

migration of the iodine during electrolysis. If iodine occurs as I^+ it should migrate to the cathode; if it occurs as ICl_2^- it should migrate to the anode. A solution 4 *N* in hydrochloric acid and 1.6 *m* in iodine monochloride was introduced in the apparatus shown in the figure. The beakers surrounding the stopcocks contained pure hydrochloric acid. After passing 15 milliamperes through the closed stopcocks for several hours, the anode beaker, B_1 , had a strong yellow color, while the cathode beaker, B_2 , was colorless. Portions from both beakers were reduced with sodium bisulfite and tested for iodine with starch and chlorine water. Iodine in large amount was invariably found in the anode beaker. The test on the cathode beaker showed no trace of iodine. To show that this was not due to leakage of ICl into the anode beaker, we used fresh acid and reversed the current; again iodine was found in the anode beaker and none in the cathode beaker.

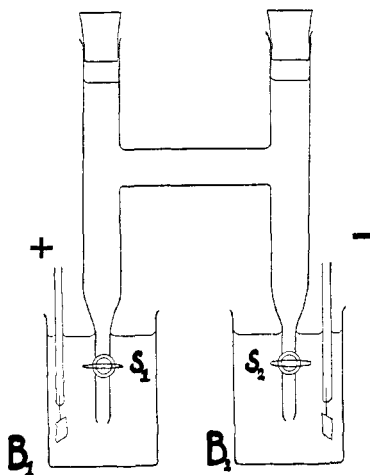


Fig. 1.

We believe that these experiments furnish strong additional evidence that the ion I^+ is present in negligible concentration, if at all, and that iodine monochloride forms extensively a negative complex ion with chloride ion.

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The Preparation of Germanium Tetrabromide and Germanium Tetraiodide

Germanium Tetrabromide.—The only method which has been described for preparing germanium tetrabromide involves the action of bromine vapor on heated metallic germanium.¹ This procedure is laborious since it requires the preliminary preparation of elementary germanium. By modifying the method which Tabern, Orndorff and Dennis² used for the preparation of germanium tetrachloride it was found possible to obtain germanium tetrabromide directly from germanium dioxide and hydrobromic acid.

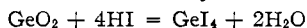
¹ Dennis and Hance, *THIS JOURNAL*, **44**, 299–307 (1922).

² Tabern, Orndorff and Dennis, *ibid.*, **47**, 2039 (1925).

Twenty-five grams of germanium dioxide was suspended in 250 cc. of 48% hydrobromic acid. The mixture was heated to a temperature somewhat short of the boiling point of the hydrobromic acid, and hydrogen bromide, prepared by the method given by Biltz³ from bromine, red phosphorus and water, was passed into the solution until the acid concentration was built up to that of the constant boiling mixture. The reaction by this time had gone almost to completion and it was finished by refluxing for a short time. It is easy to tell when a sufficient amount of hydrogen bromide has been passed into the flask, since up to that point germanium tetrabromide and water (or possibly a dilute acid solution) condense together in the reflux condenser, and the germanium tetrabromide is hydrolyzed to germanium dioxide, which deposits on the condenser tube. As soon as sufficient acidity is reached in the flask, the condensate becomes acid enough to dissolve the germanium dioxide which has been formed in the condenser. When the reaction was complete, as shown by the disappearance of practically all of the germanium dioxide in the reaction mixture and the appearance of two liquid layers in the flask, the mixture was cooled, and the tetrabromide, the lower layer, was separated by means of a separatory funnel. The crude product was separated from traces of unchanged germanium dioxide by distillation. As much as possible of the hydrobromic acid still contained in the distillate was removed by holding the liquid at 26° (the freezing point of germanium tetrabromide), and evacuating the container by means of a water pump which was connected through a drying tube. The final removal of hydrogen bromide was effected by allowing the liquid to stand over solid anhydrous sodium carbonate. The germanium tetrabromide was then redistilled and the middle fraction was found to have the proper boiling point as given by Dennis and Hance.¹ The yield of purified product was approximately 90%.

Germanium Tetraiodide.—As in the case of germanium tetrabromide, germanium tetraiodide had been prepared only by the action of the halogen on metallic germanium, a tedious procedure. Since it had been found that the tetrabromide could be prepared with ease by the action of hydrobromic acid on a suspension of the dioxide, it seemed probable that a similar direct procedure could be used for making the tetraiodide.

Twenty-five grams of germanium dioxide was placed in a flask with 250 cc. of 57% hydriodic acid (constant boiling) and the flask was fitted with a distilling column connected with a condenser. The mixture was heated by means of an oil-bath, the temperature of which was not permitted to rise above 160°. Water was formed by the reaction



but by the use of the distilling column it was possible to remove water and

³ Biltz, "Laboratory Methods of Inorganic Chemistry," translated by Hall and Blanchard, John Wiley and Sons, Inc., New York, 1928, p. 71.

keep the solution acid enough so that the reaction went in large measure to completion. As the reaction proceeded red crystals of germanium tetraiodide collected in the bottom of the flask. The tetraiodide was removed from the cold reaction mixture by filtering on a Büchner funnel and was dried in the air on a porous plate. Some unchanged germanium dioxide contaminating the tetraiodide was removed by treating the crude product with boiling carbon tetrachloride, filtering the hot solution, and crystallizing the tetraiodide from the filtrate. The yields of two separate experiments were 80 and 85% and it seems probable that stirring would increase these since the germanium tetraiodide tends to form a protective layer around the unchanged germanium dioxide.

The purified material had a melting point of 146° , the determination being made on the electric bar described by Dennis and Shelton.⁴ This agrees well with the value 144° obtained by Dennis and Hance¹ using the older capillary tube method. Analyses for germanium showed that the sample was pure.

⁴ Dennis and Shelton, *THIS JOURNAL*, **52**, 3128 (1930).

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Note on Some Periodical Properties of Atomic Nuclei.—In a recent paper Latimer¹ has described an interesting model of the nucleus of an atom consisting of a number of tetrahedra. Each of them, representing an α -particle, is built of four protons located at the corners and two electrons located in the center.

Taking such tetrahedra as elements it is easy to build larger tetrahedra consisting each of 4, 10, 20, 35 and 54 elements. The numbers of protons in such nuclei will be as follows: 16, 40, 80, 140 and 216.

If we assume, now, that atomic nuclei having analogous geometrical forms must have also analogous physical properties, we must expect some periodic regularities in the system of atomic nuclei arranged according to their weight. It is possible to prove this in the following ways.

(1) Representing the number of additional nuclear electrons in a nucleus built from α -particles as a function of the atomic weight N and taking mean values for each N , we obtain a periodic curve, the periods corresponding well to the above-mentioned law (Fig. 1).²

(2) Representing the numbers of isotopes Q as a function of N , we obtain

¹ Wendell M. Latimer, *THIS JOURNAL*, **53**, 981 (1931).

² R. A. Sonder, *Z. allgem. anorg. Chem.*, **192**, Heft 3 (1930).