Exercises for Chapters 1-4

Exercise 2. The artificial sweetener "sorbital" has a % composition by mass of 39.56% carbon (C), 7.74% H and 52.70% O. *What is its empirical formula ?* If another experiment shows that the molecular weight of sorbital is approximately 182 u, *what is its molecular formula ?*

Ans. empirical formula is $C_3H_7O_3$ and the molecular formula $C_6H_{14}O_6$.

Exercise 3. Chloroform is found to be 89.10and 10.6% carbon by mass. What is its empirical formula?

Ans. empirical formula is $C_1H_1CL_3$ or $CHCl_3$.

Exercise 4. If a car it traveling at a speed of 54.4 miles per hour, *what is its speed in meters per second ?*

Ans. *speed* = 24 [m/s]

Exercise 5. For our reactions $C_4H_8 + O_2 \longrightarrow H_2O + CO_2$
how many grams of O_2 are required to consume 5.20 g of C_4H_8 ?

Ans. 17.9 [g] of O_2 are required.

Exercise 6. How many grams of oxygen are present in 6.21 g of ferric sulphate [iron(III) sulphate] $Fe_2(SO_4)_3$?

Ans. 2.98 [g O] or 2.98 [g O_2]

Exercise 7. Metallic aluminum has a density of 2.70 g/cm^3. If a 10.25 cm $\times$ 5.50 cm piece of aluminum foil of thickness 0.606 mm is dissolved in excess aqueous HCl according to the reaction $2\,Al(s) + 6\,HCl(aq) \longrightarrow 2\,AlCl_3(aq) + 3\,H_2(g)$, *what mass* of $H_2(g)$ is produced ?

Ans. amount of H_2 produced is 1.03 [g H_2]

Exercise 8. For the reaction $KClO_3(s) \longrightarrow KCl(s) + O_2(g)$ how many grams of $KClO_3$ are required to produce 650 cm^3 of $O_2(g)$ at STP ?

Ans. require 2.37 [g $KClO_2$]

Exercise 9. One particularly useful alloy of aluminum has a composition of 93.7% Al and 6.3% Cu (by mass) and a density of 2.85 g/cm^3. If placed in excess acid HCl solution the Cu does not react, but the Al reacts according to the equation given in Exercise 7. What volume of this alloy must be dissolved to produce 3.55 g of H_2 ?

Ans. require 11.9 [cm^3 alloy]

Exercise 10. If 93.4 g of aluminum sulphate are dissolved in water and diluted to yield exactly 250. mL of solution, *what is* the solution concentration ?

$$Al_2(SO_4)_3\,(s) \xrightarrow{H_2O(l)} 2\,Al^{3+}(aq) + 3\,SO_4^{2-}(aq)$$

Ans. concentration is 1.09_2 M in $Al_2(SO_4)_3$ or $2{\times}1.09_2 = 2.18_4$ M in Al^{3+} (aq) or $3{\times}1.09_2 = 3.27_6 = 3.28$ M in $(SO_4)^{2-}$ (aq)

Exercise 11. A nitric acid (HNO_3) solution with a density of 1.424 g/mL is 70.9% acid by mass. What is its molarity ?

Ans. the solution is 16.0 M in HNO_3

Exercise 12. What is the final molarity of chloride ion $Cl^-(aq)$ in the solution obtained on mixing 255. mL of 0.125 M $MgCl_2$ solution with 855. mL of 0.350 M $FeCl_3$ solution?

Ans. final solution concentration is 0.874 M in Cl^- (aq)

Exercise 13. If equal masses of Zn(s) and Br_2(l) are brought together and allowed to react: $Zn(s) + Br_2(l)$ —
is the excess reagent, and what fraction (by mass) of it is left over?

Ans. Zn is in excess, and 59.1% (or the fraction 0.591) of it is left over

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Exercise 14. A mixture of NaBr and KBr weighing 0.560 g is dissolved in water, the resulting mixed with a solution containing excess $AgNO_3$(aq) (all Ag^+(aq) and NO_3^-(aq)) which precipitates all of the Br^-(aq) as a solid sample of AgBr(s) weighing 0.970 g. *What fraction* of the original mixture was KBr?

Ans. the fraction of the mixture which was KBr is $0.37_6 = 0.38$

Exercise 15. A sample of gaseous compound made up only of B and H weighing 0.596 g occupies 484 mL at STP. Then burned in excess O_2 is yields 1.17 g of H_2O, and all of the boron is converted to B_2O_3 .

What are: (a) its empirical formula? (b) its molecular weight?
(c) its molecular formula? (d) the weight of B_2O_3 produced?

Ans. (a) BH_3 (d) 1.50 g of B_2O_3

Exercise 16. A 4.22 g sample of a mixture of $CaCl_2$ and NaCl was dissolved, and then treated to precipitate all of the Ca as $CaCO_3$(s), which was then heated to drive off CO_2(g), leaving a sample of pure CaO(s) which was found to weigh 0.969 g. What percentage of the original mixture was $CaCl_2$?

Ans. 45.0% $CaCl_2$

Exercise 17. If Fe_3Br_8 is produced by the following mechanism, where the two reactions have the indicated efficiencies, what mass of Fe_3Br_8 is produced from 10.0 g of Fe and excess Br_2 ?

$$Fe + Br_2 \longrightarrow FeBr_2 \qquad \text{efficiency } 92.5\%$$
$$3\,FeBr_2 + Br_2 \longrightarrow Fe_3Br_8 \qquad \text{efficiency } 82.0\%$$

Ans. 36.5 g of Fe_3Br_8

Exercise 18. A "stock" solutionof HCl(aq) is 36% HCl by mass, and the density of this solution is 1.18 g/mL.

(a) What is the molarity of this stock solution?

(b) What volume of this stock solution is required to make 0.750 L of a 0.250 M solution of HCl(aq)?

Ans. (a) 11.7 M (b) 16.0 mL of stock solution
