COMMUNICATIONS TO THE EDITOR

THE RELATIVE ATOMIC WEIGHT OF OXYGEN IN WATER AND IN AIR

Sir:

Washburn, Smith and Smith [*Bur. Standards J. Res.*, **13**, 599 (1934)] burned oxygen and hydrogen from an electrolytic cell separately with "normal" hydrogen and oxygen, respectively, obtaining in the first fraction a difference of density in p. p. m., γ, between these waters and normal water -13.2 for the cell oxygen plus "normal" hydrogen and -7.8 for the cell hydrogen plus atmospheric oxygen. The cell hydrogen and oxygen burned together gave water of γ value, -20.5, approximately the sum of the first two data. A little reflection will show that if this work is correct, there is no difference between the atomic weight of oxygen in air and in water. Unfortunately it now appears that due to an unlucky compensation of effects this agreement is merely a coincidence and that there is a significant difference in the atomic weight of oxygen from the two sources.

I have electrolyzed water made from tank hydrogen and Linde oxygen (whose atomic weight in reference to atmospheric oxygen was corrected for) and burned the oxygen with tank hydrogen. Two electrolyses gave γ equal to -6.9 for this water. Two electrolyses of normal water, followed by combustion of the oxygen with the same tank hydrogen gave water having a γ value of -11.5; the difference between the results is 4.6, from which the atomic weight of oxygen in the air can be calculated to be 16.00008 if the atomic weight of oxygen in Lake Michigan water is 16.00000.

Understanding this fact makes easy the explanation of several anomalous and unexplained results of other workers. In the work of Washburn mentioned above neither his tank hydrogen nor his oxygen was "normal," *i. e.*, had the same atomic weight as the two elements in water, the hydrogen being too light and the oxygen too heavy. It is also clear why Washburn, Smith and Smith's conclusion that the oxygen isotopes fractionate more rapidly than those of hydrogen on electrolysis is erroneous. Greene and Voskuyl's [This Journal **56**, 1649 (1934)] anomalous finding that tank hydrogen burned with air resulted in water denser than normal is explained, and the results of W. Heinlen Hall and Johnston [This Journal, **57**, 1515 (1935)] indicating that the isotopes of hydrogen fractionate on combustion will now have to be largely modified. The increase in density of water obtained by myself and many others in the combustion of organic substances will have to be reinterpreted.

Incidentally the data reported here confirm the prediction of Urey and Greiff [This Journal, **57**, 321 (1935)] that when water and oxygen are brought into equilibrium, the O^{18} concentrates in the oxygen, and the conclusion that it is meaningless to express the atomic weight of oxygen to more than four decimal places.

It is hoped to repeat more accurately the experimental work described in this paper.

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Received November 18, 1935

THE PREPARATION OF 9,10-DIHYDROPHENANTHRENE AND ITS DERIVATIVES

Sir:

The selective activity of copper–chromium–barium oxide catalyst permits the expectation that in phenanthrene only, or chiefly the 9,10-double bond, which in some respects exhibits a decidedly olefinic character, would be saturated by hydrogenation in the presence of this catalyst.

Phenanthrene, purified according to Cohen and Cormier [This Journal, **52**, 4363 (1930)] and treated with, and distilled over sodium, was dissolved in 2 to 3 parts of absolute alcohol and mixed with about 10% (by weight) of catalyst 37 KAF [Connor, Folkers and Adkins, *ibid.*, **54**, 1138 (1932)]. The hydrogenation was carried out at pressures from 2000 to 4000 lb./sq. in., maintaining a temperature of 220° for twenty-four to thirty-six hours. After separating from the reaction mixture 10 to 20% of unchanged phenanthrene (as the picrate), 60 to 80% of crude 9,10-dihydrophenanthrene was obtained (after distillation *in vacuo*). No tetrahydro- or octahydrophenanthrene could be detected. The