

the largest prominences depicted in all the photographs was not seen at all at Kalocsa. The results with the spectroheliograph were not of the best, owing to haze; but from all available facts, it seems to be established that the white prominences are spectroscopically invisible because they shine chiefly by H and K light. Nevertheless, light of the same refrangibility in the electric arc undoubtedly appears violet; but it may be, as Prof. Hale suggests, that the violet tinge is overlooked in the presence of the more conspicuous colours during an eclipse. The best results obtainable with the spectroheliograph, when K light is utilised, compare very favourably in sharpness of definition, as well as in the rendering of faint details, with the best photographs taken during an eclipse.

**SHOOTING-STAR RADIANTS.**—In connection with a table of radiant points observed at Hong Kong, Dr. Doberck refers to several interesting points relating to the phenomena of shooting-stars (*Ast. Nach.*, 3360). It is pointed out that the long continuance of some of the radiants is accounted for by parabolic motion, while others can possibly be explained by hyperbolic motion. In explanation of some of the radiants having somewhat similar elements, it is suggested that they were possibly associated with different tails of the same comet.

Owing to the fact that the meteorites are heated to incandescence nearer the earth in the evening than in the morning, there is a small decrease in the average magnitude of shooting-stars during the night; before 9 p.m. the average brightness is mag. 2.7, while of those seen later it is 3.2. Again, on account of the earth's movement, the duration decreases from 0.9 sec. between 6 and 8 p.m. to 0.5 sec. between 8 and 11 p.m., and to 0.3 sec. between 11 p.m. and 4 a.m. Up to 11 p.m. the mean length of path is  $15^\circ$ , and afterwards  $13^\circ$ . The average duration, length, angular velocity per second, and the numbers of shooting-stars observed, classified according to magnitude, are shown in the following table:—

Mag.	Duration.	Length.	Velocity.	Number.
1	0.9	19	21	60
2	0.4	14	35	79
3	0.3	13	43	130
4	0.3	12	40	128
5	0.2	12	60	97

The majority of the shooting-stars below third magnitude were probably hidden by haze and artificial light.

**KEPLER AND HIS WORK.**—In a little pamphlet entitled "Kepler's Lehre von der Gravitation" (Halle, Max Niemeyer), Dr. Ernst Goldbeck gives an interesting and appreciative account of Kepler and his work. The point principally elaborated is a main difference between Kepler's methods and those pursued by Ptolemy and the older astronomers. These latter were content to solve the problem of celestial mechanics on purely mathematical lines. They were instructed in the shape of the orbits and their dependence on time; they could foretell the place of an object at a definite epoch, and this satisfied their astronomical needs. Kepler, however, the forerunner of the modern school, is concerned in the character and the operation of the force, on which these motions depend. The points surveyed by the author as affecting the development of Kepler's views in his approach to a gravitational theory of the earth are: (1) The transference of the centre of the solar system from the earth to the sun, and the consequent disturbance of Aristotle's views. (2) The impetus given to mechanical inquiry by Gilbert's magnetical investigations. (3) The discovery of the coincidence of tidal phenomena with the position of the moon, and consequently the suggested attraction. (4) The telescopic examination of the moon by Galileo, and the confirmation of the suspected identity of its general character with that of the earth. Kepler's work on Mars, and his endeavours to trace the nature of the connection between the sun and the planets, are graphically described, and the whole pamphlet well repays careful study.

#### SCIENCE AND SOCIETY AT THE CENTRAL TECHNICAL COLLEGE.

THE object of the conversazione at the Central Technical College, Exhibition Road, on Friday, June 12, was to enable the scientific public to witness the ordinary working life of the students there. Consequently, while in deference to the lady visitors, the staircases and corridors were rendered attractive

with arches of palms, arm-chairs, arc lights, and Hungarian airs, neither the blossoms, the banners, nor the band, were allowed to intrude on the apparatus and machinery, which were left as in every-day use.

Laboratory sinks remained sinks, and were not converted into make-believe flower-boxes; while no green baize covers hid the traces of oil and tools on the workshop benches, nor made them resemble extemporised billiard tables.

The Lord Chancellor, as Chairman of Council, and Lady Halsbury, received the visitors, and conspicuous amongst the 1700 were the Masters of many of the City Companies wearing their chains of office.

Exactly twelve years ago to-day (June 25, 1896) the Central Technical College was opened by the Prince of Wales, who expressed the opinion, "that the opportunities for advanced instruction, which will be afforded in the well-arranged laboratories and workshops, will enable the managers and superintendents of our manufacturing works to obtain more readily than hitherto the higher technical instruction which is so essential to the development of our trade and commerce." And, on the same occasion, the late Lord Selborne—the then Lord Chancellor—stated that "in the several laboratories with which this College is provided, new and increased facilities will be afforded for the prosecution of original research, having for its object the more thorough training of the students, and the elucidation of the theory of industrial processes."

An examination of the laboratories and workshops by the visitors at the conversazione, made it clear that the aims initially laid down for the working of the Central Technical College have been steadily kept in view. The Department of Mechanics and Mathematics showed the apparatus which had been developed for familiarising students with the laws of motion and force. Electric clocks transmit time-signals to quick-running Morse instruments for chronographically marking the instants of various experimental events. To measure "*g*," the falling body is started electrically, its moment of arrival noted electrically, and the interval measured with a vibrating tuning-fork; while for slower motions, such as that of a body rolling down an inclined plane, the electric current that liberates the ball starts a stream of water flowing from a water-clock, which again is instantly stopped on the ball touching an electric trigger placed at any desired point of its path. Apparatus for measuring centrifugal forces, studying impact, finding moments of inertia, timing the vibrations of pendulums, measuring the extensions of wire, &c., make us wish that, when, as boys thirty or forty years ago, we laboured through "little Newth," acquired a particle of Tait and Steele, and struggled with the rigidity of Routh's Dynamics, some Maxwellian demon had opened the door of Prof. Henrici's laboratory, and shown us so vivid a realisation of the principles of what, in the misleading jargon of that day, was called "statics and dynamics," with its "accelerating forces" and "moving forces."

In the same department were seen calculating machines and quadric surfaces, planimeters and plaster of Paris models, integrals for solving differential equations, and integrators for evaluating areas; while the smooth working of the latest form of Prof. Henrici's harmonic analyser, by means of which ten coefficients in a Fourier's series can be determined by going only once over a curve, led the engineer to speculate on the time when all calculations, however complex, would be done by turning a handle, and when the brain would be left quite free to think and originate.

So much attention has of late been given by School Boards and County Councils to the establishment of manual training classes, that the collection of exercises in wood-working in the Carpenter's Shop of the Engineering Department, could not fail to attract attention. But more attractive still was the laboratory for testing materials, where the deliberate motion of the lever of the 100-ton machine, stretching steel plates until they broke, and automatically writing the history of the experiment with Prof. Unwin's stress-strain-recorder, was as fascinating to the lady-visitors as to the engineers who accompanied them. And how complete is the investigation that the students can make on the properties of the materials used by the engineer and builder, could be gathered from seeing the smaller machines which were bending thick beams of wood, stretching wires, and breaking blocks of cement, as well as from examining those specially designed for testing lubricants, gauges, and the elastic constants of materials, such as the screw and mirror extensometers and compressometers designed by Prof. Unwin.

The desire of every lad to make something is gratified and educationally directed in the Engineering Workshop, which is liberally fitted with milling, planing, shaping, and slotting machines, and four of the lathes, we were told, had been made by the students themselves, while one weighing three tons, and having a 10-foot gap bed, we saw in process of construction.

The economy of a De Laval steam turbine, running at 32,000 revolutions a minute, and of a Tower spherical engine, were being tested in the Steam Laboratory, while a 40-horse power condensing engine, specially designed to illustrate the effect of varying the conditions of working, has fitted to it a very satisfactory hand-brake, indicator gear, and arrangements for measuring the circulating water, the condensed steam, the jacket and receiver drainage, &c. And, as a memento of the improvements that can be effected in prime movers by experimental inquiry, there stands the very engine used by the late Mr. Willans in his classical investigations on steam engine economy, cut through so as to expose a sectional view of the cylinders, pistons, and valves.

Adjoining the Steam Laboratory is the boiler-room, where in addition to the Lancashire and Cornish boilers, used for generating steam for the engines, is a Babcock and Wilcox boiler, used exclusively for boiler and fuel tests, with its accompaniments of feed-water measuring tanks, coal-weighing apparatus, dasymeter for determining the percentage of carbonic acid in the furnace gases, &c.

In the laboratories of the Physical Department are many instruments and pieces of apparatus that have been developed there, and specimens of which are now to be found in other colleges, electrical works, and electric lighting stations. In the dynamo room are speed cones by means of which the speed of any dynamo can be varied between wide limits, and, what is equally important for experimental purposes, can be kept at a constant value independently of variations in the speed of the engine, or in the amount of slip of a belt when it is transmitting different amounts of power. Doubts were originally expressed as to the possibility of such cones being used to transmit even 10-horse power satisfactorily, but their successful working having been proved, sets of them were reproduced for University College, Nottingham, the McGill University, Montreal, &c. This room contains many different types of dynamos, and, as space is limited, one is driven with a weighted pulley hanging in a very short belt passing over the fly-wheel of the engine, the dynamo itself being balanced on trunions, so that it turns on an axis at right angles to that round which the armature rotates.

The "injector" for producing any desired shape of wave, and so enabling one alternating current dynamo to serve the purpose of many, was shown in use, and the vibrating wire curve tracer, described at the last meeting of the British Association, was writing out the wave-forms so produced. The permeability of iron rods was being examined with the small dynamo recently shown at the Royal Society's soirée, and the regulation of transformers differentially tested with an electrostatic voltmeter, with which a pressure of one volt can be measured without any independent electrification.

Those interested in the bills sent in by Electric Light Companies had an opportunity of seeing American, English, French and German electric supply meters being tested at various temperatures in the Magnetic Research Laboratory, as well as experiments on the slow rise of temperature in underground electric mains.

The Electrical Research Laboratories contain various forms of electrostatic voltmeters, some of which were being tried, while others were in use for measuring the electric pressure at which cables and insulating oils break down by sparking. A Lorenz apparatus for the determination of the ohm, which had been constructed regardless of cost for the McGill University, and sent to the college to be tested, attracted much attention. It is certainly unique in its details, and eminently characteristic of the transatlantic millionaire who stipulates that the wealth which he showers on the laboratory named after him shall be used to purchase only the "very best apparatus." How many an English professor would delight in having such a condition imposed by a benefactor determined that the laboratory founded by him should be the most costly in the world.

In another room was a secohmmeter spinning out coefficients of self-induction, a new addition to the Wheatstone's bridge for facilitating the measurement of very small resistances, and an artificial submarine cable, electrically as long as those under the

Atlantic, with which the retardation in the passage of the telegraphic signals was demonstrated to the visitors.

In the Arc Lamp Laboratories the photometry of the arc, and the steady feeding of the carbons with various types of lamps, were shown, also the details of the experimental lamp used in the recently published researches was explained. The observer sees close to him the arc itself and its image enlarged ten times, also the spots of light indicating the current flowing and the potential difference maintained between the carbons; while in front of him are handles for regulating the current, the position of each carbon, &c. Mark Tapley would doubtless have said that there was no credit in making discoveries under *such* circumstances.

On a screen on a wall the voltmeter and ammeter spots of another arc were seen dancing up and down, and proving that when an alternating current is superimposed on a direct current arc the oscillations of potential difference and current are in the same direction when the carbons are cored, but in opposite directions when they are solid.

Gas-burners and glow-lamp testing, polarimetry, and spectrophotometry are carried out in the Senior Optical Laboratory, and the curves of results obtained by the students showed the most economical gas pressure to use with each type of burner; why it pays the gas companies to make the gas flare and the private consumer to use governed burners, and how much dearer, as far as mere light is concerned, is glow-lamp lighting than gas lighting with the Welsbach burners.

A range of rooms on the first floor is devoted to the Junior Physical Laboratories, and in them students, who frequently have never worked in a laboratory before, learn the principles of electricity, heat, light, magnetism and sound by performing an organised series of quantitative physical exercises.

In both the Physical and Chemical Departments there were several exhibits of "seeing with X-rays," the potassium-platino cyanide screens, which have been so successfully constructed by Mr. Jackson, being lent for the occasion. The majority of the exhibits, however, in the Chemical Department were connected with the educational methods employed, and with the results which have been obtained from the researches carried out by the advanced students and the staff. Prof. Armstrong has long advocated that every student of chemistry should be early infused with the spirit of scientific inquiry; and that this principle has been practised in his laboratories, and not merely preached in his lecture-room, was proved by the large number of specimens of new series of compounds which were exhibited as the outcome of the work in his department. Sulphuric derivatives of camphor prepared for the first time in a pure state, hundreds of specimens of derivatives of naphthalene—the hydrocarbon from which so many modern dye-stuffs are made—obtained experimentally, and the apparatus for many researches in course of progress, attracted attention.

In the Junior Chemical Laboratory were exhibited the apparatus and experiments used in connection with the courses to teachers that have been given at the College. This apparatus is suitable for the use of teachers giving elementary instruction in technical schools, as well as for carrying out the experiments recommended in the syllabus of elementary science (chemistry and physics) issued by the Incorporated Association of Headmasters.

For the last ten years Dr. Armstrong has made strenuous efforts to obtain adequate recognition for that hitherto much neglected, but all important branch of physical chemistry, crystallography, and in consequence the crystallographic branch of the department has gradually extended in size, until at present the laboratory devoted to that subject rivals the best on the continent for completeness of equipment. Numerous measurements and drawings of crystals that had been made by the students were exhibited, and demonstrations of the methods employed in the optical examination of crystals were given in the adjoining lecture theatre during the evening, apparatus that had been specially devised to facilitate the accurate examination of doubly refracting substances being employed for the purpose.

In the Woodcarving Department, under the direction of Miss Rowe, there was an exhibition of carving in a variety of styles by present and past students, some of the latter being now the instructors in this and in other schools of art woodcarving. A renaissance panel illustrative of the arts of sculpture, architecture, and literature, an Italian bracket, and a pediment for a bookcase, a low relief renaissance frieze, &c., showed boldness and finish, while the practical demonstrations of the different

methods of working in high and low relief attracted much attention.

What is the outcome of it all, thought the visitor, as he left with his mind whirling with slotting machines, scalar quantities, secohmmeters, and sugar analysis? Has original research been prosecuted as foreshadowed by Lord Selborne? Where are the some 200 students that have been awarded the diploma of Associateship of the Institute, and all the other special students who have passed through courses at the Central Technical College? The seventy papers communicated by the students, and the staff, to the proceedings of various scientific societies answer the first question, while the reports issued yearly by the Dean give information on the second point; some of the past students are the Principals, and some have charge of departments at technical schools; some are the chief engineers and some assistant engineers at electric light central stations in England; some hold postin chemical works, and some are railway engineers, and others telegraph engineers in India, but practically all appear to be employed. And what is a little remarkable—in view of the vast number of people who have been attracted to follow engineering pursuits during the past few years—we understand that nearly all the students who have passed through the Central Technical College are in receipt of pay for the services they are rendering, and are not paying premiums to employers for the privilege of being allowed to do hard work.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered by the Public Orator, Dr. Sandys, in presenting for the honorary degree of Doctor in Science Prof. Newcomb, of Johns Hopkins University, Superintendent of the American Nautical Almanac.

Si Thales ille Milesius, "rerum naturae certissimus explorator et astrorum peritissimus contemplator," sapiens propterea nominatus est, quod solem lunae oppositu solere deficere primus omnium vidisse fertur, etiam hunc virum sapientiae laude non indignum arbitramur, qui solis et lunae defectus omnes antiquitus observatos cum astronomiae legibus hodiernis accuratissime comparavit. Idem quanto ingenii acumine aliorum de lunae motu placita correxit; quam admirabili studiorum caelestium cognitione cum Neptuni inventore nostro consociatus est; quam infinita denique cura fratribus nostris transmarinis trans aequora navigantibus siderum cursus litterarum monumentis mandatos explicavit. Talium virorum de genere humano merita dum contemplamur, non iam miramur ipsum Vergilium a Musis esse precatum, ut sibi ante omnia

"caelique vias et sidera monstrant,  
defectus solis varios lunaeque labores."

Duco ad vos astronomum illustrem, SIMONEM NEWCOMB.

At the annual election, on June 22, at St. John's College, the Hutchinson Studentship was awarded to A. S. Hemmy, double first in Natural Sciences, for research in Physical Chemistry. Foundation Scholarships, varying in value from £100 to £50 a year, were given to the following Science Students:—K. C. Browning, D. J. Morgan, J. S. White, N. B. Harman, J. H. Howitt; and Exhibitions in Natural Science to J. A. Glover, R. F. C. Ward, A. C. Ingram, Jehu, and Yapp. In Mechanical Sciences and Engineering, Foundation Scholarships were for the first time awarded to W. S. La Trobe (£80) and A. Chapple (£50). It is noteworthy that Messrs. Hemmy, La Trobe, and Chapple, who have thus carried off the chief scientific honours, are all colonial graduates, from the Universities of Melbourne, New Zealand, and Adelaide, respectively. Mr. J. E. de Villiers, of this College, who takes the highest honours in Law, being senior in his Tripos Part I., is a graduate of the Cape of Good Hope.

The Harkness Scholarship in Geology and Palaeontology is awarded to J. H. Gray, Scholar of King's College.

In Part I. of the Natural Sciences Tripos, thirty men are placed in the first class; in Part II. eleven men attain this distinction. No woman gains a first class in either part.

SESQUICENTENNIAL gifts continue to pour in upon Princeton University. An unnamed benefactor has given funds for a new library building.

THE following are among recent appointments:—Dr. Theodor Des Coudres to be Extraordinary Professor of Physics in Göttingen University, and Dr. Otto Bürger to be Extra-

ordinary Professor of Zoology; Mr. A. A. Heller to be Instructor in Plant Taxonomy at the University of Minnesota, and Curator of the University Herbarium.

THE fitness of Convocation of the University of London to deal with such subjects as a Teaching University may be estimated from the result of the meeting held on Tuesday. The chief business was the election of a Fellow of the University, and the following gentlemen had been nominated:—Sir Joseph Lister, Mr. Walter Rivington, and Mr. Richard Mosey Stephenson. The election was one in which voting papers were permissible, and the result of the counting of the votes was that Mr. Rivington obtained 963, and Sir Joseph Lister only 846 votes.

THE report of the Technical Education Committee which was adopted at the meeting of the Devonshire County Council, held at Exeter on the 11th inst., shows that the work done on the agricultural side of Ashburton Grammar School is of so satisfactory a nature that an additional grant has been awarded to the school; also that 175 continuation schools have been maintained throughout the year. At the same meeting the following resolution was passed by a substantial majority:—"That this Council, while offering at present no opinion as to the advisability or otherwise of placing secondary education under the control of the local education authority, strongly deprecates the proposal to transfer to them any duties connected with elementary education."

A SPECIAL Committee, appointed by the West Riding County Council to watch the Education Bill, have passed the following resolution:—"That in view of the amendment to the Education Bill, 1896, whereby every non-county borough with a population of 20,000 is to appoint an Education Committee, amendments should be introduced by way of limiting the duties of the education authority of such a borough to such defined matters as may be least hurtful to the administrative county, and the cause of education."

A MEETING of the Executive Council of the County Councils Association was held on Friday morning last, at the Guildhall, Westminster. Lord Thring having briefly explained the circumstances under which the meeting had been convened, it was proposed by Lord E. Fitzmaurice, and seconded by Sir J. E. Dorington, Bart., M.P., and resolved:—"That this Council, considering the changes which have been introduced into the constitution of the education authority by the exclusion from the administrative county of non-county boroughs with a population of 20,000, is of opinion that the above change strikes a serious blow at the administration of the Technical Education Acts, and of county administration generally." It was also resolved that the Parliamentary Committee be authorised to arrange for the presentation of the foregoing resolution to the Right Hon. A. J. Balfour, M.P., and His Grace the Duke of Devonshire.

THE Education Bill has been abandoned by the Government, and the eleven days of Parliamentary time spent in discussing it have been sacrificed. It is proposed to bring up the subject afresh next January, but there is little possibility that the measure which will then be brought forward will be of the very contentious character of the one just withdrawn.

THE National Home Reading Union aims mainly to make high-class reading attractive, and to give advice with regard to courses of reading in romance, travel, biography, economics, ancient and modern history, English and foreign literatures, science and art. Once a year it is the custom of the Union to hold a summer assembly at some interesting centre, when lectures are given in connection with the courses of study which have been pursued during the past winter. This year Chester has been chosen, and the assembly takes place there between June 27 and July 6. But not only will the subjects recently studied claim attention, for there will be several lectures on the botany, geology, and architecture of the district, besides a lecture by Mr. St. John Hope on "The Arrangements of Mediaeval Monasteries," with special reference to Chester. A number of interesting excursions and social gatherings have been arranged, including a visit to Northwich to descend a salt mine.

THE Technical Education Board of the London County Council next month will appoint not more than five Senior County Scholars. Each scholarship will be tenable for three years, and of the annual value of £60, together with free instruction in a college of university rank, provided that the fees