

HW 3-4 – Chemical Equations & Stoichiometry

Problem A; Problems pg. 106 #3.60; pg. 107 #3.61, 3.66, 3.68, 3.72, 3.74, 3.76, 3.78, 3.106, 3.144

A. For the following reactions please write out all chemical formulas and balance equations:

a) Dicarbon dihydride (ethyne) + Oxygen → Carbon dioxide + Water



Start w/ 2C, 2H, odd O so double all

b) Iron (III) chloride + Ammonium hydroxide → Iron(III) hydroxide + Ammonium chloride



Need 3 Cl, 3 OH

c) Phosphorus pentachloride + water → Hydrochloric acid + Phosphoric acid



Need 5 Cl

d) Lead(II) nitrate → Lead(II) oxide + Nitrogen dioxide + Oxygen



Need even O, so even PbO

3.60 Balance the following equations

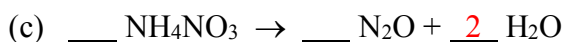
Where to start



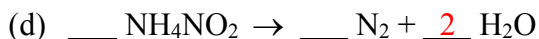
Need $\frac{1}{2} \text{O}_2$, so double all



Same as (a)



Need 4 H



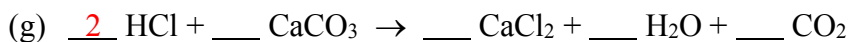
Need 4 H



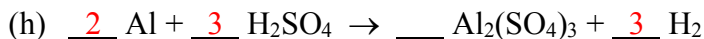
Need 2 Na



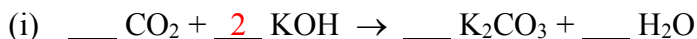
Need 4 P



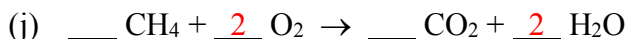
Need 2 Cl, 2 H



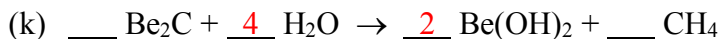
Need 2 Al, 3 SO₄



Need 2 K



Need 1 C, 4 H



Need 2 Be, 4 H



See below:



- Notice we need even H & thus N & O. Also, since there are 3 N in the products, we need ≥ 4 N, so start with 4 HNO₃:



- Not enough O in products, so next even # HNO₃:



–OR–



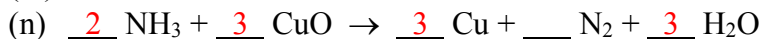
- Not enough and odd # O, so next even # HNO₃:



- This is double the first try, but now can split N differently:



Need Even H, N, O



Need 6 H (LCM), 2 N

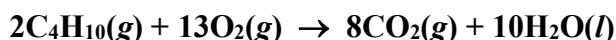
- 3.61 On what law is stoichiometry based? Why is it essential to use balanced equations in solving stoichiometric problems?

Stoichiometry is based on the law of Conservation of Mass. Balanced equations must be used in order to get the ratios of the participants (reactants and products) in the reaction correct.

- 3.66 In one reaction, 0.507 mol of SiCl_4 is produced. How many moles of molecular chlorine were used in the reaction, $\text{Si}(s) + 2\text{Cl}_2(g) \longrightarrow \text{SiCl}_4(l)$

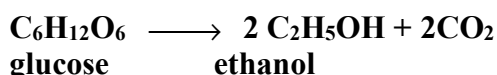
$$? \text{ mol Cl}_2 \text{ reacted} = 0.507 \text{ mol SiCl}_4 \times \frac{2 \text{ mol Cl}_2}{1 \text{ mol SiCl}_4} = \boxed{1.01 \text{ mol Cl}_2}$$

- 3.68 5.0 moles of C_4H_{10} is reacted with an excess of O_2 . Calculate the number of moles of CO_2 formed?



$$? \text{ mol CO}_2 = 5.0 \text{ mol C}_4\text{H}_{10} \times \frac{8 \text{ mol CO}_2}{2 \text{ mol C}_4\text{H}_{10}} = 20 \text{ mol CO}_2 = \boxed{2.0 \times 10^1 \text{ mol CO}_2 = 20. \text{ mol CO}_2}$$

- 3.72 Starting with 500.5 g of glucose, what is the maximum amount of ethanol in grams and in liters that can be obtained by fermentation? (Density of ethanol = 0.789 g/mL)

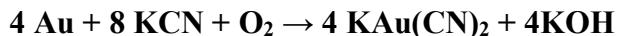


$$? \text{ g C}_2\text{H}_5\text{OH} = 500.4 \text{ g C}_6\text{H}_{12}\text{O}_6 \times \frac{1 \text{ mol C}_6\text{H}_{12}\text{O}_6}{180.16 \text{ g C}_6\text{H}_{12}\text{O}_6} \times \frac{2 \text{ mol C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_6\text{H}_{12}\text{O}_6} \times \frac{46.07 \text{ g C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_2\text{H}_5\text{OH}}$$

$$= \boxed{255.9 \text{ g C}_2\text{H}_5\text{OH}}$$

$$? \text{ L C}_2\text{H}_5\text{OH} = 255.9 \text{ g} \times \frac{1 \text{ mL}}{0.789 \text{ g}} \times \frac{1 \times 10^{-3} \text{ L}}{1 \text{ mL}} = \boxed{0.324 \text{ L}}$$

- 3.74 What is the minimum amount of KCN in moles needed to extract 29.0 g of gold?



$$? \text{ mol KCN} = 29.0 \text{ g Au} \times \frac{1 \text{ mol Au}}{197.0 \text{ g Au}} \times \frac{8 \text{ mol KCN}}{4 \text{ mol Au}} = \boxed{0.294 \text{ mol KCN}}$$

- 3.76 (a) Write the balanced equation for the preparation of laughing gas, dinitrogen monoxide from the decomposition of ammonium nitrate. (The other product is water.)



- (b) How many grams of N_2O are formed if 0.46 mole of NH_4NO_3 is used in the reaction?

$$? \text{ g N}_2\text{O} = 0.46 \text{ mol NH}_4\text{NO}_3 \times \frac{1 \text{ mol N}_2\text{O}}{1 \text{ mol NH}_4\text{NO}_3} \times \frac{44.02 \text{ g N}_2\text{O}}{1 \text{ mol N}_2\text{O}} = \boxed{2.0 \times 10^1 \text{ g N}_2\text{O}}$$

- 3.78 Calculate the number of grams of O_2 gas that can be obtained from the decomposition of 46.0 g of KClO_3 . (The products are KCl and O_2). (write the balance equation first)



$$? \text{ g O}_2 = 46.0 \text{ g KClO}_3 \times \frac{1 \text{ mol KClO}_3}{122.6 \text{ g KClO}_3} \times \frac{3 \text{ mol O}_2}{2 \text{ mol KClO}_3} \times \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = \boxed{18.0 \text{ g O}_2}$$

3.106 A certain metal oxide has the formula MO where M denotes the metal. A 39.46 g sample of the compound is strongly heated in an atmosphere of hydrogen to remove oxygen as water molecules. At the end, 31.70 g of the metal is left over. Knowing that O has an atomic mass of 16.00 amu, calculate the atomic mass of M and identify the element.

- The mass of oxygen in MO is 39.46 g compound – 31.70 g metal + 7.76 g O.
- Therefore, for every 31.70 g of M, there is 7.76 g of O in the compound MO.
- The molecular formula shows a mole ratio of 1 mole M : 1 mole O.

First, calculate moles of M that react with 7.76 g O.

$$\text{mol M} = 7.76 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} \times \frac{1 \text{ mol M}}{1 \text{ mol O}} = \mathbf{0.485 \text{ mol M}}$$

$$\text{molar mass M} = \frac{31.70 \text{ g M}}{0.485 \text{ mol M}} = 65.4 \text{ g/mol}$$

Thus, the atomic mass of M is **65.4 amu**. The metal is most likely **Zn**.

3.144 Industrially, hydrogen gas can be prepared by reacting propane gas (C₃H₈) with steam at about 400°C. The products are carbon monoxide and hydrogen gas.

(a) Write a balanced equation for the reaction.



(b) How many kilograms of hydrogen gas can be obtained from 2.84×10³ kg?

[hint: use kg-mol to avoid converting to g and back to kg.]

$$\begin{aligned} ? \text{ kg H}_2 &= 2.84 \times 10^3 \text{ kg C}_3\text{H}_8 \times \frac{1 \text{ kg-mol C}_3\text{H}_8}{44.09 \text{ kg C}_3\text{H}_8} \times \frac{7 \text{ kg-mol H}_2}{1 \text{ kg-mol C}_3\text{H}_8} \times \frac{2.016 \text{ kg H}_2}{1 \text{ kg-mol H}_2} \\ &= \boxed{9.09 \times 10^2 \text{ kg H}_2} \end{aligned}$$