Key

General Chemistry Chapter 3 & 4 Pre-Test

1.) (2 pts) What is the molar mass of tryptophan, $C_{11}H_{12}N_2O_2$?

C: 11 * 12.01 g/mol = 132.11 g/mol
H: 12 * 1.008 g/mol = 12.096 g/mol
N: 2 * 14.007 g/mol = 28.014 g/mol
O: 2 * 15.999 g/mol = 31.998 g/mol
total

204.2 g/mol

2.) (2 pts) How many moles are in 320 g of $(NH_4)_2SO_4$?

N: 2 * 14.007 g/mol = 28.014 g/mol
H: 8 * 1.008 g/mol = 8.064 g/mol
S: 1 * 32.06 g/mol 32.06 g/mol
O: 4 * 15.999 g/mol 63.996 g/mol
total 132.134 g/mol

$$320\,g * \frac{1\,mol}{132.134\,g} = 2.42\,mol\ (NH_4)_2SO_4$$

3.) (2 pts) How many water molecules are in 4.76 moles of H_2O?

$$4.76\ moles\ H_2O * \frac{6.022*10^{23}\ molecules}{1\ mol\ H_2O} = 2.866*10^{24}\ molecules$$

4.) (2 pts) How many molecules of CO_2 are there in 68 g of carbon dioxide?

$$68\,g\ CO_2 * \frac{1\ mol\ CO_2}{44.008\,g\ CO_2} * \frac{6.022*10^{23}\ molecules\ CO_2}{1\ mol\ CO_2}$$

C: 1 * 12.01 = 12.01 g/mol
O: 2 * 15.999 = 31.998 g/mol
total 44.008 g/mol

$9.31*10^{23}$ molecules CO_2

5.) (9 pts) Find the percent composition of each atom in $NaHCO_3$.

Na: 1 * 22.99 g/mol = 22.99 g/mol
H: 1 * 1.008 g/mol = 1.008 g/mol
C: 1 * 12.01 g/mol = 12.01 g/mol
O: 3 * 15.999 g/mol = 47.997 g/mol
total 84.005 g/mol

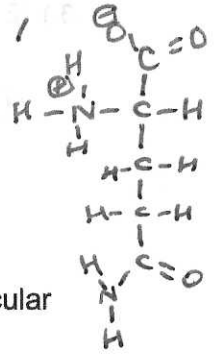
$\frac{22.99}{84.005} * 100\% = 27.4\%$
$\frac{1.008}{84.005} * 100\% = 1.2\%$
$12.01/84.005 * 100\% = 14.3\%$
$\frac{47.997}{84.005} * 100\% = 57.1\%$

6.) (9 pts) The compound glutamine has the following percent composition. What is the empirical formula?

C = 44.9 % H= 6.4 % O = 30.8 % N= 17.9 %

C → 44.9% → 44.9g * $\frac{1\ mol}{12.01\ g}$ = 3.74 mol / 1.28 = 2.92
H → 6.4% → 6.4g * $\frac{1\ mol}{1.008\ g}$ = 6.35 mol / 1.28 = 4.96
O → 30.8% → 30.8g * $\frac{1\ mol}{15.999}$ = 1.93 mol / 1.28 = 1.51
N → 17.9% → 17.9g * $\frac{1\ mol}{14.007\ g}$ = 1.28 mol / 1.28 = 1

$C_3H_5O_{1.5}N_1 \rightarrow$ $C_6H_{10}O_3N_2$



7.) (4 pts) The empirical formula for a substance is CH2O. What is its molecular formula if its molar mass is 210 g/mol?

C: 1 * 12.01 = 12.01 g/mol
H: 2 * 1.008 = 2.016 g/mol
O: 1 * 15.999 = 15.999 g/mol
total 30.025

$\frac{210\ g/mol}{30.025\ g/mol} \approx 7$

$7(CH_2O) =$ $C_7H_{14}O_7$

8.) (6 pts total, 2 pts each) Complete each of the following stoichiometry reactions.

a) $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

b) $C_2H_6 + \frac{7}{2}\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$

$2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$

c) $1\ HNO_3 + 1\ NaHCO_3 \rightarrow 1\ NaNO_3 + 1\ H_2O + 1\ CO_2$

9.) $4Na\ (s) + O_2\ (g) \rightarrow 2Na_2O\ (s)$

(12 pts total) Balance the equation. If you begin with 60 g of sodium and 100 g of oxygen

a) (5 pts) Identify the limiting reagent. Show work.

$$60g\ Na * \frac{1\ mol\ Na}{22.99g\ Na} * \frac{2\ mol\ Na_2O}{4\ mol\ Na} * \frac{61.979g\ Na_2O}{1\ mol\ Na_2O} = 80.9\ g\ Na_2O$$

Sodium

$$100g\ O_2 * \frac{1\ mol\ O_2}{31.998g\ O_2} * \frac{2\ mol\ Na_2O}{1\ mol\ O_2} * \frac{61.979g\ Na_2O}{1\ mol\ Na_2O} = 387.4\ g\ Na_2O$$

b) (5 pts) Find the mass of Na_2O produced during the reaction.

$Na: 2 * 22.99 = 45.98$

$O: 1 * 15.999 = 15.999$

$61.979\ g/mol$

$O_2: 2 * 15.999 = 31.998\ g/mol$

$80.9\ g\ Na_2O$

c) (2 pts) Find the mass of excess reagent.

$$60g\ Na * \frac{1\ mol\ Na}{22.99g\ Na} * \frac{1\ mol\ O_2}{4\ mol\ Na} * \frac{31.998g\ O_2}{1\ mol\ O_2} = 20.88g\ O_2$$

$100g - 20.88g = 79.12g\ O_2$ excess

10.) $CaCl_2\,(aq) + 2\,AgNO_3\,(aq) \rightarrow Ca(NO_3)_2\,(aq) + 2\,AgCl\,(aq)$

(12 pts total) If you begin with 90 g of $CaCl_2$ and 120 g of $AgNO_3$

a) (5 pts) Identify the limiting reagent.

$$90\,g\,CaCl_2 * \frac{1\,mol\,CaCl_2}{110.978\,g\,CaCl_2} * \frac{2\,mol\,AgCl}{1\,mol\,CaCl_2} * \frac{143.32\,g\,AgCl}{1\,mol\,AgCl} = 232.5\,g\,AgCl$$

$AgNO_3$ limiting reagent

$$120\,g\,AgNO_3 * \frac{1\,mol\,AgNO_3}{169.874\,g\,AgNO_3} * \frac{2\,mol\,AgCl}{2\,mol\,AgNO_3} * \frac{143.32\,g\,AgCl}{1\,mol\,AgCl} = 101.2\,g\,AgCl$$

b) (5 pts) Find the mass of AgCl produced during the reaction.

Ca: $1 * 40.078\,g/mol = 40.078\,g/mol$

Cl: $2 * 35.45\,g/mol = 70.90\,g/mol$

$110.978\,g/mol$

Ag: $1 * 107.87\,g/mol = 107.87$

Cl: $1 * 35.45\,g/mol = 35.45$

$143.32\,g/mol$

101.2g AgCl

Ag: $1 * 107.87\,g/mol = 107.87\,g/mol$

N: $1 * 14.007\,g/mol \quad 14.007\,g/mol$

O: $3 * 15.999\,g/mol \quad 47.997\,g/mol$

$169.874\,g/mol$

c) (2 pts) Find the mass of excess reagent.

$$120\,g\,AgNO_3 * \frac{1\,mol\,AgNO_3}{169.874\,g\,AgNO_3} * \frac{1\,mol\,CaCl_2}{2\,mol\,AgNO_3} * \frac{110.978\,g\,CaCl_2}{1\,mol\,CaCl_2} = 39.2\,g\,CaCl_2$$

$90 - 39.2 =$ 50.8g $CaCl_2$

11.) (12 pts) If you have 80 g of methane (CH_4) is reacted with 90 g of oxygen (O_2), find the liters of carbon dioxide (CO_2) produced under STP conditions.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$80\,g\,CH_4 * \frac{1\,mol\,CH_4}{16.042\,g\,CH_4} * \frac{1\,mol\,CO_2}{1\,mol\,CH_4} * \frac{22.4\,L\,CO_2}{1\,mol\,CO_2} = 111.7\,L\,CO_2$$

$$90\,g\,O_2 * \frac{1\,mol\,O_2}{31.998\,g\,O_2} * \frac{1\,mol\,CO_2}{2\,mol\,O_2} * \frac{22.4\,L\,CO_2}{1\,mol\,CO_2} = \boxed{31.5\,L\,CO_2}$$

C: $1 * 12.01 = 12.01\,g/mol$

H: $4 * 1.008 = 4.032\,g/mol$

$16.042\,g/mol$

O_2: $2 * 15.999 = 31.998\,g/mol$

12.) (12 pts total, 4 pts each) For each reaction, 1) complete each reaction by writing the potential products. 2) Balance the reaction. 3) Consult the solubility rules and identify soluble and insoluble compounds. 4) Write the net reaction.

a) $3KOH\,(aq) + Fe(NO_3)_3\,(aq) \rightarrow 3KNO_3\,(aq) +$ $Fe(OH)_3\,(s)$ (precipitate)

$$3K^+ + 3OH^- + Fe^{+3} + 3NO_3^- \rightarrow 3K^+ + 3NO_3^- + Fe(OH)_3$$

$$3OH^- + Fe^{+3} \rightarrow Fe(OH)_3$$

b) $3CaCl_2(aq) + 2Na_3PO_4(aq) \rightarrow$ precipitate $Ca_3(PO_4)_2(s) + 6NaCl(aq)$

$3Ca^{+2} + 6Cl^- + 6Na^+ + 2PO_4^{-3} \rightarrow Ca_3(PO_4)_2(s) + 6Na^+ + 6Cl^-$

$3Ca^{+2} + 2PO_4^{-3} \longrightarrow Ca_3(PO_4)_2(s)$

c) Aqueous solutions of lithium sulfate and calcium nitrate are mixed...

$Li_2SO_4(aq) + Ca(NO_3)_2(aq) \rightarrow 2LiNO_3(aq) +$ precipitate $CaSO_4(s)$

$2Li^+ + SO_4^{-2} + Ca^{+2} + 2NO_3^- \rightarrow 2Li^+ + 2NO_3^- + CaSO_4(s)$

$SO_4^{-2} + Ca^{+2} \longrightarrow CaSO_4(s)$

13.) (8 pts total, 2 pts each) Find the oxidation state of each atom within the compound.

a) H_2CO_3

+1 −2

$H_2CO_3 = 0$

$2(+1) + C + 3(-2) = 0$

$2 + C - 6 = 0$

$C - 4 = 0$

$+4 \quad +4$

$C = +4$

b) $Na_2Cr_2O_7$

+1 −2

$2(+1) + 2Cr + 7(-2) = 0$

$2 + 2Cr - 14 = 0$

$2Cr - 12 = 0$

$+12 \quad +12$

$\frac{2Cr}{2} = \frac{12}{2}$

$Cr = +6$

c) NO_3^{-1}

−2

$N + 3(-2) = -1$

$N - 6 = -1$

$N = +5$

d) SO_4^{-2}

-2

$S + 4(-2) = -2$

$S - 8 = -2$

$+8 \quad +8$

$S = +6$

14.) (8 pts total, 4 pts each) Find the oxidation state of each atom within the reaction. Indicate which atom is reduced and which is oxidized.

a) $Sb + HNO_3 \rightarrow Sb_2O_3 + NO + H_2O$

$0 \quad +1 \quad -2 \quad -2 \quad -2 \quad +1 \quad -2$

Sb $0 \rightarrow +3$ oxidized

N $+5 \rightarrow +2$ reduced

$HNO_3 \rightarrow 1 + N + 3(-2) = 0$

$1 + N - 6 = 0$

$N - 5 = 0$

$+5 \quad +5$

$N = +5$

$2(Sb) + 3(-2) = 0$

$2(Sb) - 6 = 0$

$+6 \quad +6$

$2(Sb) = 6$

$\frac{2(Sb)}{2} = \frac{6}{2}$

$Sb = +3$

b) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

$0 \quad +1 \quad -1 \quad +2 \quad -1 \quad 0$

Mg: $0 \rightarrow +2$ oxidized

H: $+1 \rightarrow 0$ reduced