After a sufficiently great number of crossings and re-crossings across the line X′OX, the particle will cross this line very nearly at right angles, at some point, N′. Vary the position of N very slightly in one direction or other, and re-project m from it perpendicularly and with proper velocity; till (by proper "trial and error" method) a path is found, which, after still the same number of crossings and re-crossings, crosses exactly at right angles at a point N″, very near the point N′. Let m continue its journey along this path, and, after just as many more crossings and re-crossings, it will return *exactly* to N, and cross OX there, *exactly* at right angles. Thus the path from N to N″ is exactly half an orbit, and from N″ to N the remaining half.

(14) When $c\mathrm{E}/(\alpha^2\beta^2)$ is a small numeric, the part of the kinetic energy expressed by $\frac{1}{2}cx^2y^2$ is very small in comparison with the total energy, E. Hence the path is at every time very nearly the resultant of the two primary fundamental modes formulated in § 13; and an interesting problem is presented, to find (by the method of the "variation of parameters") a, e, b, f, slowly varying functions of t, such that

$$x = a \sin(\alpha t - e), \qquad y = b \sin(\beta t - f),$$
$$\dot{x} = a\alpha \cos(\alpha t - e), \qquad \dot{y} = b\beta \cos(\beta t - f),$$

shall be the rigorous solution, or a practical approximation to it. Careful consideration of possibilities in respect to this case [$c\mathrm{E}/(\alpha^2\beta^2)$ very small] seems thoroughly to confirm Maxwell's fundamental assumption quoted in § 11; and that it is correct whether $c\mathrm{E}/(\alpha^2\beta^2)$ be small or large seems exceedingly probable, or quite certain.

(15) But it seems also probable that Maxwell's *conclusion*, which for the case of a material point moving in a plane is

$$\text{Time-av. } \dot{x}^2 = \text{Time-av. } \dot{y}^2, \quad \ldots\ldots (1)$$

is not true when α^2 differs from β^2. It is certainly not proved. No dynamical principle except the equation of energy,

$$\tfrac{1}{2}(\dot{x}^2 + \dot{y}^2) = \mathrm{E} - \mathrm{V}, \quad \ldots\ldots (2)$$

is brought into the mathematical work of pp. 722–25, which is given by Maxwell as proof for it. Hence any arbitrarily drawn curve might be assumed for the path without violating the dynamics which enters into Maxwell's investigation; and we may draw curves for the path such as to satisfy (1), and curves not satisfying (1), but all traversing the whole space within the bounding curve

$$\tfrac{1}{2}(\alpha^2x^2 + \beta^2y^2 + cx^2y^2) = \mathrm{E}, \quad \ldots\ldots (3)$$

and all satisfying Maxwell's fundamental assumption (§ 11).

(16) The meaning of the question is illustrated by reducing it to a purely geometrical question regarding the path, thus:—Calling θ the inclination to x of the tangent to the path at any point xy, and q the velocity in the path, we have

$$\dot{x} = q\cos\theta, \qquad \dot{y} = q\sin\theta, \quad \ldots\ldots (4)$$

and therefore, by (2),

$$q = \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}. \quad \ldots\ldots (5)$$

Hence, if we call s the total length of curve travelled,

$$\int \dot{x}^2 dt = \int q\cos^2\theta\, q dt = \int \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\cos^2\theta\, ds; \quad (6)$$

and the question of § 15 becomes, Is or is not

$$\frac{1}{\mathrm{S}}\int_0^{\mathrm{S}} ds \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\cos^2\theta = \frac{1}{\mathrm{S}}\int_0^{\mathrm{S}} ds \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\sin^2\theta\,? \quad \ldots (7)$$

where S denotes so great a length of path that it has passed a great number of times very near to every point within the boundary (3), very nearly in every direction.

(17) Consider now separately the parts of the two members of (7) derived from portions of the path which cross an infinitesimal area $d\sigma$ having its centre at (x, y). They are respectively

$$\left.\begin{aligned} &\sqrt{\{2(\mathrm{E} - \mathrm{V})\}}d\sigma \int_0^{\pi} \mathrm{N}d\theta\cos^2\theta \\ \text{and} \\ &\sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\, d\sigma \int_0^{\pi} \mathrm{N}d\theta\sin^2\theta \end{aligned}\right\}, \quad \ldots\ldots (8)$$

where $\mathrm{N}d\theta$ denotes the number of portions of the path, per unit distance in the direction inclined $\frac{1}{2}\pi + \theta$ to x, which pass either-wards across the area in directions inclined to x at angles between the values $\theta - \frac{1}{2}d\theta$ and $\theta + \frac{1}{2}d\theta$. The most general possible expression for N is, according to Fourier,

$$\left.\begin{aligned} \mathrm{N} = \mathrm{A}_0 &+ \mathrm{A}_1\cos 2\theta + \mathrm{A}_2\cos 4\theta + \&c. \\ &+ \mathrm{B}_1\sin 2\theta + \mathrm{B}_2\sin 4\theta + \&c. \end{aligned}\right\}. \quad \ldots (9)$$

Hence the two members of (8) become respectively

$$\left.\begin{aligned} &\sqrt{\{2(\mathrm{E} - \mathrm{V})\}}d\sigma\tfrac{1}{2}\pi(\mathrm{A}_0 + \tfrac{1}{2}\mathrm{A}_1) \\ \text{and} \\ &\sqrt{\{2(\mathrm{E} - \mathrm{V})\}}d\sigma\tfrac{1}{2}\pi(\mathrm{A}_0 - \tfrac{1}{2}\mathrm{A}_1) \end{aligned}\right\}, \quad \ldots\ldots (10)$$

Remarking that A_0 and A_1 are functions of x, y, and taking $d\sigma = dxdy$, we find, from (10), for the two totals of (7) respectively

$$\left.\begin{aligned} &\tfrac{1}{2}\pi\int\int dxdy(\mathrm{A}_0 + \tfrac{1}{2}\mathrm{A}_1)\sqrt{[2(\mathrm{E} - \mathrm{V})]} \\ \text{and} \\ &\tfrac{1}{2}\pi\int\int dxdy(\mathrm{A}_0 - \tfrac{1}{2}\mathrm{A}_1)\sqrt{[2(\mathrm{E} - \mathrm{V})]} \end{aligned}\right\}, \quad \ldots\ldots (11)$$

where $\int\int dxdy$ denotes integration over the whole space inclosed by (3). These quantities are equal if and only if $\int\int dxdy\mathrm{A}_1$ vanishes; it does so, clearly, if $\alpha = \beta$; but it seems improbable that, except when $\alpha = \beta$, it can vanish generally; and unless it does so, our present test case would disprove the Boltzmann-Maxwell general doctrine.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS AT BERNE.

THIS Congress began its proceedings on Monday. Fourteen countries and forty-six Geographical Societies are officially represented. France has sent 73 delegates, Germany 33, Austria-Hungary 21, Switzerland 87, Italy 21, Russia 13, Great Britain 8, and Spain, America, and the Netherlands two each. Egypt, Portugal, Roumania, Greece, Norway, and Sweden are also represented. There are, in addition, 150 Members and Associates who have not yet given in their names.

M. Numa Droz, Swiss Minister for Foreign Affairs, bade the delegates heartily welcome to Berne.

Dr. Gobat, Regierungsrath, Berne, President of the Congress, then delivered his inaugural address. In the name of the Geographical Societies of Switzerland he thanked the *savants* present for responding so cordially to their invitation.

Among the good work already done, Prof. Penck, of Vienna, has proposed the following resolution:—"This Congress on the geographical sciences, held at Berne, resolves to take the initiative in the preparation of a large map of the earth on a scale of one to a million, of which the various sections shall be delimited by latitudes and longitudes; and, with this object, it appoints an international committee to determine the principles upon which the preparation of such map shall proceed. The members of this committee shall arrange that the various States engaged in preparing maps, the societies and periodicals publishing original maps, and all private geographical establishments working in this field shall prepare detached sections of the said map, the sale of which shall also be regulated and arranged for by the committee."

In the course of his address on the subject Prof. Penck paid a high tribute to the services rendered by Mr. Stanley to the cause of geographical science, directing special attention to the fact that each of the explorer's expeditions across Africa had led to the preparation of from 20 to 30 maps.

The proposal was referred to a committee of the Congress, which will report upon it.

The subjects of an initial meridian and universal time, geographical education, orthography of geographical names, lakes and glaciers, cartography, bibliography, meteorology, commercial geography, and voyages and travels are all to be touched upon in the deliberations.

SCIENTIFIC SERIALS.

Journal of the Russian Chemical and Physical Society, vol. xxiii., No. 1.—The chief papers are:—On the molecular weight of albumen, by A. Sabanéeff and N. Alexandroff. Several determinations were made on the method of Raoult, and gave an average of 14,276, the molecular weight thus appearing to be nearly three times as great as that deduced from the formula of

Harnack (4730), and nearly nine times as high as that given in Lieberkühn's formula (1612). The molecule contains nine atoms of sulphur, of which two are easily separated. Submitted to a temperature of 40°, the solution of albumen changes its properties, and its temperature of freezing is lowered.—On the measurement of density of sea-water, by Vice-Admiral Makaroff. This elaborate work gives the results of measurements made on board the corvette *Vityaz*. The value of various instruments used during the cruise is discussed in detail, and the following formulæ are given as expressing the results of the observations between the temperatures of 0° and 30°. For distilled water, the density is—

$$S_t = 0{\cdot}9998795 = S_t(1 - 0{\cdot}000061398t + 0{\cdot}0000080021t^2 - 0{\cdot}000000004586t^3),$$

maximum density at 3°·972. For sea-water, the density of which at 15° compared with that of distilled water at 4° is = 1·019, the formula is—

$$S_t = 1{\cdot}0207769 = S_t(1 + 0{\cdot}0000222681t + 0{\cdot}0000069801t^2 - 0{\cdot}0000000476lt^3),$$

maximum density at − 1°·570. For sea-water, the density of which, also at 15°, is = 1·026, the formula is—

$$S_t = 1{\cdot}0280936 = S_t(1 + 0{\cdot}0000504531t + 0{\cdot}0000062833t^2 - 0{\cdot}0000000385lt^3),$$

maximum density at − 3°·876. The last two formulæ gave excellent results for temperatures down to − 5°. A comparison between the figures obtained by the *Vityaz* and those obtained by the *Challenger* proved very satisfactory. Finally, the author gives six most valuable tables of corrections. Tables I. and II. contain the corrections to be applied to $S_{\frac{15}{4}}$ for obtaining $S_{\frac{t}{4}}$, and *vice versâ*, from − 5° to + 36°, for both distilled and sea-water. Detailed interpolation tables are also given. Table III. contains the corrections due to the coefficient of dilatation of glass of the areometer being not equal to the normal coefficient 0·000028. The three other tables are for transferring densities $S_{\frac{17{\cdot}5}{17{\cdot}5}}$ into densities $S_{\frac{15}{4}}$.

Bulletin de la Société des Naturalistes de Moscou, 1890, No. 3.—On the *Protopirata centrodon*, Trd., by H. Trautschold (in German). The two Ichthyodornlithes from the Carboniferous of North America, described in J. S. Newberry's capital work upon the "Palæozoic Fishes of North America," Table xxxix., are very much like the Moscow fossils described by the author in the above periodical (1884 and 1886) under the names of *Edectus protopirata*, and later on, of *Protopirata centrodon*.—Geo-botanical notes about the flora of European Russia, by D. I. Litvinoff (in Russian). The common Scotch fir (*Pinus sylvestris*) grows, as known, chiefly on a sandy soil. However, it also appears in the hilly tracts of Europe and Asia, and there it grows upon a rocky soil, chiefly limestone. In the lowlands of Germany and Russia, the appearance of fir upon a rocky ground is extremely rare; but there are some exceptions to this rule—namely, on the chalk hills of the Donets, the Volga mountains, the Middle Russian plateau, and the Silurian limestones of the Baltic provinces; in all those places the fir appears in company with a number of sub-Alpine and Alpine plants which are not met with elsewhere in the Russian plains, and with a number of endemic plants very rare in Russia as a whole. The author considers these rocky islands of fir-growths as survivals from the pre-Glacial period. The paper is full of most interesting botanical data and valuable remarks upon the connection of the glaciation of Russia with its present flora.—The influence of friction upon the rotatory motion of celestial bodies, by Th. Sloudsky (in French). The auxiliary theorems, upon which the principal theorem relative to the effects of friction is based, are demonstrated, the sun being taken as an illustration.—On the origin of endosperm in the embryo-pouch of certain Gymnosperms, by Miss C. Sokolowa (in French, with three plates). Strassburger's researches have proved the similarity between the formation of endosperm and of multicellular albumen, and the partition of cells, especially as regards the Angiosperms. The same researches are pursued by Miss Sokolowa as regards the Gymnosperms, attention being paid to the part played by the nucleus in the formation of partition walls.—Contribution to the morphology and classification of the Chlamydomonads, by Prof. Goroschankin (in German, with two plates).—Preliminary note upon inter-glacial layers about Moscow, by N. Krichtafovitch.

No. 4.—Traces of an inter-glacial period in Central Russia, by N. Krichtafovitch (in German; already analyzed in NATURE).—Remarks upon the function of the nucleus in cells, by J. Gerassimoff (in German), being observations upon cells without a nucleus in *Spirogyra* and *Sirogonium*.—On the molecular weight of the albumen of the egg, by N. Alexandroff (Russian).—Why the relative masses of the brain decrease in proportion to the increase of the weight of the body, in the same type of Vertebrata, by Fernand Lataste (in French).—*Tarentula* (*Lycosa*) *opiphex*, new species, by W. A. Wagner (French, with a plate). This trap-spider inhabits Middle Russia, and is especially numerous in the fields of Orel. Its thin trap, made of one sheet of web with some mould, is even more ingenious, for its shape, than that of the *Ctemiza*.

THE *Nuovo Giornale Botanico Italiano* for July contains two articles of interest to lichenologists: an account of the lichens of Brisbane gathered by Mr. F. M. Bailey, by Herr J. Mueller; and contributions to the lichen-flora of Tuscany, by Signor E. Baroni. Signor E. Tanfani has an important paper on the morphology and histology of the fruit of the Apiaceæ (Umbelliferæ), and Prof. C. Massalongo an account of the galls made by Acari on 45 species of trees, shrubs, and herbaceous plants, as well as of the insects which produce them.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, August 5.—Mr. Frederick Du Cane Godman, F.R.S., President, in the chair.—The President announced the death of Mr. Ferdinand Grut, the Hon. Librarian of the Society, and commented on the valuable services which the deceased gentleman had rendered the Society for many years past.—Dr. D. Sharp, F.R.S., exhibited *Japyx solifugus*, from the Eastern Pyrenees, and stated that in his opinion it was a connecting link between the *Thysanura* and *Dermaptera*. He also exhibited pupæ of *Dytiscus marginalis*; one of these was perfectly developed, with the exception that it retained the larval head: this was owing to the larva having received a slight injury to the head. Dr. Sharp also exhibited specimens of *Ophonus puncticollis* and allied species, and said that Thomson's characters of the three Swedish species, *O. puncticollis*, *O. brevicollis*, and *O. rectangulus*, applied well to our British examples, and separated them in a satisfactory manner. Thomson's nomenclature, however, would, he thought, prove untenable, as the distinguished Swede described our common *puncticollis* as a new species under the name of *rectangulus*.—Mr. F. W. Frohawk exhibited a bleached specimen of *Epinephele janira*, having the right fore-wing of a creamy white, blending into pale smoky brown at the base; also a long and varied series of *E. hyperanthus*, from the New Forest and Dorking. The specimens from the former locality were considerably darker and more strongly marked than those from the chalk. Amongst the specimens was a variety of the female with large lanceolate markings on the under side, taken in the New Forest, and a female from Dorking with large, clearly defined white-pupilled spots on the upper side. Mr. Frohawk further exhibited drawings of varieties of the pupæ of *E. hyperanthus*, and also a large specimen of a variety of the female of *Euchloë cardamines*, bred from ova obtained in South Cork, with the hind wings of an ochreous-yellow colour. Coloured drawings illustrating the life-history of the specimen in all its stages were also exhibited.—M. Sergé Alphéraky communicated a paper entitled "On some cases of Dimorphism and Polymorphism among Palæarctic Lepidoptera."

EDINBURGH.

Royal Society, July 15.—Sir Douglas Maclagan, President, in the chair.—The Prince of Monaco gave an account of the new yacht which he has had fitted out for the study of the sea. He also described the investigations which he has conducted since 1886, first in the Bay of Gascony, and then around the Azores and off Newfoundland. The latter investigations extended over three years, and had as their object the investigation of the direction and speed of the surface currents in the North