parallel straight lines, A and B, and we introduce such a relation between x_0, y_0, x , and y as will express that when the former is a point on the line A the latter will be a point on B, each of the four quantities x, y, u, v may then be expressed as a function of x_0, y_0, u_0, v_0 , and it may be proved that

$$dx dy du dv = \frac{V_0}{V} dx_0 dy_0 du_0 dv_0;$$

where V_0 and V are the resolved parts of the projectile's velocity perpendicular to the two lines as it crosses A and B respectively.

For instance, let the lines be vertical $x = a$ and $x = b$, where $b - a = c$. Our equations are—

$$\begin{aligned} x - x_0 &= c = u_0 t \\ y - y_0 &= v_0 t - \frac{g t^2}{2} \\ v &= v_0 - g t \\ u &= u_0 \end{aligned}$$

$$\therefore t = \frac{c}{u_0}, \quad v = v_0 - \frac{g c}{u_0}, \quad u = u_0, \quad x = x_0 + c, \quad y = y_0 + \frac{v_0 c}{u_0} - \frac{g c^2}{2 u_0^2}$$

and

$$\Delta = 1 = \frac{u}{u_0}.$$

Also here $t = \frac{c}{u_0}$ is not constant, as it depends upon u_0 .

Next let the lines be horizontal, $y = a, y = b, b - a = c$. We then have

$$\begin{aligned} (1) \quad y - y_0 &= c = v_0 t - \frac{g t^2}{2} \\ (2) \quad x - x_0 &= u_0 t \\ (3) \quad u &= u_0 \\ (4) \quad v &= v_0 - g t. \end{aligned}$$

From (1)

$$t = \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g}, \quad x = x_0 + \frac{u_0}{g} \left(v_0 - \sqrt{v_0^2 - 2cg} \right),$$

$$y = y_0 + c, \quad u = u_0, \quad v = \sqrt{v_0^2 - 2cg},$$

and our determinant Δ is

$$\begin{vmatrix} 1, 0, \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g}, \frac{u_0}{g} \left\{ 1 - \frac{v_0}{\sqrt{v_0^2 - 2cg}} \right\} \\ 0, 1, 0, 0 \\ 0, 0, 1, 0 \\ 0, 0, 0, \frac{v_0}{\sqrt{v_0^2 - 2cg}} \end{vmatrix} = \frac{v_0}{v}.$$

If our lines were $y = mx$ and $y = mx + c$, our additional condition would be

$$y - y_0 = m(x - x_0) + c;$$

and the result mentioned could be arrived at, although with a little additional work.

The actual problem proposed by Boltzmann is the same as this in principle, although of much greater complexity, and it is treated by him with the utmost generality. The important thing here is to show that the S function with t constant is of no application, inasmuch as in both of these very simple illustrations we have t a dependent variable depending upon u_0 or v_0 .

I am only pointing out that the S method, with t independent, would not help to establish the particular proposition to which I am referring. It may lead to the determination of a law of permanence of distribution independently of this proposition and by a simpler treatment. The Boltzmann treatment, however, avoids the difficulty which may arise from the fact that *encounters*, whether of finite or infinitely short duration, involve the assumption of discontinuous forces, and, therefore, of a corresponding discontinuity in the form of the S function.

A little consideration shows that the condition E constant cannot lead to any determinate relation between the differential products $dp_1 \dots dq_n$ and $dP_1 \dots dQ_n$.

For to take again the simple case of the projectile. Here we get four equations between the nine quantities, $x_0, y_0, u_0, v_0, x, y, u, v$ and t , whence it is clear that the elimination of t

does not enable us to arrive at more than three equations between the remaining eight quantities, and therefore that we cannot express x, y, u, v separately as determinate functions of x_0, y_0, u_0, v_0 . To enable us to do this we need one additional condition, and this may be supplied in an infinite number of ways. It may be one of the conditions above considered leading to the equation $dx dy du dv = \frac{V_0}{V} dx_0 dy_0 du_0 dv_0$, or it may

be the condition t constant leading to the equality of these differential products, and so forth; but the condition E constant supplies no additional relation between the eight variables. This conclusion holds equally for n degrees of freedom, following from the two partial differential equations in $q_1 \dots q_n, Q_1 \dots Q_n$, to which the characteristic function A is subject, so that the condition E constant leads to no determinate relation between the differential products.

This conclusion is not inconsistent with Maxwell's proof. That proof takes the form—

$$dp_1 \dots dq_n = \frac{\Delta}{\Delta'} dP_1 \dots dQ_n,$$

where Δ is equal to Δ' , but it may be proved that in this case Δ and Δ' are separately zero, and therefore that, as stated above, no relation can be established between the two differential products.

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Palaeonictis in the American Lower Eocene.

PALAEONTOLOGISTS will welcome Dr. T. L. Wortman's discovery of a nearly complete skull of *Palaeonictis* in the Wahsatch Lower Eocene of Wyoming. The only specimens of this form known hitherto are the two fragmentary lower jaws from the Suessonian lignites of France upon which De Blainville founded the genus in 1841. This specimen includes the facial region of the skull and the complete lower jaws in fine preservation. We owe it to the expert skill of Dr. Wortman, for the fossil was found completely dissociated; he carried several sacks of the *débris* surrounding the fragments fifteen miles to the nearest river, and by careful washing recovered all the teeth.

The skull is about the size and form of that of the Puma (*Felis concolor*), without the long muzzle so characteristic of all the early Carnivores or Creodonts. The dental series is remarkably compressed and reduced, especially in the upper jaw, the formula being: I $\frac{3}{2}$, C $\frac{1}{1}$, P $\frac{1}{1}$, M $\frac{3}{2}$. The third upper molar has entirely disappeared, the second is as small as the little tubercular in the modern cats, the first is smaller than the fourth premolar. The latter tooth, in conjunction with the first true lower molar, is in course of transformation into a *sectorial*. This and many other features point to the conclusion that *Palaeonictis* is closely related to the Eocene ancestors of the Felidae—which have hitherto been considered a gap in the fossil series.

The type, which we may call *P. occidentalis*, will soon be fully figured and described.

HENRY F. OSBORN.

American Museum of Natural History, April 19.

WATERSTON'S THEORY OF GASES.

ON the 11th of December, 1845, a paper by Mr. J. J. Waterston, entitled "On the Physics of Media that are composed of Free and Perfectly Elastic Molecules in a State of Motion," was communicated by Captain Beaufort, R.N., to the Royal Society.

This paper was not published at the time, but was relegated to the Archives. It now, however, has just been issued as a part of the current volume of Philosophical Transactions.

It is preceded by an introduction by Lord Rayleigh, one of the Secretaries of the Royal Society, and we cannot do better—in order to call attention to this remarkable paper, which anticipates the present theories in many respects, and to explain how it is that it now appears—than print Lord Rayleigh's introduction as it stands, and also the introduction to the memoir itself.