Couchy, who, seventeen years ago, under the Empire, was Director of the French Telegraphs. The charge for carrying a letter to any place within the fortifications has been fixed at 3*d.* The two extreme points in the service are about 11,000 metres apart, and the time required for the delivery of a letter to the remotest place in the most unfavourable circumstances, and including its conveyance from the nearest station, will be within one hour.

THE Scientific Exhibition at Paris, always held on the occasion of the grand *soirée* given by Admiral Mouchez, Director of the Paris Observatory, will this year be under the management of the French Electrical Society, and its exhibits will therefore be confined to objects relating to that branch of science.

PROF. MELL, Director of the Alabama Weather Service, announces, in *Science*, that through the liberality of the Chief Signal Officer, and of several railways, daily weather-signals, predicting changes of weather and temperature, will be displayed at over one hundred telegraph-stations in that State. The predictions will be received by the Director at an early hour every morning from the Signal Office in Washington, and then promptly distributed along the railways. By paying for the cost of the signal-flags (about six dollars), any town or telegraph-station will receive free telegraphic warning of the daily weather changes. Only about five minutes are required to set the flags. A similar system has been for some time in operation in Ohio and in part of Pennsylvania, and it will doubtless have further extension.

THE Commander-in-Chief of the French army in Tonquin has given orders to have a meteorological observatory erected in Haiphong, the chief port in the delta of the Red River, to serve as a basis for a network of meteorological stations with which it is intended to cover eventually the whole of Annam and Tonquin, and which will be in telegraphic communication with the observatory in Hong Kong.

THE series of illustrations of the methods and stages of instruction in handicraft and technical training contributed by the Austrian Government to the Health Exhibition is stated to have been purchased by the Japanese Government from the Technological Museum at Vienna. The Japanese authorities have also made numerous exchanges with the representatives of other countries exhibiting at South Kensington.

THE additions to the Zoological Society's Gardens during the past week include a Common Seal (*Phoca vitulina*) from British Seas, presented by Mr. James Wyat; two Barred Doves (*Geopelia striata*), three Eastern Turtle Doves (*Turtur meena*) from Java, presented by Mr. Emil Berg; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, deposited; a Red-throated Amazon (*Chrysotis collaria*) from Jamaica, a Red-tailed Amazon (*Chrysotis erythrura*) from Brazil, three Blue Snow Geese (*Chen cærulescens*) from Alaska, purchased; a Bernier's Ibis (*Ibis bernieri*) from Madagascar, received in exchange.

OUR ASTRONOMICAL COLUMN

THE ECLIPSE OF THUCYDIDES, B.C. 431, AUGUST 3.—There has been much discussion from time to time with reference to the solar eclipse recorded by Thucydides in the first year of the Peloponnesian war, and long identified as that which occurred on August 3, B.C. 431. We are told, "the sun was eclipsed after midday, and having assumed a crescent form, some of the stars having also appeared, it again became full-orbed." This eclipse was not total, as has been frequently stated, but narrowly annular. Dr. Hartwig in 1859 calculated the circumstances according to the solar and lunar tables of Hansen, and his results were published, with those applying to other eclipses mentioned by Thucydides, in No. 1203 of *Astronomische Nachrichten*. The greatest phase, by his calculations, falls at 5h. 9m. mean time at Athens, and the magnitude of the eclipse is 0·75, rather small it will be considered, for stars to have been brought into view. But, when all the conditions of the case are borne in mind, it would appear quite possible, to speak within bounds, that Hansen's longitude of the moon may require at that epoch a correction which would suffice, with the rapid descent of the central line in latitude, to cause a great eclipse at Athens, leaving the sun of crescent form, as Thucydides reports, but with the crescent very narrow. In such a climate bright planets and stars might well have been discerned. Venus was westward at an altitude of some 35°, Mars would be near the western horizon, Jupiter had set, while Saturn was near the meridian at an altitude of something like 45°. Of the stars, Spica, Arcturus, Antares, and Vega were in favourable positions for observation.

Sir George Airy informed the writer of these lines some years since that, on the occasion of the partial eclipse of September 7, 1820, he "saw one or two stars" at Cambridge. On calculating the circumstances of the eclipse for that place, it appears the magnitude was 0·88. This is an interesting case in point.

WOLF'S COMET.—A few week's since it was remarked in this column that, according to the first elliptical orbit calculated by Prof. Krueger, this comet would approach very near to the orbit of Jupiter in about 209° heliocentric longitude, and great perturbation was possible early in the year 1875, so that the comet might not have been moving long in its present track. On this subject Prof. Krueger, who has recalculated the elements of the comet's orbit from a much wider extent of observation, expresses himself as follows in No. 2629 of the *Astronomische Nachrichten*:—"In Nr. 782 der NATURE (1884, October 23) ist hierauf bereits aufmerksam gemacht worden; ich hielt indessen damals die ersten Elemente für viel ungenauer, als sie wirklich waren, und glaubte, dass Erörterungen dieser Art noch etwas aufzuschieben seien. Die nachfolgende Rechnung bestätigt indessen die in der NATURE ausgesprochene Vermuthung in überraschender Weise." In fact, Prof. Krueger finds by his new orbit that on May 28, 1875, the comet's distance from Jupiter was less than 0·1 of the earth's mean distance from the sun, and hence it is probable that before the spring of this year the comet may have been describing a very different orbit to that in which it now moves. This, as was before remarked, will form an interesting subject of investigation, when definitive elements have been deduced from a combination of all the observations of the present appearance.

In Prof. Krueger's last orbit, founded on observations to November 7, the period of revolution is 2466·06 days, according to which the comet would have been in perihelion about February 16, 1878, in R.A. 23h. 58m., Decl. + 2°, distant from the earth 2·32, and under such circumstances not likely to have been seen. We subjoin other elements of the orbit:—

Semi-axis major ...	3·5722	Perihelion distance ...	1·5719
,, minor ...	2·9596	Aphelion ,, ..	5·5725
Semi-parameter ...	2·4521	Excentricity	0·559966

MINIMA OF ALGOL.—The following are approximate geocentric Greenwich times of minima of Algol, calculated from elements upon which the later observations of Schmidt have been brought to bear:—

		h.	m.			h.	m.			h.	m.
Nov.	27 ...	13	24	Dec.	23 ...	8	45	Jan.	26 ..	18	35
	30 ...	10	13		26 ...	5	34		29 ...	15	24
Dec.	3 ...	7	2	Jan.	6 ...	16	51	Feb.	1 ...	12	14
	14 ...	18	18		9 ...	13	40		4 ...	9	3
	17 ...	15	7		12 ...	10	29		7 ...	5	52
	20 ...	11	56		15 ...	10	18				

THE WAVE THEORY OF LIGHT[1]

THE subject upon which I am to speak to you this evening is happily for me not new in Philadelphia. The beautiful lectures on light which were given several years ago by President Morton, of the Stevens' Institute, and the succession of lectures on the same subject so admirably illustrated by Prof. Tyndall, which many now present have heard, have fully prepared you for anything I can tell you this evening in respect to the wave theory of light.

It is indeed my humble part to bring before you some mathematical and dynamical details of this great theory. I cannot have the pleasure of illustrating them to you by anything compar-

[1] A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, September 29, 1884, by Sir William Thomson, F.R.S., LL.D.

able with the splendid and instructive experiments which many of you have already seen. It is satisfactory to me to know that so many of you, now present, are so thoroughly prepared to understand anything I can say, that those who have seen the experiments will not feel their absence at this time. At the same time I wish to make them intelligible to those who have not had the advantages to be gained by a systematic course of lectures. I must say in the first place, without further preface, as time is short and the subject is long, simply that sound and light are both due to vibrations propagated in the manner of waves; and I shall endeavour in the first place to define the manner of propagation and mode of motion that constitute those two subjects of our senses, the sense of sound and the sense of light.

Each is due to vibrations. The vibrations of light differ widely from the vibrations of sound. Something that I can tell you more easily than anything in the way of dynamics or mathematics respecting the two classes of vibrations is, that there is a great difference in the frequency of the vibrations of light when compared with the frequency of the vibrations of sound. The term "frequency" applied to vibrations is a convenient term, applied by Lord Rayleigh in his book on sound to a definite number of full vibrations of a vibrating body per unit of time. Consider, then, in respect to sound, the frequency of the vibrations of notes, which you all know in music represented by letters, and by the syllables for singing, the do, re, mi, etc. The notes of the modern scale correspond to different frequencies of vibrations. A certain note and the octave above it correspond to a certain number of vibrations per second and double that number.

I may explain in the first place conveniently the note called "C"; I mean the middle "C"; I believe it is the C of the tenor voice, that most nearly approaches the tones used in speaking. That note corresponds to two hundred and fifty-six full vibrations per second, two hundred and fifty-six times to and fro per second of time.

Think of one vibration per second of time. The seconds pendulum of the clock performs one vibration in two seconds, or a half vibration in one direction per second. Take a ten-inch pendulum of a drawing-room clock, which vibrates twice as fast as the pendulum of an ordinary eight-day clock, and it gives a vibration of one per second, a full period of one per second to and fro. Now think of three vibrations per second. I can move my hand three times per second easily, and by a violent effort I can move it to and fro five times per second. With four times as great force, if I could apply it, I could move it twice five times per second.

Let us think, then, of an exceedingly muscular arm that would cause it to vibrate ten times per second, that is ten times to the left and ten times to the right. Think of twice ten times, that is, twenty times per second, which would require four times as much force; three times ten, or thirty times a second, would require nine times as much force. If a person were nine times as strong as the most muscular arm can be, he could vibrate his hand to and fro thirty times per second, and without any other musical instrument could make a musical note by the movement of his hand which would correspond to one of the pedal notes of an organ.

If you want to know the length of a pedal pipe, you can calculate it in this way. There are some numbers you must remember, and one of them is this. You, in this country, are subjected to the British insularity in weights and measures; you use the foot and inch and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English Minister, whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes.

I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change, and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform.

I know the velocity of sound in feet per second. If I remember rightly, it is 1089 feet per second in dry air at the freezing-point, and 1115 feet per second in air of what we call moderate temperature, 59° or 60°—(I do not know whether that temperature is ever attained in Philadelphia or not; I have had no experience of it, but people tell me it is sometimes 59° or 60° in Philadelphia, and I believe them)—in round numbers let us call it 1000 feet per second. Sometimes we call it a thousand musical feet per second, it saves trouble in calculating the length of organ pipes; the time of vibration in an organ pipe is the time it takes a vibration to run from one end to the other and back. In an organ pipe 500 feet long the period would be one per second; in an organ pipe ten feet long, the period would be fifty per second; in an organ pipe twenty feet long, the period would be twenty-five per second at the same rate. Thus twenty-five per second, and fifty per second of frequencies, corresponds to the periods of organ pipes of twenty feet and ten feet.

The period of vibration of an organ pipe, open at both ends, is approximately the time it takes sound to travel from one end to the other and back. You remember that the velocity in dry air in a pipe ten feet long is a little more than fifty periods per second; going up to 256 periods per second, the vibrations correspond to those of a pipe two feet long. Let us take 512 periods per second; that corresponds to a pipe about a foot long. In a flute, open at both ends, the holes are so arranged that the length of the sound-wave is about one foot, for one of the chief "open notes." Higher musical notes correspond to greater and greater frequency of vibration, viz., 1000, 2000, 4000 vibrations per second; 4000 vibrations per second correspond to a piccolo flute of exceedingly small length; it would be but one and a half inches long. Think of a note from a little dog-call, or other whistle, one and a half inches long, open at both ends, or from a little key having a tube three-quarters of an inch long, closed at one end; you will then have 4000 vibrations per second.

A wave length of sound is the distance traversed in the period of vibration. I will illustrate what the vibrations of sound are by this condensation travelling along our picture on the screen. Alternate condensations and rarefactions of the air are made continuously by a sounding body. When I pass my hand vigorously in one direction, the air before it becomes dense, and the air on the other side becomes rarefied. When I move it in the other direction, these things become reversed; there is a spreading out of condensation from the place where my hand moves in one direction and then in the reverse. Each condensation is succeeded by a rarefaction. Rarefaction succeeds condensation at an interval of one-half what we call "wave lengths." Condensation succeeds condensation at the full interval of what we call wave lengths.

We have here these luminous particles on this scale,[1] representing portions of the air close together, dense; a little higher up, portions of air less dense. I now slowly turn the handle of the apparatus in the lantern, and you will see the luminous sectors showing condensation travelling slowly upwards on the screen; now you have another condensation; making one wave length.

This picture or chart represents a wave length of four feet. It represents a wave of sound four feet long. The fourth part of a thousand is 250. What we see now of the actual scale represents the lower note C of the tenor voice. The air from the mouth of a singer is alternately condensed and rarefied just as you see here.

But that process shoots forward at the rate of one thousand feet per second; the exact period of the motion is 256 vibrations per second for the actual case before you. Follow one particle of the air forming part of a sound wave, as represented by these moving spots of light on the screen; now it goes down, then another portion goes down rapidly; now it stops going down; now it begins to go up; now it goes down and up again.

As the maximum of condensation is approached, it is going up with diminishing maximum velocity. The maximum of rarefaction has now reached it, and the particle stops going up and begins to move down. When it is of mean density the particles are moving with maximum velocity, one way or the other. You can easily follow these motions, and you will see that each particle moves to and fro, and the thing that we call *condensation* travels along.

[1] Alluding to a moving diagram of wave motion of sound produced by a working slide for lantern projection.

I shall show the distinction between these vibrations and the vibrations of light. Here is the fixed appearance of the particles when displaced but not in motion. You can imagine particles of something, the thing whose motion constitutes light. This thing we call the luminiferous ether. That is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and substantiality of the luminiferous ether. This instrument is merely a method of giving motion to a diagram designed for the purpose of illustrating wave motion of light. I will show you the same thing in a fixed diagram, but this arrangement shows the mode of motion.

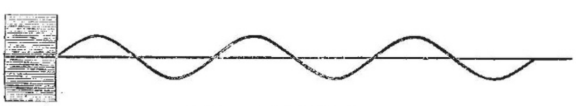
Now follow the motion of each particle. This represents a particle of the luminiferous ether, moving at the greatest speed when it is at the middle position.

You see the two modes of vibration,[1] sound and light now moving together,—the travelling of the wave of condensation and rarefaction, and the travelling of the wave of transverse displacement. Note the direction of propagation. Here it is from your left to your right, as you look at it. Look at the motion when made faster. We have now the direction reversed. The propagation of the wave is from right to left, again the propagation of the wave is from left to right; each particle moves perpendicularly to the line of propagation.

I have given you an illustration of the vibration of sound waves, but I must tell you that the movement illustrating the condensation and rarefaction represented in that moving diagram are necessarily very much exaggerated, to let the motion be perceptible, whereas the greatest condensation in actual sound motion is not more than one or two per cent. or a small fraction of a per cent. Except that the amount of condensation was exaggerated in the diagram for sound, you have a correct representation of what actually takes place in the low note C.

On the other hand, in the moving diagram representing light waves what had we? We had a great exaggeration of the inclination of the line of particles. You must first imagine a line of particles in a straight line, and then you must imagine them disturbed in a wave curve, the shape of the curve corresponding to the disturbance. Having seen what the propagation of the wave is, look at this diagram and then look at that one. This, in light, corresponds to the different sounds I spoke of at first. The wave length of light is the distance from crest to crest of the wave, or from hollow to hollow. I speak of crests and hollows, because we have a diagram of ups and downs as the diagram is placed.

Waves of Red Light.



Waves of Violet Light.

Here, then, you have a wave length.[2] In this lower diagram you have the wave length of violet light. It is but one-half the length of the upper wave of red light; the period of vibration is but half as long. Now, on an enormous scale, exaggerated not only as to slope, but immensely magnified as to wave length, we have an illustration of the waves of light. The drawing marked "red" corresponds to red light, and this lower diagram corresponds to violet light. The upper curve really corresponds to something a little below the red ray of light in the spectrum, and the lower curve to something beyond the violet light. The variation in length between the most extreme rays is in the proportion of four and a half of red to eight of the violet, instead of four and eight; the red waves are nearly as one to two of the violet.

To make a comparison between the number of vibrations for each wave of sound and the number of vibrations constituting light waves, I may say that 30 vibrations per second is about the smallest number which will produce a musical sound; 50 per second gives one of the grave pedal notes of an organ, 100 or 200 per second give the low notes of the bass voice, higher notes with 250 per second, 300 per second, 1000, 4000, up to 8000 per second give about the shrillest notes audible to the human ear.

Instead of the numbers, which we have, say in the most commonly used part of the musical scale, *i.e.* from 200 or 300 to 600 or 700 per second, we have millions and millions of vibrations per second in light waves; that is to say, 400 million million per second, instead of 400 per second. That number of vibrations is performed when we have red light produced.

An exhibition of red light travelling through space from the remotest star is due to the propagation by waves or vibrations, in which each individual particle of the transmitting medium vibrates to and fro 400 million million times in a second.

Some people say they cannot understand a million million. Those people cannot understand that twice two makes four. That is the way I put it to people who talk to me about the incomprehensibility of such large numbers. I say *finitude* is incomprehensible, the infinite in the universe *is* comprehensible. Now apply a little logic to this. Is the negation of infinitude incomprehensible? What would you think of a universe in which you could travel one, ten, or a thousand miles, or even to California, and then find it come to an end? Can you suppose an end of matter, or an end of space? The idea is incomprehensible. Even if you were to go millions and millions of miles the idea of coming to an end is incomprehensible.

You can understand one thousand per second as easily as you can understand one per second. You can go from one to ten, and ten times ten, and then to a thousand without taxing your understanding, and then you can go on to a thousand million and a million million. You can all understand it.

Now 400 million million vibrations per second is the kind of thing that exists as a factor in the illumination by red light. Violet light, after what we have seen and have illustrated by that curve, I need not tell you corresponds to vibrations of 800 million million per second. There are recognisable qualities of light caused by vibrations of much greater frequency and much less frequency than this. You may imagine vibrations having about twice the frequency of violet light and one-fifteenth the frequency of red light and still you do not pass the limit of the range of continuous phenomena only a part of which constitutes *visible* light.

Everybody knows the "photographer's light" and has heard of *invisible* light producing visible effects upon the chemically prepared plate in the camera. Speaking in round numbers, I may say that, in going up to about twice the frequency I have mentioned for violet light, you have gone to the extreme end of the range of known light of the highest rates of vibration; I mean to say that you have reached the greatest frequency that has yet been observed.

When you go below visible red light what have you? We have something we do not see with the eye, something that the ordinary photographer does not bring out on his photographically sensitive plates. It is light, but we do not see it. It is something so closely continuous with light visible, that we may define it by the name of invisible light. It is commonly called radiant heat; invisible radiant heat. Perhaps, in this thorny path of logic, with hard words flying in our faces, the least troublesome way of speaking of it is to call it radiant heat. The heat effect you experience when you go near a bright, hot coal fire, or a hot steam boiler; or when you go near, but not over, a set of hot-water pipes used for heating a house; the thing we perceive in our face and hands when we go near a boiling pot and hold the hand on a level with it, is radiant heat; the heat of the hands and face caused by a hot fire, or a hot kettle when held under the kettle, is also radiant heat.

You might readily make the experiment with an earthen teapot; it radiates heat better than polished silver. Hold your hands below, and you perceive a sense of heat; above the teapot you get more heat; either way you perceive heat. If held over the teapot you readily understand that there is a little current of air rising. If you put your hand under the teapot you get cold air; the upper side of your hand is heated by radiation, while the lower side is fanned and is actually cooled by virtue of the heated kettle above it.

That perception by the sense of heat, is the perception of something actually continuous with light. We have knowledge of rays of radiant heat perceptible down to (in round numbers) about four times the wave length, or one-fourth the period of visible, or red light. Let us take red light at 400 million

[1] Showing two moving diagrams, simultaneously, on the screen, one depicting a wave motion of light, the other a sound vibration.

[2] Exhibiting a large drawing, or chart, representing a red and a violet wave of light.

million vibrations per second; then the lowest radiant heat, as yet investigated, is about 100 million million per second in the way of frequency of vibration.

I had hoped to be able to give you a lower figure. Prof. Langley has made splendid experiments on the top of Mount Whitney, at the height of 15,000 feet above the sea-level, with his "bolometer," and has made actual measurements of the wave lengths of radiant heat down to exceedingly low figures. I will read you one of the figures; I have not got it by heart yet, because I am expecting more from him.[1] I learned a year and a half ago that the lowest radiant heat observed by the diffraction method of Prof. Langley corresponded to 28/100,000ths of a centimetre for wave length, twenty-eight as compared with red light, which is 7·3; or nearly fourfold. Thus wave lengths of four times the amplitude, or one-fourth the frequency per second of red light have been experimented on by Prof. Langley, and recognised as radiant heat.

Photographic, or actinic light, as far as our knowledge extends at present, takes us to a little less than one-half the wave length of violet light. You will thus see that while our acquaintance with wave motion below the red extends down to one-quarter of the slowest rate which affects the eye, our knowledge of vibrations at the other end of the scale only comprehends those having twice the frequency of violet light. In round numbers we have four octaves of light, corresponding to four octaves of sound in music. In music the octave has a range to a note of double frequency. In light we have one octave of visible light, one octave above the visible range, and two octaves below the visible range. We have 100 per second, 200 per second, 400 per second (million million understood) for invisible radiant heat, 800 per second for visible light and 1600 per second for invisible light.

One thing in common to the whole is the heat effect. It is extremely small in moonlight, so small that nobody until recently knew there was any heat in the moon's rays. Herschel thought it was perceptible in our atmosphere by noticing that it dissolved away very light clouds, an effect which seemed to show in full moonlight more than when we have less than full moon. Herschel, however, pointed this out as doubtful; but now, instead of its being a doubtful question, we have Prof. Langley giving as a fact that the light from the moon drives the indicator of his sensitive instrument clear across the scale, and with a comparatively prodigious heating effect!

I must tell you that if any of you want to experiment with the heat of moonlight you must compare the heat with whatever comes within the influence of the moon's rays only. This is a very necessary precaution; if, for instance, you should take your bolometer or other heat detector from a comparatively warm room into the night air, you would obtain an indication of a fall in temperature owing to this change. You must be sure that your apparatus is in thermal equilibrium with the surrounding air, then take your burning-glass, and first point it to the moon, and then to space in the sky beside the moon; you thus get a differential measurement, in which you compare the radiation of the moon with the radiation of the sky. You will then see that the moon has a distinctly heating effect.

(*To be continued.*)

[1] Since my lecture I have heard from Prof. Langley that he has measured the refrangibility by a rock-salt prism, and inferred the wave length of heat rays from a "Leslie cube" (a metal vessel of hot water radiating from a blackened side). The greatest wave length he has thus found is one-thousandth of a centimetre, which is seventeen times that of sodium light. The corresponding period is about thirty million million to the second.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Professorship of Political Economy will be filled up on Dec. 13. The Higher Local Examinations were held last June at 21 centres, and attended by 960 candidates (chiefly women), a decrease of 27. In Arithmetic the work of most of the candidates was by no means good. Euclid's propositions were well and neatly written out. In some cases attempts were made to improve upon Euclid, but usually with disastrous results. The book-work of Geometrical Conics was fairly done by the few who attempted it, but only one rider out of four was solved by any candidate. Only a few candidates tried Analytical Geometry, and they nearly all did badly. Some very intelligent work was sent up in Algebra and Trigonometry. In Statics and Dynamics the majority of candidates had made but little way. The attempts at Astronomy were few and generally slight. Altogether, in Group C (Mathematics), there were only 140 candidates, of whom 41 failed, 70 obtained a third class, and only 12 attained a first class.

In Political Economy many of the answers were vague and indefinite. In Logic the simpler questions were well answered, and Mill's inductive methods were understood. Of 45 candidates, however, only 2 gained a first class.

In Group E (Natural Science), out of 62 candidates 25 failed, while 5 obtained a first class. In Elementary Chemistry and Physics the answers were mostly unsatisfactory; Elementary Biology was much better done. Very few candidates seemed to connect the definitions of Chemistry with the facts.

In Physiology and Zoology marked improvement was shown in the answers. The principal fault was still the want of personal acquaintance with phenomena that might be easily observed. In Botany the descriptions of plants were fairly well done, and the questions on Vegetable Physiology were attempted with some success by several candidates. No candidate, however, gave a good description of the germination of a seed.

In Physical Geography and Geology the answers were, on the whole, very good, and remarkably free from errors. The one common failing was the absence of good diagrams.

Mr. James Sully, M.A. Lond., has been appointed a member of the Board of Electors to the Professorship of Mental Philosophy and Logic, in place of the late Dr. Todhunter.

Dr. Donald MacAlister has been appointed by the Senate to be an Examiner in Medicine.

MANCHESTER.—At a meeting of the Council of the Victoria University, Owens College, on Friday, November 21, Mr. J. H. Fowler, B.A. (Oxon.) was elected, on the recommendation of the Senate, to a Berkeley Research Fellowship in Zoology. The Platt Physiological Scholarship, which is also for the encouragement of original research, has been awarded to Mr. C. F. Marshall, B.Sc. (Vict.).

SCIENTIFIC SERIALS

Journal of the Anthropological Institute of Great Britain and Ireland, November 1884.—The ethnology of Egyptian Soudan, a timely and important paper, by Prof. A. H. Keane.—Additional observations on the osteology of the natives of the Andaman Islands, by Prof. Flower.—The Kubus, a small tribe in Central Sumatra, by Mr. Forbes.—Notes on prehistoric remains in Antiparos, by Mr. Theodore Bent.—The Deme and the Horde, by Messrs. Howitt and Fison; an attempt to show a resemblance between the general organisation and usages of the Attic tribes and those of the Australian aborigines.—African symbolic messages, by the Rev. C. Gollmer, describing the method in which natives of the Yoruba country send messages to absent friends by means of shells, feathers, corn, stone, coal, sticks, &c.—On the size of teeth as a character of race, by Prof. Flower.—A Hindu prophetess, by Mr. Walhouse.—On certain less familiar forms of Palæolithic flint implements from the gravel at Reading, by Mr. Shrubsole.

THE *American Journal of Science* for November contains:—Mr. Asa Gray's paper on the characteristics of the North American flora, read before the Biological Section of the British Association at the Montreal meeting; also columbite in the Black Hills of Dakota, by Mr. Blake; spectro-photometric study of pigments, by Mr. Nichols; criticism of Becker's theory of faulting, by Mr. Ross Bourne; the difference between sea and continental climate with regard to vegetation, by Mr. Buysman; chemical affinity, by Mr. J. W. Langley; the relation between the electromotive force of a Daniell cell and the strength of the zinc sulphate solution, by Mr. Carhart; a notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England, by Mr. Verrill; and a note by Mr. J. D. Dana, on the Costlandt and Struy Point hornblendic and augitic rocks.

Rivista Scientifico-Industriale, October 30.—On the origin of atmospheric electricity, of thunder-storms and volcanic eruptions (continued), by Prof. Giovanni Luvini.—Note on a simple method for determining the velocity of a railway train, by Prof. Steiner.—Note on Bauer's new radiometer, by the Editor.—On the vitality of insects in oxygen, hydrogen, carbonic acid, and prussic acid, by the Editor.