

MISCELLANEOUS PROBLEMS.

NOTE.—In analytical determinations exact atomic weights are used, in others nearest whole number except Cl = 35.5, unless otherwise indicated.

Table III may be taken as a collection of problems involving either deduction of formula from analysis or the reverse. It is computed from 1912 data.

1. Alloy of copper (8.9 sp. gr.) and silver (10.5 sp. gr.) weighs 100 grams, its sp. gr. is 9.7, what were weights of the two metals?

2. We want 100 liters of N_2O gas. What weight of ammonium nitrate must be taken? ($NH_4NO_3 = N_2O + 2H_2O$.)

3. A hydrocarbon burns producing 2 liters of CO_2 gas and 3.214 grams of water. What hydrocarbon is it, and what volume of it was burned?

4. 100 grams iron are dissolved in 200 grams sulphuric acid. What volume of ammonia solution neutralizes excess of acid, solution having sp. gr. 0.9 and containing 28 per cent. ammonia gas by weight?



5. A liter of gas at temperature 35° Centigrade, is cooled without change of pressure to -35° C. What is now its volume?

6. Calling densities of H_2 and N_2 at 0° , respectively 2 and 28, at what temperature will density of nitrogen equal that of hydrogen at zero C.?

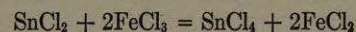
7. Ten grams of a liquid, sp. gr. = 3, just fill a spherical bulb. What is the internal radius of the bulb?

In this and all similar problems, the expression for the volume, geometrically speaking, must first be equated with the known volume.

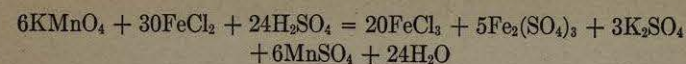
We have here to start with:

$$\frac{4\pi R^3}{3} = 3.33$$

8. Solution of stannous chloride derived from one gram of substance is oxidized by excess of ferric chloride:



The $FeCl_2$ is now "titrated" with solution of "permanganate" containing six grams of the pure salt to one liter of solution:

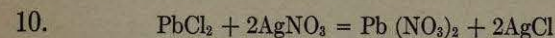


It requires 16.45 c.c. of the $KMnO_4$ solution, what is percentage of tin in the substance?

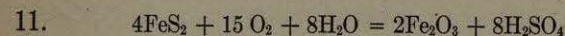
(NOTE.—Use the last equation first, finding weight of iron. Apply the data obtained to the first equation.)

9. A lead-lined cylindrical tank, 5 meters deep and 5 meters in diameter, is full of water, which, being drawn off and evaporated with a little sulphuric acid, yields 1437.05 grams of lead sulphate ($PbSO_4$).

What was the percentage of lead in the water?



In this reaction, 2.5 grams of the lead chloride were taken, and 2.58 grams of the silver chloride obtained. Assume approx. at. wts. for silver and chlorine. Find atomic weight of lead.



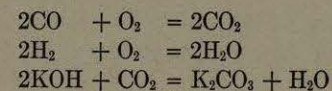
This equation shows roughly the production of sulphuric acid from pyrite. Suppose the pyrite has $7\frac{1}{2}$ per cent. impurities, and that five per cent. of the sulphur is lost in the operation. What weight of H_2SO_4 is produced from one ton of the pyrite?

12. The weight of one liter of air at 0° C. and normal pressure, is 1.293 gram. What will it weigh at normal pressure and 300° C.?

13. A liter of oxygen under normal p. and t. weighs 1.429 gram. At what temperature will a liter of it weigh one gram?

14. A mixture of carbon oxide (CO) and hydrogen (46.5 c.c.) is exploded with excess of oxygen. After the explosion there remain 35.35 c.c. of permanent gas, of which KOH solution absorbs 18.60 c.c., leaving for the residual or excess oxygen 16.75 c.c.

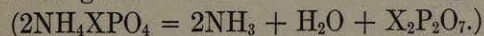
Required, original volumes of CO and hydrogen gases, also the volume of oxygen added.



This may be most easily worked back from the absorption figure for CO_2 gas.

15. What will one liter of chromium hexafluoride weigh (CrF_6)? (Use the "crith," at 0.0896.)

16. Ammonium.-Xorthophosphate (NH_4XPO_4) which weighs one gram, is heated, becoming X-pyrophosphate which weighs 0.84524 gram. What is the atomic weight of "X."

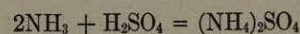


17. 21 c.c. of FeSO_4 solution require 22.05 c.c. of a solution of potassium bichromate containing 5 grams of the salt to one liter. What weight of iron in one c.c. of the iron solution? ($6\text{FeSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7$, etc.)

18. One gram of lead is dissolved and into the solution is passed sulphuretted hydrogen gas (H_2S) one liter. What is excess of the latter in weight and in volume? (Use approximate at. wts., and the "crith" method, crith = 0.0896.)

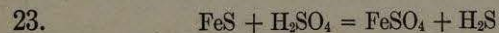
19. If the molecular weight of aluminum chloride is 267.2, what is its formula, and what would be the theoretical weight per liter of its vapor?

20. One hundred liters of ammonia gas are passed into 100 grams of sulphuric acid. What is the excess, in volume and in weight, of the ammonia?



21. A solution of silver nitrate is divided into two equal parts. One of these yields a precipitate of one gram of silver chloride. To the other, one gram of sodium chloride is added. Which is in excess, and by what weight?

22. A certain amount of CaO being converted into CaSO_4 gains 4 grams in weight. What was its weight as CaO ?



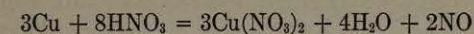
What weight of the sulphide must be taken to obtain one liter of the gas? (Iron at 56, etc.)

24. Sulphuric acid of 1.8 specific gravity contains 96 per cent. of real acid. What weight of H_2SO_4 is there in 100 c.c. of the same?

25. The iodide of a monad metal, MI , weighs 46.9 grams. Converted into the fluoride, MF , it weighs 9.1 grams. If atomic weight of iodine is 127, what is atomic weight of "M"?

26. One kilogram of sea water, sp. gr. 1.026, has what volume?

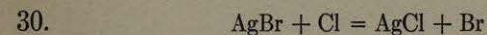
27. What length of copper wire (specific gravity = 8.9), one millimeter in diameter, will be dissolved by one kilogram of nitric acid containing 24 per cent. of HNO_3 ?



28. Ten grams of a salt soluble in water lose 3.5 grams when weighed in gasoline.

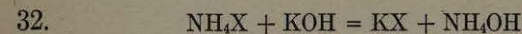
Eighty-seven grams of the gasoline fill a flask which holds 100 c.c. of water. What is specific gravity of the salt?

29. Air is heated from 0° to 819° C. Pressure remaining constant, how much of the original air remains in the flask?

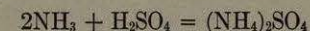


If we take atomic weight of chlorine as 35.45 and that of bromine as 79.96, if weight of the AgBr is 1.6916, what is weight of the AgCl ?

31. The sulphide of a dyad metal "RS" contains 33 per cent. sulphur. What is the atomic weight of "R"?

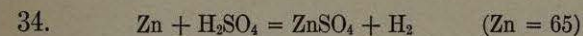


Take ten grams of the NH_4X . The NH_3 evolved (NH_4OH) is absorbed in water, and neutralizes 675.7 c.c. of solution of sulphuric acid.



Ten c.c. of this acid precipitate 0.466 gram BaSO_4 . Using approximate atomic weights, find atomic weight of "X."

33. One pound of sulphuric acid (H_2SO_4) acts on one pound of ferrous sulphide FeS . Find excess of the latter.

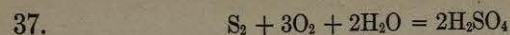


Take two lbs. of zinc and three lbs. of sulphuric acid, which is in excess, and by how much?

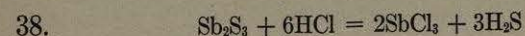
35. A solution of HCl precipitates 1 gram of AgCl for each 50 c.c. of the solution used. 4 liters of ammonia gas are passed into 1 liter of the HCl solution; give both weights and volumes of excess and deficiency.

36. (Approx. wts.) Solution of H_2SO_4 is of such strength that 1 c.c. precipitates 0.0233 gram of BaSO_4 . Into 100 c.c.

are passed 100 c.c. of ammonia gas. Find weight excess and deficiency. ($2\text{NH}_3 + \text{H}_2\text{SO}_4 = (\text{NH}_4)_2\text{SO}_4$)

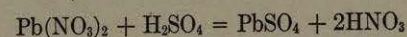


We have pyrite containing 50 per cent. of sulphur. In the operation of making sulphuric acid, 96 per cent. of the sulphur goes into the acid and 4 per cent. is lost. What weight of pyrite will produce 100 tons of the acid?



What volume of the gas is obtained from 1 kilo of the antimony sulphide?

39. We have 100 grams of lead in solution. If we have sulphuric acid of 91 per cent. H_2SO_4 , and 1.75 sp. gr., what volume of same will precipitate the lead?



40. A mixture of carbonic acid gas (CO_2) and air is at 20°C . CO_2 being absorbed out, heat must be raised to 215.3° to restore residual air to the original volume of the mixture. What were the relative volumes of the two originally? (Call original volume unity.)

41. In the analysis of a sample of hematite, each portion taken for partial analysis being 1 gram, we have the following precipitates and titration.

For silica.....	0.0731 gram....	SiO_2
For magnesia (MgO).....	0.0441 gram....	$\text{Mg}_2\text{P}_2\text{O}_7$
For manganese.....	0.0512 gram....	$\text{Mn}_2\text{P}_2\text{O}_7$
For aluminum.....	0.0246 gram....	Al_2O_3
By ignition.....	0.0103 gram....	loss

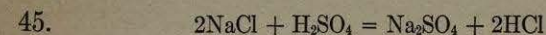
Titration for iron, 54.05 c.c. used of a solution of KMnO_4 of which 1 c.c. = 0.011 iron.

Write out the complete analysis, giving manganese as MnO and assuming the "loss" as water. Give both metallic iron and percentage as Fe_2O_3 .

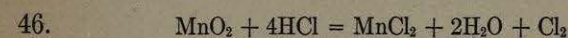
42. A dyad metal has RO for formula of its oxide and RCl_2 for chloride. A portion of the oxide weighs 1.1 and when converted into chloride weighs 1.8442 grams. If at. wt. of chlorine is 35.4 what is at. wt. of this metal?

43. "Pulp and scales." Wt. of pulp 58 grams, scales wt. 0.016 gram. Assay of pulp 0.34 oz. to ton. Wt. of metal in scales 0.014 gram. What is assay per ton?

44. One-third of an assay ton yields 0.008 gram gold. One-fifth of an assay ton yields button of gold and silver weighing 0.1348 gram (same ore). What is the assay, in gold and silver?



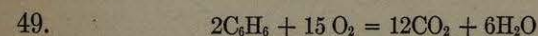
We want 200 kilos of 20 per cent. HCl acid. What weight of sodium chloride must be taken?



Pyrolusite containing 80 per cent. of MnO_2 is treated with HCl acid containing 30 per cent. of HCl . We have 10,875 lbs. of the mineral, how many lbs. of the acid must be taken?

47. A substance appears to weigh 10.7 grams when placed on one side of an untrue balance and 10.6 grams when placed on the other. What is the true weight?

48. Same as 47, but the two weights are 2 and 2.5.



In this reaction 31.8384 grams of water were produced. Find all the other terms in liters.

50. Sp. gr. of water = 1. Mercury 13.596. Alcohol 0.81. Sulphuric acid 1.85.

When the mercury barometer stands at 76 centimeters, at what height will barometers filled with the other liquids stand?

51. What is the weight of a liter of air at 30°C . and 750 mm.? (Normal, 1.293.)

52. "Pulp and scales." Wt. of "pulp" 87.478 grams. Assays zero. Scales weigh 0.020 and metal from same 0.018 gram. Find assay in oz. to ton.

53. 1722 grams of ore yield 0.02792 gram gold. Find assay in ounces to ton.

54. An ore contains 13 per cent. water. When dried it assays 58.62 per cent. metal. What would it assay before drying?

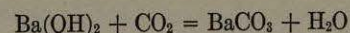
55. An ore contains 50 per cent. of metal. As charged into the furnace it has ten per cent. of its weight of barren flux added to it. What is assay of the "charge."

56. A hydrocarbon burns, producing 24 liters CO₂ gas, and 9.648 grams water. Volume of the original gas, 4 liters (that is, its theoretical volume, when reduced to 0° and 760 mm.) What was its formula?

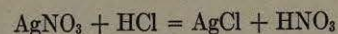
57. Ferric-ammonium and ferrous-ammonium sulphates have the respective ratios as to acid and basic radicals indicated by their names, but they crystallize with different numbers of molecules of water. Each of these salts, as crystallized, contains exactly one-seventh of its weight of iron. Find the formulæ of the crystallized salts.

58. We have a mixture of 4 tons of ore assaying 103 ounces to ton; 11 tons of ore assaying 57 ounces to ton; 2 tons of ore assaying 203 ounces to ton. What is assay of the mixture?

59. One liter of CO₂ gas at 10° C. is passed through solution of Ba(OH)₂. What weight of BaCO₃ is precipitated? (Approx. wts.)



60. Two liters of HCl gas are passed into a solution of 10 grams of silver.

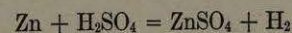


Which is in excess, and how much?

61. What is the weight of 1 liter of oxygen 16° C. and 745 mm.?

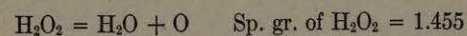
62. H₂O = H₂ + O. 10 grams water. What volumes of the gases?

63. What weight of zinc will yield 10 cubic meters of hydrogen at 15° C. and 740 mm.?



Zn at 65 at. wt. "22.4" method.

64. Ten grams of H₂O₂ (hydrogen peroxide) yield how many times their volume of oxygen, on heating?



65. An ore which contains 4 per cent. of water assays 53.76 ounces. What will it assay after drying?

66. An unweighed lot of ore is sampled and found to contain 7 per cent. water. It is rained on, and being now weighed gives 21,000 lbs. and 10 per cent. water. What was weight as received?

67. An ore containing "a" per cent. of water assays when dry "b" per cent. What would it assay "wet?"

68. Two ores have: (1) Silica, 40 per cent. FeO, 20 per cent.
(2) Silica, 10 per cent. FeO, 81 per cent.

Taking 1000 lbs. of No. 1, how many lbs. of No. 2 must be added in order that the silica and iron oxide in the mixture shall be equal in weight?

69. We have pyrite containing 42 per cent. sulphur. Product contains 75 per cent. H₂SO₄. (S₂ + 3 O₂ + 2H₂O = 2H₂SO₄.) What weight of FeS₂ for 100 tons of this product?

70. In the analysis of a spring water, one-liter portions are taken for the various determinations. It contains sulphates, chlorides, carbonates.

Analytical products weigh as below. Calculate the analysis in parts per 100,000. Residue weighs 0.9324 gram. Use exact atomic weights, Table I.

For total chlorine; AgCl.....	1.3225
For total lime, CaO; CaSO ₄	0.4180
For total KCl + NaCl; KCl + NaCl.....	0.3460
For total SO ₃ ; BaSO ₄	0.6417
For total Mg; Mg ₂ P ₂ O ₇	0.2104
For total K; K ₂ PtCl ₆	0.4164

Method of "adjudication." All SO₃ to CaO. Excess of CaO as carbonate. All others distributed as chlorides. Show two summations, one of elements and radicals, the other of proximate constituents. (Compounds.)

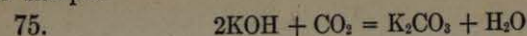
71. A closed vessel is filled with air at 0° C., and 760 mm. Heated to 546° C. What is now the pressure in atmospheres? (760 mm. = one atmosphere.)

72. Having taken 2.7273 grams of pig iron for determination of carbon, that element is burned by suitable means, resulting CO₂ gas being absorbed in a KOH bulb. (2KOH + CO₂ = K₂CO₃ + H₂O.) Weight of the bulb increases 0.125 gram. What is the percentage of carbon?

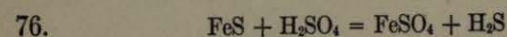
73. Phosphorus is often determined as Mg₂P₂O₇. If we wish the weight of this product to express directly the weight of the phosphorus in ten grams of the material under analysis, what weight of the latter should be taken?

74. "Pulp and scales." Weight of ore taken, 110.5 grams; assay to ton, 50 oz.; weight of "scales," 0.220 gram; weight

of metal in same, 0.209 gram. Find correct assay per ton of sample.



In this equation the caustic potash weighs 11.2 grams, what is volume of the CO_2 gas at 91°C ?

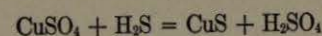


Volume of the gas being 2.232 liters, what is weight of the H_2SO_4 ?

77. The iodide of a monad metal "M" weighs 3.3000 (MI). Being converted into the chloride (MCl) the latter weighs 1.2870.

Find atomic weight of "M." (Take iodine at 127, chlorine at 35.5.)

78. Crystallized copper sulphate has the formula $\text{CuSO}_4 + 5\text{H}_2\text{O}$. Being dissolved in water and precipitated by H_2S gas we have the equation:

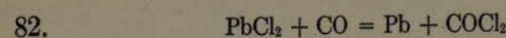


If we wish to prepare 1 liter of normal sulphuric acid according to this reaction, what weight of the crystallized sulphate must we take?

79. Pulp and scales—two metals. Ore weighs 102 grams; silver, 106 oz. to ton; gold, 2 oz. to ton. Scales weigh 0.5 gram; silver, wt. = 0.4 gram; gold, wt. = 0.08 gram. Find assay to ton for silver and gold of the sample.

80. A lot of iron ore loses 962 lbs. by drying, and assays (dry) 54 per cent. iron. Its weight as received was 26,000 lbs. What would it have assayed "wet."

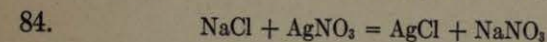
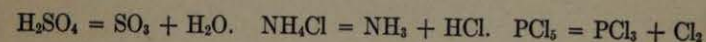
81. A closed vessel contains air at 1 atmosphere and 20°C . To what temperature must it be heated in order that the tension be raised to four atmospheres?



Using exact atomic weights, if we take 31 grams of the lead chloride, what volume of carbonyl chloride shall we obtain?

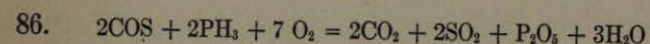
83. Explain why the "dissociation" of H_2SO_4 , NH_4Cl and PCl_5 under heat, produces twice the volume (hence $\frac{1}{2}$ the density) of the theoretical gas volumes and densities of these substances.

Assume such quantities as would yield 2 liters each of the vapors, if dissociation did not take place. The gases into which these substances dissociate are probably as below:



How much sodium chloride must be dissolved in 1 liter of water in order that 1 c.c. of the solution shall precipitate 0.01 gram of silver?

85. The oxide of a dyad metal "R" is reduced by hydrogen. $\text{RO} + \text{H}_2 = \text{R} + \text{H}_2\text{O}$. If RO weighs 1 gram, and H_2O weighs 0.2274 gram, what is the atomic weight of "R"?



(a) What is the density of the entire first member considered as a mixture, *i.e.*, before the explosion with oxygen?

(b) If volume of the first member were 8.14 liters, what is volume of "permanent gases" in the second member?

87. At what pressure will 1 liter of air weigh two grams, $t = 0^\circ \text{C}$? (Normal weight, 1.293.)

88. 85 c.c. gas at 20°C . and 580 mm. What volume at 0°C . and 760 mm.?

89. To what temperature must an open vessel be heated in order to drive out $\frac{1}{4}$ of the air contained at 0°C .? (Call $V = 1$.)

90. A sphere 2 cm. in diameter weighs 7.3304 grams. If it "just floats" in a liquid, what is the sp. gr. of that liquid? (Surface of liquid tangent to upper point of the sphere.)

91. Placing in a crucible some dried calcium oxalate, CaC_2O_4 , the whole is weighed, giving 13.4270 grams. Crucible and contents are ignited, leaving CaO. Weight of crucible and contents is now 13.2038, what is weight of crucible, and of the CaO?

92. Specific gravity flask filled with water weighs 30 grams. 4 grams of a mineral is placed in it, flask filled with water to same mark, and now weighs 33.2 grams. Find sp. gr. of the mineral.

93. Two lots of ore are weighed, assaying respectively 88 and 106 oz. to ton. Mix assays 100 oz. It is dried, loses 400 lbs. water, and now assays 102 oz. What were original weights in tons?

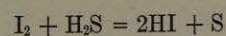
94. In a mixture or alloy of two substances (no allowance being made for change of volume in mixing) what proportion must be observed if the sp. gr. of the mixture is to be the mean of the specific gravities of the two?

95. A closed vessel at 983° C. has internal gas pressure of one atmosphere. It is now cooled to 41° C. What is now the tension, in atmospheres?

96. Analysis of a spring water. One liter yields 1.9138 grams solid residue. Following are weights of analytical precipitates or products:

For SO ₃ ; BaSO ₄	0.8260
For lime, CaO.....	0.0873
For sodium, NaCl.....	1.3910
For chlorine, AgCl.....	3.6280
For magnesium, Mg ₂ P ₂ O ₇	0.3050

It contains also H₂S gas in solution. This is determined by iodine.



The iodine solution contains 1 gram iodine to the liter. It requires 881.4 c.c. of the spring water to bring the end reaction with 100 c.c. of solution.

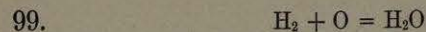
All the gravimetric determinations are made on 1 liter portions. Write analysis in parts to 100,000, and volume per liter of the H₂S gas.

Make out also separate statements for the various elements, which must in their summation check with the total analytical results by compounds, and with the total solid residue.

Lime as usual, to SO₃ radical, excess of the latter to sodium, excess of sodium to chlorine, excess of chlorine to magnesium.

97. An open vessel at temperature 16° C. is heated to 305°, then sealed and cooled back to 16°. What is now the tension (atmospheres)?

98. We have a silicate RSiO₃. In this, R being a dyad metal, the percentage of "R" is 23.6. Find its atomic weight, Si = 28.4.



What is the density of the mixture of two volumes of hydrogen and one of oxygen (without combination), and what is the theoretical density of steam at 0° C.?

100. A pyritous zinc ore is roasted until all the FeS₂ is judged to be oxidized to Fe₂O₃, the zinc being now distributed in the three forms of ZnS, ZnO and ZnSO₄.

One-gram portions are taken for analysis; following weights are obtained:

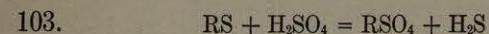
Silicious matter.....	0.0805
For total zinc, ZnO.....	0.5246
For total sulphur, BaSO ₄	1.2127
For SO ₃ , BaSO ₄	0.6710

Iron is estimated by titration, one gram portion used. Used 11.1 c.c. of a permanganate solution of which 1 c.c. = 0.008 iron.

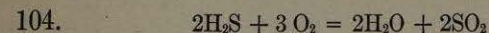
Write out complete analysis, making summations both by compounds and by elements, *e.g.*, find percentages of ZnO, Fe₂O₃, etc., also percentages of all the separate parts, such as O in ZnO, S in ZnS, SO₃.

101. Using 137 as at. wt. of barium, find atomic weight of the metal "R" when 1 gram of RSO₄ yields 1.5432 grams BaSO₄.

102. A flask weighing when empty 35 grams, weighs 93 grams when full of water and 114.016 when filled with HCl solution. Find sp. gr. of the latter.



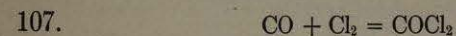
In this equation weight of RS = 1 gram. Volume of H₂S evolved is 256.5 c.c. Find atomic weight of "R."



What volume of *air* for the combustion of one liter of H₂S gas, air containing 21 per cent. by volume of oxygen? State volume of both air and oxygen in the air.

105. One liter of water at *maximum density* forms what volume of steam at 300° Centigrade?

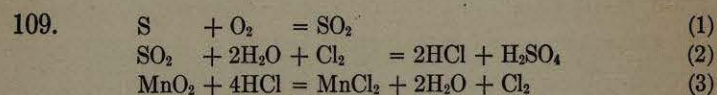
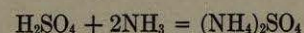
106. In a specific gravity bottle whose weight when filled with water alone is known, 19.25 grams of sand are placed and the bottle filled with water. Gain in weight over water alone is 11.55 grams. Find sp. gr. of the sand.



What is the density of the mixture in the first member of this equation. What is the density of the carbonyl chloride when

formed? If the oxygen, separately considered, was $1\frac{1}{2}$ liters in volume, what were volumes of the CO, Cl₂ and of the COCl₂?

108. We have ten grams of H₂SO₄ in water and pass in one liter of ammonia gas (NH₃). What is deficit in weight of the latter?

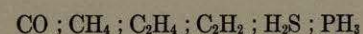


8.22 grams of sulphur are burned, the product (SO₂) caught in water, oxidized as shown in equation (2), the chlorine in this equation being produced as in equation (3).

What weight of manganese di-oxide is required to yield the necessary quantity of chlorine? What weight of air (23 per cent. oxygen) burns the sulphur? Solve without any calculation of the weight or volume of chlorine used.

110. Find a factor to pass from Na₂CO₃ + 10H₂O to Na₂CO₃. Also factor to pass from Na₂CO₃ to Na₂CO₃ + 10H₂O.

111. What volumes of oxygen burn, respectively, one liter each of the following gases (PH₃ supposed to burn H₃PO₄):



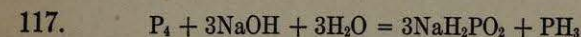
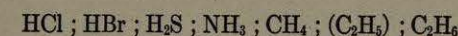
112. What weight of caustic potash (KOH) is neutralized by 50 c.c. of $\frac{1}{10}$ N. acid?

113. 10 grams of oxygen and 10 grams of carbonous oxide (CO) are mixed and exploded. (CO + O = CO₂.) The resulting CO₂ being absorbed out, what volume and weight of oxygen remain? What were volumes of the two original gases?

114. Analysis of ore. The arsenic in this analysis is precipitated as Ag₃AsO₄. This is dissolved in nitric acid, the silver precipitated as AgCl, which is weighed. Other constituents determined in usual methods. The chloride of silver, AgCl, weighs 0.2099. BaSO₄ (for sulphur), 1.378. Ferric oxide, Fe₂O₃, 0.2624. Cuprous sulphide, Cu₂S, 0.0533. SiO₂, 0.4627. Stannic oxide, SnO₂, 0.0824. Above weights are all in grams, *portions taken for analysis each one gram*. Write out calculated analysis in full, giving in summation every element separately except oxide of tin and silica (as found.) Also state percentage of metallic tin. (Find As, Fe, Cu, S, SiO₂, SnO₂.)

115. If the atomic weight of iodine were determined as 127, and its vapor, reduced to normal conditions, weighed 11.27 grams per liter, what would be: (1) Molecular weight strictly according to density found. (2) Molecular weight to be inferred by consideration of atomic weight.

116. If we assume weight of one liter of hydrogen as 0.09 gram, what weights of hydrogen are contained in the following gases, *i.e.*, in *one liter of each*?



In this reaction if we use ten grams of phosphorus: (1) What weight of NaOH will be consumed? (2) What weight of hypophosphite produced? (3) What volume of phosphine evolved?

118. We have 30 grams of NaOH which is to be made up into a $\frac{1}{10}$ N. solution. The NaOH contains $3\frac{1}{2}$ per cent. of impurities.

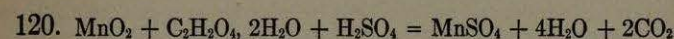
We have also solution of HCl, of which 10 c.c. precipitate 1.56 grams of AgCl. This is to be made up into a $\frac{1}{10}$ N. solution whose volume is to be equal to that of the caustic soda.

(1) What volume shall we have of the NaOH?

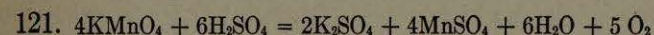
(2) What volume of the present HCl solution must be taken for dilution to the same volume as the NaOH solution?

(NOTE.—Use NaOH = 40. AgCl = 143.4. Do not use molecular weight of HCl.)

119. The chloride of a metal contains 33.83 per cent. chlorine. The specific heat of the metal is 0.0308. What is its probable atomic weight?



5 grams manganese ore yield 4.41 grams CO₂ gas. What per cent. of MnO₂ in the ore?



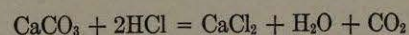
3.69 grams permanganate dissolved in one liter of water. What weight of "available oxygen" will one c.c. of the solution contain?

122. If water absorbs twice its volume of chlorine gas without change of volume: (1) What will be the specific gravity of the solution? (2) How many liters of chlorine are contained in 1000 grams of the solution?

123. If specific gravity of water is 1, what is specific gravity of air? If specific gravity of air is 1, what is specific gravity of water?

124. If potassium cyanide and sodium cyanide are valued according to their respective percentages of the cyanogen radical, and we have KCy containing 10 per cent. impurity at 22 cents per lb., would it be loss or profit to buy NaCy containing 25 per cent. impurity at the same price? Give exact amount of difference in loss or gain per lb.

125. Into one liter of HCl solution of 1.104 specific gravity are placed 35 grams marble (CaCO_3).

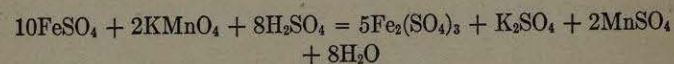
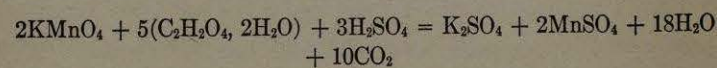


At the close of the reaction there remain 4.39 grams CaCO_3 . Find: (1) Percentage of HCl by weight in the solution. (2) Weight of calcium chloride produced. (3) Volume of the carbonic acid gas. (4) Volume of the HCl gas.

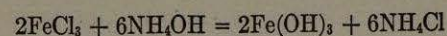
126. If 1.1486 grams of silver sulphide (Ag_2S) yield 1.000 gram silver, what is the atomic weight of sulphur? (Use exact tabular weights.)

127. One gram of a metal is converted into chloride and precipitated by silver, the AgCl weighs 2.9517. The specific heat of the metal is 0.0324. What is its atomic weight and what is formula of the chloride?

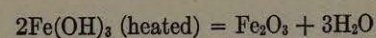
128. One half-gram of crystallized oxalic acid requires 79.36 c.c. permanganate solution for oxidation. What weight of KMnO_4 in one liter of solution, and what weight of iron is equivalent to 1 c.c. of the solution?



129. Sulphuric acid is added to 1 liter of ammonia solution, the latter remaining in excess. The ammonia solution is "normal" NH_3 . This excess now precipitates ferric hydroxide according to equation:

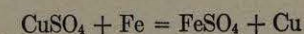


We have also:

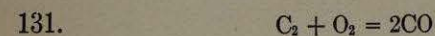


The Fe_2O_3 weighs 8 grams. Find weight of H_2SO_4 . If same had been used to generate hydrogen from zinc, what weight of zinc would have been dissolved and what volume of hydrogen at 16°C . and 740 mm. pressure would have been evolved?

130. When metallic iron is immersed in solution of copper, metallic copper is deposited on the iron, an equivalent weight of iron passing into solution.



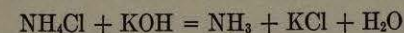
Iron weighed 10 grams. With copper coating, 10.154 grams. Find weight of the copper.



One thousand cubic meters of air are blown through strongly ignited charcoal. Air contains 21 per cent. by volume of oxygen. It goes in at $16^\circ \text{Centigrade}$, and comes out (as mixture of nitrogen and carbonous oxide gas) at $800^\circ \text{Centigrade}$. What will be the volume of the gases at exit?

132. Water at zero Centigrade absorbs 1000 times its volume of ammonia gas (NH_3). How many grams of ammonia solution can be made from one liter of water?

What weights of ammonium chloride and of caustic potash, the first pure, the latter 95 per cent. pure, must be used to obtain the ammonia gas for this solution? (Use exact weights.)



133. A spherical balloon is to be filled with hydrogen and have a "lifting power" of one metric ton. Allowing 14 to 1 as ratio of densities of air and hydrogen, also allowing nothing for displacement of cover and cargo, what will be the size of the sphere? What weights of zinc and sulphuric acid will be required to produce the hydrogen?

134. What will be the "lifting power" of a spherical balloon filled with hydrogen, four meters in diameter. (Ratio as above, 14 to 1.)

135. Into 1 liter of water at zero Centigrade pass 500 liters of HCl gas. Specific gravity is now 1.21, what is total volume of the liquid?