Scholarships of the year, and in addition to the Inglis Scholarship for English language, an extra prize for the English essay.

Shortly after taking his degree he was elected a fellow of his college, and filled the post of assistant tutor until his election to the chair of Applied Mathematics and Mechanics at University College, London, in August, 1871, a position which he held until his death. He was elected a Fellow of the Royal Society, June, 1874.

Prof. Clifford was distinguished not only for his rare talent for mathematics, but for a remarkable capacity for bringing the most advanced scientific ideas within the range of ordinary knowledge. His "Analogues of Pascal's Theorem" was written while he was still in his eighteenth year, and constitutes the first of his papers recorded in the Royal Society's catalogue. "Analytical Metrics," one of his longest and most fully worked out papers, published in the *Quarterly Journal of Mathematics*, was written in his nineteenth year. At the Royal Institution, on March 6, 1867, he addressed a large public audience for the first time, the subject of his lecture being "Some of the Conditions of Mental Development." Among his auditors on this occasion were some of the leading thinkers of the time, and from that day he took a recognized place among them. His remarkable power of explaining some of the most difficult physical conceptions to a popular audience was well exhibited at a subsequent date, on the occasion of a delivery, at St. George's Hall, of a series of lectures on subjects such as "Ether," "Atoms," and "The Sun's Place in the Universe."

The position taken up by Prof. Clifford in philosophy was never comprehensively defined by himself, but must be collected from his numerous papers and lectures of the last few years. In pure metaphysics may be specified articles on "Body and Mind" (*Fortnightly Review*, 1875), and the "Nature of Things-in-Themselves" (*Mind*, 1878); in ethics, "The Scientific Basis of Morals" (*Contemporary Review*, 1875), "Right and Wrong" (*Fortnightly Review*, 1876); and in the application of ethical theory to social and religious questions, "The Ethics of Belief" (*Contemporary Review*, 1876), "The Bearing of Morals on Religion" (*Fortnightly Review*, 1877), and an article on Virchow's address on the freedom of science (*Nineteenth Century*, 1878).

He was unmistakably one of the foremost English mathematicians of our day, and had he lived would have done much more to maintain that position; but a constitution naturally weak gave way to too close attention to his favorite studies, and the dread disease, consumption, cut short a brief but brilliant life.

ARTIFICIAL LIGHTING FOR PHOTOGRAPHY.

The subject of artificial lighting in the portrait studio is attracting much interest in England.

Three methods are employed for producing a highly actinic light suitable for the purposes of the photographer—the electric, the pyrotechnic, and that produced by the combustion of magnesium wire. Each of these lights has its special disadvantages, and for each the excellence of the results depends far more upon the arrangements for using the light than upon the light itself. And the arrangements which answer best with one light are apt to be wholly unsuited for use with any other light.

The great difficulty with electric light, next to its excessive cost, is to secure a sufficient diffusion of the rays, and to subdue their intense brilliancy without too great a loss of actinic power. A method of burning pyrotechnic compound in a paper case, whereby a larger illuminating surface is produced, gives, it is said, much better results. In the electric light the rays proceed from a point, diverge rapidly, and as rapidly lose illuminating power. Thus an electric light with six minutes' exposure failed to give anything but the most brightly lighted points of the picture, when the same light, used with an imperfect reflector, gave a better result in two minutes. With the pyrotechnic compound burned in case, or, better, in a saucer, the rays proceed from a surface of considerable extent, and are less divergent; hence at a given distance from the light the loss is much less than with the electric light. When the latter is used with a translucent screen covering the front of the reflector it shows an intensely brilliant center, surrounded by a circle less brilliant and curiously variegated by a network pattern caused by reflections; while the space between it and the center appeared quite dark in comparison. With the pyrotechnic light the screen is evenly illuminated, and no light is lost.

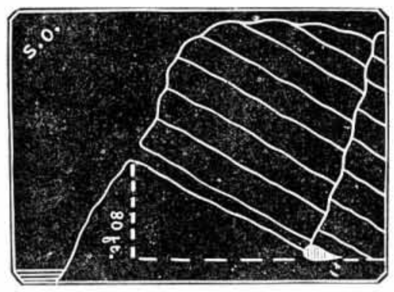
When used with an apparatus called the luxograph the results obtained are said to be very fine. The luxograph is described as a slightly conical metal cylinder resembling a kettledrum, nearly six feet across. The drumhead, so to speak, is made of a peculiar paper charged with a mineral which increases the dispersing power of the screen. The interior of the cone, or drum, is lined throughout with small mirrors, making it a powerful reflector. In the center of the back is a square lantern of blue glass, of three different tints, open at the top. The pyrotechnic powder is burned in the lantern. When the combustion has reached its height the sitter's face is flooded with a soft violet light of the most diffusive and actinic character. The fumes of the pyrotechnic compound and the brevity of the combustion are its chief disadvantages.

The best magnesium light is said to be produced by the lamp made by Mr. A. Brothers, of Manchester. It consists of an arrangement by which three ribbons of magnesium are burned at once, and the light thrown upon the sitter by parabolic reflectors. The great objection to it is the cost of operating it. In a communication to the Edinburgh Photographic Society, Mr. Thomas W. Drinkwater expresses the conviction that the method of the future will employ coal gas. As gas is ordinarily burned, the light lacks both power and actinity; but when the gas has been fortified by the addition of hydrocarbons, or, more especially, when the much lauded Sugg burner is used, an extremely brilliant, cheap, and easily managed light for photographic purposes is said to be attainable. To this process, however, the crucial test of practical use does not appear to have been applied.

In England, with its dull and foggy climate, not to speak of the chronic sunlessness of London, the question of artificial illumination for portraiture is of real and practical moment. It our sunny climate it partakes more of the character of an advertising novelty. Nevertheless it may not prove an unprofitable field for experimental work even here.

Formation of Ice Caves.

In the SCIENTIFIC AMERICAN for March 29 last, there appeared a letter from Mansfield, Ohio, inquiring as to the cause of the phenomena in an ice cave which is to be found in Decorah, Iowa, and for which there appears to have been, as yet, no cause assigned. A description of this cave is given in the same letter, of which description, so nearly as is possible, the accompanying illustration is a fair representation, as regards the main features of the case. There may be a few differences as regards the details of the cave, but so nearly as can be judged from the written description, the drawing presents the elements necessary to the peculiarities of the cave. In the figure, the cave will be seen represented as at the bottom of an inclined passage, the inclination being



that noted in the description, and the dimensions and other particulars being as nearly as possible to the proper scale. The crevice, mentioned in the description, may be imagined as a fault, which extends from the top of the cave to the top of the bluff, through which crevice mingled air and water find their way to the cave.

In regard to the mingling of air with a stream of descending water, a quotation from the pamphlet of Mr. Frizzel, on the subject of the compression of air by such streams, would not be entirely out of order. On this subject, he says:

"It is a matter of common observation that bubbles of air rise in still water with a very moderate velocity. The velocity depends, somewhat, on the size of the bubbles. Bubbles, such as issue from an orifice one eighth or one tenth of an inch in diameter, rise from a depth of fifty feet in about fifty seconds, moving rather less than one foot per second near the bottom, and rather more than that near the surface. It is plain that a bubble of air drawn into water that has a downward motion of more than one foot per second, will be carried down and subjected, in its descent, to a continually increasing pressure."

Considering, then, the description and the facts above quoted, it would not be unfair to assume that there would be a possible compression of air contained in the water, on its liberation in the cave, of about eighty pounds to the square inch. This assumption is supported by the fact that from the description, the mouth of the cave would be at least eighty feet above the level of the river, and it may be inferred that as no special mention is made on the position of the entrance, save that it is in the side of the bluff, the hill may be considered as extending above the mouth of the cave to at least the distance of the latter from the river.

The phenomenon, then, of ice being found there in the summer, can be referred, I think, to the theory of the liberation of compressed air brought down from a considerable height by a stream of water falling or flowing through a natural conduit or fissure in the rock, embodying the principle of the ancient and well known tromp used in the Catalan forge, and still in use in Corsica, Sardinia, Savoy, and many other places.

It is only necessary to imagine such imperfection in the conduit or fissure at the initial point, which is supposed to be on the top of the bluff, or far up the mountain's side, as would admit air to come in contact with the water after it had attained a velocity of more than one foot a second. When the air has reached the bottom and is liberated in the cave, it will be from a pressure equal to the height of the column of water, and it will have lost by convection in the mass through which the conduit passes, the heat due to its compression; and on being liberated, it will immediately absorb from the air and the water in the cave, the heat which it has lost in its downward passage.

"The most remarkable fact," that the cave freezes only in summer, and as the cold of actual winter comes on, the ice in the cave gradually melts and disappears, is caused, I will venture to state as an opinion, by the gradual freezing of the surface at the top of the bluff or the source of the air, to a considerable depth, thus sealing up the aperture through which the air entered the conduit.

Sir Roderick Murchison described a similar ice cave at Lletski, Russia, but gave no explanation as to the phenomena.

Ice wells are to be found at the foot of Mount Mansfield, in Vermont, and are really incipient caves, without depth enough to be clear of ice in winter, from the fact that the external winter temperature reaches the bottom or source of the summer ice.—*N. M. Lowe, in Science Observer.*

Correspondence.

The Brush Electric Light.

To the Editor of the Scientific American:

In notes on "Electric Lighting," March 1, you mention the fact that the makers of the Brush machine claim to be able to produce 17 or 18 lights from one machine with an expenditure of 13 to 14 horse power, adding: "This statement, however, should be accompanied by accurate tests, which do not appear to have been made." We desire to correct the impression conveyed by referring to the actual performance of several machines sold by us and in regular industrial use to-day. One of these is at the Merrimack Mill, Lowell, Mass.; one at the Conant Thread Company, Pawtucket, R. I.; two at the Riverside Mill, Providence, R. I.; two at the immense retail establishment of John Wanamaker, Philadelphia, Pa.

All of these machines are of same size and power, and the average of over twenty tests of power absorbed by them, taken with a dynamometer, was $13\frac{85}{100}$ horse power. Each machine furnishes 16 to 17 lights, each of 2,000 candle power, and all the lamps are placed in series on one circuit.

We are not aware that any other system of electric lighting known or described to-day can produce the result above shown. It certainly very far exceeds in economy and efficiency the Gramme-Jablochkoff system in use in Paris and London, and we do not see that Rapieff, Werdermann, Lontin, De Meritens, or any others, have actually done as much as they have.

We have just closed a contract for the lighting of Monument Park, in this city, with the Brush electric light. We displace 105 gas lamps, six-foot burners, with 12 Brush lights, and the cost to the city is considerably less than has been paid for the gas lamps, and we shall furnish not less than double the light they did.

We advertise regularly in no paper but the SCIENTIFIC AMERICAN, and have not endeavored to create a "newspaper furor" regarding our light—*à la* Edison, Sawyer, *et al.;* yet we have sold for actual industrial use in this country, within one year, over 200 Brush lights, and we are running our factory night and day on orders for similar purposes.

Regarding the use of electric light in dwellings, or on a small scale, we all agree with Mr. Brush, that there is as yet nothing before the public, here or abroad, which promises success in this direction.

Mr. Brush is aiming simply to produce the greatest possible number of powerful steady lights from one machine in one circuit with the least expenditure of power. Have you any record of results equal to his? G. W. STOCKLY,

Vice-President Telegraph Supply Company,
Cleveland, Ohio.

A CHANCE FOR INVENTORS.

The Secretary of the Treasury has constituted a board, consisting of Captain Forbes, manager of the Massachusetts Humane Society; Captain Moore and Lieut. Sparrow, of the Revenue Marine Service; together with Mr. B. C. Sparrow and Captain Patterson, of the Life Saving Service, to investigate all plans, devices, and inventions for the improvement of apparatus for use at life saving stations, which may appear meritorious and available, and to examine and test as far as practicable all such as may be submitted by the general superintendent, and to make detailed reports of the results of the investigations and tests for his information. The scope of the board embraces action upon all devices for the improvement of life saving apparatus intended to be used at the life saving stations, except wreck ordnance and its immediate appurtenances, which will be referred to a board composed of experts in gunnery, and two practical surfmen to give them aid upon points connected with the actual wreck service. Devices intended to be carried on board ship do not fall within the scope of the action of the board, as this class of life saving apparatus is taken cognizance of by the steamboat inspector's service. Capt. Forbes has been designated president, and has been directed to call a meeting of the board as early as practicable, as there are already on hand several inventions to be examined. Persons wishing to have their inventions submitted to the board may address Mr. S. I. Kimball, Superintendent of the Life-Saving Service, at Washington, D. C.

Beatty Organs and Pianos.

When a manufacturer is willing to send expensive wares to a distance at his own risk for trial, and to pay freightage both ways in case of rejection, it is evident that he has no lack of confidence in the intrinsic merit of what he has to sell. When he finds the practice a profitable one, the evidence is quite as strong that the articles offered are worthy of their maker's confidence in them, and that their rejection is not apt to occur.

The offer made in our advertising columns by Mr. D. P. Beatty, organ and piano manufacturer, Washington, N. J., tells its own story. Within a few years Mr. Beatty has built up a large and successful business; and by dealing directly with the users of his pianos and organs, avoiding agents' fees and profits, he is able to furnish superior articles at extremely low rates.