sulphate, sodium chloride and iodine in water, and of iodine in alcohol and in ether, and at 25° of arsenious oxide in water are described. Not one of these substances gives evidence of any slow chemical change accompanying the process of solution. Even in the case of the arsenious oxide, in regard to which a contrary opinion has long prevailed, this has been clearly demonstrated by the dependence of the rate of solution on the surface of contact between the solid and solution and by obtaining in fifteen minutes, with very thorough mixing, a value of the solubility, 20.6 grams As_2O_3 per liter, substantially identical with that obtained by Bruner and Tolloczko after eighteen hours stirring.

BOSTON, MASS., July, 1904.

[CONTRIBUTION FROM THE JOHN HARRISON LABORATORY OF CHEMISTRY, No. 81.]

THE ATOMIC WEIGHT OF TUNGSTEN.

BY EDGAR F. SMITH AND FRANZ F. EXNER.

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THE atomic weight of tungsten having received attention at various times, during recent years, in this laboratory, we were induced to institute a new series of experiments in this direction inasmuch as we had, after much labor, obtained pure tungstic acid[1] from which were prepared large quantities of pure hexachloride and also pure metal. Roscoe has stated that when tungsten hexachloride is directly decomposed with water and the resulting acid ignited to oxide, the latter will contain chlorine which cannot be expelled by heat. We had hoped to pursue this method, but as it had the condemnation of so high an authority the hexachloride was introduced into freshly distilled ammonia water, contained in a weighed platinum dish, with the expectation of eventually getting ammonium tungstate and chloride which would leave the trioxide upon ignition. Experience showed that the quantity of the resulting ammonium chloride was so great that even with the most careful ignition there was much danger of expelling mechanically appreciable amounts of the oxide. Nor was it forgotten that it is very doubtful whether from such a mixture the chlorine could be completely removed by heat.

[1] *Proc. Am. Phil. Soc.*, **43**, 123.

The treatment of the hexachloride directly with nitric acid was also found impracticable.

In spite of Roscoe's objection to the decomposition with water it was believed that the transposition could be carried out. Five glazed No. 2 porcelain crucibles of 40 cc. capacity were selected, thoroughly cleansed and ignited, allowed to cool in vacuum desiccators and weighed upon a specially constructed Troemner balance, sensitive to $^1/_{40}$ of a milligram. There was next introduced into each one of them tungsten hexachloride from a weighing-bottle which was reweighed after the removal of each portion. The crucibles with their chloride content were placed on water-baths and cold distilled water introduced into each. When the volume of water was insufficient for the quantity of chloride, sufficient heat was generated by the reaction to make the water boil and spattering followed. At 60° the decomposition proceeded quietly to the hydrated trioxide, which, at the beginning, had a slight greenish-yellow color, due probably to the imperfect decomposition, as mentioned by Roscoe, but this tint disappeared as the hydrochloric acid was expelled. When the mass was perfectly dry a few drops of pure concentrated nitric acid were introduced from a pipette upon the trioxide. Instantly any green tint vanished and was replaced by a rich orange-yellow color. The excess of nitric acid was slowly evaporated away and the oxide assumed a pale yellow hue.

The crucibles were now removed from the water-bath, and after careful drying were ignited for half an hour to a dull red heat, then allowed to cool in the desiccator, and at the expiration of an hour and a half were weighed.

In the calculations the values for oxygen and chlorine were taken at 16 and 35.45 respectively. The specific gravity of tungsten trioxide was found to be 7.157 and that of tungsten hexachloride 3.518.

Seven different series of determinations were made, each from a different sample of hexachloride. The results appear in the table on the following page.

It should be mentioned here that at the conclusion of these experiments etching or corrosion of the glaze of the crucibles could not be observed. Nor was there any stain upon them; they looked as if they had been unused.

No. of exp.	No. of series.	Weight of WCl_6 corrected for vacuum in grams.	Weight of WO_3 corrected for vacuum. in grams.	Atomic weight of W.	Means of series.	Mean of means.
1		3.18167	1.86085	184.04		
2	I	2.66612	1.55903	183.94	184.01	
3		3.52632	2.06244	184.05		
4		1.52117	0.88972	184.07		
5		1.22299	0.71523	184.00		
6	II	2.28445	1.33603	184.01	184.04	
7		3.25404	1.90337	184.10		
8		3.37078	1.97133	184.01		
9	III	7.76488	4.54082	183.98	183.98	
10		2.08764	1.22114	184.11		
11		2.80141	1.63859	184.09		
12	IV	3.24328	1.89681	184.02	184.08	184.04
13		4.97975	2.91262	184.06		
14		3.04036	1.77838	184.10		
15		4.31046	2.52133	184.10		
16		2.21201	1.29381	184.07		
17	V	2.70368	1.58135	184.06	184.06	
18		3.60658	2.10934	184.03		
19		2.63037	1.53835	184.02		
20		3.41668	1.99808	184.07		
21		3.49940	2.04675	184.06		
22	VI	3.86668	2.26145	184.05	184.04	
23		3.40202	1.98970	184.03		
24		3.20661	1.87533	184.01		
25		3.26386	1.90909	184.09		
26	VII	6.73833	3.94031	183.94	184.06	
27		7.37889	4.31643	184.14		

For the sake of comparison it was determined to reoxidize metal to trioxide and ascertain how well the atomic weight deduced in this manner would agree with that found from the conversion of the hexachloride into trioxide. Accordingly, portions of pure metal were weighed out into the same crucibles which had been used in the experiments with the hexachloride and gently heated with air contact. The steps in the ignition were those which any careful analyst would observe, so that they need not be mentioned here. The final oxide was uniformly yellow in color throughout its entire mass.

The weighings here, as in all previous experiments, were reduced to vacuum standard. The value of oxygen was placed at 16.

The specific gravity of the oxide was, as before, 7.157, and that of the metal 19.

In the appended table it is to be understood that each single series was made from portions of the same sample of metal. The results are:

No. of Exp.	No. of Series.	Weight of W. in grams.	Weight of WO_3 in grams.	Atomic weight of W.	Means of series.	Means of means.
1	I	2.24552	2.83144	183.96	183.96	
2	II	1.78151	2.24619	184.07	184.07	
3		1.63590	2.06270	183.98		
4	III	1.38534	1.74665	184.04	184.04	
5		1.29903	1.63774	184.09		
6		2.01302	2,53781	184.12		
7	IV	2.18607	2.75632	184.01	184.09	
8		2.36755	2.98478	184.12		
9		1.94958	2.45781	184.12		
10		4.43502	5.59141	184.09		
11		2.37603	2.99548	184.11		
12	V	2.58780	3.26260	184.08	184.10	184.065
13		2.58503	3.25886	184.14		
14		2.38298	3.00441	184.06		
15		2.05578	2.59169	184.13		
16	VI	3.60828	4.54915	184.08	184.11	
17		6.22621	7.84949	184.11		
18	VII	5.28444	6.66239	184.08	184.08	
19	VIII	3.99095	5.03138	184.12	184.12	
20	IX	7.30166	9.20647	184.00	184.00	
21		3.44143	4.33870	184 10		
22	X	2.67709	3.37541	184.01	184.08	
23		4.96735	6.26229	184.13		

In Series VII, a very large quantity of oxide was heated in hydrogen from 9 A.M. until 5 P.M. The resulting metal was placed over night in a desiccator, and on the following day a portion of it was weighed out for the eighteenth experiment, the remainder being heated for a day more in hydrogen. After standing over night, a second portion was removed and used in Experiment 19. The remainder was exposed all of the third day to the action of hydrogen, and was then oxidized for Experiment 20.

Had not the first reduction been complete, the results would not have agreed so well.

The mean atomic value from the hexachloride is 184.04, that from the oxidation of metal 184.065, or the average of the two independent series is 184.05, which probably approximates the truth very closely and may be safely regarded as the atomic weight of tungsten.

[CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS.]

THE NITROGENOUS CONSTITUENTS OF FLESH.[1]

BY H. S. GRINDLEY.

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(PRELIMINARY PAPER.)

THE results reported in this paper form a part of an extended investigation which has for its object a study of the chemistry of the nitrogenous constituents of the flesh of meats. The present knowledge of both the proteïd and the non-proteïd substances occurring in the animal body is very incomplete. The past researches upon the proteïds of animal substances have been almost, if not entirely, confined on the one hand to the proteïds of blood, and on the other hand to the proteïds of muscle freed from blood. However, flesh as sold for food always contains more or less blood. From the standpoint of physiological chemistry, in the study of the chemistry of the digestion of meats, and also in the study of the nutritive value of foods, it is highly desirable that the present very limited knowledge of the nitrogenous principles of flesh, as they exist in meat as used for food, be increased.

As it was impossible to find any definite data regarding the extent of the solubility of the different nitrogenous constituents of flesh in cold or hot water or in dilute solutions of acids, alkalies or salts, it was deemed necessary for the future work of this investigation to study somewhat carefully this question. In the first place this was done by extracting flesh successively with the following reagents: Cold water, 10 per cent. sodium chloride solution, 0.15 per cent. hydrochloric acid solution, 0.15 per cent. potassium hydroxide solution and, lastly, with hot water.

1 The expenses in connection with this research have been in part defrayed out of a grant from the Elizabeth Thompson Science Fund.