possession of trigonometric measurements of the most exact nature, extending from lat. 61° in the Shetland Islands, to lat. 34° on the southern frontier of Algeria.

The extension of this network southward and eastward in Africa, desirable as it is for the elucidation of many nice points in geodesy, is unfortunately scarcely possible in the immediate future, and science must rest content with gaining a foothold in the great continent.

T. H. N.

A NEW STANDARD OF LIGHT[1]

In the pamphlet before us we have a proposal for a new form of standard light, and the author has shown some considerable skill in drawing out his method of producing it. We cannot do better than quote his opening paragraph as showing the requisites of a standard that the author deems necessary. He says:—

"No exact measurement of any quantity, even with the most accurate and sensitive test measures available, can reasonably be expected unless the standard by which the unknown quantity is to be gauged is perfectly constant in itself; or if nature does not permit of such a desirable state of things, the causes to which the variation of the standard are due should be known, and in addition also, their quantitative effect on the standard, in order to be able to introduce a correction whenever accuracy of measurement should permit, and circumstances necessitate it."

The want of a standard of light has long been felt in physical researches, and the British Association has acknowledged the impossibility of obtaining scientific measures with the ordinary standards, and has appointed a committee to consider the question of fixing such a standard of white light, that a unit of light may be capable of accurate definition. It must not be forgotten that up to quite recent times the principal necessity for a standard at all has arisen through the introduction of gas into our dwellings and streets, and it has only been necessary to adopt one which should give the comparative illuminating powers of any variable qualities of gas. In fixing such a standard the points to be looked at were (1) that the standard should be capable of easy and exact reproduction; (2) that the colour of the light should be approximately the same; and (3) that in varying states of barometric pressure and temperature, proper corrections in the results of the comparisons should be feasible. It will be seen further on that a fourth desideratum should be introduced for scientific work. Perhaps on no subject has more attention been paid to small details than in the production of a standard candle, and as a result, when burnt under proper conditions, it gives fairly correct values of the illuminating power of gases.

In the record of Mr. Schwendler's experiments with the standard candle as against his new standard of light, we have some startling variations in the light of a standard candle, but we feel sure that, had the proper conditions been observed, there would never have occurred such a tremendous difference as 72 per cent. We are more convinced that ordinary precautions could not have beer rigidly observed when we find that some of the comparisons were made after the candle had been freshly lighted. In gas photometry it is well known that the standard candle should burn at least a quarter of an hour before it can be considered to have settled down to a steady light. The standard candle, however, is not a nice unit of light; and two years ago Mr. Vernon Harcourt introduced to the notice of the British Association a gas standard which seems to meet every requirement. By making a mixture in a small gasholder of one part of the most volatile spirit from American petroleum which distilled at 50° C. with 600 of air, or seven of the vapour with twenty of air, he produced a gas which, whilst almost insoluble in water, was permanent at all ordinary temperatures and pressures, and which was of a known composition and easy of manufacture. A jet of such a gas could be compared with the ordinary coal-gas, and any variations affecting the one would equally affect the other. The colours of the standard and coal-gas lights are also approximately the same. It seems that a standard of such a character meets the requirements for comparing the illuminating value of different coal-gases. Mr. Schwendler proposes to use the light radiated from platinum foil, when raised to incandescence by an electric current, as a new standard, and we agree that a solid instead of a gaseous body as the source of illumination is a step in the right direction. The standards made, however, appear to have been used for determining the illuminating value of the light produced by dynamo-electric machines under varying conditions of speed of armature and resistance in circuit, and it is in reference to this that we will first judge of its probable effectiveness, since for gas measurements the standards already existent suffice. Some dynamo-electric machines are advertised as generating the light of 50,000 candles, and we will suppose for the moment we are comparing such a light with Mr. Schwendler's standard.

Now it may be safely said that a standard candle, farther away than twenty feet from the photometer, would give too small a light to be practically of use as a standard, whilst if approaching the photometer within one foot the magnitude of the illuminating source would seriously affect any accurate results. In the first case the electric light would have to be about 4,500 feet away from the photometer and in the last about 220 feet. For ordinary photometric work even the least of these distances would be objectionable. The platinum standard employed by Mr. Schwendler is only about ·7 of a standard candle, and these distances would have to be increased nearly 20 per cent.

For practical measurements of this description a candle-power of fifty candles is a far preferable value, which it would be difficult to attain by the method proposed. In this case we have the distances reduced, and if the electric lamp is fixed at a distance of 100 feet, we have the movable standard ranging between twenty feet and three to four feet, and the readings become easy and are not subject to be seriously affected by the magnitude of the illuminating source; in fact, the errors of observation then become of larger magnitude than any error arising from this cause. Another point which we have to note is that as far as the colour of the light from the platinum standard is concerned, it possesses very little advantage over the ordinary gas or candle flame, and it would be impossible, or at all events incorrect, to give the illuminating value of a light such as of that produced by the electric arc in terms of the new standard; some recent experiments have demonstrated that the red light emitted by one square mile of the hollow crater in the positive carbon is equal to about the red light radiated by 40,000 standard candles, whilst the mean green light of the former is equal to the mean green light of about 135,000 of the latter, and until such a time as the relative physiological values of green and red light are accurately known it will be impossible to give any true estimate of the illuminating power of the electric light by ordinary photometric comparisons. Both in magnitude and colour, then, the proposed platinum standard of light seems to fail for measuring light produced by high temperatures.

We now turn to the details of the lamp itself. We have, firstly, a U-shaped piece of thin platinum foil cut out about 20 mm. in total length, each limb of the U being about 3 mm. in breadth, the tops of which are clipped in thick metal clips. The usual arrangements are made for passing a current through this foil, the amount being registered by a galvanometer in circuit. A

[1] On a New Standard of Light. By Louis Schwendler. From the *Journal* of the Society of Bengal, vol. xlviii. Part ii., 1879.

glass shade is also employed for steadying the light, by keeping off convection currents. There seems to be an objection to this form of lamp for accurate scientific work, where it may be necessary to use an *image* of the source of illumination. For instance, in certain spectroscopic comparisons of different lights only a small portion of the image of the incandescent platinum would fall upon the slit. Now the first difficulty that would be met with would be as to the part of the platinum that would emit a standard light. Near the contacts the heat would be conducted away so rapidly that the colour of the light would be of a different tint.

Again, presumably near the middle of the limbs of the U-shaped foil the temperature would be slightly higher than at the outsides; in fact, no two portions of the foil would be exactly at the same temperature.

For work, then, of this class, the standard seems to fail in an important particular.

The writer of this notice made many experiments on this point some years ago, and it was this objection that led him to abandon the idea of a platinum standard light of a form somewhat similar to that of Mr. Schwendler.

For a standard perfectly suited to scientific work, perhaps the following definition will be found tolerably exact:—It should be a body (solid or liquid), some known area of the surface of which can be kept at a high constant temperature. It seems probable that a combination of a body of good with one of a bad conductivity will eventually be found to offer suitable materials for a really trustworthy standard.

It would be unjust to conclude this notice without paying a testimony to the great value of the experiments which have been carried out by Mr. Schwendler in this research. It is quite possible that a modification of his platinum standard may be constructed which will eliminate the defects which are to be found in it. It is certainly a step in advance of the gas or candle standard for everything beyond merely technical work, but it is not of the same accuracy as other scientific units. W. A.

FLOW OF VISCOUS MATERIALS—A MODEL GLACIER

THREE or four years ago an experiment was arranged by Mr. D. Macfarlane and myself for the purpose of showing the flow of a viscous mass and for illustrating glacier motion. The experiment then commenced gave rise to others of a similar nature. These experiments have proved so interesting that I venture to describe some of them to the readers of NATURE.

Shortly after his discovery of the true nature of glacier motion, the late Principal Forbes was much pleased when one of his students, now the Rev. C. Watson, of Largs, showed him a quantity of shoemakers' wax which had been gradually flowing down on the bottom of a vessel accidentally left on an incline. Forbes was delighted with the wax, and considered it an admirable illustration of viscous flow. This was told to me in conversation some four years ago, and it occurred to me that a pretty illustrative glacier might be made with shoemakers' wax, and we proceeded to construct it. The model glacier has been shown year after year to the natural philosophy class in Glasgow, and has proved interesting and instructive beyond expectation.

A little wooden ravine was constructed, with a number of steep declivities and precipices and some more gentle slopes. There is one place, also, where the ravine is narrowed by projections inwards, which nearly meet each other. At the upper end of the ravine there is a flat part, on which ordinary shoemakers' wax is piled—as where snow collects at the upper end of the natural ravine; and from this collecting-ground the material flows down steadily through the ravine, giving on a small scale a most perfect display of the flow of a semi-solid material. At the beginning of each winter session a supply of shoemakers' wax is given at the top, and during the session the flow goes on slowly and steadily; hardly perceptible from day to day, but progressing from week to week, and from month to month. Every one knows what a brittle substance shoemakers' wax is at ordinary temperatures. A lump of it allowed to fall on the ground flies into a thousand pieces. Watching this brittle apparent solid flowing down an inclined plane, brings very vividly before the mind the real nature of the glacier's flow. To imitate on the small scale Forbes's celebrated experiment of planting a row of stakes in the glacier, in order to compare the flow in the middle with the flow at the edges—the experiment which really established the fact of *viscous* flow—I have sometimes put a row of dots of white paint across our pitchy glacier. In a few days the more rapid motion of the middle portion, and the less rapid motion of the parts near the edges, is made apparent. There are others of the glacier phenomena which are also beautifully imitated by the shoemakers' wax. Little crevasses are sometimes formed, though not very often owing to the great effect of temperature on the plasticity of the material; and the cross-markings that are noticeable at the foot of a glacier are brought out extremely well.

Last year Sir William Thomson commenced a new and curious experiment on shoemakers' wax as a viscous material. A large circular cake of it about eighteen inches across and three inches thick was made. This was put into a shallow cylindrical glass vessel, which was filled with water to keep the temperature from varying with any great degree of rapidity. Below the cake a number of corks were put, and on the top there were put some lead bullets. The result has been that in a year the corks have floated up through the wax, and are coming out at the top; the bullets have sunk down through the wax, and have come out at the bottom; and this, it is to be observed, has gone on while the wax was at all times in such a condition as to be excessively brittle to any force suddenly applied, such as a blow from a hammer, or such as would be occasioned were the cake of wax to be allowed to fall on a stone floor. J. T. BOTTOMLEY

THE SCOTTISH ZOOLOGICAL STATION

SOME months ago the opening of a zoological station on the Scottish coast was mentioned in these pages. This station—the first enterprise of the sort in Britain—has been established in connection with the University of Aberdeen, and under the directorship of the Professor of Natural History, Dr. Ewart, who was, this year, assisted in the conduct of the station by Mr. Patrick Geddes.

The site chosen was the little fishing station of Cowie, about half a mile north of Stonehaven, and fifteen miles south of Aberdeen. But one of the chief advantages of the station is that it is not a fixed building of brick or stone, but a movable one of wood, which can be taken, if necessary, to a new place every year, and, after the season's work, taken down and packed up for the winter.

The annexed cuts give an excellent notion of the appearance and internal arrangements of the place. It is a wooden structure (Fig. 1) about 32 feet long by 16 wide, supported on low wooden piers and having a thin wooden roof covered over with sailcloth. In each of the longer sides are five windows, in one of the shorter sides the door, in the other two windows. Inside (Fig. 2), a partition divides the building into two parts—a larger, the laboratory proper, with eight out of the ten side windows, and a smaller, the library and director's room, with two of the side and both end windows.

In the library there is a bench or working-table (Fig. 2, *T*) running round three sides, with shelves (*S*) above, for books, apparatus, and bottles. In the laboratory there is a table (*T*) to each window, intended to accommodate two