Darcy's pipes were not uniform between the gauge points, the sections varying as much as 20 per cent., and the temperature was only casually given. These matters rendered a close agreement unlikely; it was rather a question of seeing if there was any systematic disagreement. When the curves came to be shifted, the agreement was remarkable; in only one respect was there any systematic disagreement, and this only raised another point; it was only in the slopes of the higher portions of the curves. In both my tubes the slopes were as 1·722 to 1; in Darcy's they varied according to the nature of the material, from the lead pipes, which were the same as mine, to 1·92 to 1 with the cast iron. This seems to show that the nature of the surface of the pipe has an effect on the law of resistance above the critical velocity.

16. *The Critical Velocities.*—All the experiments agreed in giving $v^c = \frac{1}{278}\frac{P}{D}$ as the critical velocity, to which correspond as the critical pressure $i_c = \frac{1}{47700000}\frac{P^2}{D^3}$, the units being metres and degrees Centigrade. It will be observed that this value is much less than the critical velocity at which steady motion broke down.

17. *General Law of Resistance.*—The log. homologues all consist of two straight branches, the lower branch inclined at 45°, and the upper one at n horizontal to 1 vertical, except for the small distance beyond the critical velocity these branches constitute the curves. These two branches meet in a point, O, on the curve at a definite distance below the critical pressure, so that, ignoring the small portion of the curve above the point before it again coincides with the upper branch, the logarithmic homologues give for the law of resistance for all pipes and all velocities $A\frac{D^3}{P^2}\, i = \left(B\frac{D}{P}\, v\right)^n$, where n has the value unity as long as either member is below unity, and then takes the value of the slope n to 1 for the particular surface of the pipe.

If the units are metres and degrees Centigrade—

$$A = 67{,}700{,}000$$
$$B = 398$$
$$P = 1 + 0{\cdot}0336\ T + 0{\cdot}000221\ T^2.$$

This equation then, excluding the region immediately about the critical velocity, gives the law of resistance in Poiseuille's tubes, those of the present investigation, and Darcy's, the range of diameters being from 0·000013 metres (Poiseuille, 1843), to 0·5 metres (Darcy, 1857); and the range of velocities from 0·0026 to 7 metres per sec., 1883.

This algebraical formula shows that the experiments entirely accord with the theoretical conclusions. The empirical constants are A, B, P, and n; the first three relate solely to the dimensional properties of the fluid which enter into the viscosity, and it seems probable that the last relates to the properties of the surface of the pipe.

Much of the success of the experiments is due to the care and skill of Mr. Foster of Owens College, who has constructed the apparatus and assisted me in making the experiments.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 15.—M. Blanchard, president, in the chair.—Note on a formula of Hansen in connection with the mechanism of the heavens, by M. F. Tisserand.—On the measurement of the forces brought into play in the various actions of human locomotion (continued), three illustrations, by M. Marey. By combining the indications obtained from the dynamometer with those yielded by instantaneous photography, a continuous comparison may be made of the forces brought into action with the movements resulting from them. The various applications of these two methods will form the subject of future experiments.—On a memoir by M. Raoult, entitled: "Loi générale de Congélation des Dissolvants,"—report by MM. Cahours, Berthelot, and Debray. Water holding saline bodies in solution freezes at a lower temperature than pure water, and the English physicist Blagden had shown in 1788 that the lowering of the freezing-point due to this cause is in many cases in proportion to the quantity of matter held in solution. This principle is now generalised by M. Raoult, who arrives at the conclusion that the freezing-point of any liquid compounds capable of solidification is lowered by all solid, fluid, or gaseous bodies dissolved in them. The reporters agree with the author that his methods will be found useful in supplying new means for ascertaining by a simple process the degree of purity of given substances.—Trial trip of an electric screw balloon made by MM. A. and G. Tissandier, note by M. G. Tissandier. This preliminary experiment took place at Auteuil on October 8, and was attended by a certain measure of success, although the apparatus proved powerless to prevent the spinning motion of the balloon when heading against aërial currents. The trip will be renewed as soon as certain improvements have been made in the electromotor suggested by this experiment.—Studies made on the summit of the Pic du Midi, with a view to the establishment of a permanent astronomic station, note by MM. Thollon and Trépied.—On the transformation of certain equations of the second degree to two independent variables, and on some integrations thence deducible, by M. R. Liouville.—On a method of isolating the calorific from the luminous and chemical rays, by M. F. van Assche.—On the form and characters of the reflex muscular contraction, by M. H. Beaunis.—On the resisting power of a ring whose outer surface supports a normal pressure constant as to unity of length of its mean axis, by M. J. Boussinesq.—On surfaces whose total curve is constant, by M. G. Darboux.—Indices of refraction of fluate of lime for the rays of different wave-lengths as far as the extreme ultra-violet, by M. Ed. Sarasin.—Note on a new method of insulating the metallic wires used in telegraphy and telephony, by M. C. Widemann.—Note on the determination of the equivalents of metals by means of their sulphates, by M. H. Baubigny.—On the process at present employed to determine the glucose in cane-sugar, by M. P. Lagrange. The object of this paper is to show that the quantitative analysis of glucose, made on a liquor whether treated or not with subacetate of lead, is liable to serious errors.—Analysis of a specimen of guano from the Cape Verde Islands, by M. A. Andouard.—Zoological dredgings and thermometric soundings in the lakes of Savoy, by M. F. A. Forel.—On the organisation of the *Spadella Marioni*, a new species from the Gulf of Marseilles, by M. P. Gourret.—On some peculiarities in the structure of Tunicata, by M. L. Roule.—Fresh studies on the fossil ruminants of Auvergne, by M. Depéret.—On the treatment of strabismus by means of the capsular "advancement," by M. L. de Wecker.—On the part played by the ligneous vessels in the upward movement of the sap, by M. J. Vesque.—Note on a lunar mirage observed on the night of October 11, by M. Virlet d'Aoust.

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