# QUANTITATIVE ANALYSIS.

(PART 1.)

(1) See Art. **1.**

(2) Sodium hydrate, or sodium carbonate.

(3) (*a*) Magnesium-ammonium arsenate $MgNH_4AsO_4$.

(*b*) When this precipitate is heated, water and ammonia are driven off, and magnesium pyroarsenate $Mg_2As_2O_7$ is formed.

(4) See Art. **100.**

(5) $1.036 \times 24.73 \div 100 = .2562028$ weight of chlorine. $.2562028 \div .423 \times 100 = 60.57$ per cent. of $Cl$ in sample. As dividing by 100 and then multiplying the result by 100 merely makes extra work without changing the final result, this is always omitted in actual work. This may be stated as follows:

$$\frac{1.036 \times 24.73}{.423} = 60.57. \quad \text{Ans.}$$

(6) (*a*) and (*b*) See Art. **3.**

(7) See Art. **21.**

(8) (*a*) A mixture of antimony sulphide $Sb_2S_3$, free sulphur, and water.

(*b*) See Art. **60.**

(9) See Art. **100.**

(10) $.250 \times 70 = 17.50$. $17.50 \div 1 = 17.50$ per cent. of iron found. Taking 56 for the atomic weight of iron and

278 for the molecular weight of ferrous sulphate, we have: $(56 \div 278) \times 100 = 20.14$ per cent. of iron calculated. $20.14 - 17.50 = 2.64$ per cent. error.

(11) In answering this question the student should give, in his own words, a brief outline of the general method of determining substances gravimetrically, from what he has learned in the Instruction Paper and by practice.

(12) As oxide or as metallic nickel. The metallic nickel may be obtained either by precipitation and reduction, or by electrolytic deposition. See also Arts. **22** and **24.**

(13) (*a*) and (*b*) See Arts. **58** and **59.**

(14) See "Volhard's Method for *Cl*, *Br*, *I*, *Ag*, and *Cu*."

(15) See Art. **6.**

(16) (*a*) $CuS$.

(*b*) $Cu_2S$.

(17) See Art. **71.**

(18) (*a*) and (*b*) See Arts. **38, 39, 40, 41,** and **100.**

(19) One cubic centimeter of decinormal silver nitrate precipitates .003537 gram of chlorine, which is equivalent to .005837 gram of sodium chloride. Hence,

$.005837 \times 30 = .17511$ gram of sodium chloride. Ans.

(20) See Art. **6.**

(21) (*a*) Magnesium-ammonium phosphate $MgNH_4PO_4$.

(*b*) When ignited, ammonia and water are expelled, and magnesium pyrophosphate $Mg_2P_2O_7$ is formed.

(22) By means of certain organic compounds, known as indicators, which change color when the reaction of the solution changes. See also Art. **78.**

(23) See Art. **101.**

(24) (*a*) and (*b*) See Art. **7.**

(25) (*a*) and (*b*) See Art. **39.**

(26) See Art. **66.**

(27) If a sample were not dried before making a determination, the result obtained would not represent the percentage of the given element in the compound analyzed, but would represent the percentage of this element in a certain mixture of this compound and water.

(28) See Art. **9.**

(29) (*a*) and (*b*) See Arts. **62** and **63.**

(30) (*a*) and (*b*) See Art. **35.**

(31) See Art. **111.**

(32) $NaCl + AgNO_3 = AgCl + NaNO_3$

(33) (*a*) and (*b*) See Arts. **64** and **65.**

(34) See Art. **43.**

(35) See Art. **57.**

(36) The weights would bear the same relation to each other as the molecular weights of the compounds; hence, taking the molecular weights of copper sulphate and copper oxide as 249 and 79, respectively, we have

$$249 : 79 = 1 : x. \quad x = .3172. \quad \text{Ans.}$$

(37) See Art. **13.**

(38) Precipitates are heated in order to get them in forms in which their exact composition is known. In every case the heat serves to expel water, and in some cases it changes the precipitate from a compound of variable composition to a weighable compound whose exact composition is known. For instance, when ferric hydrate is heated, it is changed to ferric oxide, and when magnesium-ammonium phosphate is ignited, it is changed to magnesium pyrophosphate, etc.

(39) (*a*) and (*b*) See Art. **43.**

(40) (*a*) and (*b*) See Arts. **71** and **87.**

(41) This relation depends on the facts that the atomic weight of sulphur is twice that of oxygen, and that there are 2 atoms of copper united with 1 atom of sulphur, while there is 1 atom of copper united with 1 atom of oxygen;

hence, the metal and non-metal are united in the same proportion in each case. In the case of cuprous sulphide, we have 126 parts of copper united with 32 parts of sulphur, while in copper oxide we have 63 parts of copper united with 16 parts of oxygen. Multiplying the weights of copper and oxygen in this compound by 2, we have the metal and non-metal united in the ratio of 126 to 32 in each case.

(42) (*a*) As 20 cubic centimeters of normal sulphuric acid neutralize 20 cubic centimeters of normal sodium hydrate, this solution contains the same weight of sodium hydrate that would be contained in 20 cubic centimeters of a normal solution; hence, it is only necessary to calculate what this weight is. As 1 cubic centimeter of normal sodium hydrate contains .04 gram of the solid, 20 cubic centimeters contain .8 gram.

(*b*) Similarly for sodium. According to the definition of a normal solution, 1 liter contains 23 grams of sodium. Then 1 cubic centimeter contains .023 gram, and 20 cubic centimeters contain .46 gram of *Na*.

(43) The nitric acid is added to dissolve the silver, and the hydrochloric acid to precipitate it as chloride, thus replacing the chlorine that has been driven off. See also Art. **12.**

(44) (*a*) See Art. **68.**

(*b*) See Art. **34.**

(45) See Art. **90.**

(46) (*a*) See Art. **18.**

(*b*) See Art. **19.**

(47) See Art. **14.**

(48) (*a*) and (*b*) See Art. **55.**

(49) Methyl-orange.

(50) The oxide method, the sulphide method, and the electrolytic method.

(51) See "Acidimetry and Alkalimetry."

(52) See Art. **57.**

(53) (*a*) and (*b*) See Arts. **94** to **99.**

(54) As a molecule of cuprous sulphide contains 2 atoms of copper, and a molecule of copper sulphate contains but 1, 2 molecules of copper sulphate are required to produce 1 molecule of cuprous sulphide. Bearing this in mind, and taking the molecular weights of copper sulphate and cuprous sulphide as 249 and 158, respectively, we have

$$158 : 498 = .3 : x. \quad x = .9456 \text{ gram.} \quad \text{Ans.}$$

(55) See Art. **91.**

(56) See Art. **19.**

(57) See Art. **15.**

(58) (*a*) and (*b*) See Arts. **24** and **25.**

(59) If the solution from which chlorine is to be precipitated is heated, chlorine will be expelled by the nitric acid added with the reagent, and the result will be too low. Silver is not volatilized in this way, and if some of the chlorine of the reagent is driven off, it makes no difference, as enough will be added to precipitate all the silver at any rate.

(60) See Art. **35.**

(61) See Arts. **26** and **27.**

(62) See Art. **94.**

(63) Cuprous sulphocyanide $Cu_2(SCN)_2$.

(64) See Art. **76.**

(65), (66), (67), (68), (69), (70) The percentage of the elements to be determined in the compounds sent for analysis cannot be given, as it will vary somewhat from time to time. A careful record of the composition of each sample is kept, however, and the student will be graded upon his results.