called the marine branch of hydrodynamics are of such great value, has stated that "he has never noticed a wave so much as 10ft. high in 10ft. water, nor so much as 20ft. high in 20ft. water, nor 30ft. high in five fathoms water; but he has seen waves approach very nearly to those limits." Mr. Russell has not stated whether the depths of water referred to are those below the trough of the sea or below the still-water level. In my book on "Harbours" I gave three observations on short waves from 2ft. 6in. to 3ft. high, which corroborated Mr. Russell's statement, supposing him to refer to the depth below the hollow. But since that time I had an opportunity, during a N.E. swell in July 1870, of observing the depths in which waves of a larger class broke at the Promenade Pier at Scarborough, where the heights could be measured with very considerable accuracy on the iron piles and open sloping slip or grating at the seaward end of the pier; and the following are the results :—

Heights of waves from hollow to crest.

′	″
5	6
5	0
5	0
5	6
5	3 = mean height.

The mean depth of water below the trough was 10ft. 3in.

Heights of the highest waves from hollow to crest.

′	″
6	0
6	0
8	0
6	0
6	0
6	6 = mean height of highest waves.

The mean depth of water below the trough was 13ft. 8½in. So that in both cases those waves did not follow Mr. Russell's law, but *broke when the depths below their troughs were about twice their own height.*

It must not be supposed, as is generally believed, that the height of the crest above the mean level of the sea is equal to the depression of the trough below that level; for Prof. Rankine has lately shown that this is not the case. When L = length of wave, H = height from trough to crest.

$$\text{Crest } \textit{above} \text{ still water} = \frac{H}{2} + \cdot 7854\,\frac{H^2}{L}.$$

$$\text{Trough } \textit{below} \text{ still water} = \frac{H}{2} - \cdot 7854\,\frac{H^2}{L}.$$

These formulæ, he states, are exact only for water of considerable depth as compared with the wave's length.

Edinburgh THOMAS STEVENSON

CYCLONES IN THE INDIAN OCEAN

SEVERAL cyclones have passed Mauritius since the latter part of January. From the 24th to the 30th of that month the barometer at the Observatory fell from 29·888 to 29 708 inches, with the wind squally from E. At 10 A.M. on the 30th it was intimated to the newspapers that there were "indications of a hurricane approaching the island;" but at 2 P.M., the wind having in the interval veered to N. of E., it was announced that there was "little danger."

This storm was encountered by the schooner *Emily*, on her passage from Tamatave, from Jan. 29 to Feb. 1. At the commencement of the gale, she was in 19° 31′ S., and 53° 30′ E. The wind veered from N.E. to E., S.E., S., S.W., W., and N.W., with a "tremendous sea and torrents of rain," and the lowest reading of the barometer on board was 29·00 inches. The vessel escaped with the loss of only a few sails.

The storm then curved to the S. and E., and was experienced by the barques *Gladiateur* and *Abbotsford* on Feb. 2 and 3, in 31° to 29° S., and 54° to 55° E. With the former vessel the wind veered from E. to N.E. and N., blowing at one time with great violence. The barometer at 8 A.M. on the 2nd was at 28·80, and the wind from E.N.E. The *Abbotsford* had the wind from the same direction, and her barometer was at 28·40 at 5 A.M. on the 2nd. Both vessels had a "tremendous sea and torrents of rain," and they lost sails and bulwarks.

On Feb. 5 the barometer at Mauritius, after rising to 29·790, again began to fall, and on the 7th was at 29·606. The wind was squally from S.E., and it veered to S. by W., from which point there was a gentle breeze at 9.30 P.M. on the 7th, with fine clear weather.

At 10 A.M. on the 7th it was announced that "the weather of the last two or three days indicated the passage of another storm, which then broke between E.N.E. and E.;" and at 10 A.M. on the following day that "the storm had curved to the S. and S.E."

This storm was encountered by the barque *Elizabeth*, from Melbourne to Mauritius, on the 7th and 8th, in 20° 16′ S., and 68° E. The wind was strongest from E.N.E. to N.N.E., and the lowest barometer was 29·20. There were "torrents of rain." By standing back to the E. the *Elizabeth* avoided all danger.

On Sunday, Feb. 11, the barometer at the Observatory, after rising to 29·870, again began to fall, with the wind squally from S.E., and the weather fine. During the 12th it fell ·060 inch, and ·090 inch more during the 13th, with the wind still squally from the same quarter. At 10 A.M. on the 14th the following notice was sent to the newspapers :—"A hurricane since the 11th. It now bears about E.N.E. of us. There are some signs that it will pass to the E. and S. of the island, but there is danger." The barometer still falling, and the wind increasing to strong breezes from S. by E. to S.S.E, at 3 P.M. a telegram was sent to Port Louis (6 miles off), stating that "the centre of the hurricane was about 350 miles to the E.N.E., and approaching the island," and soon afterwards storm signals were hoisted at the railway stations. The barometer at 3 P.M. stood at 29·612, and the wind, which was then S. by E., was blowing with an estimated force of 2·5lbs. on the square foot.

At 9 A.M. on the 15th the barometer was at 29·478, with a strong gale from S.E., and it was estimated and announced that the "centre of the storm bore about N.N.E. 150 to 200 miles, and that it was still approaching the island." At 3 P.M. the wind being from E.S.E. to E. by S. in increasing gales, and the barometer at 29·382, it was telegraphed to Port Louis that "the centre was about 150 miles to N. by E., and that it would probably pass, with an increase of wind, to N.W. and W. of the island, without doing much damage."

During the night the wind increased considerably from E.S.E. to E. by S., and the barometer attained its lowest reading (29·328) at 1 A.M. on the 16th; but the mercury was oscillating, being at 2 A.M. at 29·356, and at 3 A.M. 29·330; and the time of the greatest depression of the mercury, as shown by the barograph (at the Magnetic Observatory, three miles off) was 2.40 A.M. At 9 A.M. the barometer was at 29·440, with the wind at E. to E. by N., and it was announced that "the centre bore N.N.W., and that there was no danger."

The barometer then continued to rise, until, at noon on the 18th, it was at 29·882, with a moderate breeze from N.E.

It is worthy of remark that the wind never went beyond N.N.E., but gradually backed to East.

This storm was more or less encountered at sea by the *Harpesia*, *Gryfe*, *Oleander*, *St. Germaine*, *Misser*, *S. S.*

Danube, *Staffordshire*, *William Fairbairn*, *Pendragon*, *Odalisk*, and *Paolo Revello*, some of which suffered severely.

At 5 A.M. on the 15th, the *Staffordshire*, in about 18° 30′ S. and 61° E., was thrown on her beam ends, and in great danger of foundering. The *William Fairbairn*, a fine iron vessel of 1,293 tons, lost all her masts and sails, and had her decks almost completely swept. On the 13th, in 19° 2′ S., and 64° 40′ E., she had a strong gale from S.E., which increased to a hurricane. About 7 P.M. her barometer was at 28·70, and early on the 14th the wind shifted from S.E. to N.W. The *Paolo Revello*, on the 14th, in 18° 8′ S. and 61° 54′ E., was completely gutted. The captain's papers and log-book, cabin furniture, &c., together with the chief officer and nine men, were washed overboard.

From the logs hitherto received it appears that the storm was formed between the S.E. trade-winds, and the N.W. monsoon from the 7th to the 9th. On the 10th the centre was in 13°¼10′ S. and 78° 30′ E.; on the 12th in 15° 6′ S., and 71° 34′ E.; on the 14th in 17° 15′ S., and 63° 28′ E.; on the 16th in 20° 7′ S., and 55° 50′ E.; and on the 18th in 22° 15′ S. and 51° 50′ E. During the first six days it travelled on a W.S.W. course, and then curved a little towards the south. It passed about 165 miles north of Rodrigues at noon on the 14th, about 65 miles north of Mauritius early on the 16th, and N.N.W., &c., of Reunion from noon on the 16th to noon on the 17th. Its average rate of progression was nine miles an hour, and the area over which the wind blew from strong breezes to hurricane violence was about 800 miles.

The fact that in this, as in other storms, the wind at Mauritius did not veer more than twelve points, seems to be explained by the incurving of the air towards the centre.

On the evening of the 15th, or morning of the 16th, seventeen vessels put to sea from the roadsteads of Reunion, and their fate is not yet known. If they held to the N.W., with the wind from S.E., they probably got into the heart of the storm.

CHARLES MELDRUM

Mauritius, March 8

P.S.—The aurora seen here on the night of the 4th to 5th February, was also seen at sea by several vessels. Here are extracts from their logs :—

Olive Branch in 27° 47′ S. and 59° 48′ E.—"At 10 P.M. the sky became very red and fiery—southern lights."

Abbotsford in 30° 9′ S. and 56° 10′ E.—"Dull atmosphere. Aurora australis reflecting brightly in the south, giving light over all the ship. Clouds tinged with deep red."

Elizabeth in 20° 33′ S. and 78° 3′ E.—"At 10 P.M. Aurora australis unusually bright."

Gladiateur in 30° 32′ S. and 57° 28′ E.—"At 8 P.M. a red and yellow and strange looking sky. Midnight, sky the same."

Pendragon in 13° 43′ S. and 84° 13′ E.—"At midnight very suspicious-looking weather to the S., the sky being quite red."

William Fairbairn in 32° 57′ S. and 60° 2′ E.—"At 10 P.M. looking ugly, and meteorological signs of a hurricane. Midnight same, and up till 3 A.M. when it cleared off."

Caton in 31° 31′ S. and 108° 10′ E.—"Midnight, red sky, like fire to E.S.E."

Oleander in 38° 26′ S. and 31° 53′ E.—"From 7.30 to 11.30 P.M. the sky was illuminated with a very brilliant Aurora australis."

There is little doubt that the suspicious-looking weather to the S., seen by the *Pendragon* in about 14° S., was the aurora. Captain McKenzie of the *W. Fairbairn* reports that his standard compass was affected to the extent of ¾ of a point, and his other compass to the extent of two to three points. C. M.

PHYSICAL SCIENCE IN GLASGOW UNIVERSITY

THE Physical Laboratory of Glasgow University, which till quite lately was the only one in this country, dates from the year 1852. It was with difficulty that room could be found for a laboratory of any kind in the old building; but in the new building, of which this is the second year of habitation, considerable space has been set apart for Experimental Natural Philosophy.

At present six rooms belong to the department, exclusive of the Professor's private sitting-room and the store-rooms, and on the completion of the tower, which is not yet finished, additional rooms will be devoted to it. The whole suite of rooms is arranged so as to be in direct communication with those of the professors of mathematics, engineering, and astronomy.

The chief lecture-room is 42ft. long by 35ft. broad, its side windows look nearly north and south, and over the lecture table there is a glass-covered turret, or louvre, the top of which is 40ft. from the floor. The windows of the room are completely darkened with the greatest ease by means of double curtains of blue baize, an inner and an outer curtain for each window, and these can be unfurled and furled at a moment's notice; two baize screens, one below the other, are drawn across the base of the louvre. The room is ventilated, as are all the rooms in the new University building, on Mr. Phipson's plan. Pure air is drawn down a shaft in the tower by fanners, which are worked by a small steam engine. The air is passed through a dry chamber, containing hot water pipes, and is then driven mixed with any quantity of fresh cold air that may be required, into the class-room. It enters at the top of the room, and the used air is drawn off through passages below the floor.

Benches are arranged for about 150 students. They are not on a level, but rise at an angle of 25°, and beneath them there is a large convenient space, with shelves for 50 or more cells of Daniell's battery, which I shall describe immediately.

Of the other five rooms one is an additional lecture and experiment room, one is the general laboratory, one is the principal apparatus room and museum, and the remaining two are used for storing apparatus and for occasional experimenting. The laboratory is on the ground floor, and is below the lecture-room, which is on the second story. It is a room 52½ft. long by 34ft. broad. It has six windows, three looking north and three looking south, and these can be darkened like those in the lecture-room by means of drop curtains of baize. Three quarters of the floor is wood, the remainder concrete, covered with Portland cement; but in order to get perfectly steady tables, piers of masonry, built on the foundation, rise through the floor, and on them the feet of the tables rest. The flooring does not touch the piers at all, and thus, however much the floor may shake, the table remains comparatively steady. This arrangement gives far greater steadiness than a complete stone floor. Besides these piers there are two somewhat larger stone constructions, which are also unconnected with the flooring; one of these is intended for a large steady table; and on the other there is a massive stone erection (Fig. 1), on which is to hang a pendulum for a clock, or for experiments on the force of gravity. It is intended that the point of suspension of the pendulum shall be perfectly free from vibration.

Some of the tables are ordinary working tables. On others, instruments such as the electrometer and electro-dynamometer are set. Below the table there are frames for supporting 500 cells of a constant Daniell's battery, which were in use in the old college, and a great part of which are now re-charged.

In one corner of the room there is a wooden enclosure, which is fitted up as a small chemical bench. The ordinary reagents and apparatus for chemical testing are thus at hand.