by the fact that during his undergraduate career he was awarded several prizes for excellence in Latin and mathematics. After his graduation in 1858 he continued his studies in New Haven until 1863, when he received the degree of doctor of philosophy and was appointed a tutor in the college for a term of three years. During the first years of his appointment he taught Latin, and in the third year physics, in both of which subjects he had earned distinction as an undergraduate. In 1866 he went to Europe, spending the winter in Paris, and the following year in Berlin where he attended the lectures of Magnus and other notable teachers of physics and mathematics. After spending the winter of 1868–69 in Heidelberg, where Helmholtz and Kirchoff were then lecturing, he returned to his home in New Haven. Two years later he was appointed professor of mathematical physics in Yale College, a position which he filled with distinction until the time of his death, April 28, 1903.

Professor Gibbs was most widely known for his contributions to the science of thermodynamics, and in all of the standard treatises on this subject his name repeatedly occurs. It is probably true that no one ever displayed greater originality in method of treatment or discovered a larger number of important thermodynamical principles than did Gibbs.

In 1873, when thirty-four years of age, he published in the Transactions of the Connecticut Academy[2] his first paper, entitled "Graphical methods in the thermodynamics of fluids." In this paper the reader will be impressed with the author's inclination to employ geometrical illustrations in preference to mechanical models as aids to the imagination. Gibbs recognized the fact that such models seldom fully correspond with the phenomena they are intended to represent and accordingly sought geometrical illustrations of his equations. In this endeavor he probably has had few if any equals. The late Professor Bumstead in commenting on his skill in this direction wrote as follows:

> With this inclination, it is probable that he made much use of the volume-pressure diagram, the only one which, up to that time, had been used extensively. To those who are acquainted with the completeness of his investigation of any subject which interested him, it is not surprising that his first published paper should have been a careful study of all the different diagrams which seemed to have any chance of being useful. Of the new diagrams which he first described in this paper, the simplest, in some respects, is that in which entropy and temperature are taken as coördinates; in this, as in the familiar volume-pressure diagram, the work or heat of any cycle is proportional to its area in any part of the plane; for many purposes it is far more perspicuous than the older diagram, and it has found most important applications in the study of the steam engine. The diagram, however, to which Professor Gibbs gave most attention was the volume-entropy diagram, which presents many advantages when the properties of bodies are to be studied, rather than the work they do or the heat they give out. The chief reason for this superiority is that volume and entropy are both proportional to the quantity of substance, while pressure and temperature are not; the representation of coexistent states is thus especially clear, and for many purposes the gain in this direction more than counterbalances the loss due to the variability of the scale of work and heat. No diagram of constant scale can, for example, adequately represent the triple state where solid, liquid and vapor are all present; nor, without confusion, can it represent the states of a substance which, like water, has a maximum density; in these cases the volume-entropy diagram is superior in distinctness and convenience.

His second paper, entitled "A method of geometrical representation of the thermodynamic properties of substances,"[3] attracted the attention of physicists throughout the world. He here selects volume, entropy and energy as the three coordinate axes and proceeds to develop the properties of the resulting thermodynamic surface, the geometrical conditions for equilibrium, the criteria for its stability and the conditions for coexistent states, as well as those for the critical state. The importance of this work was quickly recognized by James Clerk Maxwell who, towards the end of his life, constructed a model of such a surface with his own hands and presented a cast of it to Professor Gibbs.

These two papers demonstrated to the world Gibbs's extraordinary powers in the domain of mathematical physics, and presaged the appearance of his most celebrated contribution to scientific literature, entitled "On the equilibrium of heterogeneous substances."[4] This paper, which won for him universal fame, was published in two parts in the Transactions of the Connecticut Academy, the first part appearing in 1876 and the second part in 1878. The author here applied the principles of thermodynamics to the conditions of equilibrium between substances differing not only in chemical properties, but also in physical state. The few attempts which had been made prior to the work of Gibbs to bring chemical action within the scope of the fundamental laws of thermodynamics had proven only partially successful. No broad generalizations, connecting thermal energy and chemical energy, similar to the relations which were known to obtain in the case of mechanical energy, had been established. It was Willard Gibbs who supplied the stroke of genius necessary to the solution of the problem. Not only did he blaze the trail, but in this masterly pub-

[2] Trans. Conn. Acad., 2, 309, (1873).

[3] Trans. Conn. Acad., 2, 382 (1873).

[4] Trans. Conn. Acad., 3, 108 (1876); 3, 343 (1878).