stars of the 4th or 5th magnitude could be distinctly seen through the tail. The tail pointed in a direction about midway between Sirius and Procyon. M. Dechevrens, the director of the Zi-ka-Wei Observatory (near Shanghai) has devoted a good deal of attention to this comet, the result of which will directly be published.

Amateur Mechanics is the name of a new illustrated monthly Magazine, conducted by Mr. P. N. Hasluck, and published by Trübner and Co.

WE have received from the U.S. Naval Observatory the results of the observations made to determine the longitude of the observatory of the J. C. Green School of Science, Princeton, N.J. The final result is that the latter is oh. 9m. 34s.·538 east of the central dome of the observatory.

THE earthquake in Panama on November 7 was followed by a violent shock on November 13 at 2.30 a.m. It was observed also at Taboga and Colon. It is remarkable that all the Central American earthquakes since August last have occurred between midnight and daybreak. Their general direction was invariably from north to south, and it is supposed that they proceeded from one and the same cause. The West Indian cable broke, at a point about thirty miles from land, during a violent shock. The centre of the disturbance seems to lie near the West Indian Isles. During the second week of December seven shocks were felt in the Spanish province of Almeria. On December 8 at 10.1 p.m. a fearful shock lasting four seconds was felt at Tecuci (Roumania). Its direction was from south-east to north-west. Another earthquake is reported from Hermagor (Carinthia). It occurred on December 10 at 2 a.m., and was preceded by a terrible thunderstorm.

AN "Illustrirte Bienenzeitung," organ for the propagation of rational apiculture, will be edited by Prof. Adolphson of Zürich, beginning on the 1st inst.

IN the Pelion district a moderately violent earthquake occurred on December 11, but no damage was done. Upon the island of Santorin new volcanic activity has recently been noticed; also in the subterranean volcano which formed near Missolunghi.

THE additions to the Zoological Society's Gardens during the past week include a Himalayan Bear (*Ursus tibetanus*) from Burmah, presented by Capt. Connor; two Bronze Fruit Pigeons (*Carpophaga ænea*) from India, presented by Mrs. A. H, Jamrach; four Barred-shouldered Doves (*Geopelia humeralis*) from Australia, presented by Mr. Ernest L. Bentley; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by Mr. K. Digby; a Gannet (*Sula bassana*), British, presented by Mr. Thomas Keen; a Cape Bucephalus (*Bucephalus capensis*) from South Africa, presented by Mr. H. Pillans; a White-fronted Lemur (*Lemur albifrons* ♀) from Madagascar, four Wood Thrushes (*Turdus mustelinus*), a Golden-winged Woodpecker (*Colaptes auratus*) from North America, two Cirl Buntings (*Emberiza cirlus*), two Crested Grebes (*Podiceps cristalus*), a Razorbill (*Alca torda*), a Bar-tailed Godwit (*Limosa lapponica*), a Red-throated Diver (*Colymbus septentrionalis*), British, purchased.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE ON MAY 6.—The right ascensions and declinations of the moon for 1883, both in the *Nautical Almanac* and the *American Ephemeris*, depend upon Hansen's Tables, with the recent corrections of Prof. Newcomb. They furnish as accurate positions as are obtainable from existing tabular data, and it will be of interest to trace their bearing upon the circumstances of the total eclipse of the sun which crosses the Pacific on May 6. On laying down the belt of totality upon the Admiralty chart of this ocean, it appears that the following islands are included within it, viz.:—Rance, Buffon, Beveridge, Flint, Caroline, and Chanel Island (in the Marquesas); the positions read off from the general chart or for Flint, Caroline, and Chanel Island, from the enlarged Admiralty charts are as follow:—

Rance Island,	Long.	176	22	West.		Lat.	24	20	South.
Buffon ,,	,,	170	0	,,		,,	20	39	,,
Beveridge,,	,,	167	50	,,		,,	20	0	,,
Flint ,,	,,	151	50	,,		,,	11	25	,,
Caroline ,,	,,	150	6	,,		,,	9	54	,,
Chanel ,,	,,	140	31	,,		,,	7	55	,,

From direct calculation for each of these points the following local mean times of beginning of totality, the duration of the same, and the sun's approximate altitude at the time, result:—

	Totality begins May 6.				Duration.			Sun's Altitude.
	h.	m.	s.		m.	s.		°
Rance Island,	8	47	36	a.m.	3	27	...	29
Buffon ,,	9	22	18	,,	4	20	...	38
Beveridge,,	9	34	48	,,	4	1	...	41
Flint ,,	11	19	43	,,	5	26	...	61
Caroline ,,	11	33	4	,,	5	7	...	63
Chanel ,,	0	43	32	p.m.	1	47	...	63

It should be mentioned that the semi-diameter of the sun has been taken from the *Nautical Almanac*; that of the moon was obtained from her horizontal parallax, using the factor 0·2725. The duration of totality at Sohag in Egypt in the eclipse of last May was exactly given by this arrangement.

THE MINOR PLANETS.—The part of the *Berliner Astronomisches Jahrbuch* for 1885, containing ephemerides of the minor planets for 1883, has been issued to the various observatories in advance of the publication of the annual volume. It contains approximate places for every twentieth day of 224 of these bodies, the latest being No. 225, with accurately calculated opposition ephemerides of 43, each extending over about five weeks; this division of the *Jahrbuch* occupies upwards of one hundred pages.

There are six cases during the year where the planets approach the earth about opposition, within her mean distance from the sun. On June 22 *Phocea* is at a distance of 0·93, declination + 16°; on July 12 the distance of *Clio* is 0·96, declination −35½°; on August 1 that of *Isis* is 0·90, declination −28°; on October 1 that of *Polyhymnia* is 0·98, declination +8½°; on October 20 that of *Virginia* is 0·98, declination +13°, and on December 11 *Flora* in perigee is at a distance of 0·97, with declination +18°. Galle's method of determining the solar parallax, so strongly advocated and ably applied by Mr. Gill, is not likely to fail for want of opportunities of applying it. As regards the magnitude near opposition we have in the case of *Phocea* 9·0; *Clio*, 10·2; *Isis*, 8·8; *Polyhymnia*, 9·7; *Virginia*, 9·9; and *Flora*, 8·2.

During the year 1883 four of these planets descend below 14m., from coming into opposition not far from aphelion.

COMET 1882 *c*.—Mr. Gill has secured five complete observations of this comet (discovered by Mr. Barnard in September) on the meridian S.P., with the transit-circle at the Cape of Good Hope, between November 11 and 30, so that places for upwards of a fortnight after the perihelion passage will be available for calculation.

THE EDUCATION OF OUR INDUSTRIAL CLASSES[1]

IT is, I believe, according to precedent, now that another year's work of the Science Classes here has been crowned by the award of prizes, that I should address you on some topic allied to the matters which have brought us together to-night. I need not search long for a subject, for the scientific education of those engaged in our national industries—upon the success or failure of which, in the struggle for existence, the welfare of our country so largely depends—is now one of the questions of the day. I propose, therefore, to lay before you some facts and figures bearing upon the education of our industrial classes, and I shall attempt to make what I have to say on that special point clearer, by touching upon some preliminary matters, which will show how it is that such a question as this has not been settled long ago; and further, that we can, if we wish, settle it now in

[1] An address delivered in presenting the prizes at the Coventry Science Classes, by J. Norman Lockyer, F.R.S.

the full light of the experience gained elsewhere, instead of wasting let us say a quarter of a century in costly experiments which may perhaps leave us in confusion more confounded. To begin, then, why is this question being discussed now? There is a great fact embodied in the most concrete fashion in the way in which our Government is now compelled to deal with our national education. Side by side of the Education Department by which our Minister controls in the main that book learning which has been given time out of mind, there has sprung up during the last thirty years another department—the Science and Art Department—by which he controls a new kind of national learning altogether. We have added to the old study of books a new study of things. This new learning was, we may say, only introduced in 1852, in which year the Queen in her speech on opening Parliament said: "The advancement of the fine arts and of practical science will be readily recognised by you as worthy the attention of a great and enlightened nation." We have since found out that they are indeed worthy the attention of a great nation, and more than this, that no nation can be called enlightened whose citizens are not skilled in both; in fact, that they are to peace what cannon and swords are to war. But for a nation to foster them is one thing, to include them in a national scheme of education is another. Ought they to be so included? Let us see. What do we mean by education? Roughly speaking, we may say that there are two distinct schools of thought on this subject, although the existence of these two schools is not so generally recognised as it should be. According to one view, the human mind is an elastic bag into which facts are to be crammed for future use. A variation of the view is that the mind is inelastic, and then the stuffing-process becomes more serious, and instead of depending upon a natural expansion, a process like that in use by the manufacturers of soda-water is employed. It is not to be wondered at that the youthful mind likes neither of these methods; what ought to be a true delight becomes a real agony, and hence it is, as a Warwickshire man wrote many years ago—

"Love goes toward love
As schoolboys from their books;
But love from love
Toward school with heavy looks."

—The mind on this view resembles a store where, as our American cousins say, everything, from a frying-pan to a frigate, which shall be useful to the owner in after life, is to be found. Hence such terms as Grammar School, Trade School, Science School, Commercial Academy, and hence I am sorry to say, systems of examination which too often only serve to show what a boy can remember, and little care about either what a boy can do, or whether he can think. So much for one view. Now for the other. It is more difficult to image it, but in the absence of a better illustration, the mind may be likened to the body—a thing to be trained so that its grace, its freedom, its strength, its grasp, indeed all its powers in all directions and in all ways may be brought out by proper training. If the training is one-sided its power cannot be many-sided, but it is most useful when many-sided. Therefore, as each muscle of the body has to be properly trained to make a perfect man, so must the educational system brought into play be such as to train to its uttermost and bring out each quality of the mind. Each faculty of it when called into play becomes as a two-edged sword in the arms of a strong man. In this, or some such way, then, may we picture to ourselves the difference between instruction in its real sense, and education in its real sense. Now, which of these systems is the better one? We shall see at once that the first may give us a mind stored with facts covering a large or a small area; it may be bookkeeping, or it may be Latin, or anything else. But will the mind be able to use this store in all cases? We grant *knowledge*, but may not *wisdom* linger? Those of us who have got to Voltaire's second stage, and who have studied men, know that this too often happens, and that much knowledge does not prevent the owner from being absolutely unfitted to grapple with the problems which each rising sun brings to him for solution. The other system, on the other hand, if the training is not thoroughly all-round, may give us a man who finds that the questions presented to him on his entrance to active life are precisely those which require the application of that quality of mind, whichever it may be, which was least trained at school. He may find himself face to face with problems of the existence of which he never dreamed, and so far removed from his experience that his mind, however powerful in some directions, fails to grapple with them. We seem, then, on the horns of a dilemma. Instruction may provide us with a store of facts, which the mind does not know how to use. Education may provide us with a mind which has been trained in a world utterly different from the real one. How can we escape from this dilemma. *We must use the materials of that instruction which is most useful to us in our progress through life as a basis for the complete education of the mind.* Which instruction is the most useful to us? The poet tells us, that "the proper study of mankind is man"; but when we come to prose and read the views of those who best know the needs of modern society, and especially industrial society, we read something like this which I quote from the report on elementary and middle class instruction, published by the Royal Commission of the Netherlands: "The idea of *Industrial Society* not limited to agriculture, manufactures, and trade or commerce, but understood in its widest signification, points plainly to the acquiring of the knowledge of the present world, and to its application to economical and technical pursuits." Now, here is a subject on which a volume might be written, but I shall only point out to you the obviousness of the importance of the study, not merely of ourselves, *or* of the world around us, but of ourselves, *and* of the world around us. This lands us in the necessity of training our minds in literature or humanities, and science and art—the study of the humanities enables us to know the best thoughts, and the most stable conclusions on vital questions, arrived at by our forerunners and those who are fighting the same battles in other lands. The study of science enables us, on the other hand, to get a true idea of the beautiful universe around us, of our real work in the world, and of the best manner in which we can do that work in closest harmony with the laws of Nature. Did we study the external world alone we should not profit by the experience of those that preceded us. Did we study humanities alone we should be shorn of half our natural strength in face of many of the problems placed before us by the conditions of modern life; and, more than this, all the glories of the beautiful world on which our lot is cast, and the majesty of the universe of which that world forms part would hardly exist for us, or give rise only to dumb wonder. Here let me tell you a little story. Three years ago when travelling in America, one morning, at a little station—we were approaching the Rocky Mountains—I was astonished to see a very old and venerable French curé in his usual garb enter the car, and as he was evidently in some distress of mind, and as evidently had little command of English, I asked him in his native language if I could be of any service to him. There was a difficulty about a box which I soon settled, and then we sat down and entered into conversation. He soon found out that I was very astonished to see him there and told me so. I acknowledged it. "It is very simple," he said, "I am very old, and six months ago I was like to die and I was doing my best to prepare myself for the long journey. In my fancies I imagined myself already in the presence of *le bon Dieu*, and I fancied this question addressed to me, 'M. le curé, how did you like the beautiful world you have left'? I rose in my bed as this thought came into my head for I—I who—figure to yourself—had dared to preach of a better world for fifty years, was, oh! so ignorant of this. And I registered a vow that if *le bon Dieu* allowed me to rise from that bed of sickness I would spend the rest of my life in admiring his works—*et me voici!* I am only on my journey round the world; I am going now to stop at the Yosemite Valley a few days *en route* for San Francisco and Japan, and the box, Monsieur, which your kindness has rescued for me contains a little scientific library, now my constant companion in my delicious wanderings." Our general scheme of education, therefore, unless it is to be one-sided, must combine science with the humanities. But, so far, I have said nothing about art. Now, from the educational point of view, science and art are very closely connected, inasmuch as in the early stages of both studies the student's powers of observation are brought out and trained in the most perfect way, while in the later stages, to succeed in either, he must have learned that very important thing—how to use his hands—and at whatever age you put it that a boy or a girl should use the hand neatly and skilfully, before that age you should take care that some elementary grounding at all events, in the only training which can do this, shall have been given. No amount of Greek, or of useful or of useless geography, or even of rule of three, can prevent the fingers being all thumbs, unless some such training has been given, and for the very earliest training drawing is undoubtedly the best. But this is by no means the only advantage of the combination. Anyone who has to go over thousands of examination papers finds in nineteen

cases out of twenty that an orderly drawing or diagram is generally associated with an orderly mind. In fact, a diagram may be regarded as an index of the amount and accuracy of the knowledge possessed by the student. The text of the student who fails in the diagram is generally a more awkward jumble than the diagram itself. Hence the facts show that this training of the hand is accompanied by much good mental results. This is now so generally recognised, that in a not distant period, no professor of biology, for instance, will attempt to demonstrate practically microscopic structure to students who have had no preliminary training in drawing. This is one example out of many which might be given, for as natural science is the study of nature, and as we can only study her by phenomena, the eye, and the hand, and the mind, must work together to achieve success, and he who attempts to describe the geology of a district, the minute structure of a frog's foot, an eclipse of the sun, or the rings of Saturn, in words, and words only, has only done half his work; to complete it he must appeal to art for aid. Now, many of you may be prepared to concede, without any further insistance on my part, that an elementary acquaintance with art is of great, nay, of even essential importance, not only for its own sake, but because of its aid in natural studies. We must then add art to science and literature in order to form a complete curriculum. Here pardon me one moment's digression from the direct line of my argument. Many will agree that science is aided by art who deny that art is aided by science to the same extent. Indeed, some are prepared to urge that one who proposes to devote himself to art can derive no possible benefit from the study of science. Let us inquire into this a little. If we wish to excel in the art of figure-painting, we must know anatomy, a most important branch of science; and as a matter of fact, many artists study anatomy as minutely as many surgeons do; and in the old days, when the artist and the poet were more saturated with the knowledge of the time than they are now, we find the great Leonardo at once professor of anatomy and founder of a school of painting as yet unsurpassed. If we pass from the figure to ornamental design, or if we wish to show objects in perspective, is not every line, whether straight or curved, dominated by an appeal to geometry? Again, suppose we take landscape. Here we meet with phenomena of colour as much regulated by law as are the phenomena of form, and an anatomy of colour is fast being formulated, which to the artist of the future will be as precious as the anatomy of form has been in the past, and will ever continue to be. Let us take, for instance, an artist who wishes to paint a sunset, one of the most magnificent sights which it is given to man to witness. The sky is covered with clouds here and there, and not only do the colours of the clouds vary, almost from moment to moment, but in all cases they present the strongest contrast to the colour of the sky itself. The artist is bewildered, and finds each effect that he would seize to be so transient that at last he gives up in despair the attempt to note down the various tints. But the possession of a knowledge of the part played by the lower strata of our atmosphere in absorbing now one and now another of the components of the light of the setting sun, would change this despair into a joy almost beyond expression. For the bewildering changes of colour are then discovered to be bound together by a law as beautiful as the effects themselves. There is another point of view. One is frequently pained in seeing in an otherwise noble work of art, evidences that the artist was crassly ignorant of the phenomena he attempted to represent, and in his attempts to transcend nature had only succeeded in caricaturing her, painting, for example, a rainbow in perspective, or a moon with its dark side turned towards the setting sun. Yet these are almost trifles, and, in fact, here we have the excuse of the ignorant artist—now, I am thankful to say, the representative of a class that is fast disappearing—for his defence is, that he has nothing to do with such small matters, and that accuracy of this kind may quite properly be sacrificed to secure the balance of his picture. Now, to return to the main drift of my address, we have seen that in any complete system of education neither science nor art must be neglected by the side of the old humanities—the old more purely literary studies; and it is indeed fortunate for us that we live in an age in which the laws and the phenomena of the external world have been studied and formulated with such diligence and success that it is as easy now to teach science, in the best possible way, as it is to teach classics in the best possible way. It is half a century since the Germans found out the importance of the new studies from a national point of view. We are now finding it out for ourselves, and finding it out not a moment too soon, and it is not needful for me to tell you that the transformation which is going on is aeknowledged to be one of the highest national importance. It is no longer an abstract question of a method of education; it is a question of the life or death of many of our national industries, for, in a struggle for existence, how can a man who wins his bread by the application of national laws to some branch of industry, if he be ignorant of those laws, compete with the man who is acquainted with them? If for man we read nation, you see our present position. How far then have we got with our transformation, limiting our inquiry to primary and secondary instruction? First, as to elementary education. The idea of the education—the compulsory education, if necessary, of all the citizens in a state—dates from the time of Luther. It is a horrible thing that we should have had to wait three and a half centuries since his time for such a measure, which is an act of simple justice to each child that is brought into the world. In 1524 Luther addressed a letter to the Councils of all the towns in Germany begging them to vote money, not merely for roads, dykes, guns, and the like, but for schoolmasters, so that the poor children might be taught, on the ground that if it be the duty of a State to compel its able-bodied citizens to take up arms to defend the fatherland, it is *a fortiori* its duty to compel them to send their children to school, and to provide schools for those who, without such aid, would remain uninstructed. Thanks to our present system, now about ten years old, out of an estimated population of 8,000,000 children between the ages of two and fifteen, we had last year nearly four millions at school, and out of an estimated population of 4,700,000 between five and thirteen, we had 3,300,000 at school. Among this school population elementary science is at last to be made a class subject, and we find mechanics, mathematics, animal physiology, and botany among the specific subjects in addition to the three R's. 120,000 children received education in these specific subjects last year, and if we are justified in assuming that as many will learn science when it becomes a class subject as now already learn drawing, we may expect in a year or two to have this 120,000 swelled into three-quarters of a million. I must again insist upon the fact that practical teaching in science is the only thing that can be tolerated. Of course, with a new subject the great difficulty is the difficulty of the teacher. Any system, therefore, of economising teaching power is of the highest importance. I am glad to know that a system suggested by Col. Donnelly, which uses the utmost economy of teaching power, has been carried into admirable practical effect at Birmingham, and I believe also at Liverpool, and other large towns. So that in the most important centres we may be certain that science will be taught in the best manner. It is worth whie to dwell on this system for a moment. Under it practical teaching is given to boys and girls of the fifth and higher standards, and also to the pupil teachers. The subject chosen for the boys is mechanics, that for the girls domestic economy, giving each of these subjects a wide range of meaning. There is a central laboratory in which the experiments are prepared, and from which the apparatus ready for use is conveyed in a light hand-cart to the various schools—twenty-six in number in Birmingham—belonging to the Board. In this way it is possible to give twenty lessons a week, and the circuit of the schools can be made in a fortnight. In the intervals between the visits of the demonstrator the class teachers recapitulate his lessons and give the children written examinations. About 1200 children are now being instructed in this way. To make the instruction as real as possible, children are brought out to aid in performing the experiments, objects are passed round, and questioning at the end of the lecture is encouraged. In the education, then, of our children, from the ages of five to thirteen, we may reasonably expect to find that science teaching will in the future be carefully looked after. We now come to the secondary education. Here, again, great progress has been made during the last few years. The real difficulties against its introduction have been the overcrowded state of the old curriculum, the scarcity of teachers, the want of sympathy with it, and the ignorance of its importance on the part of some headmasters. But to those headmasters who held the view that no real training could he got out of a subject which boys studied without positive pleasure, parents began to reply that whether the boy liked it or not he must get that knowledge somewhere. But where the experiment was really tried under good conditions it was soon found not only that the boys were willing to give three or four hours a week of their playtime to scientific subjects, but that the

one or two hours filched from the curriculum were more than made up for by the greater ease with which the other subjects could be learnt, in consequence of the additional training of the mind which the new subjects gave. We may hope, then, that in the course of time our secondary education may be much improved in the direction indicated. What we may expect, taking the principle of natural selection as our guide will be this. First, the head-masters will themselves be men chosen among other grounds for their knowledge of science, they will become more and more all round men. Next, the curriculum will be arranged not for the few who go to the University, but for the many who do not. We shall have more science and less Greek in the early years of the school course. We shall have laboratories, and drawing rooms, and workshops. In some schools we may find modern living languages taught in a living way replacing the dead languages altogether. Now, here our difficulties begin. We are face to face indeed with the same difficulties which the Continental nations, our precursors in educational matters, have experienced. Our secondary education is at the present moment all but absolutely separated from the primary one. Of the 4,000,000 scholars on the books of elementary schools last year there were only 44,000 over the age of fourteen, and it is to be feared that the remainder left school at that age, most of them, the best as well as the worst of them, to fight the battle of life with such an education as they had got up to that time. Germany, again, was the first to find out that this would never do, even though in that country science and art was taught in the Primary School. And for the reason that though such a meagre education might possibly do for ordinary workers in their hives of industry, it was totally insufficient for the future foremen, overseers, and the like, and special schools were established to carry their education further. Quite of late years this question has been studied in the most interesting way in the Netherlands, under the advice of a wise minister, whose example will be followed some day in our own country. Let me briefly refer to it. This work began in 1863. In that year in Holland there were no middle class or secondary schools for artisans, but there were evening schools for drawing which dated from 1827. "Burgher Schools" were established to provide the secondary instruction still felt to be needed by those who otherwise would have to content themselves with the primary instruction (although in its more extended form it contained natural philosophy, mathematics, and modern languages). In these schools—some day, some night schools (in these the lessons went on from September to May), with a course of two or three years, we find mathematics, theoretical and applied mechanics, and mechanism, physics, chemistry, natural history, either technology or agriculture, drawing, gymnastics, and other subjects among the fixed subjects, modelling and foreign languages being permissive. These burgher schools were compulsory in all parishes of 10,000 inhabitants. The evening burgher schools especially were at once seized on with avidity, chiefly by apprentices and the like. Here let me give you some statistics which will show you how these schools were working even ten years ago. They are much more flourishing now, but I have not the figures. I will show how the Dutch (of whom it cannot be said, to vary an old rhyme,

> In matters of *learning* the fault of the Dutch,
> Is giving too little and asking too much.

for the instruction is practically free), who are already learning a trade or working at one, use the evening hours for the further cultivation of their minds.

	Population.	Number of students in Burgher Schools.
Delft	23,000 ...	171
Utrecht	64,000 ...	283
Deventer	81,000 ...	285
Dordrecht	26,000 ...	146

Among the students at these schools in 1874 were 1582 carpenters and joiners, 472 smiths, &c., 236 plumbers and masons, 170 goldsmiths, engravers, &c., 320 painters, to give examples. Higher burghar schools were also established in the chief towns. In these schools still more advanced instruction was given: and here the course was for five years. In all these schools there was a considerable state endowment, and an endowment on the part of the town, so that the fees were almost nominal, and in some cases even the instruction was gratuitous. When I was inspecting these schools in Holland with an eminent man of science, whose advice had helped largely to make them such a success, and when I expressed to him my astonishment at the smallness of the fees—only a very few shillings a year—he put before me the question of State aid to schools in a way which had never struck me before. He said: "We regard it as a sort of education insurance. A small tax is paid by everybody during the whole of his life, and in this way a man who brings up children for the service of the State is helped by him who shirks that responsibility; and the payment which each citizen is called upon to make towards this instruction is spread over his whole life, and does not come upon him when he is probably most pinched in other ways. Now for one practical result of the establishment of these schools. The year 1863 found Holland full of the notion that every hour a child spent away from the desk or the bench after thirteen was time wasted; but after these burgher schools were instituted a change came over the spirit of that dream, and now no employer of labour except of the lowest and most manual kind in Holland, will look at a boy who cannot produce a certificate from his burgher school. Another very remarkable thing was soon observed, with a most important moral for us. The great difference between their burgher schools and the old gymnasia, the equivalents of our grammar schools, was a greater infusion of science into the teaching, and the introduction of three modern languages in addition to Dutch, Latin and Greek being omitted altogether from the curriculum. After four years of this training, many of the boys showed such high promise that all connected with them thought it a pity that they should not enter a university. They were therefore allowed six months as an experiment to take up Latin and Greek, and the result was that in a great number of cases they beat the gymnasia boys in their own subjects, and passed with flying colours. The Real Schul in Germany and the modern sides of our own secondary schools are almost the exact equivalents of the higher burgher schools to which I have especially called your attention. What, then, is the experience which has been gained in these gigantic educational experiments, experiments by which we may profit, as we are so late in the race, if we care to do so. One point is that if a chance is put before those who have passed through the elementary schools of further culturing their minds, they seize upon it with avidity. Another is that the employers of labour appreciate the value of the greater intelligence thus brought about. It is better to have to instruct in a trade men who have shown themselves anxious to learn, than to have to do with blockheads. Another, I think, is this: Your best secondary school is best for everybody; a secondary school with a properly mixed curriculum of literature, science, and art, is best for him who proceeds either to the University or to the workshop. A second-rate education in a second-rate school, gives us a second rate man, and we do not want our national industries to be worked entirely by second-rate men. On this point I am glad to fortify what I have said by a reference to Dr. Siemens' important address at the Midland Institute the week before last. He says: "It is a significant fact that while the thirty universities of Germany (you see they do not educate by halves in Germany; they have seven times as many universities as we have in England) continued to increase, both as regards number of students and high state of efficiency; the purely technical colleges, almost without exception, have during the last ten years been steadily receding, whereas the provincial Gewerbe Schuls have, under the progressive minister, von Falke, been modified so as to approximate curriculum to that of the gymnasium or grammar school. "As regards middle-class education, it must be borne in mind that at the age of sixteen, the lad is expected to enter upon practical life, and it has been held that under these circumstances at any rate it is best to confine the teaching to as many subjects only as can be followed up to a point of efficiency and have reference to future application. It is thus that the distinction between the German gymnasium or grammar school and the real Schule or technical school has arisen, a distinction which, though sanctioned to some extent in this country, also by the institution of the modern side, I should much like to see abolished." We see then the gradually increasing weight of opinion, and the result of the experiments both in Germany and Holland, and I may add France, point to these conclusions. Some kind of secondary education must be provided for the best students when they leave the elementary school, either before they begin work or while they are at work. Our secondary education should go practically along one line, how far soever the student goes along that line, some, of course, will go further than others; *provided always that our secondary education is the best possible, that is, having the broadest base.* Now, if this be generally conceded our problem in England, at

the present moment, is simpler than we thought it. We are face to face with the fact that it is for the good of the nation that those who have passed most successfully through the elementary education must continue that education in a secondary school, whether for two, or for three, or for six years, matters little for the argument. Are we then to build technical schools for such students? Thirty years ago the answer would have been yes. To-day we may say firmly, no. If a town has a grammar-school, let the town see that the curriculum of that school is based upon our best secondary models. If the town has no such school, then let it build one. If one school is not sufficient, then build two. That town will be the best off in the long run which gives the greatest number of free exhibitions from the elementary schools into such a school as this, and that town will be the wisest which holds out such inducements at the earliest possible moment. I have lately read with much interest a copy of resolutions and suggestions, passed at a meeting of an Association of Elementary Teachers in the north of England. From these we may gather that this question is already one of practical politics. It is agreed that the secondary education of the best boys leaving the elementary schools must also on. It is also taken for granted that the question lies between building a technical school or utilising the grammar school. One argument used in favour of the latter cause is, that the grammar school will be strengthened by drawing to itself the best boys from the elementary schools. The present proposals are that a number of free scholarships should be competed for annually, that these free scholarships shall, if need be, be supplemented by exhibitions from the fund at the disposal of the Governors (I should not accept this at once. Why should not the town pay them?), and the length of time for which these scholarships shall be tenable is not to be less than three years. You see, then, that in the north of England, at all events, it is conceded that the best children in our elementary schools should have a three years' course in a school of higher grade in which, of course, all the class subjects in the Elementary Code will be expanded, and all the linguistic studies of the grammar school taken in hand. When this system is at work, as it is bound to be in a few years, two things will happen, and it is as well we should be prepared for them. In the first place, our secondary schools—all of one model, the best model, be it understood—must so arrange its curriculum, that the students can leave after a three years' course, if need be, for the workshop or the office, or after a longer course for the University. That is the first point. The second one is this. The present system of apprenticeship will be called in question. A boy who has been educated to the age of sixteen will learn very much more in three or four years, and will be very much more valuable to his master during that time than he who was formerly bound apprentice at the age of thirteen or fourteen, with his fingers all thumbs, and no mind to speak of. It seems to me as it does to a daily increasing number, that the present mode of dealing with those matters which were formerly regarded as arts and mysteries known only to a few, and carried on on a small scale under the eye of the master, is dead against the system of apprenticeship as it has come down to us. Now the master does not teach, and the boy in nine cases out of ten has no opportunity of grasping the whole of the art or mystery at all. Many of you will begin to think that you are listening to the play of Hamlet with the part of the Prince of Denmark omitted, for so far I have said nothing whatever about technical education. I have said nothing about it for the reason that I believe the less said to a boy about technical education before he is sixteen years old the better. I now proceed to discuss this question, which is far more important, far more a national question, than you would gather from the debates in Parliament. What is technical education? It is the application of the principles of science to the industrial arts. And the rock ahead against which I am anxious to join Dr. Siemens in warning you is this: Under the influence of the present scare—for it is a scare, and a real one—there is a chance that attempts may be made to teach the applications to those who are ignorant of principles, whereas we have to fight those who study applications with a full knowledge of the principles which underlie them. We may congratulate ourselves on the fact that when we have once made up our minds as to the right place of technical instruction in our scheme of education, we have much of the necessary machinery already at our disposal; and the recent action of the City Guilds and of the Government is enormously increasing the quantity and improving the quality of this machinery. Let us first consider the classes now formed all over the country under the auspices of the Science and Art Department. Their development in the last thirty years has been something truly marvellous. When the Queen, in 1852, opened Parliament, there were already 35,000 students of art, but practically no students of science, in this country, amongst the industrial classes. That 35,000 will, if the present progress goes on, give us nearly 1,000,000 students of art at the end of this year; while the science schools have increased from 82 in 1860 to 1400 in 1880, with 69,000 students. The system which has thus developed so enormously has dealt chiefly with pure science, but for the future we shall have side by side with it, and built upon the same lines, a system of teaching the applications of this pure science to each of our national industries. He who wishes in the future to have to do in any way with the manufacture of alkali, gas, iron, paper, or glass, to take instances, or in the dyeing of a piece of silk, or the making of a watch, to take others, will find the teaching brought to his door, and obtainable almost for the asking. Here, again, we may congratulate ourselves, for while those who know most about the subject tell us that the more ambitious attempts at technical instruction in Germany and elsewhere have failed, because the teaching is not in sufficiently close contact with the works in which the processes are actually carried on, the system to which I have drawn your attention will enable the instruction to be given at night to those who have already begun practical work during the day. We have, then, come to this: that putting together what is most desirable in the abstract, and what has been practically proved to be the best, the education of our industrial classes should be, and can easily be, something like this. The boy will go to an elementary school till he is thirteen. He will then pass with an exhibition, if necessary, to a secondary school till he is sixteen. He will there go on with his science—now a class subject in the elementary school—and begin the study of languages. At sixteen he will leave school and begin the battle of life, and can still in the evening proceed further with his studies in pure science, if the secondary education has left him too ill-equipped in that direction. Having thus got the principles of pure science into his mind he will be able to take up the technical instruction in the particular industrial art to which he is devoting himself. But be the number of our future foremen and managers who who have had this extra three years of secondary instruction, large or small, if there be in Coventry let us say out of your population of 45,000, one thousand boys, or girls, or men, who are anxious not only to learn science, but its application to their particular industries, then the Government is ready to endow Coventry with a sum varying from two thousand to six thousand pounds a year, according to the results of the examinations, if two subjects of pure science are taken up, and the students pass. The City Guilds are prepared to endow the town with from 1000*l.* to 2000*l.* a year additional, provided some application of the principles of science to the industrial arts is taken up, and evidence forthcoming that the principles themselves have been studied. Now if among your 45,000 there is not 1000 who care for these things which are vital to your trades, seeing that abroad these things are cared for, how can your trades stand against foreign competition? Let such a system as this go on for twenty years, and we shall hear nothing more of the decay of our national industries. Now here I am bound to point out a distinct gap in the present system. We have classes for art, classes for pure science, classes for applied science, but where are the classes for languages? The modern languages are taught so badly in our secondary schools, that it is hopeless to expect that sufficient knowledge, either of French or German can be acquired in the three years' course to enable the student to find out what his French and German rivals are doing in the branch of industry which he takes up; and we must, moreover, consider those who may wake up to the importance of studying science and its technical applications after the chance of a secondary education is lost. Such classes then are a real want. But I will not end my address by a reference to what I regard as an unfortunate gap, but would rather conclude what I have to say by pointing out that the scheme I have sketched out need be no Utopia, so far, at all events, as a supply of well-trained teachers is concerned. This, up to the present time, has been the real difficulty. But now that the authorities at South Kensington have started summer courses of lectures to teachers, and that they actually pay the teachers for going to learn, the methods of teaching, both in the elementary and secondary schools, and evening classes, cannot fail to improve. Quite recently, too, we have seen the inauguration of a Normal

School, where Royal Exhibitioners and other free students are admitted without payment; where the teacher has the first claim, and where he can attend any single course for a nominal fee. Now every town of importance in the country should associate itself with the Government in this attempt, and should have one, at least, of its citizens always in training there, so that the scientific instruction in that town, whether primary, secondary, or tertiary, should always be at its highest level. On the other side of the road, too, at South Kensington, is rapidly rising another institution where we may hope the teachers of our technical instruction will receive an equally careful training. So that you see, to bring what I have to say to a conclusion, that though we are late in the day, though many people have not yet made up their minds as to what is best to be done—and I acknowledge that the question is hedged in with difficulties on all sides—there is an easy solution of the difficulty based on the experience of other countries, which is at the same time an act of simple justice; that this solution requires no dislocation if we adopt it, but simply a natural growth of our existing means, and that all the newest developments of our educational machinery will all fall naturally into place.

THE TRANSIT OF VENUS[1]

The Observations at the Cape

THE long looked-forward-to transit of Venus occurred yesterday afternoon, causing, we may be sure, a flutter of excitement amongst astronomers throughout the whole of the world. To some the special duty was entrusted of carefully noting everything connected with the ingress of this familiar planet, and after they had concluded their labours at the setting of the sun, it fell to astronomers in other portions of the globe to pay equally minute attention to the planet's egress. By and bye we may expect columns of thoughtfully worked-out details in connection with this peculiar and interesting astronomical event, all of which will tend to still further solve the problem of the exact distance of the sun from the earth. We need not remind our readers that herein consists the whole scientific value of the transit. When crossing the sun's disc the planet is at its nearest distance from the earth—estimated at about 25,000,000 miles—and through the peculiar facilities thus afforded of directly measuring its parallax, observers are enabled to calculate the parallax of the sun, which to astronomers is a matter of very considerable importance. The credit of the suggestion of this particular method of calculation is due to Dr. Halley, and it is still popularly held to be the best for the purpose. But accompanying the rapid strides astronomic science has taken in its development since the days of Halley, instrumental means have been invented and accepted by modern astronomers, which appear to afford methods, perhaps even more exact, of arriving at the desired result. For all this, however, the transit of Venus retains a powerful hold upon the popular mind, and, indeed, upon the minds of many astronomers, as the best method. There is, too, one specially strong argument why a particular interest should be taken in this planet's transit. No one who witnessed the phenomenon yesterday will live to see it again—unless, indeed, he fairly outrivals old Parr and other gentlemen famed for longevity. Occurring as these transits do at the unequal but regular recurring intervals of 8, 122, 8, and 105 years, no one could well expect to see more than two in a lifetime. The last took place in 1874, while the next will occur in December, 2007. It need, therefore, be no longer surprising why, both popularly and scientifically, the event is regarded as one of such special interest, and why the most eminent scientific observers are selected to note everything that takes place.

Before proceeding to refer to the observations which were taken yesterday at the Royal Observatory we may mention that, acting under the advice of the Astronomer-Royal of the Cape of Good Hope (Dr. Gill), the British Transit of Venus Committee decided upon establishing stations at Aberdeen Road and Montagu Road as auxiliary places of observation to the principal station here at the Observatory itself. And before proceeding further it may be added that Natal has come forward very pluckily in this matter, exhibiting an amount of interest in astronomic science which does great credit to that colony. Mr. Escombe himself contributed a sum of between 400*l.* and 500*l.* for the purpose of providing a proper telescope; while two merchants subscribed 50*l.* each, the Corporation of Durban giving 300*l.*, and the Natal Government voting 500*l.* towards founding an observatory for the colony, and the defraying of expenses connected with taking observations of the present transit. As a pleasant sequel to this, we are glad to learn by telegraph, that Mr. Neison, who was in charge of the party of observation there, most successfully observed the internal contact at Durban, the enterprise of Natal thus meeting with a well-merited reward. As announced by us some time since, South Africa was selected by the Americans as a station for one of their photographic transit of Venus expeditions under the charge of Prof. Newcomb, who has the reputation of being one of the most celebrated of living astronomers. On arrival here Prof. Newcomb, after consultation with the best authorities as to atmospheric conditions, &c., finally decided, with the kind consent of the trustees of the Huguenot Seminary to take his observations from the foot of the gardens of that institution at Wellington. We hope to shortly hear of the entire success of the labours of the party, and perhaps to see some specimens of their photographic skill.

At the Observatory itself it need scarcely be said that for some weeks past great preparations had been made for the event. There are few living astronomers who have more carefully studied the subject of the transit of Venus than the present Astronomer-Royal here, Dr. Gill, and few are more thoroughly posted up in all the details of the rare occurrence. In 1874 Dr. Gill was Chief Astronomer to Lord Lindsay's Transit of Venus Expedition to the Mauritius, where he not only took most valuable observations, but evinced a very intimate acquaintance with the entire subject. It was only to be expected, therefore, that in this instance no detail in connection with the arrangements for a proper observation in Cape Colony would be lost sight of by the Astronomer-Royal. The few visitors who received invitations to the Observatory yesterday found Dr. Gill courteous and affable as ever, but wholly absorbed in the important work on hand. "You may go here and go there, look through that glass and have a peep through the other one," were his remarks just before commencing operations, "but whatever you do, please don't speak to me or any of the observers until the internal contact has been made." No injunction not to speak to the "man at the wheel" could have been more respected than this, and from that moment until a couple of hours later Dr. Gill and his assistants became objects of almost reverential awe to those outside the pale of strict astronomic science.

One of the principal instruments employed was a new equatorial telescope by Grubb of Dublin, made and seat out here specially for the transit of Venus, the old wind tower in which it is now mounted having been prepared as an observatory for its reception. There was also a heliometer which had been used at the last transit by Dr. Gill at the Mauritius, and was afterwards borrowed by him from Lord Lindsay for use on the Isle of Ascension, where he made a determination of the sun's distance from the planet Mars. Subsequently this fine instrument was purchased by Dr. Gill and was brought out here as his private property on his being appointed Astronomer-Royal at the Cape. Another noticeable instrument employed yesterday was the great theodolite intended for the trigonometrical survey of India. The designs of Col. Strange, however, from which it was constructed, were so long in being carried out in manufacture that General Walker, the Director of Survey, decided not to bring it into use, especially as it was somewhat too heavy for service in the field. Upon the application of Dr. Gill, it was lent by the Indian Government, for the purpose of some special researches in which that gentleman was engaged at the time, and it was successfully employed the other day in taking observations of the great comet. The other instruments included a small equatorial telescope of 3⅛ inches aperture, which was used by Mr. Stone on the occasion of the last transit of Venus; an equatorial telescope of 7 inches aperture, which has also been for some time at the Observatory, and a telescope of 2½ inches aperture belonging to Capt. Jurisch, examiner of diagrams in the Surveyor-General's department. Having mentioned the several instruments, we must go on to state by whom they were used. Dr. Gill himself observed the contact of Venus with the sun's limb, with the new 6-inch aperture equatorial, a similar observation being taken by Mr. Maclear with the 7-inch equatorial. Dr. Elkin, a scientific friend and guest of the Astronomer-Royal, took observations with the heliometer; Mr. Freeman, with the great theodolite; Mr. Pillans, with the small equatorial; and Capt. Jurisch with his own equatorial. Several important measures were also taken at the heliometer by Dr. Gill and Dr. Elkin.

[1] From the *Cape Times*, December 7, 1882.