nearly the temperature of the outer glass in which the blackened thermometer is enclosed), we have not indeed an absolute measure of solar intensity; for all measures of that must, it would seem, depend on the substance exposed and the conditions as to cooling, &c., under which the exposure takes place, but a sensitive test by which slight variations in its amount can be determined, and the amount at different places and different times compared. F. W. STOW

The Aurora of February 4

THE following is an account of the aurora of February 4 as seen by a gentleman living in Russia, at Anspatti, in the province of Vitebsk. After stating that the barometer had risen very high (30·2), he says:—"To-night, as I drove home from Reugarten, there was the most beautiful aurora borealis I ever saw. It began in the north-west, and gradually rose higher and higher, till at last it reached the horizon a little north of east, and such a broad band, or rather succession of bands, that it covered half the heavens. It was a bright rose colour, and its light and colour were reflected by the snow, so that the whole earth was rosy; though it was between nine and ten o'clock, and there was no moon, it was nearly as light at day. It is still in full force as I am writing, and I can see it from my window, but it constantly changes its form and colour." I think the latitude of the place is 56 or 57. J. M. H.

Aurora Island

NATURE for May 25 (which has only just reached this part of the world) contains a note respecting the reported disappearance of Aurora Island in the New Hebrides. In that note the small upraised coral island of that name north-east of Tahiti is confounded with Aurora—a high volcanic island—more than 40° to the west of the former. It is scarcely to be wondered at that the mistake should be made when the name of the island is alone given; but when "Aurora Island, one of the New Hebrides group," is spoken of as being to the "north-eastward" of the well-known island of Tahiti one feels surprised at the misconception.

Has it yet been clearly defined to which Aurora the report refers, and is it not more probable that the captain's chronometer was out, or that his reckoning was incorrect, than that either island has really been submerged? A few months ago Dr. George Bennett, F.L.S., of Sydney, New South Wales, showed me a sketch which he made of Aurora in the New Hebrides some years ago. From that the island appears very mountainous, and the map of Melanesia, in Petermann's Geographische Mittheilungen (1870), makes it about twenty miles long and 2,000ft. high.

S. J. WHITMEE

Samoa, South Pacific, Nov. 4, 1871

P.S.—The following notes of earthquakes in the Samoa group may be of interest to some of your readers:—

May 14, 1871.—2.5 P.M. First a vertical, followed by a horizontal, shock.
July 1, ,, —9.30 A.M. Slight horizontal shock.
,, 16, ,, —12.10 P.M. Vertical shock.
Aug. 3, ,, —12.15 P.M. Slight horizontal shock, accompanied by a loud rumbling noise.
Sept. 23, ,, —6.45 A.M. A slight horizontal shock.

I was absent from Samoa from September 1870 to April 1871. During that time there were eight shocks of earthquake in the group; but the dates and other particulars were not noted. One is reported as having been the most severe shock known here. Earthquakes have been more frequent in Samoa for the past year or two than formerly.

FOUL AIR IN MINES AND HOW TO LIVE IN IT

I.

I BEG to forward you for publication in NATURE an account of some very interesting experiments recently made at Chatham, on the employment of a respirator in military mining. They were conducted in a thoroughly practical manner by Mr. J. Edward Gibbs, a highly intelligent young officer of Engineers, who, I may add, has given the respirator a very convenient form, and, I trust, will continue the work he has so well begun.

It is to be borne in mind that the cotton wool employed in the respirator is not to be *steeped* in glycerine, but *moistened* with this substance; the wool ought to be well teased until all its fibres are wettedb, ut they must not form a clot. JOHN TYNDALL

"When on duty at the Defensive Mines one day during the mining operations of July and August 1871, three men were brought out in a fainting state, caused by a rush of foul air in untamping. Thinking some means might be devised for preventing such accidents, and the consequent loss of time and panic, I consulted with Captain Malcolm, R.E., who proposed Prof. Tyndall's firemen's respirator for consideration. Colonel Lennox sent me to the maker to inquire, and I returned with one.

"With the assistance of Quartermaster-Sergeant Ingram of the Chemical Laboratory, and several books of reference, I have collected the following notes:—

"After exploding a charge of gunpowder at a gallery-head, it becomes dangerous to untamp, because of the poisonous gases produced by the combustion of the powder. These gases are CO_2, N, CO, HS, C_2H_4, and H. The only gases that are present in sufficient quantities to harm are CO_2 and CO. CO_2 to the amount of $\frac{1}{200}$ (·005) of the bulk of the air at the gallery-head would render it unfit to sustain life. CO to the amount of $\frac{1}{100}$ (·01) would do the same. 100 lbs. of powder evolve 22559·38 cubic in. of gas at 60° F. and 30″ B., of which 9429·7896 are CO_2, and 2249·848 are CO.

"Miners working in the presence of the foul air from the explosion suffer in two ways. If affected suddenly, they feel a burning at the nape of the neck, and their limbs tremble, they turn giddy and faint. This is to be attributed chiefly to the CO. The miners are also affected in a slower manner by the CO_2. They feel their breathing becoming difficult, as if there were a weight on their chest, with a tight feeling in the head; if not brought into the fresh air they are in time overcome and faint. This also brings on headache, on coming into fresh air.

"Any method of getting rid of the foul gases by chemical means must interfere greatly with the progress of the work. In any case there would be considerable difficulty in destroying the CO, as it has neither acid nor basic properties. A *good* system of ventilation through hose would clear the galleries of the foul air, but would not overcome the difficulty of untamping, because at any moment of the process there may be a rush of foul gas, which would take effect on the men at work, before the ventilation could carry it away.

"A good respirator worn by each of the men employed at untamping might overcome this difficulty. Prof. Tyndall's respirator for firemen is constructed with a view to enable the men to inhale pure air when at work in a burning house, by separating the smoke and noxious vapours. It consists of two parts; (1) the mouth-piece; (2) the body of the respirator.

"The mouth-piece is an invention of a Mr. Carrick, hotel-keeper at Glasgow, who had patented it.* It has two valves, *i* and *e*. (See NATURE, June 15, 1871.) The air inhaled comes from below, up through the body of the respirator and through *i*. The exhaled breath closes *i*, and escapes through *e*, thus keeping the contents of the body of the respirator cool. There is an aperture *o*, which fits closely round the lips, and to prevent respiration through the nose, there is a nose-pad fixed on top of the mouth-piece. A wire-gauze partition separates the mouth-piece from the contents of the body of the respirator.

* This is not the mouth-piece now adopted.—J.T.

"The body of the respirator is about 4in. or 5in. long, and contains at the top a layer of cotton wool, moistened with glycerine to prevent any solid particles escaping into the mouth from lower layers, and also to stop those very minute particles of the smoke that may not have been arrested below. Next comes a layer of dry cotton wool, then a layer of charcoal fragments, another layer of dry cotton wool, and then some fragments of slaked lime. Below this comes some more cotton wool, and then the wire-gauze cover or cap at the bottom.*

"For smoke the layer of lime is not necessary, but in the mines it would be of the greatest use, because it has a great attraction for CO_2. The layer of charcoal would absorb the CO and the HS in the air, and the mixture inhaled would be perfectly innocuous. The disadvantages of this respirator in its present form for mining purposes are—that it is too long, and an effort is required in breathing through the small valves.† Mr. Ladd, of Beak Street, Regent Street, the maker of these respirators, has made some improvements in the mouth-piece, which may overcome some of the inconveniences of the old pattern.

"I received permission to use the R.E. workshops for experimenting on the shape best suited for use in the mines. Tyndall's respirator has been severely tested in dense and pungent smoke from pinewood, and it succeeded to the perfect satisfaction of Captain Shaw, Chief Officer of the London Fire Brigade. Firemen are to wear it attached to hide helmets, but for the mines any arrangement which will support the respirator and keep it close to the mouth during work, without being hot or uncomfortable, will suffice.

"*Experiments made with the Respirator.*—On Saturday, August 19, 1871, a trial of the respirator was made in the Chemical Laboratory, S.M.E., in the presence of Colonel Lennox, Dr. Fox, and others. I was shut up in an air-tight cupboard, with the respirator on. By my side were jars containing CO and CO_2 in a proportion of $\frac{1}{200}$ each of the cubic content of the cupboard (141,698·4 cubic in.), not allowing for the space occupied by my own body and the stool on which I sat. The respirator contained animal charcoal and lumps of slaked lime mixed together, thus dispensing with one layer of cotton wool. After emptying all the jars, I remained for ten minutes in the full mixture (fifteen minutes in all) without the slightest discomfort except from the awkward shape of the respirator. I was then called out.

"On Monday, the 21st, another trial was made in the presence of Dr. Fox and Lieuts. Abney and Galwey. This time a rabbit and three birds were placed in the cupboard with me. The respirator contained, in addition to the charcoal and slaked lime, a small quantity of sulphate of soda. The only cotton wool used was a small layer soaked‡ in glycerine at the top, and a thin layer of dry wool at the bottom. The sulphate of soda was introduced according to Prof. Graham's advice, in order to give an atom of O to the CO to form CO_2, becoming itself sulphite of soda. The content of the cupboard is 141,698·4 cubic in.: from this would have to be deducted the space taken up by my body, say $3\frac{1}{2}$ cubic ft. (Dr. Parke's Hygiene), or, roughly, 6,000 cubic in., leaving 135,698 cubic in. 1,890 cubic in. of CO_2 in jars were introduced from a pressure bag, making altogether:—

1,890 cubic in. of CO_2
1,921 cubic in. of CO,

or 3,811 cubic in. of poisonous gases in addition to my exhaled breath, or about 3 per cent. of the capacity of the cupboard. In order to perfect the mixture of the gases, I waved a towel about constantly, and after the end of the trial, a taper being extinguished at the top of the cupboard showed that the CO_2 had been stirred up to the top. The rabbit and two birds died at the same time, about twenty-three minutes after the cupboard was closed, while the CO from the pressure bag was being introduced. I stayed in the cupboard thirty minutes (five minutes after the mixture was completed and seven minutes after the death of the animals). When I came out I felt a pressure on my ears, as when descending too rapidly in diving. Dr. Fox said that this was produced by my blood, my heart then beating at a high rate.

"This is satisfactory, as showing that the gases had not affected me, but only the exertion of breathing through the respirator, for thirty minutes, combined with the heat of the close atmosphere in which I was.

"To prove that the gases did not affect me, I quote some extracts from Dr. Park's 'Hygiene':—'Dr. Angus Smith says the breathing of CO_2 to the extent of 1·5 to 2 per cent. produces slowness of heart action, while the respirations become quickened if not gasping; this is perceptible with as little as ·1 per cent. Less than $\frac{1}{2}$ per cent. of CO has produced poisonous symptoms, and more than 1 per cent. is rapidly fatal to animals. CO in excess produces loss of consciousness, slowness of heart action, and finally paralysis of the heart.

"The slowness of diffusion of the two gases was remarkably shown by the effect on the third bird. The cage which held it was suspended at the top of the cupboard. The bottom, back, and top were of wood, the other sides were of wood for about $1\frac{1}{2}$ in. and then of wire. The bird, which was at first on a perch, was very soon affected by the impure air, and fell to the bottom of the cage. Here the wooden bottom and sides evidently supported a layer of pure air, for although the bird had lost consciousness, and indeed was considered to be dead, yet after being brought out into fresh air, it was revived by ammonia, and after an hour or so fluttered away. The other animals, that were not so protected, died before all the gases had been introduced.

"On examining the sulphate of soda, very little was found to have been changed into the sulphite; it would, therefore, seem that a constant change occurred, the sulphate giving up oxygen to the CO, becoming sulphite, and then the sulphite taking oxygen from the air to form the sulphate. Whether the good effect of the first change compensates for the loss of free oxygen in the second change is a question for the opinion of a chemist; however, Prof. Graham's recommendation is of great weight.

"All that were present agreed that the trial was perfectly satisfactory, and I think this is a fair conclusion. For the object in view throughout has been to devise some plan by which a man may work for some time in a foul mine, and may be secure from the effects of a rush of foul gas caused in untamping, &c.

"Defensive mines, though small, poison the ground more effectively than overcharged mines, which allow most of the gas to escape. I have before shown the total amount of CO and CO_2 evolved by the explosion of 100 lbs. of powder, which, according to our late operations, seems to be an average charge. It is probable that a large proportion of these gases would escape into the air, and that the rest would be diffused equally all round the charge. Therefore only a small amount is likely to be encountered at any one point. Hence it would seem that the respirator, which has succeeded with very powerful mixtures of poisoned air, would be quite enough to guard the miners from any of the gases from explosions.

"It only remains now to hit upon a convenient shape which will not render the breathing laborious. If we succeed in this, it is likely that the respirator would be of use also in civil work, such as exploring mines in search of bodies after a colliery accident."*

J. E. G.

* This order may be varied in different ways without prejudice to the respirator.

† These objections have been in great part met by the recent forms of the respirator.

‡ See remark in the introduction above.

* This is one of the purposes contemplated by myself, but the suggestion of Mr. Gibbs is independent and original.—J. T.