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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

FRANÇOIS MARIE RAOULT.

THE death of Raoult, on April 1, 1901, removes from France one of her most brilliant investigators. Raoult was born at Fournes (Nord) on May 10, 1830, and was, therefore, nearly seventy-one years old when he died. After finishing his academic training in Paris, he began his career as a teacher in the Lycée at Reims at the age of twenty-three. In 1870 he was called to the chair of chemistry at Grenoble. In 1889 he was elected dean of the Faculty of Sciences in Grenoble—a position which he held until his death.

The earlier work of Raoult was devoted to problems of a purely physical nature. His thesis, presented for the degree of Doctor of Science was on 'The Electromotive Force of Voltaic Cells,' and much of his earlier work had to do with the phenomena connected with electrolysis.

His most important work, however, and that with which his name will always be connected, was done after 1870, while at Grenoble. When Raoult took up the study of the lowering of the freezing-point and of the vapor-tension of solvents by dissolved substances, our knowledge of these phenomena was hardly more than qualitative. A few regularities had been pointed out by Blagden, Coppet, Wüllner, Emden, Rüdorff and others, but scarcely any generalization worthy of the name had been reached.

The reason why the laws which obtain in these fields had not been discovered is to be found chiefly in the fact that aqueous solutions had been used, and we know to-day that water dissociates electrolytes, and in varying amounts depending upon the dilution of the solution. Thus, of all the solvents which could have been used in studying these phenomena, no one was so poorly adapted to the discovery of any relations which might exist as water.

When Raoult took up the study of the lowering of the freezing-point of water by dissolved substances, he did not limit himself to aqueous solutions, but employed solutions in acetic acid, benzene, nitro-benzene, etc. From his work with non-aqueous solutions he discovered his well-known law: "A molecule of any substance dissolved in one hundred molecules of a liquid lowers the freezing-point of the latter a nearly constant amount." The experimental data upon which this law is based were published in 1884.*

A little later (1886) Raoult took up the study of the lowering of the vapor-tension of solvents by dissolved substances. Here also he worked with non-aqueous solutions, and showed that the lowering of the vapor-tension is proportional to the ratio between the number of molecules of the dissolved substance and the total number of molecules present.

The work of Raoult, then, brought out this important point, that the lowering of the freezing-point of a solvent, as well as the lowering of its vapor-tension, depends only upon the ratio between the number of parts of the dissolved substance and the number of parts of the solvent which are present.

This work of Raoult, however, led to a still more important discovery. He found that electrolytes, *i. e.*, those substances which in solution conduct the current, give greater lowering of the freezing-point of water than non-electrolytes. An example will make this clear. Hydrochloric acid, sodium hydroxide and sodium chloride in water lower its freezing-point nearly twice as much as methyl alcohol of the same concentration. We recognize in the acid, base and salt types of electrolytes, and in methyl alcohol a typical non-electrolyte. Raoult was not able to point out the meaning of this important discovery. This was left for another.

The work of Pfeffer on the osmotic pressure of solutions led, in the hands of van't Hoff, to the discovery of the relations between the osmotic pressure of solutions and the gas-pressure of gases. But these relations hold only for the osmotic pressures of non-electrolytes. The electrolytes all exert an osmotic pressure which is greater than that shown by the non-electrolytes. van't Hoff was not able to explain the abnormally large osmotic pressures exerted by the electrolytes.

The Swedish physicist, Arrhenius, took up this question, and, as we know, furnished a satisfactory answer to it. He asked, Why is it that electrolytes give abnormally large osmotic pressures, abnormally large depressions of the freezing-point and vapor-tension of solvents? The work of Raoult had shown that lowering of freezing-point and of vapor-tension depends only upon the number of parts present in a given volume of the solution. Therefore, when these phenomena manifest themselves to an abnormally large degree it means that we have more parts present in the solution than we suppose. This gave to Arrhenius the key to the solution of the problem, and the theory of electrolytic dissociation was the result.

This work of Raoult, together with that of Pfeffer on osmotic pressure, forms the foundation of the new physical chemistry.

An account of the work of Raoult should

* *Ann. Chim. phys.* [6] **2**, 66. Harper's Science Series, IV.

be supplemented by a brief reference, at least, to his more important characteristics. He was not a man who desired fame, but devoted his whole life to one ideal—the discovery of truth. Although connected with a comparatively small institution, he never lost his enthusiasm for his work, and one of his very last investigations, on the lowering of the freezing-point of water produced by non-electrolytes, probably contains the most accurate measurements of these values which have ever been made.

Raoult as a man seems to have combined most of those qualities which are so much admired. We have abundant evidence of his kind-heartedness and genial disposition. A letter from his pen was always an inspiration to more strenuous effort in research, and invariably left the impression that the highest aim of man should ever be to increase the sum of human knowledge.

In Raoult not only France has lost her most prominent physical chemist, but the world has lost one of the leading men of science.

HARRY C. JONES.

CHARLES HERMITE.

THE fourteenth of January, 1901, should be marked with a black stone in the annals of mathematics. Then the eminent geometer, the incomparable man, the great Hermite, one of the glories most pure of France, was lost to science, and implacable death threw into mourning his family, his friends and his admirers.

As mathematician of the first rank he leaves to the glory of his country and of all humanity a superb scientific monument erected in sixty years, completely dedicated to 'his dear *analyse*' (to use one of his phrases) and to preparing, by the infusion of his genius placed at the service of teaching, that galaxy of illustrious mathematicians who now so much adorn our sister nation. Like Sturm, he united in an extraordinary degree the qualities of a professor who wins the love of his disciples to those of one who inculcates the love of science for science.

Endowed, like his compatriots Pascal and Clairaut, with singular precocity, we see him, yet a scholar of the lyceum Louis le Grand, win the prize for mathematics with a noteworthy thesis, and shortly after, as student of the Polytechnic School, attract the attention of Jacobi with his first works and place himself as of right in the first rank among the analysts of Europe.

It is not our object to make a minute analysis of the works of the great geometer, to which would be necessary time and competence that we lack. Our aim is much more modest; we seek to render what is heartfelt homage to the man we have so deeply venerated and from whom we have received infinite proofs of benevolence during the fifteen or sixteen years that we have had the honor to possess his friendship, in so many ways precious.

It is not possible, speaking of Charles Hermite, to fail to say how in the higher analysis, in algebra and in the theory of numbers, one encounters everywhere the footprints of his giant tread. How could we leave unmentioned his memoir on the exponential function, where in demonstrating the transcendence of the number e he opens the way which eleven years after conducted Lindemann to the demonstration of the analogous property of π, solving in negative form the celebrated problem which for two thousand years had in vain fatigued geometers?

Nor can we pass in silence the enormous contribution which Hermite brought to the *Theory of Forms*: his law of reciprocity, his admirable researches on associate covariants, his work on quintic forms, his memoir on the equation of the fifth degree and his celebrated theorem having Sturm's as corollary.