protean; our faith in this measure is rudely shaken by the statements on pp. 104-5. There are many interesting statements in Chapter XII., but one finds it difficult to discover why the heading should be "Chemical Affinity."

The time is surely past when we are to expect the chemical student to be content with a sketchy outline of such subjects as affinity and thermo-chemistry. If these subjects are really parts of the science of chemistry—and surely they are all-important parts—let them be dealt with as such, and not thrust into a corner and treated so that the student is ready to conclude that, if he is able to repeat the properties of the elements and their compounds, he must of necessity be a chemist. The real science of chemistry is something more than a string of disconnected facts and a few mutually independent hypotheses.

We cannot but think that, had the authors of this book cut out most of the graphic formulæ, been content to use the notation adopted by other chemists, and carefully considered, digested, and arranged the materials they have brought together in the first nineteen chapters, they would have produced a much better and a much more scientific treatise. M. M. P. MUIR

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

### Mr. Lowne on the Morphology of Insects' Eyes

(1) IT is, I imagine, sufficiently obvious that I was not at liberty to state in my previous letter the circumstances connected with the action of the Royal Society in regard to Mr. Lowne's paper, now inaccurately related by him.

It is also clearly impossible that I should take any notice of Mr. Lowne's letter in your journal of April 9 (p. 528) beyond expressing my surprise that he should suppose that I have had any personal feeling in regard to him or his work, and my regret that he should accuse Prof. Schäfer, Dr. Hickson, the Royal Society, and the Cambridge histologists of ill-treating him in various ways.

(2) I would beg to assure my friend Dr. Romanes that he is mistaken if he imagines that I intend to publicly discuss the affairs of the Linnean Society with him either here or elsewhere. At the same time I consider that I am at liberty to express my judgment as to the scientific value of a paper published by the Linnean Society, and that neither he nor the author of the paper are entitled to object to my discharging what I conceive to be my duty in this respect. E. RAY LANKESTER

11, Wellington Mansions, N.W.

### Abnormal Season in the Niger Delta

As you are aware the waters of the Nile are at present abnormally low, and having just received a letter from the Niger, I thought it might interest you to learn that the season is abnormal also there. My correspondent, who has an experience of many years on the river, states:—

"We have had the most extraordinary weather since the commencement of the year—heaps of rain up to the present during both months (January and February), and yesterday one of the worst tornadoes I have ever seen, and that from the due north; usually the bad ones come about Christmas from the south-east. I never saw rain, up to the present, after Christmas during the first three months of the year, which are the unhealthy ones. These months are this year so far fairly healthy, although the falling of so great a river as the Niger must wash down a mass of filth, not so much from the towns on the banks as from the hundred small and large villages and towns up all the creeks or tributaries along its banks."

I have asked if any barometer observations are made, and if I could have a return of them for the past year.

J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green, Dublin, April 16

### Tardy Justice

YOU well advocate the establishment of a well-endowed scientific University in London. Perhaps, however, London is like a mass of dough which needs leaven. Why should not the Corporation of the City of London be that leaven? Perhaps, however, the Corporation needs that some one should employ a yeast-germ in order to start its fermentation. Or, if it be lawful to compare that august body to a pump, perhaps a handle is necessary which some one may work. Why should not the yeast-germ, or the handle, be found in Gresham College?

April 17 Z.

### A Query

I WONDER if any of your readers could suggest a material which would fulfil the following requirements:—(1) Great cheapness; (2) capability of being readily cast, or moulded, into simple shapes with no delicacy of detail; (3) not very brittle; (4) not fusible under a temperature of 100° F. It should also afford a surface which could be readily painted, and it should not be too heavy, a specific gravity not much in excess of water being the best. India-rubber I find answers all requirements sufficiently well, except that it is much too expensive a material.

April 17 M. X.

### The Use of Artificial Teeth by the Ancients

THIS is not a new discovery, as stated in *Cosmos* (see NATURE, April 16, p. 564). Cicero, De Legib. II., 24, quotes a law from the Twelve Tables forbidding the combustion or burial of costly golden articles, but allowing an exception in favour of "teeth fastened with gold" (*Quoi auro dentes vincti escunt, &c.*).

Heidelberg, Germany, April 18 O. S.

### Far-Sightedness

A PANORAMA of the Alps, as seen from the Piz Langard in the Engadine, used to be sold, upon which Mont Blanc was figured, though some 3° distant. On a remarkably clear day this was pointed out to me, and I have no reason to doubt that I actually saw Mont Blanc at that distance. One morning I was walking on the terrace in front of Mr. Leland Cossart's house in Madeira, at an elevation of close upon 2000 feet above the sea, when the conversation turned on far-sightedness, and I pointed out two specks on the horizon as vessels. This they proved to be, when my friend informed me that no vessels had before been made out on the horizon from that position, even with the telescope. J. STARKIE GARDNER

7, Damer Terrace, Chelsea, April 17

## AIMS AND METHODS OF THE TEACHING OF PHYSICS[1]

THE United States Bureau of Education has recently employed Prof. Charles K. Wead, A.M., Acting Professor of Physics at the University of Michigan, to draw up a set of inquiries respecting the teaching of physics and to collate and discuss the answers received. The results of his labours are now before us in a rather unusually lengthy circular issued by the Bureau. They are drawn from seventy replies to a set of questions sent to a selection made by the Commissioner of Education of masters of schools of various grades in the United States, compared also with information gathered from England and other countries. A table at the end showing as clearly as can be done in a word or two under each heading the tendency of each answer, makes it easy to

[1] "Circular of Information," No. 7, 1884, of the U.S. Bureau of Education. (Washington, 1884.)

see the points of difference and the correspondents who differ.

The replies seem to show :—

(1) A widely-spreading preference for science over literature or classics,—(*a*) as training of the mind; inducing habits of observation such as no study of grammar does, and consequently a great increase in what is called common sense, which close attentiveness soon spreads to other studies also, giving each observer who has caught the spirit of inquiry and learnt how to observe, compare, and draw conclusions himself, confidence in his own observations, instead of depending upon the authority of some book. It is well described from the master's point of view :—

"The advantages of the study have been : (1) Wonderful quickening of the intellect, lively interest in the school ; (2) subsequent growth into the scientific and scholarly spirit, developing a wonderful ingenuity in mechanical contrivances and the manipulation of tools ; (3) doubling (in some instances quintupling) the number of boys who take the high school course, and giving many a strong bent to industrial pursuits in their better-skilled departments. It has secured students of broader power of thought and generalisation. It has cultivated the senses so that pupils were not 'nature-blind.' It has trained to the habit of nice adjustment of probabilities, which has reacted with marked power in giving a critical acumen in classical research" (p. 16).

Since, therefore, it is our middle and higher classes who have to look to their brains for their success in life it is they specially who want this training in scientific method which will "teach them how to learn, not what to know."

(*b*) As valuable information—valuable first from a utilitarian point of view :—

"When one reflects how few persons there are who know the composition of a drop of water or a grain of sand in comparison with those who are familiar with a Latin verb or a Greek preposition, and how much each of these separate classes of educated people is accomplishing, it seems plain to me that instruction in physics is of the utmost importance to our people ; for, beyond all doubt, scientific men have done, are doing, and will do more for the advancement and well-being of our country than any other class of her citizens" (p. 50).

And from this same point of view *any* scientific information is valuable to children who leave the elementary schools early in life, though it is generally urged that stuffing them with incoherent facts is a most useless education, and that what information is given must, therefore, form part of a scheme for teaching them observation. The American Association for the Advancement of Science protests against any way of *giving* them information ; they must *get* it.

Such information, however, is also rising in value as an accomplishment, and the lack of it will soon be looked upon as an ignorance of classics was a generation ago. It will be felt that "no knowledge of language can atone for an ignorance of nature," and that a neglected *h* or a false quantity is a very venial offence compared with wondering why eclipses never take place when the moon is half full.

2. That in the lowest schools, lessons on the elements of science should be given : examples being taken as much as possible from the most familiar toys and other objects about them. Experiments with such things are urged, because they are a fascination to the young, and a relief from committing Latin Grammar to memory. But the desirability of making this instruction the preparation for the higher classes is met by the fact that so few go on to them, and it seems clear that something more exact and systematic should be commenced among those who do go on ; for, unless this is done, although a boy may have acquired some general notions of the terms and subject-matter, yet if fundamental points have been neglected in the lower schools, either the college class must be kept back to study these points, or he must build all his advanced work on an uncertain foundation.

(3) A further divergence is found on the question of experiments. A successful experiment is a great power for good, but it is a gift to be able to make experiments accurately and successfully : and, if the experiment fails, the faith in all teaching connected with it is shaken ; still less can it be made the basis of fresh conclusions. Imperfect experiments, therefore, are an unmixed mischief, and for elementary classes all should be done by the teacher, who, besides a good general knowledge, should have some manual skill in using or even in making apparatus : "otherwise mistakes in method and fact will be common in his teaching, and his instruction will be a constant appeal to the text-book or other authority, thus losing the very thing that is of peculiar value in the training derived from the study of science." If the higher school students are put to experimenting when unqualified for it, and with inadequate means, habits of slovenly experimenting and inconsequent induction are formed, or the student is disgusted with the unsatisfactory nature of the whole thing.

(4) In the upper grades, however, and among specially gifted boys the value of experiments both by teacher and scholar is insisted upon almost as uniformly as it is among those who study the science of teaching and the teaching of science in England. "No support is given to the notion common among men of a literary education that physics can be learned as history is, by reading a book. Experiments are essential to the study, and to profess to teach physics without providing suitable experiments in sufficient number to illustrate the subject must be considered as a case of false pretences." Learning science by experiments draws out powers of the mind that school-teaching of every other kind, involving as it does unquestioning submission to authority, completely numbs. The exact observation of facts and, on the one hand, the bringing those into relation which had seemed unconnected, and, on the other hand, the loosening of independent facts that wise saws have placed in close relation ; in a word, discovery, with its necessary companions, self-reliance, independent thought, shrewdness of judgment—the very qualities which make a successful man of the world—are all developed by experimental science instead of the too frequent opposite effect which makes anxious business fathers dread too much schooling for the sons who will have to follow them.

(5) Parallel to (3) and (4) are the conclusions drawn as to making apparatus. Bad apparatus induces imperfect experiment, and, as laboratory work must be serious and yield visible results or it will be despised, the apparatus for the students' use must not be flimsy, or in the nature of a plaything merely. It is therefore penny wise and pound foolish for a teacher to make his own apparatus. If his time is worth anything his productions will cost more than the more perfect work of an instrument maker ; and, besides the great chance of imperfection from the beginning, it will be liable to such faults as warping, and, moreover, not likely to suit the next teacher. On the other hand, such a general rule as this is not intended to tie the hands of gifted teachers who can make everything that comes in their way their slave to answer their questions. There is a rapid descent from such to the plodding worker who teaches for daily bread.

The most difficult question to answer confidently, after taking the opinion of so many doctors, is whether teaching of any use to elementary schools can be made without serious disadvantage to form part of a course pursued further by the higher classes. The Circular finds unanimous agreement among the United States teachers that it is most desirable ; and, after quoting English opinions that

our Universities ought to be able to frame such a course, urges that a committee of teachers who have carefully considered the evidence here supplied should be able to draw up a practical scheme sufficiently definite, detailed, elastic, and progressive to secure its wide adoption. Unless this is done, a teacher's work cannot be measured, and he will get neither credit nor cash for it from his judges; and no amount of public opinion will really make such teaching general while this remains so. A good practical suggestion in accordance with these conclusions is that some experienced teacher should devote his power to the preparation of cheap leaflets, not stitched together, for a brief inductive course, from which each teacher might select a series according to his circumstances. W. ODELL

## THE WORK OF THE U.S. SIGNAL OFFICE UNDER GENERAL HAZEN[1]

THE recent examination by the joint commission of General Hazen and other witnesses, as to the efficiency and economy of the present administration of the Signal Office, is said to have brought out several statements as to the character of the work done by the Weather Bureau, and the progress made by it during the last few years. The following is a brief summary of these, and especially of Prof. Abbe's statement showing the status and work being pursued during the present fiscal year :—

The Signal Service employs 1 chief, 14 second lieutenants, and 500 enlisted men, of whom 150 are sergeants, 30 are corporals, and 220 are privates, but all generally known as Signal Service observers. These 515 persons constitute the Signal Corps proper: but 6 officers detailed from the line of the army are also temporarily attached to the service ; and these have control of the disbursements, the property, the weather-predictions, the display of signals, the testing and comparison of instruments, the arctic stations, the international bulletin, the monthly weather review, the Pacific Coast section, and other main divisions of work.

These 6 officers, by the operation of the present laws, are being diminished in number by 2 annually, their places being filled by promotions from among the sergeants of the corps ; so that in a few years the service will employ only officers and men of the Signal Corps proper. This elimination of officers who have had from ten to twenty years' experience in the Signal Service and the army is somewhat deprecated by General Hazen, who is very naturally loath to lose their services, while they themselves are loath to go ; although it is evident that the corps proper already contains abundant and excellent material for the future needs of the service.

The Signal Service also employs a number of civilians —namely, 2 chief clerks, several clerks of lower classes, and a scientific staff of 3 professors, 4 junior professors, and 1 bibliographer, and a large number of civilian observers, printers, messengers, artisans, &c.—at various points throughout the country. The number of civilian *employées* at the central or Washington office is 64, all of whom give their whole time to the work. The total of those employed at other stations is apparently much greater than this ; but each is employed only a short time daily, and most of them receive but 25 cents per day for some one special observation and record. The enlisted men of the service occupy about 200 stations scattered throughout the United States, including Alaska, at an average distance of 200 miles apart. About an equal number of stations are also occupied by civilians, observing the height of water in the rivers, or displaying storm-signals. From about 4500 other civilian observers reports are received gratuitously by mail on weekly or monthly forms. These observers are classified about as follows : voluntary land observers, 270 ; voluntary marine observers, 480 ; international observers, 330 ; Canadian observers, 18 ; state weather service, 450 ; tornado observers, 1200 ; thunderstorm reporters, 2000.

The following are some of the more prominent and important steps of progress taken during General Hazen's administration :—

The introduction of consulting specialists and civilian experts in the available working force of the office ; the assignment of selected sergeants and privates to work demanding a higher education and special aptness for investigation or study ; the organised study of tornadoes, thunderstorms, atmospheric electricity, and other important novel fields of meteorological study ; the introduction of weather-signals upon railroad-trains for the benefit of the farmers, and of local town-signals for the benefit of each community ; the establishment of more severe rules for the verification of predictions, so that the 85 per cent. claimed at present means much more than it did a few years ago : the enlistment of a higher grade of men, the improvement of the courses of instruction for men and officers, the compilation of a working index to the literature of meteorology and the signal-office library, the organisation of new divisions in the office, especially of the study-room, the physical laboratory, the marine division, and the examiner's division ; the publication of a monthly summary of international simultaneous observation, with a weather-chart showing especially the storms on the Atlantic and Pacific Oceans that affect the United States ; the special study of atmospheric moisture with a view to improved methods of determining this factor ; the special study of the exposure of thermometers, and correct methods for determining the temperature of the air ; the maintenance of two polar and several auxiliary stations in pursuance of an international system for the study of the meteorology of the Polar regions ; the adoption of many of the recommendations of the European International Meteorological Congresses looking to uniformity of methods throughout the world ; the adoption of improved methods of reducing barometric observations to sea-level ; the stimulus given to the formation of State Weather Services (this great advance has been wholly due to Gen. Hazen, who has not hesitated to declare himself in favour of co-operation, and not monopoly ; by his circulars and assistance over fifteen States have been led to develop minute internal systems for the study of local climate and the dissemination of weather-predictions) ; the stimulus given to higher scientific work by members of the Signal Service, by requiring and publishing professional papers, signal-notes, treatises, &c. ; the addition to the Signal Office of a few experts in scientific matters, who are responsible for the proper conduct of work requiring special study ; the establishment of a high class of standard instruments, and more exact methods for testing-apparatus furnished to the stations, thus assuring against any deterioration in the accuracy of the work through many years to come ; the encouragement and co-operation in scientific work, bearing on meteorology, by outside parties, such as spectroscopy, the study of solar heat and atmospheric absorption, and the prosecution of balloon-voyages ; the adoption of a uniform standard of time for all observers ; the adoption of a uniform standard of gravity for barometric reductions ; the introduction of new special cautionary signals for high north-west winds and cold waves ; the extension of signal-service stations in Alaska for the proper study of storms that strike the Pacific coast, and are followed by the severe cold waves from Manitoba.

In the prosecution of these and other multifarious labours the signal-service certainly demands a high degree of organisation, discipline, and intelligence ; and it is by no means clear that this can be obtained in any better way than by a proper combination of military and civilian observers and scientific men.

[1] From *Science*.