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.

UNIVERSITY OF PENNSYLVANIA.

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

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

BY EDGAR F. SMITH AND HARRY B. HARRIS.

Received May 31, 1895.

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

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

products of the reaction were the corresponding metallic chlorides, together with phosphorus oxychloride. Tüttschew (*Jahr. 1867*, 205), working upon titanium dioxide with a modified method, obtained a double chloride corresponding to the formula $TiCl_4.PCl_5$.

It seemed to us of some interest to extend the study to the oxides of zirconium and thorium, thus completing the reaction with the more metallic bodies of Group IV of the periodic system. The procedure adopted by us consisted in introducing ignited and pure zirconium dioxide with its equivalent of phosphorus pentachloride into hard glass tubes, which were sealed after the air had been exhausted from them. The reaction appeared not to occur at 150° C., but after heating to 190° C., for a period of eight hours, a complete change was observed. A crystalline mass was noticeable and drops of phosphorus oxychloride were scattered through the tubes. These were opened at both ends and quickly connected with a chlorine generator, and distillation carried out by careful heating in an air-bath. Phosphorus oxychloride and some pentachloride were expelled. At 190° C., crystals made their appearance in the cooler part of the tube, projecting beyond the air-bath. These were transparent and almost half an inch in length. That portion of the tube in which they had collected was severed, tightly closed, and weighed. It was then introduced into water. A hissing sound was quite distinct. Zirconium hydrate soon separated. After standing a while this was dissolved in dilute nitric acid, and reprecipitated with ammonia. Later it was found that to let the weighed chloride slowly absorb moisture from the air and then bring it into water insured better results. The percentage of zirconium found equaled 37.52 per cent., while the chlorine was 61.62 per cent. The theoretical requirements for the tetrachloride are 38.79 per cent. of zirconium and 61.21 per cent. of chlorine. Our zirconium result is low, yet the figures from three or four analyses concord so closely that there can be no question as to the correct nature of our product. A compound of zirconium chloride with either phosphorus pentachloride or oxychloride would require decidedly less zirconium and more chlorine. Hence, we can safely conclude that with our conditions of experiment phosphorus pentachloride changes zirconium dioxide to the corresponding chloride. Thorium dioxide was subjected to a similar treatment. The temperature, however, at which the reaction seemed to proceed almost to completion was about 240° C. Exactly the same course was pursued in subsequently eliminating the excessive phosphorus compounds. The product analyzed showed the presence of a little phosphorus, not enough to establish the existence of a double chloride, therefore its quantity was deducted from the quantity of material used in the analysis. The thorium found equaled 62.23 per cent. and the chlorine 38.37 per cent., while the theoretical requirements for thorium tetrachloride are 62.23 per cent. thorium and 37.77 per cent. chlorine.

Our experiments supplement the investigations of Weber and justify the general inference that the dioxides of all the metallic members of Group IV are changed to tetrachlorides when heated under pressure with phosphorus pentachloride.

UNIVERSITY OF PENNSYLVANIA.

NEW BOOKS.

A TEXT-BOOK OF CHEMISTRY INTENDED FOR THE USE OF PHARMACEUTICAL AND MEDICAL STUDENTS. BY SAMUEL P. SADTLER AND HENRY TRIMBLE. Octavo, pp 950. Philadelphia: J. B. Lippincott & Co., 1895.

The title on the cover is "Pharmaceutical and Medical Chemistry," from which it is to be regretted that the authors did not omit the word "Medical," as its use compels a remonstrance against the view which they apparently entertain, that the needs of the medical student in the department of chemistry do not extend beyond the study of the properties of drugs and the methods of chemical manufacture. Physiological, hygienic and toxicological chemistry are almost utterly ignored. A mere outline of the chemistry of urea is compressed into less than a page, while more than two pages are devoted to alizarin. Serum albumen is dismissed in four lines, without a word about the testing of urine for albumen. The discussion of the degrees of purity of natural waters is barely hinted at in a few lines, without any reference to the methods of examination of water, even