faces of revolution, described in "Popular Lectures and Addresses," vol. i., 2nd edition, pp. 31-42, suggests a corresponding method for the solution of dynamical problems.

Reduction of every problem of Two Freedoms in Conservative Dynamics, to the drawing of Geodetic Lines on a Surface of given Specific Curvature, by Lord Kelvin.

1. Any conservative case of two-freedom motion is proved to be reducible to a corresponding case of the motion of a material point in a plane.

2. In plane conservative dynamics, with any given value for the energy-constant, E , the resultant velocity, q , at any point (x, y) is a known function of (x, y) , being given by the equation

$$q^2 = 2(E - V) \dots (1)$$

where V denotes the potential at (x, y) ; and every problem depends on drawing lines for which $\int q ds$ (the Maupertius "action") is a minimum.

3. Considering any part, S , of the infinite plane, find a surface, S' , such that any infinitesimal triangle $A'B'C'$ drawn on it has its sides q/q_0 of those of a corresponding triangle ABC in the field, S , of our plane problem; q_0 denoting the value of q at any particular point (x_0, y_0) in the plane. By the principle of least action we see instantly that the lines on S' corresponding to paths on S , are geodesic. Thus the *adynamic* case of motion of a particle on S' , is found as a perfect and complete representative of the motion on the plane surface S , under force with any arbitrarily given function V , for its potential, and any particular given value, E , for the total energy of the moving particle.

4. It is easily proved that the surface S' , to be found according to §3, exists; and that its specific curvature (Gauss's name for the product of its two principal curvatures) at any point; is equal to

$$\frac{q_0^2 \Delta^2 \log q}{q^2}$$

5. Examples are given of the finding of S' . As one example, illustrating the practical usefulness of this method in dynamics, the problem of the parabolic motion of an unresisted projectile is reduced to the drawing of geodetic lines on a certain figure of revolution of which the explicit equation is expressed in terms of elliptic functions.

THE PERIODIC VARIATIONS OF ALPINE GLACIERS.

THIS twelfth Report, dealing with the Alpine glaciers and their changes, by Dr. Forel, comes in the nick of time, and will be generally welcomed, for it announces that the question of glacier-changes in the Alps will in future be studied systematically; and, further, we learn in a postscript that the State Council of the Canton of Le Valais have, on the proposition of M. Maurice de la Pierre, head of the Home Department, decided to take under its efficient direction the studies of observation and control of the variations of glaciers. These observations are confided to the charge of the Cantonal Administration of Forests, the head of which is M. Antoine de Torrenté at Sion. M. Forel records this act of intelligent and prudent administration with keen satisfaction and true gratitude, and would gladly see it imitated by other cantons possessing glaciers. M. Forel publishes also the report, which, in compliance with the wishes of M. de la Pierre, he had addressed to the Home Department of Le Valais. It is equally applicable to the glaciers of other cantons in Switzerland, and we therefore print it *in extenso*.

M. de la Pierre, Councillor of State, head of the Home Department, Sion.

SIR,—Referring to the interview you granted me on January 31, and in reply to your question, I have the honour to give you the following particulars:—

Glaciers in general, and particularly those of Le Valais, are subject to variations in shape, which, according to an irregular periodicity, cause them sometimes to grow in length, in breadth, in thickness, sometimes to decrease, often in very considerable proportions. These variations, which in recent centuries have attracted the attention of the populations interested and of naturalists, have in this century been the subject of direct study, especially during the last twenty years.

It has been recognized that most of the great catastrophes which

have ravaged the region of the high Alps, have been caused by these glacial variations. It is when the glacier extends, lengthens, arrives at its maximum, that it not only invades the fields and destroys Alpine chalets, but barricades the valleys, arrests the flow of rivers, and creates temporary lakes, the evacuation of which ravages the country; or else, surpassing its usual dimensions, it forms an avalanche, the destructive power of which is terrible. Taking my examples from Le Valais, I attribute to forces of this kind: the catastrophes of the Valley of Saas, 1633, 1680, 1772, caused by the overflow of the lake Mattmarck, due to the stoppage of the Viège by the glacier of Allalin; the catastrophes of the valley of Bagnes, 1545, 1605, 1818, caused by the formation of a temporary lake behind the barricades of the glacier of Giétroz; the catastrophes of Randa, 1636, 1819, caused by the fall of the glacier of Bies, which had assumed extraordinary dimensions; perhaps we might also attribute to the same source the inundations of St. Bartholomew, 1560, 1635, 1636, 1835, which may have been due to the excessive increase and fall of the terminal extremity of the glacier of Plan-névé of La Dent-du-Midi.

Since these variations of glaciers are the cause of great catastrophes in mountainous regions, they are deserving of attentive study; there is scope to form theories and to recognize the rhythm of their periodicity; it is very necessary to be able to foresee their development, in order to ward off threatening events.

Now, the preparatory study which we have made within the last few years has shown us that the periodicity of glacial variations is much longer than was formerly believed to be the case; the popular dictum that the increase in the size of glaciers recurs every seven years is certainly incorrect. We cannot yet give definite figures, but probably the cycle of glacial variation is as much as 35 to 50 years. The latter period alone has been studied attentively; if 1850 or 1855 be fixed upon as the epoch of maximum of glaciers, they have been steadily decreasing in past years, so that from 1870 to 1875 we were not aware of a single one on the increase. In 1875 the Glacier des Bossons du Mont Blanc gave the signal for a new period by commencing to lengthen out; it was followed in 1878 and 1879 by the glaciers of Trient and Zigiorenove, then successively by some thirty glaciers in different valleys of Le Valais; but the phase of increase is not yet general in your canton; a number of large glaciers, Arolla, Otemma, Corbassière, Le Gorner, Le Rhone, are still decreasing or stationary. It is only of the Mont Blanc group that the increase can be said to be general; in Le Valais it is in process of development, and we are still very far from the maximum stage of glaciers. If, as is probable, the maximum only arrives at the commencement of next century, the actual period of glaciers will have lasted more than fifty years.

Thus this is a phenomenon, whose cycle is equal or superior to that of the average human life; one generation of men witnesses only one of the glacial variations. It is a phenomenon of such majestic slowness that its study is exceptionally difficult.

A phenomenon of which a man can, in his whole life, see but one manifestation, surpasses in its amplitude the powers of initiative individual study. To observe the facts of so prolonged a period, organizations are required of a superior duration. Shall we address ourselves, therefore, to learned societies, which, being continually renewed, may be supposed to have sufficient continuance? We fear that, even in the most powerful of these societies, Societies of Naturalists and the Alpine Clubs, a sufficiently keen interest in observations, which can only be utilized after the lapse of some generations will not be felt for the observations to be organized and carried out with the necessary perseverance. It seems to us that the State alone, by virtue of the indefinite continuance it enjoys, is in a position to follow out this study with a sufficiently long grasp. However much we may be in favour of private individual or collective initiative action in researches and scientific work, in this special case we believe it advisable to have recourse to the State administration, considering it the only institution of sufficient duration to proceed to the study of phenomena of such extreme slowness.

We therefore take the liberty of addressing ourselves very respectfully to the Government of the Canton of Le Valais, and begging it to introduce the study and observation of the variations of glaciers, which have so great an influence on the prosperity of mountain populations.

It seems to us that the State department best fitted for such a

study would be that of the Administration of Forests. The forest inspectors and their agents are called upon by their functions to travel over the high valleys of the Alps; they would thus be able, without great additional labour, to undertake the observation of glaciers.

As to the programme on which they should work, we would simplify it as much as possible, and reduce it to two points:—

1. To attentively survey the glaciers in order to fix for each one the year of maximum and the year of minimum extent in their successive variations.

2. To specially watch the dangerous glaciers, and warn the Administration of the danger they may cause by assuming exaggerated dimensions during their phase of development.

In order to carry out this double programme, the Government should charge each inspector of forests to study the glaciers of his district, and to inscribe on a register *ad hoc* the state of growth and decline of each glacier every year. For important glaciers, interesting or dangerous, he should have measurements made from fixed marks, and state in exact figures the changes in the dimensions of the glaciers; for little, uninteresting, or unimportant glaciers, occasional inspection and the reports of the mountaineers would suffice to ascertain their state of growth or decrease.

M. Antoine de Torrent, Inspector-General of the Forests of Le Valais, has long been occupied in collecting observations on the glacial variations of our Alps; it is from him that we have obtained all the facts recorded by science in this field of research in Le Valais; it is for him, not for us, to give instructions as to the way in which the observations should be organized.

This study is not an expensive one; it calls for no great outlay on the part of the State, nor does it make great demands on the powers and the time of the observers. It may lead to important and useful results. It can only be successfully carried out by the State, since that alone has the necessary persistence to continue it long enough. I therefore venture to recommend these studies on the variation of glaciers to your great benevolence, and to the enlightened solicitude with which you follow all questions interesting to the public welfare. Men of science, who consecrate their lives to the study of the phenomena of nature, are ready to help you to the best of their ability to study these questions from a theoretic point of view. But it is necessary, in order to arrive at practical results, to have a collection of materials of observation which the State alone seems to us capable of bringing together with success.

Accept, M. le Conseiller de Etat, the expression of my very respectful and devoted consideration.

F. A. FOREL.

Morges, February 10, 1892.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 8.—M. de Lacaze-Duthiers in the chair.—The "Pythonomorphs of France," by M. Albert Gaudry. Announcing the discovery of the snout of one of the great chalk reptiles termed pythonomorphs by M. Cope, on account of their similarity to the sea serpent as imagined by the ancients. The specimen is from a pythonomorph 10m. long, and was found in the upper chalk of Cardesse, near Pau. It is similar to the *Mosasaurus giganteus* of Maestricht, and has been termed *Liodon mosasauroides*. A smaller and somewhat similar specimen was also found, and was termed *Liodon compressidens*. These and a few minor fragments are the first representatives of the pythonomorphs found in France.—On the production of sugar in the blood at the expense of the peptones, by M. R. Lépine.—On the lava of July 12, 1892, in the torrents of Bionnasay and Bon-Nant (catastrophe of Saint-Gervais, Haute Savoie), by M. P. Demontzey. After describing the probable course of the catastrophe, the writer comes to the following general conclusion:—That the lava of July 12 has behaved exactly like those which have been observed before in the torrents of the Alps and the Pyrenees. That its energy was all the more disastrous as the transport in masses commenced in the most elevated regions of the torrent basin after the sudden bursting forth of a large body of water concentrated more rapidly even than in the most violent hailstorms in the upper basins of torrents without glaciers. That the volume of the deposited materials of all sorts—estimated at about one million cubic metres—presents no anomaly in comparison with the

relatively small amount of water, which effected the transport by a series of successive bounds, with alternate momentary accelerations and retardations of speed. That this torrent phenomenon has substituted for a simple and hitherto harmless rivulet a torrent whose activity can be mastered with a relatively short delay. That both in the Alps and the Pyrenees similar cases of the transformation of peaceful rivulets into formidable torrents can be cited, aggravated by the fact of their being caused by rain, which is even more difficult to predict and ward off than the dangers presented by a glacier. And lastly, that this great disaster could not have been provided against, since nobody had had the idea even of exploring the glacier of Tête-Rousse.—On a property of lamellar bimetallic conductors submitted to electromagnetic induction, by MM. Ch. Reignier and Gabriel Parrot. An arrangement recalling Faraday's disc is obtained by substituting for the ordinary copper conductors thin plates composed, along their thickness, of a very magnetic and a highly conducting metal, so placed that the lines of force are perpendicular to their thickness. The flow of induction emanating from the north pole is divided into several sheets of parallel lines very close together, which only traverse the magnetic portions of the bimetallic conductors, and the tubes of force become cylindrical. The available energy in such an arrangement increases at a rate which is sensibly proportioned to the height of the conductors. An apparatus constructed on this principle gave, with a weight of 750 kg. and a velocity of 500 revolutions, 32,000 watts giving an output of 42 watts per kg. of the machine.—The application of the measurement of density to the determination of the atomic weight of oxygen, by M. A. Leduc. The composition of water by volume, and thence its composition by weight, were determined by finding the density of a mixture of hydrogen and oxygen produced by the electrolysis of an alkaline solution. After an electrolysis of several days, during which the superfluous gas was allowed to escape through mercury, the liquid and the platinum poles were saturated with gas, and the density obtained by the method previously described did not vary by more than 0.0001 gr. The value within $\frac{1}{100}$ per cent. was 0.41423. The volume ratio between hydrogen and oxygen was 2.0037 at 0°, and the atomic volume of oxygen 1.9963. The atomic weight of oxygen by this method is 15.877, and by the synthetic method 15.882, so that 15.88 must be taken for the mean atomic weight. Hence the molecular weight of water vapour is 17.88, and its theoretical density 0.622.—On the general form of boiling-point curves for central substitution compounds, by M. G. Hinrichs.—Note on the existence in the earth of an acid mineral substance as yet undetermined, by M. Paul de Mondesir. If all the carbonic acid contained in lime be driven off by a strong acid, and the ratio of lime to carbonic acid be carefully measured, the lime is found to exceed the quantity necessary for saturation. The earth remains always acid and capable of decomposing carbonate of lime in the cold. That this acid residuum cannot be humic acid or free silica is proved by the total destruction of the organic substances by ignition or potassium permanganate, which leaves the property in question unaffected. The quantity of acid matter varies from .2 to 1 per cent. of the earth. It is very stable, and its composition has not yet been determined.—Calcareous soap and boiler explosions, by M. A. Vivien.—Papine, a new animal substance, by M. A. B. Griffiths. This is extracted from the skin of the chrysalis of several lepidoptera.—On the colouring matter of *Micrococcus prodigiosus*, by the same.—On the coccoid state of a nostoc, by M. C. Sauvageau.—On an algal living in the roots of the *Cycadæa*, by M. P. Hariot.—On the presence of fossils in the azoic formations of Bretagne, by M. Charles Barrois.—On the discovery of cut flints in the quaternary *Rhinoceros Mercki* alluvium of the Saône valley at Villefranche, by M. Ch. Depéret.

ROME.

R. Accademia dei Lincei, June 5.—The 289th annual meeting, honoured by the presence of H. M. King Umberto I.—The President introduced the two committees charged with the examination of the works in competition for the two royal prizes of 10,000 lire each, one for social and economic sciences, the other for mathematical sciences. Senator Lampertico, reporting for the first committee, said that, although two essays, one on "Ancient Socialism," by Salvatore Cognetti de Martiis, and another on the laws of the distribution of wealth, bearing the motto, "Laboremus," had shown considerable merit, the committee had not felt justified in awarding the prize to either.