SI Worksheet

3/28/22

Chapter 3

1. Balance the following chemical reactions

   a. $2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(g)$

   b. $6\ Na + Fe_2O_3 \rightarrow 3\ Na_2O + 2\ Fe$

   c. $2\ Na_3PO_4 + 3\ CaCl_2 \rightarrow Ca_3(PO_4)_2 + 6\ NaCl$

2. A compound is found to contain 26.56% potassium, 35.41% chromium, and the remainder oxygen. Find its empirical formula.

$26.56\text{g K} \times \frac{1\text{mol K}}{39.10\text{g}} = 0.679\ \text{mol K} / 0.679 = 1 \times 2 = 2$

$36.48\text{g Cr} \times \frac{1\text{mol Cr}}{52.00\text{g}} = 0.702\ \text{mol Cr} / 0.679 = 1.033 \times 2 = 2.066$

$36.96\text{g O} \times \frac{1\text{mol O}}{16.00\text{g}} = 2.31\ \text{mol O} / 0.679 = 3.402 \times 2 = 6.802$

$K_2Cr_2O_7$

3. A sample of a compound with a formula mass of 34.00 g is found to consist of 0.44 g H and 6.92 g O. Find its molecular formula.

$0.44\text{g H} \times \frac{1\text{mol}}{1.01\text{g H}} = 0.435\text{mol} / 0.4325 = 1.01$

$6.92\text{g O} \times \frac{1\text{mol}}{16.00\text{g}} = 0.4325\ \text{mol} / 0.4325 = 1$

empirical formula = OH

molecular formula = O_2H_2

$\frac{\text{molecular formula}}{\text{empirical formula}} = \frac{34.00}{17.01} = 1.999$

4. 12.915 g of a biochemical substance containing only carbon, hydrogen, and oxygen was burned in an atmosphere of excess oxygen. Subsequent analysis of the gaseous result yielded 18.942 g carbon dioxide and 7.749 g of water. Determine the empirical formula of the substance.

$$\text{mass of C} = 18.942\text{g}\,CO_2 \times \frac{1\text{mol}\,CO_2}{44.01\text{g}} \times \frac{1\text{mol C}}{1\text{mol}\,CO_2} \times \frac{12.011\text{g C}}{1\text{mol C}} = 5.169\text{g C} \rightarrow \frac{0.4303\text{ mol}}{0.4298}$$

$$\text{mass of H} = 7.749\text{g}\,H_2O \times \frac{1\text{mol}\,H_2O}{18.01\text{g}} \times \frac{2\text{mol H}}{1\text{mol}\,H_2O} \times \frac{1.01\text{g H}}{1\text{mol H}} = 0.869\text{g H} \longrightarrow \frac{0.8604\text{ mol}}{0.4298}$$

$$\text{mass of O} = 12.915 - 5.169 - 0.869 = 6.877\text{g O} \longrightarrow 0.4298\text{ mol}/0.4298$$

1 C : 2 H : 1 O $\quad \boxed{CH_2O}$

5. After combustion with excess oxygen, a 12.501 g of a petroleum compound produced 38.196 g of carbon dioxide and 18.752 of water. A previous analysis determined that the compound does not contain oxygen. Establish the empirical formula of the compound.

$$38.196\text{g}\,CO_2 \times \frac{1\text{mol}\,CO_2}{44.01\text{g}} \times \frac{1\text{mol C}}{1\text{mol}\,CO_2} = 0.8679\text{ mol C}/0.8679 = 1 \times 5$$

$$18.752\text{g}\,H_2O \times \frac{1\text{mol}\,H_2O}{18.01\text{ mol}} \times \frac{2\text{mol H}}{1\text{mol}\,H_2O} = 2.0824\text{ mol H}/0.8679 = 2.3996 \times 5$$

5 C : 12 H $\quad C_5H_{12}$

Chapter 4

6. Take the reaction:

$$4\,NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

In an experiment, 3.25 g of NH3 are allowed to react with 3.50 g of O2.

a. Which reactant is the limiting reagent?

$3.25\,g\,NH_3 \times \frac{1\,mol\,NH_3}{17.04\,g} \times \frac{4\,mol\,NO}{4\,mol\,NH_3} \times \frac{30.01\,g}{1\,mol\,NO} = 5.724\,g\,NO$

$3.50\,g\,O_2 \times \frac{1\,mol\,O_2}{32.00\,g} \times \frac{4\,mol\,NO}{5\,mol\,O_2} \times \frac{30.01\,g}{1\,mol\,NO} = 2.63\,g\,NO$ ← O_2 is limiting

b. How many grams of NO are formed?

2.63g NO

c. How much of the excess reactant remains after the reaction?

$2.63\,g\,NO \times \frac{1\,mol\,NO}{30.01\,g\,NO} \times \frac{4\,mol\,NH_3}{4\,mol\,NO} \times \frac{17.04\,g}{1\,mol\,NH_3} = 1.493\,g\ of\ NH_3\ is\ used$

$3.25g - 1.493g = 1.76\,g\,NH_3\ excess$

7. Given the following reaction to produce Iodine gas:

$$2NaI + MnO_2 + 2H_2SO_4 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + I_2$$

What is the percent yield of I_2 if the actual grams produced is 39.78 grams of I_2 from 62.55 grams of NaI and excess of all the other reactants?

$$62.55\text{g NaI} \times \frac{1\text{mol NaI}}{149.89\text{g}} \times \frac{1\text{mol } I_2}{2\text{mol NaI}} \times \frac{253.8\text{g}}{1\text{mol } I_2} = 52.96\text{g } I_2$$

↑ theoretical yield

$$\%\text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{39.78\text{g}}{52.96\text{g}} \times 100\%$$

$$= 75.11\%$$

8. If the typical yield is 86.78%, how much SO_2 should be expected if 4897 grams of ZnS are used? (2803 of SO_2)

$$2\,\mathbf{ZnS} + 3\mathbf{O_2} \rightarrow 2\mathbf{ZnO} + 2\mathbf{SO_2}$$

$$4897\text{g ZnS} \times \frac{1\text{mol ZnS}}{97.48\text{g}} \times \frac{2\text{mol SO}_2}{2\text{mol ZnS}} \times \frac{64.07\text{g}}{1\text{mol SO}_2} = 3218.62\text{g SO}_2$$

↑ theoretical yield

$$\%\text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}}$$

$$.8678 = \frac{\text{actual}}{3218.62\text{g}} = 2793.1\text{g}$$ ← actual yield

Chapter 5

9. For the reaction below what volume of 0.45 M $FeCl_2$ is needed to react with 35.0 g Al?

$$2\,\mathbf{Al\ (s)} + 3\mathbf{FeCl_2\ (aq)} \rightarrow 2\mathbf{AlCl_3\ (aq)} + 3\mathbf{Fe\ (s)}$$

$$35.0\text{g Al} \times \frac{1\text{mol Al}}{26.98\text{g}} \times \frac{3\text{mol FeCl}_2}{2\text{mol Al}} \times \frac{1\text{ L}}{0.45\text{mol FeCl}_2} = 4.32\text{ L}$$

10. I have 345 mL of a 1.5 M NaCl solution. If I boil the water until the volume of the solution is 250 mL, what will the molarity of the solution be?

$$M = \frac{\text{mol}}{V}\ (V)$$

$$MV = \text{mol}$$

$$V = \frac{\text{mol}}{M}$$

$$\mathbf{M_1V_1 = M_2V_2}$$

$$(1.5\ M)(345mL) = x\ (250\ mL)$$

$$x = 2.07\ M$$

11. Finish the precipitation reactions below and write the net ionic reactions:

a. barium nitrate + ammonium phosphate →

$$3\ Ba(NO_3)_2\ (aq) + 2\ (NH_4)_3PO_4\ (aq) \rightarrow Ba_3(PO_4)_2\ (s) + 6\ NH_4NO_3\ (aq)$$

$$3\ Ba^{2+}(aq) + 6\ NO_3^-\ (aq) + 6\ NH_4 + (aq) + PO_4^{3-}(aq) \rightarrow Ba_3(PO_4)_2\ (s) + 6\ NH_4^+\ (aq) + 6\ NO_3^-\ (aq)$$

Net Ionic: $3\ Ba^{2+}(aq) + 2\ PO_4^{3-}\ (aq) \rightarrow Ba_3(PO_4)_2\ (s)$

b. calcium hydroxide + iron(III)chloride →

$$3\ Ca(OH)_2\ (aq) + 2\ FeCl_3\ (aq) \rightarrow 3\ CaCl_2\ (aq) + 2\ Fe(OH)_3\ (s)$$

$$3\ Ca^{2+}\ (aq) + 6\ OH^-\ (aq) + 2\ Fe^{3+}\ (aq) + 6\ Cl^-\ (aq) \rightarrow 3\ Ca^{2+}\ (aq) + 6\ Cl^-\ (aq) + 2\ Fe(OH)_3\ (s)$$

Net ionic equation: $Fe^{3+}\ (aq) + 3\ OH^-\ (aq) \rightarrow Fe(OH)_3\ (s)$

12. Strong electrolyte, weak electrolyte, or non-electrolyte?

$Ca(NO_3)_2$	Strong electrolyte	$Fe(OH)_3$	Non-electrolyte
$KClO_4$	Strong electrolyte	H_3PO_4	Weak electrolyte
NaOH	Strong electrolyte	$MgCl_2$	Strong electrolyte
HF	Weak electrolyte	CH_3OH	Non-electrolyte

13. For the following nuetraluzation reactions complete and balance the equations, write the net ionic equation, and identify the spectator ions (if any).

a. **$1\ H_2SO_4\,(aq) + 2\ NaOH\,(aq) \rightarrow 2\ H2O + 1\ Na2SO4$**

Net ionic equation: $H^+(aq) + OH^-(aq) \rightarrow H_2O\,(l)$

Spectator Ions: $SO4^{2-}$, Na^+

b. **$H_3PO_4\,(aq) + 3\ LiOH\,(aq) \rightarrow Li_3PO_4\,(aq) + 3\ H_2O\,(l)$**

Net ionic equation: $H_3PO_4\,(aq) + 3\ OH^-(aq) \rightarrow PO_4^{3-}(aq) + 3\ H_2O\,(l)$

Spectator ions: Li^+

c. **$HC_2H_3O_2\,(aq) + KOH\,(aq) \rightarrow H_2O\,(l) + KC_2H_3O_{2\,(aq)}$**

Net ionic equation: $HC_2H_3O_{2\,(aq)} + OH^- \rightarrow H_2O\,(l) + C_2H_3O_2^-$

Spectator Ion(s): K^+

14. In each equation determine what is (1) being oxidized, (2) being reduced, (3) the oxidizing agent and (4) the reducing agent

a. $Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$

Cl^0 to Cl^{1-}; reduced/ox. ag.

Br^{1-} to Br^0; oxidized/red. ag.

b. $C + H_2SO_4 \rightarrow CO_2 + SO_2 + H_2O$

C^0 to C^{4+}; oxidized/red. ag

S^{6+} to S^{4+}; reduced/ox. agent

c. $HNO_3 + HI \rightarrow NO + I_2 + H_2O$

N^{5+} to N^{2+}; reduced/ox. agent

I^{1-} to I^0; oxidized/red. Agent