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.*)

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.

[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.