Ch. 10 Quiz Review

Name: _____

10.1 / 10.2 – Moles & Mole Calculations

1 mol = 6.022×10^{23} particles , 1 mol = (Molar Mass) g

10.3 – % composition & Chemical formulas

$$\text{\% by mass of element} = \frac{\text{mass of element}}{\text{mass of compound}} (100\%)$$

$$\text{\% by mass of element} = \frac{\text{mass of element in 1 mol compound}}{\text{Molar mass of compound}} (100\%)$$

Molecular Formula = (x) E.F. (X = whole #)

$$\text{Molecular Formula} = \left(\frac{\text{Molar Mass}}{\text{E.F. mass}}\right) \text{E.F.}$$

One mole of a substance contains Avogadro's Number (6.02×10^{23}) of molecules.

How many molecules are in the quantities below?

1. 2.0 moles	$\left(\frac{6.022\times10^{23}\ \text{molecules}}{1\ \text{mol}}\right)$ =	1.2×10^{24} molecules
2. 1.5 moles	$\left(\frac{6.022\times10^{23}\ \text{molecules}}{1\ \text{mol}}\right)$ =	9.0×10^{23} molecules
3. 0.75 mole	$\left(\frac{6.022\times10^{23}\ \text{molecules}}{1\ \text{mol}}\right)$ =	4.5×10^{23} molecules
4. 3.4×10^{26}	$\left(\frac{1\ \text{mol}}{6.022\times10^{23}\ \text{molecules}}\right)$ =	560 mols
5. 7.5×10^{19}	$\left(\frac{1\ \text{mol}}{6.022\times10^{23}\ \text{molecules}}\right)$ =	0.00012 mols 1.2×10^{-4} mols

#moles

GRAM FORMULA MASS

Name _____

Determine the gram formula mass (the mass of one mole) of each compound below.

1. $KMnO_4$ $39.10 + 54.94 + 4(16.00) = 158.0\ g/mol$
2. KCl $39.10 + 35.45 = 74.55\ g/mol$
3. Na_2SO_4 $2(22.99) + 32.07 + 4(16.00) = 142.1\ g/mol$
4. $Ca(NO_3)_2$ $40.08 + 2(14.01) + 6(16.00) = 164.1\ g/mol$
5. $Al_2(SO_4)_3$ $2(26.98) + 3(32.07) + 12(16.00) = 342.2\ g/mol$
6. $(NH_4)_3PO_4$ $3(14.01) + 12(1.008) + 30.97 + 4(16.00) = 149.1\ g/mol$

MOLES AND MASS

Name _____

1. 25 g of NaCl = _____ mols NaCl $22.99 + 35.45 = 58.44\ g/mol$

$25\ g\ NaCl \left(\frac{1\ mol\ NaCl}{58.44\ g\ NaCl}\right) = 0.43\ mol\ NaCl$

2. 125 g of H_2SO_4 = _____ mols H_2SO_4 $2(1.008) + 32.07 + 4(16.00) = 98.09\ g/mol$

$125\ g\ H_2SO_4 \left(\frac{1\ mol\ H_2SO_4}{98.09\ g\ H_2SO_4}\right) = 1.27\ mol\ H_2SO_4$

3. 100. g of $KMnO_4$ = _____ mols $KMnO_4$ $39.10 + 54.94 + 4(16.00) = 158.0\ g/mol$

$100\ g\ KMnO_4 \left(\frac{1\ mol\ KMnO_4}{158.0\ g\ KMnO_4}\right) = 0.633\ mol\ KMnO_4$

4. 0.25 moles of KCl = _____ g KCl $39.10 + 35.45 = 74.55\ g/mol$

$0.25\ mol\ KCl \left(\frac{74.55\ g\ KCl}{1\ mol\ KCl}\right) = 19\ g\ KCl$

5. 3.2 moles of $CuSO_4$ = _____ g $CuSO_4$ $63.55 + 32.07 + 4(16.00) = 159.6\ g/mol$

$3.2\ mol\ CuSO_4 \left(\frac{159.6\ g\ CuSO_4}{1\ mol\ CuSO_4}\right) = 5.10\ g\ CuSO_4$

Mixed Mol Problems

1. How many grams are there in 1.5×10^{25} molecules of CO_2? $12.01 + 2(16.00) = 44.01$

$1.5\times10^{25}\ CO_2 \left(\frac{1\ mol\ CO_2}{6.022\times10^{23}\ CO_2}\right)\left(\frac{44.01\ g\ CO_2}{1\ mol\ CO_2}\right) = 1.1\times10^{3}\ g\ CO_2$

5. How many atoms are there in 1.3×10^{22} molecules of NO_2?

1 molecule NO_2 = 3 atoms (1 N & 2 O)

$(1.3\times10^{22})3 = 3.9\times10^{22}$ atoms

6. A 5.0 g sample of O_2 is in a container, How many mols of O_2 are in the container?

$2(16.00) = 32.00\ g/mol$

$5.0\ g\ O_2 \left(\frac{1\ mol\ O_2}{32.00\ g\ O_2}\right) = 0.16\ mol\ O_2$

7. How many molecules of O_2 are in the container in Problem 6? How many atoms of oxygen?

$0.16\ mol\ O_2 \left(\frac{6.022\times10^{23}\ O_2}{1\ mol\ O_2}\right) = 9.4\times10^{22}$ molecules O_2

$\times 2 = 1.9\times10^{23}$ atoms O

PERCENTAGE COMPOSITION

Name _____

Determine the percentage composition of each of the compounds below.

1. $KMnO_4 = 158.0\ g/mol$

K = 24.7%

Mn = 34.8%

O = 40.5%

$\frac{39.10\ g}{158.0\ g} = 24.7\%\ K$ $\quad \frac{54.94\ g}{158.0\ g} = 34.8\%\ Mn$ $\quad \frac{64.00\ g}{158.0\ g} = 40.5\%\ O$

2. $Al_2(SO_4)_3 = 342.2\ g/mol$

Al = 15.8%

S = 28.1%

O = 56.1%

$\frac{53.96\ g}{342.2\ g} = 15.8\%\ Al$ $\quad \frac{96.21\ g}{342.2\ g} = 28.1\%\ S$ $\quad \frac{192.0\ g}{342.2\ g} = 56.1\%\ O$

Solve the following problems.

3. How many grams of oxygen can be produced from the decomposition of 100. g of $KClO_3$? 39.15 g O (work on next page)

4. How much iron can be recovered from 25.0 g of Fe_2O_3? 17.5 g Fe

5. How much silver can be produced from 125 g of Ag_2S? 108.5 g Ag

% Comp # 3-5

3) **Step 1** - determine % comp.

$KClO_3 \rightarrow 39.10 + 35.45 + 3(16.00) = 122.6\ g/mol$

$\%K = \frac{39.10}{122.6}(100\%) = 31.91\%$

$\%Cl = \frac{35.45}{122.6}(100\%) = 28.92\%$

$\%O = \frac{48.00}{122.6}(100\%) = 39.15\%$

Step 2 → $\frac{39.15\ g\ O}{100\ g\ KClO_3} \Rightarrow 100\ g\ KClO_3 \left(\frac{39.15\ g\ O}{100\ g\ KClO_3}\right)$

$= 39.15\ g\ O$

4) Fe_2O_3 $2(55.85) + 3(16.00) = 159.7\ g/mol$

$\%Fe = \frac{111.7\ g}{159.7\ g} = 69.94\%$

$\%O = \frac{48.00\ g}{159.7\ g} = 30.06\%$

$250\ g\ Fe_2O_3 \left(\frac{69.94\ g\ Fe}{100\ g\ Fe_2O_3}\right) = 17.5\ g\ Fe$

5) Ag_2S $2(107.87) + 32.07 = 247.8\ g/mol$

$\%Ag = \frac{215.7}{247.8} = 87.06\%$ $\quad \%S = \frac{32.07}{247.8} = 12.94\%$

$125\ g\left(\frac{87.06\ g}{100\ g}\right) = 108.8\ g\ Ag$

WHAT IS THE EMPIRICAL FORMULA?

1. 75% carbon, 25% hydrogen

$75\text{g C}\left(\frac{1\text{mol C}}{12.01\text{g C}}\right) = 6.2\text{ mol C}$

$25\text{g H}\left(\frac{1\text{mol H}}{1.008\text{g H}}\right) = 24.8\text{ mol H}$

$C_{6.2}H_{24.8}$ $\quad 6.2 \div 6.2 = 1$, $\quad 24.8 \div 6.2 = 4$

CH_4

2. 52.7% potassium, 47.3% chlorine

$52.7\text{g K}\left(\frac{1\text{mol K}}{39.10\text{g K}}\right) = 1.35\text{ mol K}$

$47.3\text{g Cl}\left(\frac{1\text{mol Cl}}{35.45\text{g Cl}}\right) = 1.33\text{ mol Cl}$

$K_{1.35}Cl_{1.33}$

$1.35 \div 1.33 = 1.01$

$1.33 \div 1.33 = 1$

KCl

3. 22.1% aluminum, 25.4% phosphorus, 52.5% oxygen

$22.1\text{g Al}\left(\frac{1\text{mol Al}}{26.98\text{g Al}}\right) = 0.819$

$24.5\text{g P}\left(\frac{1\text{mol P}}{30.97\text{g P}}\right) = 0.791$

$52.5\text{g O}\left(\frac{1\text{mol O}}{16.00\text{g O}}\right) = 3.28$

$Al_{0.819}P_{0.791}O_{3.28} \div 0.791$

$Al_{1.04}P_1O_{4.15}$

OK to round

$AlPO_4$

WHAT IS THE MOLECULAR FORMULA?

1. The empirical formula of a compound is NO_2. Its molecular mass is 92 g/mol. What is its molecular formula?

$NO_2 = 14.01 + 2(16.00) = 46.01\text{ g/mol}$

$\frac{92}{46.01} = 1.9996 \Rightarrow 2$ $\quad NO_2 \times 2$

N_2O_4

2. The empirical formula of a compound is CH_2. Its molecular mass is 70 g/mol. What is its molecular formula?

$CH_2 = 12.01 + 2(1.008) = 14.03\text{ g/mol}$

$\frac{70}{14.03} = 4.99 \Rightarrow 5$ $\quad CH_2 \times 5$

C_5H_{10}

3. A compound is found to be 40.0% carbon, 6.7% hydrogen and 53.5% oxygen. Its molecular mass is 60. g/mol. What is its molecular formula?

$40\text{g C}\left(\frac{1\text{mol C}}{12.01\text{g C}}\right) = 3.33\text{ mol C} = 1\text{ mol C}$

$6.7\text{g H}\left(\frac{1\text{mol}}{1.008\text{g H}}\right) = 6.65\text{ mol H} = 2\text{ mol H}$

$53.5\text{g O}\left(\frac{1\text{mol}}{16.00\text{g}}\right) = 3.34\text{ mol O} = 1\text{ mol O}$

E.F. $= CH_2O$

$12.01 + 2(1.008) + 16.00 = 30.0\text{ g/mol}$

$\frac{60}{30} = 2$ $\quad CH_2O \times 2$

$C_2H_4O_2$

4. A compound is 64.9% carbon, 13.5% hydrogen and 21.6% oxygen. Its molecular mass is 74 g/mol. What is its molecular formula?

$64.9\text{g C}\left(\frac{1\text{mol C}}{12.01\text{g C}}\right) = 5.40\text{ mol C} \Rightarrow 4$

$13.5\text{g H}\left(\frac{1\text{mol H}}{1.008\text{g H}}\right) = 13.4\text{ mol H} \Rightarrow 9.9 \rightarrow 10$

$21.6\%\text{ O}\left(\frac{1\text{mol O}}{16.00\text{g}}\right) = 1.35\text{ mol O} \Rightarrow 1$

EF $= C_4H_{10}O_1$

$4(12.01) + 10(1.008) + 16.00 = 74.12\text{ g/mol}$

$\frac{74\text{ g/mol}}{74.12\text{ g/mol}} = 1$

$C_4H_{10}O$