tential) and the corresponding pH value. The equation for this relationship is

$$\text{Log}_{10} E = -0.0633\ p\text{H} + 0.4080$$

where E is the absolute potential of the benzaldehyde electrode.

In contrast to the quinhydrone system, the benzaldehyde system is irreversible. The chemical change involved seems to be the reduction of benzaldehyde to benzyl alcohol; hydrions and electrons both being present, a potential with reference to the other half-cell (calomel) is influenced by the pH of the solution into which the benzaldehyde is stirred.

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RECEIVED AUGUST 2, 1934

THE ATOMIC WEIGHT OF PROTACTINIUM

Sir:

Part of the one tenth gram of protactinium oxide, recently isolated by M. S. Agruss and the writer [THIS JOURNAL, **56,** 2200 (1934)] has been used for the first direct determination of the atomic weight of protactinium. An x-ray photograph of this material kindly taken by Dr. W. C. Pierce had shown no impurities.

The classical method of M. C. de Marignac [*Ann. chim. phys.* [IV] **9,** 250 (1866)] for tantalum was utilized for this determination. Potassium protactinium fluoride (K_2PaF_7) was prepared from the oxide. It crystallizes in beautiful colorless sharp long needles, very insoluble in water containing 0.5% of hydrogen fluoride. It is stable in air and can easily be dried to constant weight at 20 or 100°. This was reconverted into the oxide by fuming with sulfuric acid, diluting with water, precipitating with ammonia, filtering the hydroxide, and igniting and weighing as oxide. All operations were carried out in and with platinum equipment. All the chemicals were highly purified. A very sensitive ultra microbalance [K. W. H. Kühlmann, Hamburg, Germany] was used; all weights were corrected to vacuum. Further details will be given in a subsequent paper.

The first preliminary analysis gave 61.18 parts of the oxide and 39.67 parts of potassium sulfate per 100 parts of potassium protactinium fluoride. Assuming the formula to be K_2PaF_7 and protactinium to have an atomic weight of 231, 61.29 and 39.40 parts, respectively, should have been obtained. This agreement definitely establishes the pentavalency of protactinium and the formula Pa_2O_5 for the oxide.

The two final determinations gave the following results:

K_2PaF_7, g.	Pa_2O_5, g.	$2K_2PaF_7$:Pa_2O_5	At. wt., Pa
0.091907	0.056274	1.6332	230.4
.070047	.042913	1.6323	230.8

For the atomic weights of the other elements the 1934 values of the International Committee were used [G. P. Baxter, Mme. P. Curie, O. Hönigschmid, P. Lebeau and R. J. Meyer, THIS JOURNAL, **56,** 753 (1934)].

The mean value of the atomic weight of protactinium is 230.6, or in whole numbers 231, with an accuracy of about ±0.5 unit. This value is in complete agreement with F. W. Aston's results on actinium lead (AcD = 207), obtained by means of his mass spectrograph.

For a precision atomic weight determination the analysis of the recently discovered $PaCl_5$ [A. V. Grosse, THIS JOURNAL, **56,** 2200 (1934)] will probably be more suitable; however, the latter can be used to its full advantage only when larger quantities of protactinium will be available. Such a determination is planned in the future.

We are much indebted to the management of the Universal Oil Products Co., Chicago, for placing at our disposal the facilities of their Research Laboratories.

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RECEIVED OCTOBER 3, 1934

HALOGENATION INHIBITION BY OXYGEN

Sir:

Bauer and Daniels [THIS JOURNAL, **56,** 2014 (1934)] present evidence for the inhibition of the halogenation of cinnamic acid by oxygen and in their last paragraph suggest that the influence of oxygen on reactions of this type may be quite general.

In these Laboratories the inhibiting effect of oxygen on certain halogenation reactions has been observed in many instances, and is the subject of patents granted to this Company.