either stage by taking up *two* only of the subjects." This has been so for some years past, and there have always been *five* questions in each subject. As the maximum number of questions a candidate may attempt is eight, this gave a choice in each subject of four questions out of five. But this year, without any previous notice, the number of questions in each subject is reduced to *four*, so that a student who only takes up two of the subjects has absolutely no choice. He may be well prepared, yet if he happen to have overlooked *one* of the points dealt with in the questions, his chance of a first class is seriously diminished.

In making this unlooked-for change, the Department practically takes away with one hand what it gives with the other.

Secondly, in the advanced paper, the second question in Sound runs thus: "If a string 24 inches long weighs half an ounce, and is stretched with a weight of 81 pounds find its rate of vibration when bowed or struck."

Now this is a problem not on *comparative* measurements, which are fairly within the grasp of an advanced student, but on *absolute* measurements. To solve this question requires a knowledge not merely of the principles of sound, but also of theoretical mechanics and of numerous mathematical details, besides considerable dexterity in manipulating units, which is about the most perplexing thing a student ever encounters, and has hitherto never been called for except in the honours stage.

To set such a question as one of *four*, and offer no choice, is in effect to condemn the students at the outset, and must have a most depressing effect upon the classes in future years. At any rate, if the Department intended to introduce absolute measurements into the advanced stage, it is only fair that they should have given notice.

Thirdly, the last question in Heat (advanced) asks the student to "sketch an apparatus for determining the *coefficient of expansion* of a gas at constant *volume*." Perhaps the examiners will kindly inform us how a gas can expand, its volume at the same time remaining constant. Possibly the word "expansion" is a misprint for "increase of elasticity," in which case Balfour Stewart's apparatus should be sketched; or, possibly the word "volume" is a misprint for "pressure," in which case Gay-Lussac's apparatus is required; or, possibly there is an intentional confusion of phraseology in order to perplex the candidates.

Misprints occur in one or more papers nearly every year. Last year there was an error in Mathematics, Stage 3, when a certain equation was printed with the figure 4 instead of 1, thus causing candidates to waste time and become flurried, and here again we have the same kind of thing.

A SCIENCE TEACHER OF SEVEN YEARS' STANDING.

May 21.

DR. NANSEN'S JOURNEY ACROSS GREENLAND.

FROM a communication sent us by Dr. Nansen, we are able to give some details of the remarkable journey across Greenland which he accomplished last summer. We need only briefly recall the most important attempts which had previously been made to cross a country which is exactly in the condition of our own islands during the Glacial period. The first serious attempt was made in 1878 by Jensen and Steenstrup, who, from the west coast in lat. 62° 30′ N., managed to get some 40 miles into the interior, after many difficulties and dangers, ascending a mountain to a height of 5000 feet, from which they saw the inland ice rising gradually towards the interior. Then came the famous expedition of Baron Nordenskiöld in 1883. He, with a comparatively large party, started much further north than the previous expedition, a short distance south of Disco Island. The party succeeded in penetrating some 90 miles eastwards, to an altitude of 5000 feet. The Laplanders, however, who accompanied Nordenskiöld went in their snow-shoes 140 miles further, travelling over a continual snow desert to a height of 7000 feet. The next serious attempt was made by an American, Mr. R. E. Peary, in the summer of 1886. Mr. Peary started much further to the north than Nordenskiöld, and his course was due east. He reached 100 miles from the edge of the ice-blink, or inland ice, his highest elevation being 7525 feet.

Dr. Nansen felt sure that the only way to cross the ice was by means of *ski* (a special kind of long snow-shoe) and sledges. He had many applications to be allowed to accompany him; but he selected only five companions—a lieutenant in the army, a shipmaster, a Norwegian peasant, and two Lapps. The expenses of the expedition were generously supplied by Mr. Augustin Gamel, of Copenhagen. The party left Christiania early in May 1888 for Iceland, whence they embarked on board a sealer for the east coast of Greenland. Dr. Nansen's own account of his attempts to land is of interest as showing the condition of the ice and the currents off the East Greenland coast:—

"On June 4 we left Iceland in the *Jason* for Greenland. My hope was that early in June we should be able to reach the coast in the neighbourhood of Cap Dan, in latitude about 65° 30′ N.; but I was disappointed, as large masses of ice stopped us at a distance of 50 miles from the coast. At last, on July 17, we approached the land at the Termilik Fjord, west of Cap Dan, and I determined to leave the ship. In our two boats we had to force our way about ten miles through the ice. The current was, however, very strong, the ice-floes were thrown and pressed against each other, and during such a pressure of the ice one of our boats was broken. We were then very near to the coast, but the boat could not float, and some hours passed before the leak could be restored. In the meantime, the ice was very much pressed, and we went adrift, the speed with which the current carried us off from the coast being much greater than that with which we could advance on the ice. At the great rate of about 28 miles each twenty-four hours we were driven southwards along the coast. We tried to reach land three times, but by a rapid current we were again carried towards the sea.

"At last, on July 29, we succeeded, and reached land at Anoritok, 61° 30 N. lat. Originally, I had thought to land at Inigsalik, in 65° 30′ N. lat. We had consequently come 240 miles too far southwards. Our destination was Christianshaab, in Disco Bay, to reach which we should be obliged to go in our boats northwards, to cross the continent at a more northerly latitude. To get northwards was not, however, very easy. Masses of Polar ice were pressed towards the land, and very often the axe alone could break a way through the tightly pressed ice-floes."

Two parties of heathen Eskimo were met with, who were at first rather distrustful of the strangers, as they had scarcely ever before seen Europeans.

On August 10 (more than a month behind time) the party reached Umiavik, 64° 30′ N., whence the start was to be made across the inland ice. Dr. Nansen and Captain Sverdrup the next day made an excursion to examine the glacier. They got ten miles from the coast, and reached a height of 3000 feet. On August 15 a start was made, there being five sledges to pull, one loaded with 400 pounds, pulled by Dr. Nansen and Captain Sverdrup. Two days later they were stopped by a heavy gale which kept them in their tents for three days. At first the intense heat compelled them to travel only at night. Dr. Nansen goes on to say:—

"At some distance from the coast the snow became, however, very deep and bad for pulling. We were also met by a heavy gale from the north with snow-drift, so that we could advance only very slowly. I hoped that it would soon become better, but each day it became worse. It was only too clear that if it continued in this way we would not be able to reach Disco Bay till the middle of September, when the last ship left for Europe. Though I expected to find more difficult ice in this direction, I changed our route and turned towards Godthaab. That was on August 27. We had then reached about 64° 50′ N., about 40 miles from the coast, and a height of about 7000 feet. By this change

of direction, the wind became so favourable that we could use sails on the sledges, and thus they became less heavy to pull. In this manner we advanced during three days, then the wind went down, and we were obliged to lower our sails.

"In the beginning of September we reached a quite flat and extensive plateau, which resembled a frozen ocean. Its height was between 8000 feet and 9000 feet, though towards the north it seemed to be considerably higher. Over this plateau or highland we travelled more than two weeks. The cold was considerable. I am not, however, able to give an exact statement of the temperature, as our thermometers did not go low enough. I believe that on some nights it was between −45° and −50° C. (between 80° and 90° F. below freezing point) In the tent where we (six men) slept, and where we cooked our tea and chocolate, it was even less than −40° C. (72° F. of frost). During one month we found no water. To get drinking-water we were obliged to melt snow either in our cooking apparatus or by our own warmth in iron bottles, which were carried inside our clothes on our bosoms. The sunshine on these white snow-fields was bad for the eyes, but no case of snow-blindness occurred. Only one day, September 8, we were stopped by a snowstorm ; the next day, when we wanted to continue our journey, we found the tent was quite buried in the snow.

"On September 19, we got a favourable sailing wind, and then we advanced very rapidly. That day we got the first sight of the mountains of the west coast. In the night we were stopped by dangerous ice with many crevasses, after having very nearly lost several men and sledges in one of them. We met here with very difficult and uneven ice, where we advanced very slowly. At last on September 24, we reached land at a small lake to the south of Kangersunok, a fjord inside Godthaab. On September 26, we reached the sea at the inner end of the Ameralik fjord, in 64° 12′ N. latitude."

This really finished the journey across Greenland. With considerable difficulty the party reached Godthaab, where, as the last ship was gone, they had to spend the winter, reaching Copenhagen only last week. So far Dr. Nansen has not been able to tell us much more than we knew already about the interior ice of Greenland; though he will probably give us full details in the paper which he is to read at the Royal Geographical Society on June 24.

ON THE TELLURIC ORIGIN OF THE OXYGEN LINES IN THE SOLAR SPECTRUM.[1]

M. EIFFEL having very obligingly put the tower in the Champ-de-Mars at my disposal for any experiments and observations that I cared to make there, I decided to take advantage of the powerful electric light which had been installed, to make certain studies of the telluric spectrum, and, in particular ,that which relates to the origin of the lines of the spectrum of oxygen in the solar spectrum.

We know now that there exist in the solar spectrum many groups of lines that are due to the oxygen contained in our atmosphere ; but one may ask himself whether these groups are due exclusively to the action of our atmosphere, and the solar atmosphere between counts for nothing, or whether their origin is double—in a word, Are these groups purely telluric or telluric-solar ?

To settle this question, one may have recourse to a certain number of methods. One of the most trustworthy is that of displacement, the origin of which rose from the beautiful conception of M. Fizeau, and which has been applied by M. Thollon and perfected by M. Cornu.

[1] Translation of a paper read by M. J. Janssen before the French Academy of Sciences on May 20, 1889 (*Comptes rendus*, cviii. No. 20).

The application of this was too difficult in the present case.

We may also observe the diminution of intensity which the groups undergo when we ascend in the atmosphere, and by careful comparisons when possible, and especially by a great number of observations, we may judge if the diminution of the intensity of the lines would permit us to conclude that they would completely disappear at the limits of the atmosphere. This is the method employed in the last Mont Blanc expedition (Grands-Mulets). Or, we may again proceed with a comparison of the uniformity of the lines by installing a powerful light giving a continuous spectrum at such a distance that the thickness of atmospheric air traversed may have the same action as that of the terrestrial atmosphere on the rays of the sun, when it is near the zenith.

This last circumstance is very fortunately found realized in the respective situations of the Eiffel Tower and the Meudon Observatory. The tower is at a distance from the Observatory of about 7700 metres, which very nearly represents the thickness of an atmosphere having the same weight as the terrestrial atmosphere and a uniform density, and equal to that of the atmospheric layer traversed by the sun's rays.

In addition to this, the considerable power of the magnificent light actually installed on the summit of the tower permits the employment of the instrument that had served me at Meudon and at Grands-Mulets for the sun. I have, however, made use of a condensing lens in front of the slit in order to give the spectrum an intensity quite comparable to that of the solar spectrum in the same instrument.

Under these conditions the spectrum is shown with extreme vividness, and extends beyond A. The B group appeared to me as intense as with the sun on the meridian in summer. The A group was equally well defined. Other groups could be distinguished, and notably those of water-vapour, their intensity showing the hygrometric state of the column of atmosphere traversed.

I should have liked to study the oxygen groups with the great spectrometer of MM. Brunner and a Rowland's grating, but the limited time during which the light was turned on to me did not permit it. I hope to do so another time.

Not one oxygen band is seen in the visible spectrum, although the thickness of the layer of oxygen traversed was equivalent to a column of more than 260 metres of oxygen at a pressure of six atmospheres—that is to say, at the pressure under which the tube in our laboratory shows them with a length of only 60 metres, or four times as small. This well shows that, for oxygen, the lines follow an entirely different law from the bands.

Indeed, whilst for the lines the experiment of last Sunday shows us that it appears indifferent whether we employ a column of gas at constant density or a column equivalent in weight but with variable density ; for the bands, on the contrary, the absorption taking place following the square of the density, the calculation shows that there would be required, at the surface of the sun, a thickness of atmosphere of more than 50 kilometres to produce them.

I do not look upon the experiment of last Sunday as more than bringing forward a fact more to a group of studies—a fact which requires to be exact and developed. But it is certain to myself, that the height at which the tower of the Champ-de-Mars makes it possible to place the light source, and its power, will enable me to make other similar experiments of higher interest.

Before concluding, I wish to thank M. Eiffel for the liberality with which he put his beautiful edifice at the disposal of science. I equally thank MM. Sautter and Lemonnier for their kindness.