TABLE VI.

Vapor-Tensions of Mixtures of Benzene and Chloroform at 34.8°.
Vapor-Tension of Benzene at 34.8° is 145.4 mm. of Mercury.
Vapor-Tension of Chloroform at 34.8° is 289.2 mm. of Mercury.

Molecules $CHCl_3$ in 100 molecules of liquid mixture.	Molecules $CHCl_3$ in 100 molecules of gaseous mixture.	Grams $CHCl_3$ in vapor.	Grams C_6H_6 in vapor.	Tension of $CHCl_3$ in mm.	Tension of C_6H_6 in mm.	Volume of air in cc.	Barometer in mm.	Internal pressure in mm.
16.97	24.30	0.3243	0.6607	39.6	123.5	1032	755	25
50.53	63.74	1.1513	0.4187	130.7	74.3	1030	756	25
59.47	73.25	1.4770	0.3531	162.2	59.2	1030	749	25

[TO BE CONTINUED.]

[CONTRIBUTION FROM THE JOHN HARRISON LABORATORY OF CHEMISTRY. NO. 2.]

THE ELECTROLYTIC DETERMINATION OF RUTHENIUM.

BY EDGAR F. SMITH AND HARRY B. HARRIS.

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FROM time to time efforts have been made in this laboratory to gather information upon the deportment of the metals of the platinum group toward the electric current. Palladium, platinum, and rhodium have been determined quantitatively, and also separated electrolytically from other metals of the group, *e. g.*, palladium from iridium. The purpose of this communication is to present data relating to the electrolysis of ruthenium salt solutions. The literature of electrolysis does not contain any information upon this point.

The salt upon which the experiments were made was the double chloride of potassium and ruthenium. It was prepared by fusing the finely divided metal with potassium nitrate and hydroxide. This fusion was made in a silver crucible. The aqueous extract was acidified with hydrochloric acid, and the solution was then evaporated to crystallization. Much potassium chloride separated at first, but finally the double salt appeared in minute red-colored needles.

The platinum dish in which the electrolytic decomposition was carried out was coated upon its inner surface with a layer of copper. In the first trials the solution of the double salt was mixed with three grams of sodium acetate, and acted upon by a current of $N.\ D._{100} = 0.01$–0.05 ampere. The quantity of the ruthenium salt not being very abundant it was necessary to conduct the determinations with rather small amounts of material.

Thus, fifty cc. of the double chloride solution contained 0.0593 gram of ruthenium metal. The results of four trials were:

1	0.0119 gram of ruthenium in five cc. of solution, equal to 0.0595 gram in fifty cc.
2	0.0589 gram in fifty cc. of solution.
3	0.0593 " " " "
4	0.0590 " " " "

The metal deposit in each instance was dull black in color. A tendency to sponginess was also observed.

As other metals of the platinum group had been precipitated successfully from a phosphate solution (*Am. Chem. J.*, **13**, 206) ruthenium was tried under similar conditions.

In the experiments that follow, fifty cc. of the salt solution contained 0.0407 gram of metal. Fifteen cc. of disodium phosphate (1.0358 sp. gr.) and one cc. of phosphoric acid were added to this solution. The current was of the same strength as that used in the first series of experiments. The metallic deposits weighed:

1	0.0402 gram.
2	0.0407 "
3	0.0413 "

The ruthenium in each instance was bright and steel-like in appearance. It was also very adherent. There was not the slightest indication of sponginess. In the two series just given the deposit of metal was washed first with warm water, and subsequently with absolute alcohol. The period of precipitation continued through the night, although six hours were found to suffice for the complete deposition of the ruthenium.

In a third series of two trials, fifty cc. of the salt solution contained 0.0100 gram of ruthenium. The phosphate, phosphoric acid, and the current were the same as in the series immediately preceding. Results:

1	0.0101 gram ruthenium.
2	0.0100 " "

The deposits, as before, were bright and apparently crystalline.

Mention has already been made that palladium and platinum could be separated electrolytically from iridium (*Am. Chem. J.*, **16**, 435) when present together with the latter in a phosphate solution. This was, however, not found possible with rhodium, although this metal was successfully deposited from a similar solution. As ruthenium, from the results just given, allies itself with palladium, platinum, and rhodium, so far as its deposition from a phosphate solution was concerned, it seemed of interest to ascertain whether a separation of it from iridium could be effected.

Separation of Ruthenium from Iridium.—Here again a solution of ruthenium was used in fifty cc. of which there was 0.0100 gram of ruthenium. To this were added ten cc. of an iridium solution (equal to one-tenth gram of iridium), ten cc. of disodium phosphate, 1.0358 sp. gr., and three cc. of phosphoric acid. The current was $N. D._{100} = 0.01$ ampere. It acted through the night. The deposit of ruthenium in each of the three experiments was bright, metallic, and perfectly adherent. It was washed and dried as in the determinations described in the preceding lines. Results:

1	0.0104 gram of ruthenium.
2	0.0096 " " "
3	0.0100 " " "

Additional experiments on the separation of the two metals were made with similar results.

It would be of interest and value to study the conduct of ruthenium in alkaline solutions. Wöhler[1] observed that the metal could be quickly brought into solution when the current acted upon it in the presence of an alkali. It is altogether probable that, under such conditions, its separation from the other metals of the group could be quite readily brought about, but lack of material will, at least for the present, prevent any such investigation.

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[CONTRIBUTION FROM THE JOHN HARRISON LABORATORY OF CHEMISTRY. NO. 3.]

THE ACTION OF PHOSPHORUS PENTACHLORIDE UPON THE DIOXIDES OF ZIRCONIUM AND THORIUM.

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SOME years ago Weber (*Jahr. 1859*, 77) studied the action of phosphorus pentachloride upon inorganic oxides, such as those of silicon, titanium, and tin, and demonstrated that the

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[1] *Ann. Chem.* (*Liebig*), 146, 375.