TEST SOLUTIONS OF THE UNITED STATES PHARMACOPŒIA.*

N. A. DUBOIS AND O. H. STRINGER.

Ever since Dr. Lyman Spalding in the year 1817 proposed the formation of a National Pharmacopœia, the subject matter of the U. S. P. has been of the utmost interest and importance both to the pharmacist and the physician. This publication has, by the efficient efforts of various revision committees, passed through eight revisions each of which has brought out new and important advancement; until in the present Eighth Decennial Revision we have an admirable representation of the wonderful efforts of the American people in a strife for the higher ideals of a more ethical, scientific, and righteous standard.

Since, however, man is not omniscient and his mental machine not a perfect one as yet, we find that this standard is not absolutely perfect and necessarily these revisions must go on; and in accordance with the rapid advances in scientific knowledge which our thinkers and research workers are giving us in all branches.

Our work should always be for something better. Something which will help to make knowledge easier to acquire, easier to retain and more definite. Anything which will save time or labor either mentally or physically, or increase the efficiency in the gaining of knowledge or the making of a product, therefore, must be considered as a step in advance.

It seems that the present test solutions of the U. S. P. furnish material for thought along these lines.

In the table are given some of the Test Solutions as found in the Eighth Decennial Revision of the U. S. P. These are simply taken at random from among the solutions frequently used in the regular qualitative tests.

For convenience, they have been arranged in groups of corresponding normality concentrations.

The very concentrated acids and ammonia water are purposely left out because they must necessarily always be of the percentage strength or concentration at which the manufacturer furnishes them to the trade.

Column No. 1 gives the number of the solution as it is here considered, Column No. 2 the name of the chemical, Column No. 3 the chemical formula, Column No. 4 the U. S. P. concentration and Column No. 5 the corresponding weights to produce solutions which are chemically equivalent to each other or a simple multiple of equivalent.

The solutions have also been arranged in normality concentrations which have been found convenient and to give good results in a testing laboratory.

The table must not be taken as in any wise complete, but is simply given as an illustration of conditions as they exist. The figures in brackets give the number of the test solution in the U. S. P.

A brief consideration of this table will show at once that there is no general relation whatever between any two test solutions and their chemical equivalence; and furthermore, no attention is paid to the water of crystallization in the U. S.

*Read before the Northern Ohio Branch, March 1, 1912.

P. concentration, whereas, this must always be weighed with the chemical and should be considered, as it is in the weights taken for the normality concentration.

No.	Name	Acids Dilute, Formula	U. S. P. Concentration	Normality Concentration. Double Normal 2N
1	Hydrochloric Acid (46)......	HCl	10%=100 gms. per 1000 c.c.	72.92
2	Nitric Acid (71)............	HNO_3	10%= " " " " "	126.10
3	Sulphuric Acid (118)........	H_2SO_4	10%= " " " " "	98.08
4	Acetic Acid (2).............	$HC_2H_3O_2$	6%= 60 " " " "	120.08
5	Tartaric Acid (120)..........	$C_4H_6O_6$ in	3%=333.33 " " " "	150.06
		Alkalies Dilute.		
6	Sodium Hydroxide (108).....	$NaOH$	5%= 50 gms. in 1000 c.c.	80.12
7	Potassium Hydroxide (90)...	KOH	5%= 50 " " " "	112.32
8	Ammonium Hydroxide (7)...	NH_4OH	10%=100 " " " "	70.18
		Salts.		
9	Ammonium Carbonate	$(NH_4)_2CO_3$	Not given in the U. S. P....	96.16
10	Ammonium Carbonate (8)...	$NH_4HCO_3NH_4NH_2CO_2$	20%=200 gms. per 1000 c.c.	157
11	Ammonium Chloride (9).....	NH_4CL	10%=100 " " " "	107.06
12	Sodium Carbonate (106).....	$Na_2CO_3.H_2O$	10%= " " " " "	124.10
				Normal N
13	Barium Chloride (19)........	$BaCl_2.2H_2O$	10%= " " " " "	122.17
14	Calcium Chloride (26).......	$CaCl_26H_2O$	10%= " " " " "	109.51
15	Cobalt Nitrate (32)..........	$CO(NO_3)_26H_2O$	10%= " " " " "	146.00
16	Ferric Chloride (41).........	Indefinite — not less than 22% metallic iron in form of chloride—	10%=100 gms. in 1000 c.c. $FeCl_3$	54.11
17	Lead Acetate (55)...........	$Pb(C_2H_3O_2)_2.3H_2O$	10%=100 gms. in 1000 c.c.	189.51
18	Magnesium Sulphate (59)....	$MgSO_4.7H_2O$	10%=100 " " " "	123.28
19	Mercurous Nitrate (56)......	$HgNO_3$	10% of mercury=131.27....	262.34
20	Potassium Dichromate (86)...	$K_2Cr_2O_7$	5%= 50 gms. in 1000 c.c.	49.08
21	Potassium Ferrocyanide (89).	$K_4Fe(CN)_6.3H_2O$	10%=100 " " " "	105.72
22	Sodium Acetate (103)........	$NaC_2H_3O.3H_2O$	10%=100 " " " "	136.14
23	Sodium Phosphate (111).....	$Na_2HPO_4.12H_2O$	10%=100 " " " "	119.45
24	Stannous Chloride (115).....	$SnCl_2.2H_2O$	10%=100 " " " "	112.72
				Half Normal N/2
25	Ammonium Oxalate (11).....	$(NH_4)_2C_2O_4.H_2O$	4%= 40 " " " "	35.54
26	Copper Sulphate (36)........	$CuSO_4.5H_2O$	10%=100 " " " "	62.44
27	Mercuric Chloride (60)......	$HgCl_2$	5%= 50 " " " "	67.8

To speak briefly, consider solutions 1 and 6 made according to the U. S. P. Here we have a solution of hydrochloric acid and one of sodium hydroxide.

The ratio of their respective concentrations per unit volume is 100 to 50. In order that the unit volume of the two solutions should be chemically equivalent, this should be 72.92 to 80.12, numbers vastly different from the U. S. P. ratio.

Again consider the U. S. P. weight ratio for solutions. (2) (Nitric Acid) and (8) (Ammonium hydroxide) which is 100 to 100, while the ratio of the weight for a double normal solution of each of these is 126.10 to 70.18. This means of course that if made according to the U. S. P. it would be necessary to go through a calculation to find the number of cubic centimeters of the two solutions equivalent to each other, which gives approximately 126 cc. of the Nitric Acid solution to neutralize 70 cc. of the ammonium hydroxide, whereas if made double normal in both cases we know at once that the same number of cc. of both solutions are equivalent, or 100 cc. of nitric acid would neutralize 100 cc. of ammonium hydroxide.

The convenience accompanying the use of solutions of relative normality equivalent strength is easily seen, even when the sole use is for qualitative tests. One readily becomes accustomed to the volume of precipitate caused by say one cubic centimeter of a normal solution of a certain precipitant. Knowing this and the volume of precipitate of similar composition produced by one cubic centimeter of an unknown solution he can readily estimate the approximate concentration of the particular element in his unknown. It is well known that by this method one can with a little practice estimate within a very few per cent. as to the purity of a salt from a qualitative test or as to the per cent. of a certain impurity in it.

On the other hand, these solutions of relative normality concentration might be made a means of great convenience and time saving in making certain preparations. It is only necessary to keep in mind that equal volumes of all solutions of the same normality are equivalent chemically. That is, one cubic centimeter of any double normal solution will exactly react with one cubic centimeter of any other double normal solution, if a reaction takes place at all. The same thing of course holds for normal and for half normal solutions. Thus 100 cc. of any double normal solution will react with 100 cc. of any other double normal solution, 200 cc. of any normal solution and 400 cc. of any half normal solution.

As an example of a simple class of preparations, suppose it is desired to make a normal solution of ammonium acetate, i. e., one containing one gram molecule per liter (63 grams $NH_4C_2H_3O_2$) or 6.3 gms. in each 100 cc. It is simply necessary to mix 50 cc. of ammonium hydroxide (solution 7 in the table) with 50 cc. of acetic acid (solution 4 in the table).

As an example of the application of these solutions in a more complicated preparation, let us consider the making of Ammoniated Mercury or White Precipitate (mercuric amido chloride—NH_2HgCl). This is made from the solutions of mercuric chloride and ammonium hydroxide. These as is seen from the table are half normal and double normal respectively or $HgCl_2 = N/2$ and $NH_4OH = 2N$. Since normal solutions are equivalent and the mercury bichloride is one-fourth the normal concentration of the ammonium hydroxide, the volumes of these two solutions must be mixed in the inverse ratio of 400 cc. of $HgCl_2$ N/2 to 100 cc. of NH_4OH 2N.

It is evident that the precipitate will weigh approximately four times the equivalent of 100 cc. of a half normal solution or the equivalent of 100 cc. of a double normal solution, and therefore, since mercuric amido chloride is a divalent salt, it will weigh one-tenth of a gram molecule and by simple inspection of the molecular weight of NH_2HgCl — 249.61, we have 24.9 grams.

In conclusion it may be said that the use of stock solutions related to the normal solution will in many cases save time and labor in the way of quantitative operations, when only approximations are necessary and will also be effective in materially simplifying calculations and shortening the time necessary in making many preparations.

CLEVELAND SCHOOL OF PHARMACY, DEPT. OF WESTERN RESERVE UNIVERSITY.