, great heating power, one volume of acetylene being for practical purposes nearly twice as effective as one volume of ordinary gas. This means an immense saving of time in all heating operations, and in many cases, such as small fusions and simple glass-working operations, we are able altogether to dispense with the blow-pipe; the burner alone supplying quite sufficient heat. Our installation has only just come into use, but, so far, has given us no trouble. We have used an acetylene blow-pipe for nearly a year, and have had no difficulties. The cocks and general fittings should be thoroughly good; any one who has not gone into the matter will be surprised to find what an indifferent article, as regards leakage, is the average gas-cock. It will be found that the cocks tend to work stiff, probably on account of the absorption of the acetylene by the lubricant, and it is much to be desired that the question of the most suitable lubricant should be investigated.

The Laboratory, Felsted School, Essex. A. E. MUNBY.

Immunity from Snake-bites.

IN case any of your readers may be working on the subject suggested by Mr. Dawson Williams in NATURE, March 4, page 415, that mosquitoes may be the carriers of pathogenic microbes, I send you the following.

In a town in the interior of Asia Minor, where I resided some years, and where malarial fever was at all times very common, I frequently noticed that when the wind blew from the direction of swamps in the vicinity, bringing numbers of mosquitoes, there would be an increase in the number of men, both native and European, down with fever *about a week later*. Had the wind brought the malaria, or dust containing fever germs from the swamps, the increase in number of fever cases might have been expected within two or three days; but as generally a week elapsed, some less direct cause was to be sought, and I always thought the mosquitoes were the culprits.

That mosquitoes do more than inject a specific toxin may be inferred from a fact I have noticed—that people who have been living in the interior of this country and have become inured to the bites of the insects from the swamps, on coming to this town, where sewerage and dirt of all descriptions abound, are painfully conscious of the attacks of mosquitoes here, nd *vice versâ*.

Those who have suffered much from fever are generally immune from the usual pain of mosquito bites, and I have heard natives say that they have suffered so much from fever that even the mosquitoes will not bite them.

During the summer months, in certain localities in the interior, labourers are exposed to the bites and stings of tarantulas and scorpions. I have frequently seen men stung several times in the same season, and found that *invariably* they suffered less from each successive sting or bite. J. BLISS.

Smyrna, March 12.

The Stereoscopic Studies of Clouds.

SINCE 1894, I have been making stereoscopic studies of clouds with wide separation of the cameras.

Beyond the direct interest of the pictures, the method has a practical value.

(1) In the measure of the distance of clouds by photogrammeters, it is usual to mark by a pin-prick the corresponding points of the two prints. Through the vagueness of cloud outlines it is easy to err in doing this, but any error thus made is easily detected by the stereoscope.

I have recently learnt that this method has been already suggested by Mr. M. J. Amsler-Laffon, of Schaffhausen, but I do not know whether it has been previously put to a practical test.

(2) My photographs were taken by visible signal without electric connection, some of them with a base of fully five hundred yards, and the clear stereoscopic definition seems to show that in ordinary cases the expensive electric connection of the cameras may be dispensed with, without affecting the value of the plates for purposes of measurement.

19 The Boltons, S.W. JOHN TENNANT.

FAMOUS SCIENTIFIC WORKSHOPS.

I.—LORD KELVIN'S LABORATORY IN THE UNIVERSITY OF GLASGOW.

AS Lord Kelvin stated nearly twelve years ago, in an address at the opening of the Physical and Chemical Laboratories at the University College of North Wales, the establishment of scientific laboratories at universities and colleges for the experimental training of students is a comparatively recent idea. Private laboratories, no doubt, existed at a very early period. The old alchemists had places, sometimes secret retreats, meanly appointed, like the den of Wayland Smith, sometimes, when the purse and protection of a powerful patron were at their command, more luxurious quarters, in which they carried on their search for the elixir of life, and the key to the transmutation of metals.

Der in Gesellschaft von Adepten,
Sich in die schwarze Küche schloss,
Und, nach unendlichen Recepten,
Das Widrige zusammengoss.

When what was spurious and unscientific in the old alchemy had gradually sublimed away, when chemistry had grown up in its place, and the experimental study of natural philosophy had begun, the only laboratories (anatomical schools excepted), as a rule, were those in the houses of investigators, and to these admission was given by the masters only to their favourite disciples. There the work done was entirely that of research: such a thing as a course of laboratory exercises, carried on with a view to the passing of an examinational test of experimental knowledge and dexterity, was undreamed of. What a change has taken place! Now, no scheme of instruction in physics, chemistry, or biology is deemed complete which does not include an extensive course of practical work to be performed by the ordinary students; and excellent and well-appointed laboratories are provided at every institution which aims at giving university instruction in scientific subjects. This is all as it should be, were it not that the examinational test is in too many cases made a great deal too much of.

The Scottish Universities have often been criticised adversely, most frequently by men who knew little about them or the work they do, but on several memorable occasions they have led the way in scientific progress. To a resident graduate of the University of Cambridge the world owes the Newtonian Philosophy, but it was James Gregory, in the University of St. Andrews, who first taught the Newtonian doctrines in a University course; and Lord Kelvin was, we believe, the first teacher of Natural Philosophy who opened a physical laboratory to his students. The beginning was a memorable one. Soon after his appointment fifty years ago to the Glasgow Chair, Lord Kelvin was beginning his great series of researches on the Electrodynamic Qualities of Matter, and invited his students to aid him. Others hearing of the new work going on volunteered for service, and new branches of research were quickly opened out. Then began that famous experimental work which has been carried on at Glasgow through half a century, and still so actively continues.

The physical laboratory for many years was a disused wine-cellar in the old University buildings. To this was added, in course of time, the discarded Blackstone examination room, and in this modest suite of rooms the experimental work of the department was done, until the University removed twenty-six years ago to its palatial buildings at Gilmorehill.

For the most part the work done in this laboratory was of the nature of research. A good man was set to make some of the easier observations in an investigation which was in progress, and, beginning thus, he in a short time obtained very considerable skill in experimental processes by carrying out the determinations of the various physical constants which were required for the final result. For the best men this plan answered remarkably well. Their interest was excited, was kept alive by their constant intercourse with the guiding spirit of the place, and their zeal was such that, as the writer can testify, the laboratory corps, as it used to be called, has been known to divide itself into two squads—one which worked during the day, the other during the night, for weeks together, so that the work never paused.

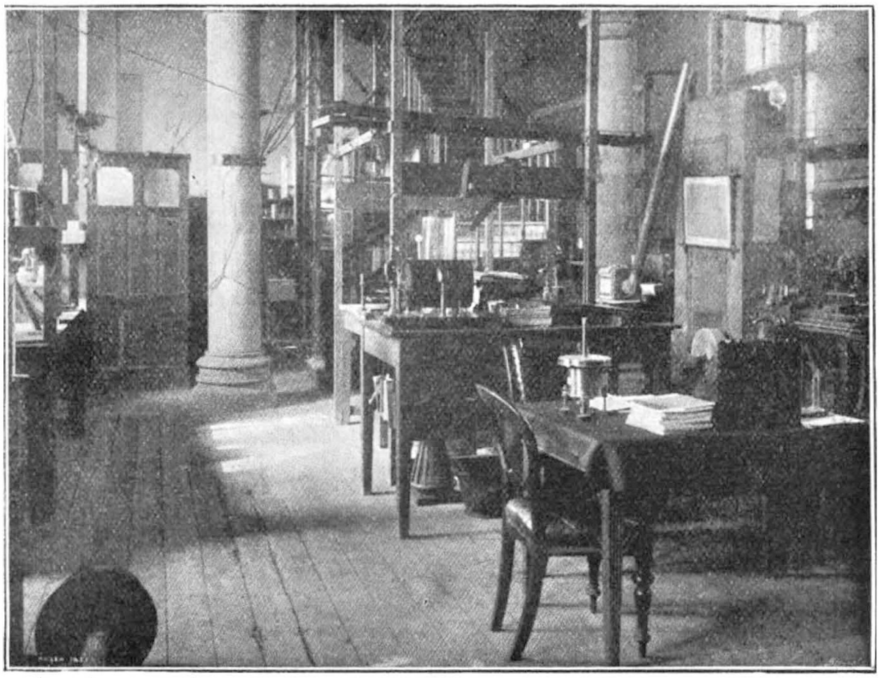
The University of Glasgow is built somewhat after the fashion of colleges in Oxford and Cambridge, in the form of a double quadrangle, and in a style of Gothic architecture, with crow-step gables and turrets, rather common in baronial residences in Scotland.

Although the amount of space devoted to the Department of Natural Philosophy in the University is considerable, the physical laboratory, it must be confessed, suffers from the general plan adopted for the buildings. Of the convenience of the quadrangular arrangement for a college, consisting in the main of suites of rooms for students and fellows, with dining-rooms, class-rooms, &c., there can be no question; but for a *university*, in which provision must be made for great experimental departments, such as physics, chemistry, physiology, zoology, and anatomy, it is far from being well adapted. Such departments are best provided for by detached buildings, or "Institute," as they are called in Germany, if possible within the University grounds.

The adjoining figure gives a view of a part of the general working laboratory. In the foreground is a writing-table, on which stands a magnetostatic voltmeter. At that table Lord Kelvin generally sits when he is in the laboratory, and occupies himself with the consideration of results which are being obtained by the men at work in the laboratory, or with the dictation of his correspondence to his secretary.

A little to the right is a stone erection built on an independent foundation. This contains a chamber in which apparatus requiring a steady support can be suspended; and it was here that the pendulum was hung by which Messrs. George and Horace Darwin made their first attempt to determine directly the attraction of the moon on a body at the earth's surface.

Behind the writing-table is another table with vertical beams at its corners, which give it somewhat of the appearance of a "four-poster" bedstead. To these vertical beams cross-bars are attached for the support of pieces of apparatus in the manner shown in the illustration.



From "Good Words."] [*From a photograph by T. and R. Annan and Sons, Glasgow.*

FIG. 1.—View of part of the General Laboratory.

In the background are two stone pillars supporting a partition wall of the rooms above, and to these were led wires from a large battery of tray Daniell cells which, before the advent of really practical dynamos, stood in the right-hand corner of the laboratory under the staircase, and supplied the current required for the various kinds of experimental work in progress. On the left of the pillars is seen part of another four-poster, and the door of a private room, partitioned off from the main laboratory, in which special experiments, or reductions of results can be carried on without interruption.

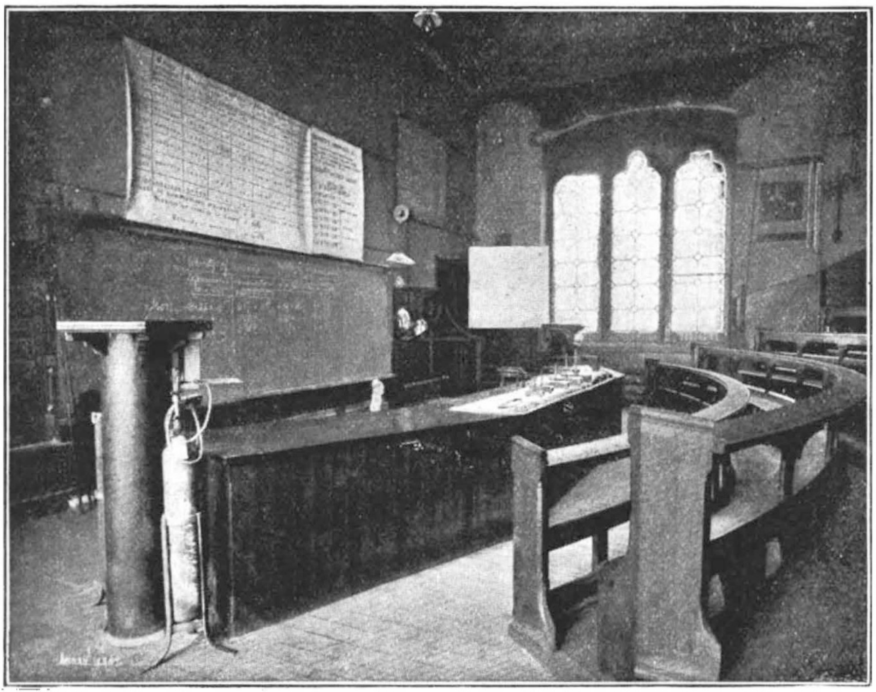
Passing up the stairway, seen at the back in the illustration, we arrive on the upper floor in a small room formed under the seats of the Lecture Theatre. Thence we can pass directly into the Lecture Theatre, or into the Apparatus Room, which is directly behind it.

The adjoining figure gives a view of the interior of the Lecture Theatre as seen from its large oriel window in the front of the building. It is a lofty apartment lighted mainly by two large windows, one the oriel just referred to, the other, seen in the picture, looking into the west quadrangle. On the sill of the latter window, which is passed each day by every student entering or leaving the room, are usually arranged a series of semi-secular experiments, in illustration of those lectures on the "Properties of Matter," which have always formed a most interesting and suggestive part of Lord Kelvin's course, and which, to every one who has heard them, have intensified the regret, felt by so many, that the second volume of Thomson and Tait's "Natural Philosophy," in which this subject was to be specially treated, is not to appear.

In one of these experiments a slab of pitch, or of shoemakers' wax in water in a glass jar, is made to confine a number of common corks below it, while in the water above the jar are placed a few lead bullets. After a month or two some of the corks are found in the water above the pitch, while the lead bullets have sunk down through the pitch to the bottom of the jar. Other corks are on their way through, and, being imbedded in the pitch, are lost to view; and of the paths followed by the corks and bullets, which have made the passage, no trace remains. All the time the pitch or wax is so brittle as to fly to pieces if thrown down on a table, or violently struck with a hammer.

To the small continuously applied forces due to the corks and bullets the pitch has behaved like a fluid; indeed, its properties have been precisely those of a highly viscous liquid. It has offered resistance to change of shape, but the resisting force has depended on the rate of progress of the change, not, as elastic resistance would, on the amount of change already accomplished. On the other hand, a piece of the same pitch melted into the form of a bell, and struck with a hammer in the ordinary way, would give out a musical note, showing that for rapidly alternating changes of shape the forces excited in the pitch are proportional to the strains produced; which indicates that the material under the latter conditions possesses the properties of a solid. Thus one and the same substance may, according to the circumstances in which it is placed, behave either as a viscous liquid or as an elastic solid.

This result is important as bearing upon the difficulty as to how the luminiferous ether, under any conceivable estimate of its density, can possess so high a degree of rigidity as to transmit the waves of transverse oscillation, which, according to the elastic solid theory of the ether, we have in light, with a velocity of 3×10^{10} centimetres per second; while the planets and the components of double or multiple stars move freely through it. The difficulty (if it is a real difficulty, and is not to be got rid of in a new view of the propagation of light based on electromagnetic theory) is not explained by this experiment; but it is reduced by it to an affair of properties of matter, by being shown to have a parallel in a phenomenon of which we have undoubted experience.



From "Good Words."] [From a photograph by T. and R. Annan and Sons, Glasgow.

FIG. 2.—Lecture Theatre, from front window.

Another piece of apparatus in the window is a model glacier in which a slope of wood takes the place of the sloping bed on the mountain-side, and shoemakers' wax that of ice. [See Dr. Bottomley's description in NATURE for December 18, 1879 (vol. xxi. p. 159).]

In the window also are generally displayed tubes illustrating the diffusion of liquids into one another, and the osmotic passage of a sugar solution through a diaphragm.

On the other side of the room is a large oriel window, which is partly visible in the view of the class-room table and lecture apparatus given in Fig. 3. Set up in this oriel window are two tall tubes running nearly the whole height of the room, and protected by wooden cases fitted with glass doors. One of these tubes illustrates the diffusion of sulphate of copper solution upwards into water, and the water itself in the opposite direction. The other tube shows the same thing for water and alcohol. These tubes were set up nearly a quarter of a century ago, soon after the new building was taken possession of by the University; and the original surfaces of separation, with the dates, are marked upon them. This is, perhaps, the longest experiment on diffusion that has ever been carried on; but of course it is capable of infinite duration, as an infinite time would have to elapse before the liquids in the tubes were completely mixed by this process. In his lectures Lord Kelvin is fond of accomplishing the work of an infinite time in diffusion, by reversing two or three times a closed tube in which the liquids have been originally separated by their different specific gravities.

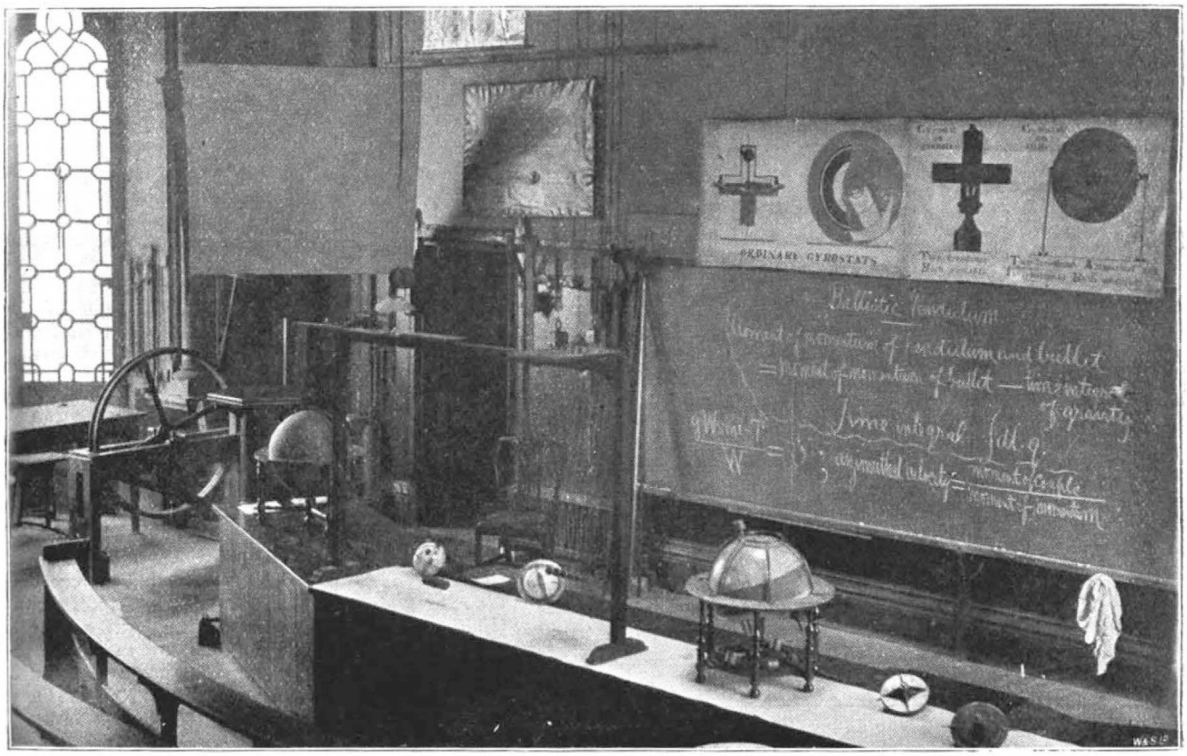
The progress of diffusion in the secular experiments is shown by the motion of specific gravity beads (small beads of glass of known mean specific gravity), which float in the liquid, and mark by their change of position the advance within the liquid of a stratum of given density. Thus the state of the liquids can be seen at a glance without either disturbing the apparatus, or setting up more or less troublesome observing instruments.

The picture shows the lecture-table with apparatus for illustrating gyrostatic action and precessional motion. On the table and to the right are ordinary gyrostats, towards the left are two hollow spheroidal gyrostats which can be filled with water, and between stands a model, well known to all Glasgow students, for illustrating the precessional motion of the earth, which arises from its gyrostatic action. One of the hollow spheroids is oblate, the other is prolate, with the same deviation from sphericity in each case. When they are filled with water and rotated, the oblate spheroid behaves like an ordinary solid gyrostat; the motion of the other is unstable, and the spin disappears immediately. On the wall are diagrams showing the construction of a gyrostat and its rotational stability under various modes of support which render it essentially unstable when there is no rotation.

Above the lecture-table is a large opening extending to the roof, so that it is possible to suspend from the roof-beams pendulums, ropes, gyrostats, and many other things of great importance for physical illustration.

The apparatus-room is a large apartment, like the other rooms of the laboratory, from eighteen to twenty feet in height. It contains two large cases of instruments occupying a large part of the floor-space, and two smaller wall-cases at the ends of the room. Here are stored the instruments used for class illustrations and research; but in the cases also are many pieces of apparatus, quaint and old-fashioned in form and ornamentation, made to a great extent from fine old mahogany. Besides these "urväter Hausrath" the cases contain several instruments of more modern design, which are far more historically interesting. One of these is the first reflecting galvanometer used by Lord Kelvin as a receiving instrument for signals through a submarine cable, the identical galvanometer, in fact, with which signals were received on board ship in the famous cable expedition of 1857, 1858; another is one of the pieces of apparatus with which Joule determined the dynamical equivalent of heat; and another is a replica of Dr. Andrews' apparatus for the investigation of the critical states of gases.

In another room upstairs there used to be a complete museum of electrometers and other electrical instruments. There were to be found old attracted disc-, heterostatic, and idiostatic-electrometers, and a series of instruments illustrating the development of the quadrant form of electrometer, from the first rude model to the marvellously complete and delicate contrivance for measuring differences of electric potential, which is not one of the least of the benefits Lord Kelvin has conferred on electrical science.



[*From a photograph by J. Lockhart Field, Glasgow.*

FIG. 3.—Lecture Table, with gyrostats, precessional globe, &c., and diagrams illustrating gyrostatic action.

Beyond the lecture-room, on the side remote from the apparatus-room, is the private room of the Professor of Natural Philosophy. There Lord Kelvin, in the early years of the new University buildings, used to work a good deal. Now the private room is occupied for the most part by his nephew, Dr. J. T. Bottomley, who has had the adjoining room fitted with benches, mercury air-pumps, and other apparatus suitable for investigation of the properties of high vacua.

On the floor above the apparatus-room and lecture-room are further cases for apparatus, and a battery-room the floor of which is caulked to prevent liquid from passing through into the rooms beneath.

The Physical Department and Lord Kelvin's house at the University are lighted with electricity. Current is generated for this purpose by a dynamo driven by a gas-engine in a small room on the ground-floor adjoining the general physical laboratory. The dynamo is kept continually running, and feeds a large secondary battery in another small room above the engine-room. This battery is used to supply current for special laboratory purposes, and also to feed and regulate the incandescent lamps throughout the department.

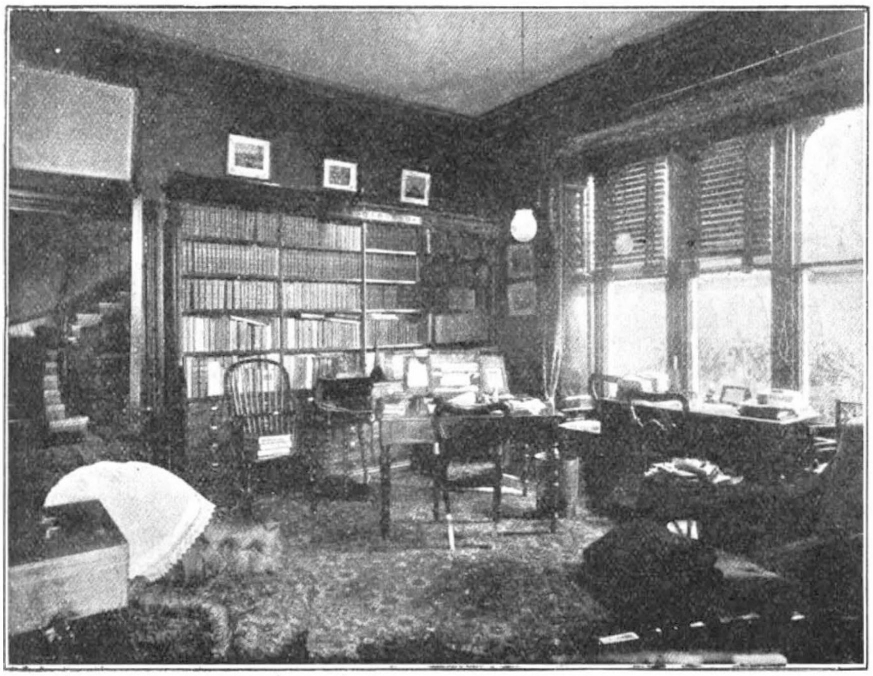
Perhaps the first telephone line to be established in this country was that erected between the University and the instrument factory of Mr. James White, who used to be well known as Lord Kelvin's instrument-maker. This line existed alone for some time, and formed the nucleus from which sprang the Glasgow Telephone Exchange, one of the first to be established in Britain.

Before leaving the laboratory proper we must not omit to mention the secular experiments on the effect of long-continued pulling stress on the length of wires of different materials, which are being carried out under the superintendence of Dr. J. T. Bottomley in one of the lofty rooms of the University tower. There, within a case of iron extending from a short distance above the floor of one room to the bottom of the one beneath it, a distance of about sixty feet, are hung wires of gold, platinum, and palladium, two for each metal, one of the two in each case being loaded with three-fourths of the breaking weight, the other with about one-tenth of the breaking weight. The lengths of these wires are observed from time to time by Dr. Bottomley by means of a cathetometer specially constructed for the purpose (see B.A. Rep., 1879, 1886).

In the same room there used to exist, and probably exists still, a mercury pressure-gauge, consisting of a long iron tube running for about 100 feet down a well which passed from the lofty room in which the wires are suspended to another below it in the tower.

In speaking of Lord Kelvin's laboratory we ought not to confine ourselves to the University laboratory, or even to Glasgow. Lord Kelvin's house, for example, is part of his laboratory; in fact, in a very true sense his laboratory or workshop includes wherever he happens to be. In train and steamer, at home or abroad, he is ever at work; and, no matter where he may be, he is in constant communication by post and telegraph with the corps of workers at Glasgow, is in daily receipt of the results of their work, and occupied with the deduction of consequences, and the consideration of how the researches in progress may be developed and extended.

The adjoining figure is a view of Lord Kelvin's study in his house at the University. The writing-table at the window is that generally used by Lord Kelvin; that in the middle of the room is the table of his secretary. In this room he spends several hours of each day, when he is at home, carrying on his literary work with his secretary, contriving models to illustrate the arrangement of the molecules in a crystal, molecular tactics, or mechanism for imitating the functions of the luminiferous ether, or occupied with one of his numerous inventions.



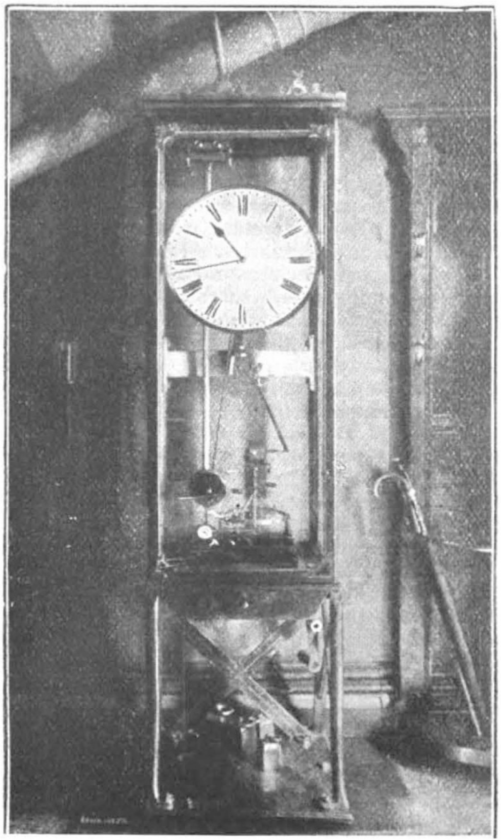
From "Good Words."] [*From a photograph by T. and R. Annan and Sons, Glasgow.*

FIG. 4.—Interior of Study in Lord Kelvin's House at the University of Glasgow.

The practical applications of physical science which Lord Kelvin has made are very varied, and they still occupy a considerable amount of his time and attention. Just outside his study, in the hall of his Glasgow house, stands a very remarkable clock which is designed to run at an almost strictly uniform rate (instead of discontinuously, like ordinary clocks and watches), and to show Greenwich mean time to a higher degree of approximation than is possible with a clock possessing any of the ordinary escapements. A full account of this clock is to be found in NATURE for January 11, 1879 (vol. xv. p. 227).

The instrument-making establishment formerly presided over by James White, and now carried on by a firm which has succeeded him, is a large factory situated in Cambridge Street, Glasgow, and in many respects may be considered a branch of Lord Kelvin's laboratory. A portion of it is shown on the next page (Fig. 6). The workshops consist of several floors, which are set apart for different departments of the work carried on. An 80-H.P. engine supplies power for the machinery, which comprehends many instruments and tools, such as lathes, &c., of precision. A large and fully-equipped standardising laboratory is provided on the ground-floor for the graduation of the standard electrical instruments which Lord Kelvin has recently placed in the hands of practical electricians.

Here his various navigational and electrical instruments are made, tested, and sent out for use; and here, when at home, he spends a part of almost every day. His usual programme is, after giving instructions regarding the correspondence of the morning to his secretary, and lecturing to his class from 9 to 10 o'clock, if it is one of his days to do so, to walk or drive into town to White's, there often to remain until time to return to the University for a midday lecture or for luncheon. In these visits to White's many scientific problems have been solved, and many others have been suggested, the solution of which, if unattainable, had to be avoided by



[From a photograph by T. and R. Annan and Sons, Glasgow. From "Good Words."]

FIG. 5.—Astronomical Clock in the Hall of Lord Kelvin's House.

material. This in its turn, owing to the invention of telephony, has had to be modified by the introduction of quantities which, neglected before, become in rapid periodic signalling of primary importance. Thus we have the complete theory of the propagation of electric waves along wires, with which we have been made familiar by the researches of Lord Kelvin himself, Heaviside, J. J. Thomson, and Hertz.

Another important part of Lord Kelvin's real laboratory used to be his yacht. For many years his commodious schooner, the *Lalla Rookh*, was put in commission early in April; and from then till the end of October, Lord Kelvin sailed the seas. Sometimes he went as far as Madeira, or up the Mediterranean, but generally he cruised between the Clyde or the Hebrides and the Solent. Wherever he was, he was busy with scientific research, and the mathematical discussion of some abstruse problem in fluid motion, carried on with note-book and pencil, alternated with a trial of some new form of sounding machine, or an observation of waves or ripples. Lord Kelvin is a thoroughly skilled and scientific navigator; in fact he is one of the most distinguished authorities, not only on matters of physical science, but also on questions of naval architecture and practical navigation.

In all the work of the Physical Laboratory the aim has ever been to render the student self-dependent and resourceful. The writer well remembers being told, not long after he entered the laboratory, that he ought to have taken to pieces a quadrant electrometer to find out what prevented it from acting properly, when all else had failed to disclose the fault in the instrument. And many others have had similar experience. It is very doubtful, indeed, if too much is not done for students in many laboratories, in the way of arranging for their individual pieces of work, and furnishing them with ready set-up and unexceptionable instruments.

But beyond everything in the laboratory at Glasgow has ever been Lord Kelvin's presence and example, and adopting some other means of obtaining the desired result. These constant relations of practice to theory and theory to practice, which Lord Kelvin, in consequence of his great inventive activity, has had always to keep in view, have been fraught with important consequences to science.

It would be difficult to say how many of Lord Kelvin's contributions to the advancement of pure science have resulted from his keen interest in applications of science, and his knowledge of the resources and uses of mechanism; but it is certain that many of them may be credited to this account. It was the practical question of how to signal at a rate commercially successful through a submarine cable that led him to the discussion of the diffusion of electricity through a long copper conductor, separated from an external conductor by a cylindrical sheathing of insulating

From "Good Words."] [From a photograph by T. and R. Annan and Sons, Glasgow.

FIG. 6.—A part of James White's Instrument Factory.

the charm of his personal influence. Throughout his long tenure of the chair of Natural Philosophy, he has carried lightly like a flower the weight of honour which the scientific world has united to render to him. He has remained ever the same kind friend of his students, and his interest in them, old and young, and in every scientific worker, has found many quietly sympathetic modes of expression. The enthusiastic testimony to his pre-eminence as a scientific man, and to his admirable personal qualities, which was borne by the whole world at the magnificent celebration last June, will not soon be forgotten by those who had the privilege of taking part in that great ceremonial: it was an emphatic tribute to the greatness of the part which the Physical Laboratory at Glasgow has played in science during the last fifty years.

A. GRAY.

JAMES JOSEPH SYLVESTER.

HE is dead, and it becomes a sad duty to give a brief account of his long life and great work.

Born in London September 3, 1814, he was the youngest but one of seven children of Abraham Joseph Sylvester. He was the last survivor. Three sisters lived for many years at Norwood, and of his three brothers two, Frederick and Joseph, lived for the most part in America, whilst George resided at Worcester.

He obtained his early education at private schools in London; thence he went to the Liverpool Institution, and in 1837 graduated at St. John's College, Cambridge, as Second Wrangler. The first five names in the Mathematical Tripos of the year are Griffin, Sylvester, Brumell, Green, Gregory. It is astonishing to think that Green, of immortal memory, has been dead for nearly fifty years! Sylvester was keenly disappointed at his failure to be senior of the year. He was always of an excitable disposition, and it is currently reported that, on hearing the result of the examination, he was much agitated. Being of the Jewish persuasion, he was unable to take his degree at Cambridge, but later he obtained a degree at the University of Dublin. On leaving Cambridge he at once commenced the long series of mathematical papers, which he was to contribute to scientific periodicals all over the world, by the publication, in vol. xi. of the *Philosophical Magagine*, of an analytical development of Fresnel's optical theory of crystals.

This was followed by some articles upon subjects of applied mathematics, and it was not until 1839 that he brought his intellect to bear upon the analysis of continuous and of discontinuous quantity, departments of pure mathematics which well-nigh monopolised his attention for the remainder of his life. He was appointed Professor of Natural Philosophy at University College, London, and later on held the post of Professor of Mathematics in the University of Virginia. He returned to England in the year 1845, and the first period of his scientific career may be said to have closed. He had published some thirty papers, and was already well known in both hemispheres as an original and imaginative man of science. The subjects dealt with comprise "Dialytic Method of Algebraical Elimination," "Sturm's Functions," "Criteria for Determining the Roots of Numerical Equations," "The Calculus of Forms" (afterwards known as the "Theory of Invariants"), "The Equation in Integers $Ax^3 + By^3 + Cz^3 = Dxyz$." The latter problem was a favourite subject of thought throughout his life, and the first problem in the theory of numbers that he attacked. The theory of invariants sprang into existence under the strong hand of Cayley, but that it emerged finally a complete work of art, for the admiration of future generations of mathematicians, was largely owing to the flashes of inspiration with which Sylvester's intellect illuminated it. The nomenclature of the theory is almost entirely due to him. The words "invariant," "covariant," "Hessian," "discriminant," "contravariant," "combinants," "commutant," "concomitant," are a few of those introduced by him at this time, which have been part of the stock-in-trade of mathematicians ever since.

A beautiful theory of the rotation of a rigid body about a fixed point, after Poinsot, should be mentioned. It is one of the few papers that he wrote on dynamics.

For ten years after his return from Virginia he was occupied with a firm of actuaries. He founded the Law Reversionary Interest Society, and also accomplished a considerable amount of mathematical research. In 1853 appeared his first important memoir in the *Philosophical Transactions* of the Royal Society, bearing the title, "On a theory of the syzygetic relations of the rational integral functions, comprising an application to the theory of Sturm's functions and that of the greatest algebraical common measure." This is a masterly exposition, covering 170 quarto pages.

In 1855 he was appointed Professor of Mathematics at the Royal Military Academy, Woolwich. This was a great relief, as the work of an actuary was manifestly unsuitable, and had indeed been most distasteful to him. He held this professorship for fifteen years. It was a time of great activity. Year by year his fame increased, and recognition by foreign academies was liberally bestowed. In addition to continual work at the theory of invariants, he laboured at some of the most difficult questions in the theory of numbers.

Cayley had reduced the problem of invariant enumeration to that of the partition of numbers. Sylvester may be said to have revolutionised this part of mathematics by giving a complete analytical solution of the problem, which was in effect to enumerate the solutions in positive integers of the indeterminate equation—

$$ax + by + cz \; . \; . \; . + ld = m$$

Thereafter he attacked the similar problem connected with two such simultaneous equations (known to Euler as the Problem of the Virgins), and was partially and considerably successful. In June 1859, he delivered a series of seven lectures on compound partition in general at King's College, London. The outlines of these lectures, printed at the time for distribution amongst his audience, are now being published for the first time by the London Mathematical Society. He was assisted in the preparation of these lectures by Captain (now Sir Andrew) Noble, with whom from that time forth he was in sympathetic friendship.

The year 1864 may be regarded as the time of his greatest intellectual achievement, which caused him to be considered as one of the foremost of living mathematicians. On April 7, 1864, he read a paper before the Royal Society of London, bearing the title "Algebraical Researches, containing a disquisition on Newton's rule for the discovery of imaginary roots, and an allied rule applicable to a particular class of equations, together with a complete invariantive determination of the character of the roots of the general equation of the fifth degree, &c." In the "Arithmetica Universalis," Newton gave a rule for discovering an inferior limit to the number of imaginary roots in an equation of any degree, but without demonstration. Neither did he give any indication of the mental process by which he was led to conjecture the truth of the rule, nor did he set forth the evidence upon which it rests. For years the question of proving or disproving the rule had been a crux of the science. Euler, Waring, Maclaurin and Campbell were amongst those who sought in vain to unravel the mystery. The only step that had been gained was to show that if *any* negative terms occur in the quadratic elements involved in the statement, there must be *some* imaginary roots. This, however, was not a great step,