appearance of the imago, but the general effect of the low temperature was to reduce or abolish the orange discoidal spot on the fore-wing of both sexes, while under the high temperature the pale hue of the female appeared to assume a yellower tinge. In one instance this effect was well marked.

In *Vanessa atalanta* some further changes were observed as the result of high temperatures; the most remarkable of which were the appearance of a scarlet patch on the fore-wing between the red cross-band and the costa, and a long streak of grey-blue scales near the inner margin of the same wing. The most efficacious way of producing these modifications in this and other species of *Vanessa* appeared to be the use of a temperature of 95° F. to 102° F. for 12–14 hours at an early stage, afterwards gradually lowered, but still kept up to 85° F. or more till near emergence.

Some cooled specimens of *V. urticæ* bore great resemblance to the northern variety *polaris*. Heated specimens were like the southern form *ichnusa* in the shade and extent of the red ground colour, and also in the tendency towards disappearance of the isolated dark spots on the fore-wing. All three spots, however, were affected in these specimens, whereas in *ichnusa* the spot nearest the hind margin retains the normal appearance. Other changes were observed in the outer border, and in the shape of the fore-wing, the angulation being diminished.

Pupæ of *V. antiopa* at a low temperature gave similar results to those obtained with this species by Dr. Standfuss, but they were much less marked.

Experiments in 1896.—Pupæ of *P. daplidice*, L., from eggs laid in March, kept at a temperature of 70° F. to 80° F., gave the ordinary summer form. Some of the same batch, kept in the open air after five or six weeks' cooling at 52° F., emerged as the spring form *bellidice*. In *Melitæa didyma*, Esp., cooling at 51° F. was found to produce an extension of the black markings on the under side of the hind-wings. Of two specimens forced at 94° F., one was of an abnormally fiery tint.

Some specimens of *Saturnia pavonia*, L., from North Italy, forced in late winter and early spring, were much paler, ruddier and more uniformly coloured than those kept out of doors. This species is therefore not so resistent to temperature-conditions as many other winter pupæ.

Vanessa urticæ, var. *polaris*, from Lapland, was found to be sensitive to temperature, though less so than specimens from Central Europe.

Further experiments during the present year (1897) have shown that the tawny ground colour in *Argynnis paphia*, L., is brightened, and the size of the dark markings reduced by warmth, while the contrary effect follows exposure to cold. Also in *Aporia cratægi*, L., a low temperature causes much thickening and spreading of the black lines which mark the course of the nervures.

This ends the series of experiments so far undertaken and carried out by Mr. Merrifield. It is to be hoped that he will be able to continue and extend researches so interesting in themselves and so valuable to science. The present paper is concerned with facts only, not with their interpretation; but it must be obvious to any one who considers the remarkable results here briefly recorded, that they constitute an important contribution towards the better understanding of many disputed questions.

It may be well in conclusion to give Mr. Merrifield's own enumeration of the kinds of change observed. "The changes produced by temperature," he says, "are mainly of three kinds, viz. (1) general change, often striking, in the colouring, without material alteration in the pattern or form of the markings, but often with much enhancement or diminution in their intensity; (2) change caused by the substitution of scales of a different colour, either singly and generally distributed so as to be scattered, or so grouped as to cause a material change in pattern; (3) change in general appearance caused by imperfection in the development of scales or of their pigment. No. 1 seems a direct effect of temperature, not affecting vigorous development. Under No. 2 are to be ranged the most radical changes in pattern, as in the extreme case of *Araschnia levana-prorsa*, which have been explained on the theory of reversion to an earlier form. In No. 3 the wings are often somewhat reduced in size; the scales are scanty, irregularly placed, and often misshapen and deficient in pigment, the membrane of the wing showing between them. The three are more or less combined in many cases."

The figures which illustrate this paper were drawn from the plates which accompany Mr. Merrifield's papers in the Entomological Society of London's *Transactions*. F. A. DIXEY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor announces that he has opened a University Benefaction Fund, to which he has placed during the present term donations for various academic purposes amounting to nearly 3500*l.* This sum includes a gift of 1000*l.* from Dr. Peckover, Lord-Lieutenant of Cambridgeshire, and a grant of 1050*l.* from the Mercers' Company for the rebuilding of the medical schools. The family of the late Sir George M. Humphry, Professor of Surgery, have contributed 600*l.* towards the latter object, by way of a memorial gift; and Mr. H. Westwood Hoffman, 100*l.*

The Rede Lecturer for the ensuing year is Sir Henry Irving.

Prof. Ewing, F.R.S., has been appointed Chairman of Examiners for the Mechanical Sciences Tripos. Mr. A. F. Stabb has been appointed University Lecturer in Midwifery.

The examinations in Sanitary Science will begin respectively on April 19 and April 26, 1898, the incidence of Easter having rendered the advertised dates inconvenient.

A scheme of theoretical and practical training has been organised for members of the University who are intending to become masters in public schools. The scheme is under the direction of the Teachers' Training Syndicate, and will be carried out in connection with the existing Day Training College. Certificates of efficiency will be granted to candidates who have pursued the prescribed course and passed the examinations of the Syndicate.

THE Council of the Institution of Civil Engineers have awarded a Salomons scholarship of 50*l.* to Mr. Edward Ernest Tasker, a student of the Technical College, Finsbury.

THE University of Upsala has received from Mr. Franz Kempe the sum of 150,000 knonor (about 8333*l.*) for an associate professorship of plant biology. Dr. Lundström has been nominated to occupy the chair.

SINCE the beginning of the academical half-year (states the *Lancet*) all students attending the chemical and physical laboratories of the University of Heidelberg have been insured against accidents happening in the course of the lectures, of the laboratory work, and of scientific excursions. The insurance premium is paid by the treasury of the University, which has also made a new regulation in connection with the subject requiring the students to pay a small sum in addition to the class fees.

A Fellowship to be called the Geoffrey Fellowship, of the value of 100*l.* a year for three years, has been presented to Newnham College, Cambridge, and will be awarded in June 1898. The Geoffrey Fellow will be required to reside at Newnham College, and to pursue independent study in some department of learning, letters or science. Candidates must be women who have obtained honours in a Cambridge Tripos Examination or in the Oxford Final Schools. They should send in their names to Mrs. Verrall, President of the Associates of Newnham College, before May 1, 1898. Each application should be accompanied by a statement of qualifications, a scheme of the work which the candidate proposes to carry out, and, if possible, a dissertation or other evidence of work done. Further information respecting conditions of tenure, &c., may be obtained from Mrs. Verrall, Newnham College, Cambridge.

SPEAKING at Northampton a few days ago, Lord Spencer urged that great efforts should be made to improve secondary education in England. Much had been done for education in the Victorian age, but it was absolutely necessary to fill the gaps existing between primary education and University education. He trusted that the measure which the Government would introduce would be satisfactory to all educationists, and he knew if it was it would have the support of even the opponents of the Government. One of the great difficulties in the way of carrying out technical education was the want of good secondary education. No more useful measure had been passed during the reign of the Queen than that giving county councils and borough councils grants for technical education, for it had stimulated a desire for secondary education and technical education. What was now wanted was a measure which would put technical education on something of the same basis, though not perhaps under the same supervision, as primary education. More aid was wanted from public funds and from rates. When they had that they would have attained something of great benefit to the people of the country. Technical education was necessary. He was not one of those who could see for a moment that the prosperity of England was on the wane. But if England meant to keep her position in the commercial world she must not be behind with regard to the most important thing which had arisen in modern days connected with commerce—namely, the necessity of giving technical instruction to those who had to work in England's commercial market.

SCIENTIFIC SERIALS.

American Journal of Science, December.—A microsclerometer, for determining the hardness of minerals, by T. A. Jaggar. This instrument depends upon the energy required to make a boring of a certain diameter and depth under a given weight and by means of a diamond point of a cleavage tetrahedron of perfect shape. The hardness is measured by the number of turns required to make the boring, or by the depth reached after a certain number of revolutions. The depth is measured by a microscope attached to the boring point, by bringing successive divisions of a slanting micrometer scale into focus. The values found for the hardness of Mohs's scale-minerals show even greater gaps than those obtained by Pfaff and Rosival. Taking corundum as 1000, topaz is 152, quartz 40, orthoclase 25, apatite 1·23, fluorite 0·75, calcite 0·26, and gypsum 0·04.—On the sapphires from Montana, by G. F. Kunz. Sapphires were first found in transported gravels along the bars of the Upper Missouri, then in the earthy products of decomposed dikes, and lastly further down in the unaltered igneous rock itself. Much beautiful material has already been obtained, but little of high value.—On the corundum-bearing rock from Yogo Gulch, Montana, by L. V. Pirsson. The dikes of igneous rock containing sapphire and corundum are of a dark grey, basic appearance, and have an uneven fracture. In thin sections it appears as a dark lamprophyre, consisting mainly of biotite and pyroxene. There is a little iron ore present, but much less than is usually seen in rocks of this class.—Electrical measurements by alternating currents, by Henry A. Rowland. Gives some twenty-four methods of measuring inductances, capacities and resistances by means of alternating currents. Some of these depend upon a new principle in the shape of an adjustment of two currents to a phase difference of 90°. This is done by passing one current through the fixed, and the other through the suspended coil of an electrodynamometer. The fixed coil may then be made to carry a heavy current, and the sensitiveness of the apparatus is greatly increased. Inductances can be compared to within 1 in 10,000, but care must be taken not to twist the leads, as their electrostatic action is then very great. The question of standard inductances is thus practically solved.

THE latest issue of the *Izvestia* of the Russian Geographical Society is of exceptional interest. It contains, first, a brief sketch, by P. K. Kozloff, of the Roborovsky's Tibet expedition, in which the author dwells especially upon his own "excursions"—that is, the journeys which he made separately from the main body of the expedition, and gives very valuable data relative to the nature, and especially the animal world, of the visited regions. The reports about the journey in the Sy-chuan province, and to the Southern Kuku-nor ridge are especially interesting.—The geologist, E. E. Anert, contributes a very valuable sketch of his journeys in Manchuria. He started from the Suifun river, near Vladivostok, and went first to Ninguta, and then to Ghirin, the capital of Manchuria, where he took a boat and went down the Sungari till its junction with the Amur. The great Manchurian river, up to Ghirin, has been described already in 1864, by the expedition of Colonel Chernyaeff, who had with him the astronomer Usoltseff and P. Kropotkin; but the papers of these two explorers, which were printed in the *Memoirs* of the Siberian Geographical Society, were destroyed, as well as the original maps, during the Irkutsk conflagration, and remained almost quite unknown to geographers.—A third paper, of great interest, is by V. I. Lipsky, who was the leader of the Hissar expedition of 1896. Notwithstanding great difficulties, due to heavy snowfalls in winter, which were followed by heavy rains in spring, Lipsky explored the Hissar ridge from the south. The heights of the passes are from 12,000 to 14,000 feet. Ten new glaciers were discovered; they all lie above the 10,000 feet level, and are all surrounded by large moraines testifying to their previous larger extension.—The fourth paper is by Th. K. Drizhenko, who was at the head of a hydrographic expedition for the exploration of Lake Baikal in 1896. The paper is accompanied by a map of the lake showing the positions of the 100, 400 and 700 fathoms depth-lines, and another map showing the distribution of surface temperature during the month of August. The work of the expedition was continued this summer as well.—In the same issue G. V. Levitsky discusses the advisability of having a few seismic observatories in Siberia and Central Asia, each provided with a horizontal pendulum.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 9.—"On the Refractivities of Air, Oxygen, Nitrogen, Argon, Hydrogen, and Helium." By Prof. William Ramsay, LL.D., F.R.S., and Morris W. Travers, B.Sc.

In the course of an investigation on the nature of helium, many measurements of the refractivities of different samples were made with a view to determining their composition.

Since, on account of the great difference between the refractivities of air and helium, it was found inconvenient to compare the two gases directly, the helium was compared with hydrogen, and the refractivity of the hydrogen was afterwards determined with regard to air. As a check the hydrogen was subsequently compared with oxygen, and nitrogen free from argon, these gases were also measured against one another, and against air. At a later stage in the investigation the refractivities of argon and carbon dioxide were also determined.

The measurements were made by the interference method described by Lord Rayleigh (*Proc. Roy. Soc.*, 59, 198-208).

Special attention was paid to the purity of the gases examined and a full description of the methods of preparation is given in the paper. It is possible that the discrepancies between the results obtained by various observers may be due to the presence of impurities in the gases which they employed.

The mean values obtained for the refractivities of the gases examined are tabulated below.

Refractivities of Gases, Air equal to Unity.

	Directly compared.	Through Oxygen.	Through Nitrogen.	Through Hydrogen.	Through Argon.
Hydrogen ...	0·4733	0·4737	0·4727	—	—
Oxygen ...	0·9243	—	0·9247	0·9237	0·9261
Nitrogen ...	1·0163	1·0155	—	1·0170	1·0191
Argon	0·9596	0·9577	0·9572	—	—
Carbon dioxide	—	1·5316	—	—	—

Calculated from the determinations given above, assuming Dale and Gladstone's formula for mixtures of gases, the refractivity of air becomes 99·647 instead of 100.

Turning to the determinations of other investigators, it was found that since Dulong, in 1826, no single experimenter had made measurements of both oxygen and atmospheric nitrogen. Mascart determined the refractivity of nitrogen, and found it to be 1·0178, a value which closely agrees with the figure given above.

Lorenz determined the value for oxygen, 0·9347, but there is reason to doubt the purity of the gas which he employed. The refractivity of air calculated from the data of Mascart and Lorenz becomes 100·15.

Since the value obtained for the refractivity of air, calculated from the values obtained for oxygen, nitrogen and argon, differs from 100 by an amount far exceeding the limit of experimental error, we were driven to the conclusion that the refractivity of air is somewhat less than the refractivities of its constituents, taken in the proportion in which they occur.

It appeared advisable to try other mixtures; and a mixture of hydrogen and helium was first selected, because these are both very "perfect" gases, inasmuch as their critical points lie very low. It was to be expected that if a difference between calculated and found values should exist, it should be of the inverse character to that of a mixture of oxygen and nitrogen, for they are two somewhat "imperfect" gases. The result has borne out this idea.

A mixture was made of 20·60 c.c. of hydrogen and of 20·12 c.c. of helium free from argon, and of the density 1·960; and with the refractivity of the mixture those of hydrogen and