formed by rarefaction, and consequent refrigeration, of the metallic gases constituting the stratum in which the cyclone exists. He argues that it is formed within the mass of cooled hydrogen drawn from the chromosphere into the vortex of the cyclone. Speaking of the cyclones, he says:—'Dans leur embouchure évasée ils entraîneront l'hydrogène froid de la chromosphère, produisant partout sur leur trajet vertical un abaissement notable de température et une obscurité relative, due à l'opacité de l'hydrogène froid englouti' (*Revue Scientifique*, March 24, 1883). Considering the intense cold required to reduce hydrogen to the 'critical point,' it is a strong supposition that the motion given to it by fluid friction on entering the vortex of the cyclone, can produce a rotation, rarefaction, and cooling, great enough to produce precipitation in a region so intensely heated."—(*Essays*, 1891 Edition, vol. i., pp. 188-9.)

Churchfield, Edgbaston. F. HOWARD COLLINS.

Direct Determination of the Gravitative Constant by Means of a Tuning-fork. A Lecture-Experiment.

THE following direct experiment for finding the value of the constant g has proved an instructive one for use with students beginning dynamics, and combines extreme simplicity with greater accuracy than might be anticipated.

A rectangular strip of thick plate-glass with one face lightly smoked is dropped past the end of a sounding tuning-fork of known pitch, and which, by means of a light attached style, traces on the smoked surface a fine rippling line whose undulations give a complete record of the relative motion. From measurements of such a trace the value of g can be determined immediately with an error of not more than $\frac{1}{2}$ per cent.

For let l_1 and l_2 be the distances fallen through in two equal consecutive intervals of time (t). Then $\frac{l_1}{t}$ and $\frac{l_2}{t}$ are the velocities at the middles of these two intervals, and $\frac{l_2 - l_1}{t}$ is therefore the velocity gained in time t, and $\frac{l_2 - l_1}{t^2}$ is the acceleration.

With a fork giving 384 complete oscillations per second it was found convenient to take for t the time of 30 oscillations; l_1 is then the length of any 30 consecutive waves and l_2 that of the next 30. These lengths were measured by means of a millimetre scale printed on card and held against the trace, tenths of a millimetre being estimated. The value of the difference $(l_2 - l_1)$ was thus determined from several measures made in different parts of the trace, and, after some preliminary trials, it was found that such measures seldom differed by more than $\frac{1}{2}$ per cent. from their mean, and that the means of different traces agreed about equally well among themselves. Under the given conditions $(l_2 - l_1)$ is just under 6 centimetres. The experiment takes only a moment to perform, and the plate can be at once exhibited as a lantern slide.

In order to obtain good traces a little care must be exercised. The smoking should be very light. A fine bristle from a clothes- or hearth-brush, 2 to 4 cm. long, stuck on with a scrap of wax, may be used as a style, and it should be inclined downwards so as to make an angle of 45° or less with the vertical face of the plate and project well under the plate before this is let fall, so as to be considerably bent while tracing. By furnishing each prong with such a bristle two simultaneous tracings are obtained. Although the method is independent of the actual velocity with which the plate reaches the style, yet it is best to let the plate fall from quite close above the end of the style (within, say, 1 cm.), so that as many wave-lengths as possible may be marked on the plate. The fork also should be strongly bowed with a violin bow, so as to give sharply accentuated ripples, the positions of whose crests are defined with greater precision than would be those of gentler undulations. The plate itself can be conveniently let go if the upper part of its suspension is a single string with a knot at the top, and to prevent its swinging in the air or turning as it descends, it may be held against a narrow smooth backing of hard wood. Without these precautions the trace is liable to show curvature and other irregularities, and indeed under any circumstances the first one or two undulations traced near the advancing edge of the plate are liable to be irregular. The more massive the plate the less is its motion affected by the pressure of the tracing style.

Although as a means of finding the value of g such a method does not compare for accuracy with the use of a pendulum, yet for the converse process of determining the pitch of a fork from measures of its trace and the known value of g, it may be of utility; for, since the length $(l_2 - l_1)$ is proportional to the *square* of the vibration-number, the percentage error will now be halved or reduced to about 1 in 400, and I have little doubt that a careful experimenter, by attending to the causes of error, might further improve on this. A. M. WORTHINGTON.

R.N.E. College, Devonport, September 12.

A Meteor.

ON Wednesday, September 14, at 7h. 9m. p.m. a large meteor was seen by about twenty people, including myself, who were driving from Penmaenmawr to Conway. It was first observed in the south-east just above the Conway mountain. It was visible for about 30°, fell very slowly in a wavy line inclined at a small angle to the horizon, disappearing behind the mountain. It seemed to be very near the ground as it passed over the mountain.

The sky was quite bright, so that only Mars was clearly visible in it. The meteor appeared to the eye about the size and brightness of Jupiter at the present time, and was of a slightly bluer tint than that planet. There was no perceptible variation in size and brilliance while the meteor was in sight.

September 19. GRACE E. CHISHOLM.

Crater-like Depression in Glaciers.

A PROPOS de la cavité du glacier de Tête Rousse que M. Vallot et moi avons découverte et dont vous parlez dans NATURE (September 1), M. R. von Lendenfeld vous écrit (NATURE, September 15) qu'il a trouvé des dépressions cratériformes sur le glacier de Tasman, dans la Nouvelle Zélande. Permettez-moi de vous signaler que de pareilles dépressions existent sur certains glaciers des Alpes et notamment sur le glacier de Gorner, où la carte suisse en indique 26. Elles sont en général à peu près circulaires; leur plus grande dimension horizontale atteint parfois 130 mètres et leur profondeur 30 mètres. L'inclinaison de leurs parois varie en général de 45° à la verticale. Elles reçoivent souvent de l'eau qui s'engouffre au fond dans un moulin ou qui s'écoule, par une crevasse, dans une dépression voisine. Au mois d'août dernier, l'une d'elles formait un véritable petit lac glaciaire que j'ai sondé avec M. Etienne Ritter au moyen d'un bateau démontable; la profondeur de l'eau était presque partout de 5 à 6 mètres, sauf dans un trou, vraisemblablement un moulin, où ma sonde est descendue jusqu'à 21 mètres. Il est probable que, lorsque la pression de l'eau aura élargi le moulin par où elle s'écoule, la cavité se videra.

Les dépressions ne me paraissent avoir aucune analogie avec la cavité que j'ai vue à Tête Rousse. Leur origine est assez mal connue (voir Heim, "Gletscherkunde," p. 246); il est possible, comme le pensait primitivement votre honorable correspondant, qu'elles soient d'anciens moulins transformés.

J'en ai vu une également sur la Mer de Glace, entre le Montanvers et le Tacul.

L'étude de ces dépressions, encore très incomplète, serait très intéressante, et je les signale à l'attention de ceux qui parcourent les glaciers.

Veuillez agréer, monsieur, mes civilités empressées.

Thonon, le 17 Septembre. ANDRÉ DELEBECQUE.

GENERALIZATION OF "MERCATOR'S" PROJECTION PERFORMED BY AID OF ELECTRICAL INSTRUMENTS.

THE following mode of generalizing Mercator's Projection is merely an illustration of a communication to Section A of the British Association at its recent meeting in Edinburgh, entitled "Reduction of every Problem of Two Freedoms in Conservative Dynamics to the Drawing of Geodetic Lines on a Surface of given Specific Curvature." An abstract of this paper appeared in NATURE for August 18.

In 1568, Gerhard Krämer, commonly known as "Mercator" (the Latin of his surname), gave to the world his chart, now of universal use in navigation. In it every island, every bay, every cape, every coast-line, if not extending over more than two or three degrees of longitude, or farther north and south than a distance equal to two or three degrees of longitude, is shown very approximately in its true shape: rigorously so if it extends over distances equal only to an infinitesimal difference of longitude. The angle between any two intersecting lines on the surface of the globe is reproduced rigorously without change in the corresponding angle on the chart.

Mercator's chart may be imagined as being made by coating the whole surface of a globe with a thin inextensible sheet of matter—sheet india-rubber for example (for simplicity, however, imagined to be perfectly extensible but inelastic)—cutting away two polar circles to be omitted from the chart; cutting the sheet through along a meridian, that of 180° longitude from Greenwich for example, stretching the sheet everywhere except along the equator so as to make all the circles of latitude equal in length to the circumference of the equator, and stretching the sheet in the direction of the meridian in the same ratio as the ratio in which the circles of latitude are stretched, while keeping at right angles the intersections between the meridians and the parallels. The sheet thus altered may be laid out flat or rolled up, as a paper chart.

What I call a generalized Mercator's chart for a body of any shape spherical or non-spherical, is a flat sheet showing for any intersecting lines that can be drawn on a part of the surface of the body, corresponding lines which intersect at the same angles. One Mercator chart of finite dimensions can only represent a part of the complete surface of a finite body, if the body be simply continuous; that is to say, if it has no hole or tunnel through it. The whole surface of an anchor ring can obviously be mercatorized on one chart. It is easily seen, for the case of the globe, that two charts suffice to mercatorize the whole surface; and it will be proved presently that three charts suffice for any simply continuous closed surface, however extremely it may deviate from the spherical form.

In "Liouville's Journal" for 1847, its editor, Liouville, gave an analytical investigation, according to which, if the equation of any surface whatever is given, a set of lines drawn on it can be found to fulfil the condition that the surface can be divided into infinitesimal squares by these lines and the set of lines on the surface which cut them at right angles. Now it is clear that if we have any portion of a curved surface thus divided into infinitesimal square allotments, that is to say, divided into infinitesimal squares, with the corners of four squares together, all through it, we can alter all these squares to one size and lay them down on a flat surface with each in contact with its four original neighbours; and thus the supposed portion of surface is mercatorized. Except for the case of a figure of revolution, or an ellipsoid, or virtually equivalent cases, Liouville's differential equations are of a very intractable kind. I have only recently noticed that we can solve the problem graphically (with any accuracy desired if the problem were a practical problem, which it is not) by aid of a voltmeter and a voltaic battery, or other means of producing electric currents, as follows:—

1. Construct the surface to be mercatorized in thin sheet metal of uniform thickness throughout. By thin I mean that the thickness is to be a small fraction of the smallest radius of curvature of any part of the surface.

2. Choose any two points of the surface, N, S, and apply the electrodes of a battery to it at these points.

3. By aid of movable electrodes of the voltmeter, trace an equipotential line, E, as close as may be around one electrode, and another equipotential line, F, as near as may be around the other electrode. Between these two equipotentials, E, F, trace a large number, n, of equidifferent equipotentials. Divide any one of the equipotentials into n equal parts; and through the divisional points draw lines cutting the whole series of equipotentials at right angles. These transverse lines and the equipotentials divide the whole surface between E and F into infinitesimal squares (Maxwell, "Electricity and Magnetism," § 651).

4 Alter all the squares to one size and place them together, as explained above. Thus we have a Mercator chart of the whole surface between E and F.

N and S of our generalization correspond to the north and south poles of Mercator's chart of the world; and our generalized rule shows that a chart fulfilling the essential principle of similarity realized by Mercator may be constructed for a spherical surface by choosing for N, S any two points not necessarily the poles at the extremities of a diameter. If the points N, S are infinitely near one another, the resulting Mercator chart for the case of a spherical surface, is the stereographic projection of the surface on the tangent plane at the opposite end of the diameter through the point, C, midway between N and S. In this case the equipotentials and the stream-lines are circles on the spherical surface cutting N S at right angles, and touching it, respectively.

For a spherical or any other surface we may mercatorize any rectangular portion of it, A B C D, bounded by four curves, AB, BC, CD, DA, cutting one another at right angles as follows. Cut this part out of the complete metallic sheet; to two of its opposite edges, A B, D C, for instance, fix infinitely conductive borders. Apply the electrodes of a voltaic battery to these borders, and trace n equidifferent equipotential lines between AB and DC. Divide any one of these equipotentials into n equal parts, and through the divisional points draw curves cutting perpendicularly the whole series of equipotentials. These curves and the equipotentials divide the whole area into infinitesimal squares. Equalize the squares and lay them together on the flat as above.

If we have no mathematical instruments by which we can draw a system of curves at right angles to a system already drawn, we may dispense with mathematical instruments altogether, and complete the problem of dividing into squares by electrical instruments as follows: Remove the conducting borders from AB, DC; apply infinitely conductive borders to AD and BC, apply electrodes to these conducting borders, and as before draw n equidifferent equipotentials. This second set of equipotentials, and the first set, divide the whole area into squares.

KELVIN.

THE ACTIVE ALBUMEN IN PLANTS.[1]

ONE of the most important chemical functions of plant-cells is that synthesis of albuminous matter which serves for the formation of protoplasm. The *living* protoplasm, however, is composed of proteids entirely different from the ordinary soluble proteids, as well as from the proteids of *dead* protoplasm. In other words, if living protoplasm dies, the albuminous constituents change their chemical character. We observe that in the living state a faculty of autoxidation (respiration) exists, which is wanting in the dead condition; and Pflüger, in 1875, drew from this the conclusion that in protoplasm the chemical constitution of the living proteids changes at the moment of death.

Various other considerations force us to accept this logical conclusion. Chemical changes readily occur in all those organic compounds that are of a *labile* character. There exist so-called labile atom-constellations that are in lively motion, and are thus prone to undergo change, the atoms falling into new arrangements which

[1] This paper was read before the Liège meeting of the International Congress of Physiologists, of whose proceedings we gave some account last week.