

III. The change of rotation of a solution of lactic acid can be expressed by a mathematical equation.

IV. When the specific rotation $64^{\circ}8$ is reached, the law of change must be expressed by a different equation.

V. The initial solubility of lactic acid is 1 part lactic acid in 10.64 parts water.

VI. The permanent solubility is 1 part lactic acid in 3.23 parts water.

IV. "On the Microrheometer." By J. B. HANNAY, F.R.S.E., F.C.S., lately Assistant Lecturer on Chemistry in the Owens College, Manchester. Communicated by H. E. ROSCOE, LL.D., F.R.S., Professor of Chemistry in the Owens College, Manchester. Received December 11, 1878.

(Abstract.)

In this paper the author reviews the work done by chemists and physicists in determining the relation between the chemical composition of a liquid and its rate of flow through a capillary tube. Poiseuille* ascertained, in a very accurate manner, all the physical laws relating to the rate of flow, as regulated by temperature, pressure, and dimensions of the tube; but on examining saline solutions he could make nothing of the numbers presented, because he used percentage solutions instead of solutions proportional to the equivalent of the body dissolved. Graham,† noticing that Poiseuille had discovered a hydrate of alcohol by running various mixtures of alcohol and water through the tube, examined mixtures of the various acids with water, and found that the hydration proceeded by distinct steps of multiple proportions. Several others, notably Guerout,‡ have since worked on the same subject, but as they have only worked on organic liquids, and have done all the rates at the same temperature, the results throw no light on the phenomena. Thus water runs about five times as quickly at 100° as at 0° ; and in a series of alcohols, such as Guerout experimented upon, the differences between their boiling points were very great, so that, their vapour tensions or molecular mobilities being quite incomparable while at the same temperature, the experiments do not admit of any real interpretation. The author reserves the organic part of the investigation, which requires the determination of vapour tensions, till a future paper, and in the present deals with saline solutions.

The phenomenon of the flow of liquids through capillary tubes has

* "Ann. de Chim. et de Physique," [3], t. vii, 50.

† "Phil. Trans.," 1861, p. 373.

‡ "Comptes rendus," lxxix, p. 1201; lxxx, p. 1025.

been called in this country transpiration, while in other countries no distinct name has been adopted; and as the English word is already in use in French for another purpose, and properly applies to gases (the laws relating to which are quite different), the author proposes to use for liquids the term "Microrheosis," from *μικρός* and *ῥέω*, the instrument being called the microrheometer. The form of apparatus which the author finally adopted is figured in the paper, and is so arranged that when the liquid is introduced, as many experiments as may be desired may be tried, and the pressure and temperature, as well as the atmosphere in which the experiment is conducted, may be varied, while the thermometer indicating the temperature is at the mean point of the system. The author gives a curve for water from 0° to 100°, the differences of rate being smaller as the temperature rises.

Various salts are then examined, being dissolved to form "normal" solutions; but as the solubility of some salts is too low for such solutions, the effect of the amount of salts dissolved is determined. This is found to be directly proportional to the amount of salt in solution. Values for many salts in solution are then given, each number being the mean of ten experiments, and the probable error of the mean is calculated in each case. The conclusions arrived at are these. The rate of flow does not depend on any of the "mechanical" features of the salt, such as crystalline form, specific volume, solubility, &c.; but upon the mass of the elements forming the substance and the amount of energy expended in its formation. Each element has a value of its own, which is continued in all its compounds. Thus all the salts of potassium and sodium formed by the same acids have a constant difference. In like manner each metalloïd and acid radicle has a value which is continued in all its combinations. Then the greater the combining value of an element the quicker is its microrheosis; thus potassium has a higher rate than sodium, barium than strontium, strontium than calcium, and so on. The microrheosis also varies with the amount of energy in the compound; thus nitrates stand highest, as they contain most energy; then chlorides; and, lastly, sulphates, which are exhausted compounds.

The instrument, bringing to light as it does the fundamental relations of combining weight and energy in chemical action, will be of the utmost importance in chemical physics, as by its use, not only will the amount of energy evolved in reactions be determined, but the mass combined; or, in other words, the chemical equivalent of the elements involved will be found.