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Evaluation of Quantitative Experiments

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EVALUATION OF QUANTITATIVE EXPERIMENTS

MELVIN MUELLER AND R. W. GETCHELL

The purpose of this evaluation of quantitative experiments for general college chemistry was; first, to learn the different types of quantitative experiments used; second, to examine the methods or instructions given; third, to run a few trials to discover the range of error expected; and fourth, to determine the cause of error in some cases.

It was the aim to carry out all trials as a general chemistry student would, using a good grade horn pan balance with a \$6.00 set of weights. At least three trials were run to determine the expected range of error and to give a basis for determining the desirability of the method or material used. In no case are the results to be taken arbitrarily as the limit within which a student's answer must fall in order to be correct.

A total of fifteen general chemistry texts and laboratory manuals were investigated. Ten specific qualitative experiments were the most common. They are indicated in Table I.

Table I

Experiment	Frequency
Equivalent Weight	13
Composition and Formula of a Compound	12
Decomposition of Potassium Chlorate	12
Water of Hydration	11
Standard Solution	8
Molecular Weight	7
Titration	7
Atomic Weight	6
Solubility of a Solid	3
Synthesis of a Compound	3

Two authors use horn pan balances, five others employ a quantitative balance, and the remainder merely specify a "sensitive" balance. The following are evaluations of the individual experiments investigated together with a summary of the trials run.

The general procedure followed by all authors in the equivalent weight experiment is to displace hydrogen from hydrochloric acid with a metal and determine the number of grams of metal necessary to produce 1.008 gm. of hydrogen. Magnesium, aluminum, zinc, and iron are the metals used.

The determination of the composition or formula of a compound is carried out by either synthesizing or decomposing a compound. The most common compounds synthesized are copper sulfide, lead sulfide, tin oxide and sodium chloride. Potassium chlorate and copper oxide are the two compounds decomposed. The percentage composition or formulas are calculated from the weights.

There are two methods followed in the decomposition of potassium chlorate. Four authors determine the percentage of oxygen in the compound while four authors calculate the weight of one liter of oxygen. Five authors out of seven use either manganese dioxide or ferric oxide as a catalyst. In the first set of trials manganese dioxide was used as a catalyst. The trials seemed to indicate that more oxygen was driven off when manganese dioxide was used as a catalyst than was actually present in the potassium chlorate. Upon further investigation, it was found that oxygen was driven from manganese dioxide if the temperature reached 535 degrees C.

The general method used by all authors in the determination of the water of hydration is to place 1-2 gm. of the hydrate in covered crucible, heat, cool, and weigh. The most common hydrates used are copper sulfate, barium chloride, and gypsum. A full flame was

Table II

	Percentage	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	+2	+4	+6	+8	+10	+12	+14	
Equivalent Wt. (Mg)																			
" " (Al)																			
" " (Zn)																			
Comp. & Formula (Cu ₂ S)																			
" " " (SnO ₂)																			
" " " (Fe ₂ O ₃)																			
" " " (KClO ₃)																			
Decomp. of KClO ₃ (% O)																			
" " " (Wt. l l.)																			
" " " (Wt. l l.)																			
H ₂ O of Hydration (BaCl ₂)																			
" " " (CuSO ₄)																			
Atomic Weight (Fe)																			
" " (Pb)																			
" " (Sn)																			
Sol. of a Solid (K ₂ Cr ₂ O ₇)																			
" " " " (KNO ₃)																			

used with the barium chloride. It was found necessary to use a 7 cm. flame and the crucible supported 9.5 cm. above the top of the burner in heating the copper sulfate.

In the determination of the atomic weight, four authors use Dulong and Petit's Law, which states that the product of the specific heat and atomic weight is a constant, 6.4. The large error in the trials was due to the difficulty in experimentally determining the specific heat.

The general procedure followed in determining the solubility of a solid is to saturate a certain volume of water and then evaporate over steam. The solubility is determined from the weight of the solute. The result of all trials is given in Table II.

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