NEW EXPERIMENTS IN RADIO-ACTIVITY.

BY JACQUES BOYER.

The apparatus herewith illustrated have been designed for the purpose of demonstrating the principal properties of radium salts and other radio-active bodies, and exhibiting their luminous, phosphorescent, electric, and thermal effects. Most of the experiments were designed or modified by M. Daune, Mme. Curie's assistant at the Sorbonne, for the exhibition of radio-active phenomena to a class.

The electrical conductivity of the air which is induced by the presence of radium is illustrated by means of the apparatus shown in Fig. 1. Adjustable spark gaps with micrometer scales are connected to the poles of a Ruhmkorff coil. A Geissler tube is connected in series with one pole and its spark gap, and the resistances are so adjusted that sparks pass in the other spark gap only. If a glass tube containing a grain or two of radium is brought near the inactive spark gap the resistance of the air is diminished so that sparks pass and the Geissler tube glows brightly.

The apparatus for the study of the radio-activity of mineral waters (Fig. 2) is composed of an electroscope surmounted by a glass cylinder which contains a central electrode connected with the rod of the electroscope. The gas dissolved in the mineral water is expelled by a current of air which is forced through the container by compressing a rubber bulb. The gas traverses drying tubes containing sulphuric acid and phosphoric anhydride, and then enters the tube that surmounts the electroscope. If the gas possesses radio-active properties due to the presence of radium emanation the electroscope will be discharged. In this manner radio-activity has been detected in the waters of Spa.

M. Daune has devised for these experiments a simple electroscope which is very sensitive to radio-active influences. The gold leaves are suspended from a glass rod which terminates above in a knot and is inclosed in a glass tube, to which it is attached by a metal frame. The radio-active effect on the conductivity of air is manifested at distances of several yards from the radio-active substance, and through paper, wood, metals, the human body, and other objects. A screen of lead 4 inches in thickness diminishes the effect very slightly.

I have seen in the laboratory of the De Lisle establishment at Nogent a remarkable apparatus for the demonstration of the evolution of heat by radium. This apparatus (Fig. 3) consists of a very sensitive thermometer, the bulb of which is hollow and surrounds a thin-walled glass tube which is prolonged beyond the bulb opposite the stem. The thermometer is inclosed in a wide glass tube which is exhausted of air to a "Crookes vacuum" and is sealed around, but not over, the end of the little tube that penetrates the thermometer bulb. If a bit of radium is introduced into this little tube and pushed up into the bulb, the heat evolved by the radium will cause the mercury to expand. The vacuum between the thermometer and the outer tube almost prevents loss of heat by direct thermal radiation from the thermometer itself, but a certain quantity of heat is conducted from the thermometer by the walls of the outer vessel, and thence radiated or conducted away. The rate of this loss of heat increases with the elevation of temperature and when it becomes equal to the constant flow of

heat received from the radium the end of the column of mercury ceases to advance. One decigramme (1.4 grains) of radium produces a movement of about four inches, and if the instrument is standardized it may be used as a calorimeter for the measurement of the heat evolved by radium. The most curious of M.

Fig. 4.—"Perpetual Motion" Due to Radio-activity.

Daune's devices is a novel "perpetual motion." The apparatus (Fig. 4) consists of a glass tube containing a small axial glass tube closed at the bottom and open to the outer air at the top, which is fused to the wall of the globe. The lower part of the tube is surrounded by a tube of brass which rests on an insulating post of quartz supported by a brass rod below. The brass tube bears a gold leaf which forms an electroscope.

If a Crookes vacuum is produced in the globe and

Fig. 3.—Apparatus Showing Evolution of Heat by Radium.

a little tube containing radium is dropped into the open mouth of the central tube, the negative rays, or β particles, emitted by the radium, traverse the two thin glass tubes and communicate their charge to the enveloping brass tube. The gold leaf diverges until it touches a platinum wire connected to earth, which discharges it and the brass tube to which it is attached. But a new negative charge at once begins to accumulate and when it has attained a certain value

the gold leaf again touches the platinum wire and a second discharge takes place. These alternate charges and discharges and to-and-fro movements of the gold leaf are repeated indefinitely under the influence of a very small quantity of radium.

Ramsay's Work on the Degradation of Copper to Lithium.

In a recent lecture delivered at Johns Hopkins University, Prof. Ira Remsen remarked that it is an easy matter to explain the work of Sir William Ramsay to any one who is familiar with chemistry. It is correspondingly difficult to make it clear to those who are not familiar with chemistry. In a few words, Ramsay has made it appear probable that when radium emanation is allowed to stand in contact with a water solution of copper sulphate, a very minute quantity of lithium is formed. He believes that this lithium is formed from the copper. If this be true it is evident that the elementary form of matter known as copper, which has hitherto been regarded as unchangeable, is capable of change. It should be emphasized that the extent of this change is very slight indeed, the quantity of lithium formed being too small an amount to be weighed.

Sir William Ramsay is one of the most skillful experimenters in chemistry to-day, and whatever he says is worthy of the most careful consideration. He believes that this transformation has been effected. In a letter dated September 16, received by Prof. Remsen from Sir William Ramsay, in which he tells of his work, there is nothing to indicate that his belief has been shaken. At the same time, in his published article he is cautious and uses the following words: "These experiments must be considered as preliminary. It is necessary first to find out where to search for the unknown before proper experiments can be made." He further says: "It is evident that the research of which the foregoing is a description, is merely a preliminary survey of the field to be explored, and that much work must be done before the tentative hypothesis which has been put forward can be substantiated."

To the chemist and physicist, Ramsay's results are of special interest because they promise to throw light upon that great problem—the constitution of matter. Those who are looking for practical results, using this expression in the ordinary sense, will be disappointed. There would be little advantage to the world even if copper could be transformed into lithium on a large scale, for as has been stated, the change is extremely small, and there is little or no probability that the extent will be markedly increased. There is nothing whatever in Ramsay's results to suggest the possibility of making copper from lithium, and even if this were possible, its manufacture on a commercial basis would be entirely out of the question, for copper is very much cheaper than lithium.

Sir William Ramsay is continuing his experiments, and in the course of time we may expect to learn from him whether his present views receive confirmation. If this should prove to be the case, physicists and chemists will have food for much thought. One of the fundamental problems presented to scientific men is the nature of the elementary forms of matter and their relations to one another. Anything that throws light on this problem is of importance.

Fig. 1.—Demonstrating the Conductivity of Air Under the Influence of Radium.

Fig. 2.—Testing Mineral Water for the Presence of Radium Emanation.

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