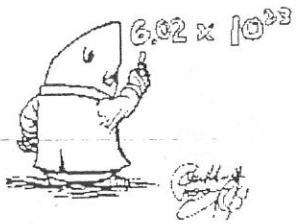
Ch 10: Mole Packet

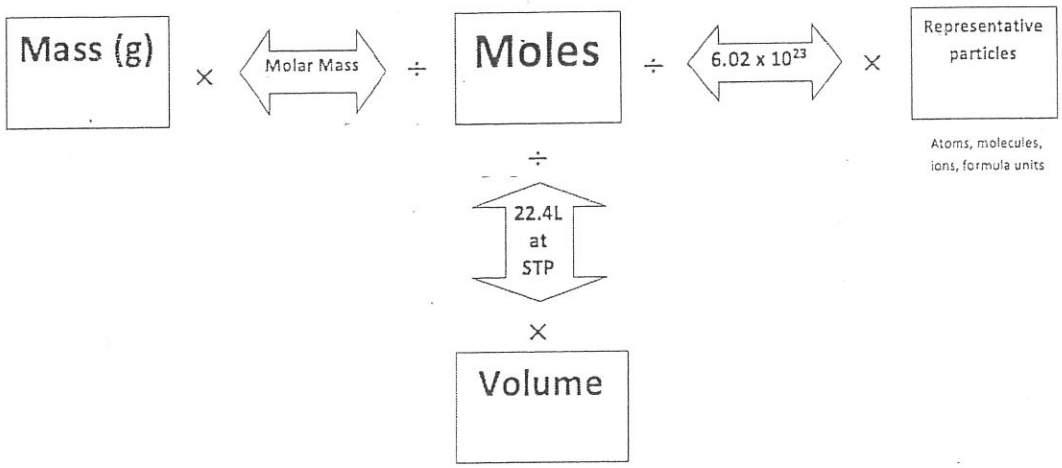
Key



The following packet includes various calculations from Ch 10. It is your responsibility to practice these problems before the quiz.

Calculations:

1. Molar Mass
2. Moles-Particles
3. Moles-Mass
4. Moles-Volume
5. Mixed Mole Problems
6. % Composition
7. Empirical and Molecular Formulas



Molar Mass Practice Worksheet

Find the molar masses of the following compounds:

1) $NaBr$ 102.9 g/mol

2) $PbSO_4$ 303.3 g/mol

3) $Ca(OH)_2$ 74.1 g/mol

4) Na_3PO_4 164.0 g/mol

5) $(NH_4)_2CO_3$ 96.0 g/mol

6) $C_6H_{12}O_6$ 180.0 g/mol

7) $Fe_3(PO_4)_2$ 357.4 g/mol

8) $(NH_4)_2S$ 68.1 g/mol

9) $Zn(C_2H_3O_2)_2$ 183.4 g/mol

10) AgF 126.9 g/mol

Percent Composition Worksheet

Find the percent compositions of all of the elements in the following compounds:

1) $CuBr_2$

Cu: 28.4%
Br: 71.6%

2) $NaOH$

Na: 57.5%
O: 40.0%
H: 2.5%

3) $(NH_4)_2S$

N: 41.1%
H: 11.8%
S: 47.1%

4) N_2S_2

N: 30.4%
S: 69.6%

Mole-Particle Practice Worksheet

1 mole of particles = 6.02 x 10^{23} particles

(Particle is the generic word that we use in chemistry for: molecule, formula unit, ion, atom, etc.)

Hints:

- ***Always begin by writing out the formula for any compound in the problem.***
- ***Remember to give your answer to the correct number of significant digits***

Part One: One Step Conversion

1. How many formula units are there in 2.45 moles potassium chloride?

$$2.45\,mol \left| \frac{6.02\times10^{23}\,units}{1\,mol} \right. = 1.47\times10^{24}\,units$$

2. How many molecules are there in 31.8 moles of water?

$$31.8\,mol \left| \frac{6.02\times10^{23}\,units}{1\,mol} \right. = 1.91\times10^{25}\,molecules$$

3. How many moles are 2.85 x 10^{18} atoms of iron?

$$2.85\times10^{18}\,atoms \left| \frac{1\,mol}{6.02\times10^{23}\,units} \right. = 4.73\times10^{-6}\,moles$$

4. How many moles are 9.05 x 10^{22} ions of chloride?

$$9.05\times10^{22}\,ions \left| \frac{1\,mol}{6.02\times10^{23}\,units} \right. = 0.150\,mol$$

5. How many formula units are in 3.55 moles of aluminum sulfate?

$$3.55\,mol \left| \frac{6.02\times10^{23}}{1\,mol} \right. = 2.14\times10^{24}\,units$$

6. How many moles of copper are 4.57 x 10^{13} atoms of copper?

$$4.57\times10^{13}\,atoms \left| \frac{1\,mol}{6.02\times10^{23}} \right. = 7.59\times10^{-11}\,mol$$

7. How many formula units of magnesium hydroxide are found in 5.88 moles?

$$5.88\,mol \left| \frac{6.02\times10^{23}}{1\,mol} \right. = 3.54\times10^{24}\,units$$

8. 4.5 x 10^{16} molecules of carbon dioxide are equal to how many moles?

$$4.5\times10^{16}\,molecules \left| \frac{1\,mol}{6.02\times10^{23}\,molecules} \right. = 7.48\times10^{-8} \rightarrow 7.5\times10^{-8}\,mol$$

Part Two: Multi-Step Conversions

9. How many ions of fluoride are there in 0.23 moles of iron(III) fluoride?

FeF_3

$$\frac{0.23 \text{ moles}}{1 \text{ mol}} \left| \frac{6.02\times10^{23} \text{ molecules}}{1 \text{ mol}} \right| \frac{3 \text{ ions}}{1 \text{ molecule}} = 4.2\times10^{23} \text{ ions F}$$

10. 4.50 moles of sodium sulfate contain how many atoms of sulfur?

$$\frac{4.50 \text{ mol } Na_2SO_4}{1 \text{ mol}} \left| \frac{6.02\times10^{23} \text{ molecules}}{1 \text{ mol}} \right| \frac{1 \text{ atom S}}{1 \text{ molecule}} = 2.71\times10^{24}$$

11. 2.3×10^{24} ions of silver are found in how many formula units of silver carbonate?

Ag_2CO_3

$$\frac{2.3\times10^{24} \text{ ion Ag}}{1 \text{ ion}} \left| \frac{1 \text{ atom}}{1 \text{ ion}} \right| = 2.3\times10^{24} \text{ formula units}$$

12. How many atoms of carbon are found in 4.7×10^{25} molecules of carbon monoxide? CO

$$\frac{4.7\times10^{25} \text{ molecules}}{1 \text{ molecule}} \left| \frac{1 \text{ atom C}}{1 \text{ molecule}} \right| = 4.7\times10^{25} \text{ atoms C}$$

13. There are 8.57×10^{26} atoms of phosphorous in how many moles of diphosphorous pentoxide? P_2O_5

$$\frac{8.57\times10^{26} \text{ atoms P}}{2 \text{ atoms}} \left| \frac{1 \text{ molecule}}{6.02\times10^{23} \text{ molecule}} \right| \frac{1 \text{ mol}}{} = 712 \text{ moles}$$

14. How many atoms of chlorine are in 2.00×10^{10} moles of carbon tetrachloride? CCl_4

$$\frac{2.00\times10^{10} \text{ mol}}{1 \text{ mol}} \left| \frac{6.02\times10^{24} \text{ molecules}}{1 \text{ mol}} \right| \frac{4 \text{ atoms Cl}}{1 \text{ molecule}} = 4.82\times10^{34} \text{ atoms Cl}$$

15. How many total ions are found in 12.6 moles of copper(I) sulfite?

Cu_2SO_3

$$\frac{12.6 \text{ moles}}{1 \text{ mol}} \left| \frac{6.02\times10^{23} \text{ formula units}}{1 \text{ mol}} \right| \frac{6 \text{ ions}}{1 \text{ formula unit}}$$

$$= 4.55\times10^{25} \text{ ions}$$

Name Key

Mass-Mole Conversion Handout

Date _____

Convert each of the following from grams to moles:

1. 15.0 g C_2H_6 0.499 mol

$$15.0\text{g } C_2H_6 \left| \frac{1\text{mol}}{30.07\text{g}} \right.$$

2. 140.0 g NaOH 3.5 mol

$$140.0\text{g NaOH} \left| \frac{1\text{mol}}{40.00\text{g}} \right.$$

3. 27.2 g H_2O 1.51 mol

$$27.2\text{g } H_2O \left| \frac{1\text{mol}}{18.02\text{g}} \right.$$

4. 45.7 g $CaCO_3$ 0.457 mol

$$45.7\text{g } CaCO_3 \left| \frac{1\text{mol}}{100.09} \right.$$

Convert moles to grams in each of the following:

5. 1.5 moles NH_3 25.55 g

$$1.5\text{mol} \left| \frac{17.03\text{g}}{1\text{mol}} \right.$$

6. 0.65 moles H_2SO_4 63.75 g

$$0.65\text{mol} \left| \frac{98.08\text{g}}{1\text{mol}} \right.$$

Convert the following to grams:

7. 3.01×10^{23} atoms Na 11.5 g Na

$$3.01\times10^{23}\text{ atoms} \left| \frac{1\text{mol}}{6.02\times10^{23}\text{ atoms}} \right| \frac{22.99\text{g}}{1\text{mol}}$$

8. 2.41×10^{24} molecules CO_2 176 g CO_2

$$2.41\times10^{24}\text{ molecules} \left| \frac{1\text{mol}}{6.02\times10^{23}\text{ molecules}} \right| \frac{44\text{g}}{1\text{mol}}$$

Using Factor-Labeling, convert the following to particles:

9. 29 grams Ca 4.4×10^{23} particles Ca

$$29\text{g Ca} \left| \frac{1\text{mol}}{40.08\text{g}} \right| \frac{6.02\times10^{23}\text{ particles}}{1\text{mol}}$$

10. 42.5 grams H_2 1.27×10^{25} particles H_2

$$42.5\text{g } H_2 \left| \frac{1\text{mol } H_2}{2.02\text{g } H_2} \right| \frac{6.02\times10^{23}\text{ particles}}{1\text{mol } H_2}$$

THE MOLE AND VOLUME

Name _____

For gases at STP (273 K and 1 atm pressure), one mole occupies a volume of 22.4 L. What volume will the following quantities of gases occupy at STP?

1. 1.00 mole of H_2 | $\frac{22.4\,L}{1\,mol}$ — 22.4 L H_2
2. 3.20 moles of O_2 | $\frac{22.4\,L}{1\,mol}$ — 71.7 L O_2
3. 0.750 mole of N_2 | $\frac{22.4\,L}{1\,mol}$ — 16.8 L N_2
4. 1.75 moles of CO_2 | $\frac{22.4\,L}{1\,mol}$ — 39.2 L CO_2
5. 0.50 mole of NH_3 | $\frac{22.4\,L}{1\,mol}$ — 11.2 L NH_3
6. 5.0 g of H_2 | $\frac{1\,mol}{2.02\,g}$ | $\frac{22.4\,L}{1\,mol}$ — 55 L H_2
7. 100. g of O_2 | $\frac{1\,mol}{32\,g}$ | $\frac{22.4\,L}{1\,mol}$ — 70 L O_2
8. 28.0 g of N_2 | $\frac{1\,mol}{28\,g}$ | $\frac{22.4\,L}{1\,mol}$ — 22.4 L N_2
9. 60. g of CO_2 | $\frac{1\,mol}{44\,g}$ | $\frac{22.4\,L}{1\,mol}$ — 30.5 L CO_2
10. 10. g of NH_3 | $\frac{1\,mol}{17.03\,g}$ | $\frac{22.4\,L}{1\,mol}$ — 13.2 L NH_3

(4)

MIXED MOLE PROBLEMS

Name _____

Solve the following problems.

1. How many grams are there in 1.5×10^{25} molecules of CO_2?
$1.5\times10^{25}\,molecules \mid \frac{1\,mol}{6.02\times10^{23}} \mid \frac{44\,g}{1\,mol}$ — 1096 g CO_2
2. What volume would the CO_2 in Problem 1 occupy at STP?
$1.5\times10^{25}\,molecules \mid \frac{1\,mol}{N_A} \mid \frac{22.4\,L}{1\,mol}$ — 558 L CO_2
3. A sample of NH_3 gas occupies 75.0 liters at STP. How many molecules is this?
$75.0\,L \mid \frac{1\,mol}{22.4\,L} \mid \frac{N_A}{1\,mol}$ — 2.02×10^{24} molecules
4. What is the mass of the sample of NH_3 in Problem 3?
$75.0\,L \mid \frac{1\,mol}{22.4\,L} \mid \frac{17.03\,g}{1\,mol}$ — 57.0 g NH_3
5. How many atoms are there in 1.3×10^{22} molecules of NO_2?
$1.3\times10^{22}\,molecules \mid \frac{3\,atoms}{1\,molecule}$ — 3.9×10^{22} atoms NO_2
6. A 5.0 g sample of O_2 is in a container at STP. What volume is the container?
$5.0\,g\,O_2 \mid \frac{1\,mol}{32\,g} \mid \frac{22.4\,L}{1\,mol}$ — 3.5 L O_2
7. How many molecules of O_2 are in the container in Problem 6? How many atoms of oxygen?
$5.0\,g \mid \frac{1\,mol}{32\,g} \mid \frac{6.02\times10^{23}\,molecules}{1\,mol}$ — 9.41×10^{22} molecules; 1.88×10^{23} atoms

DETERMINING EMPIRICAL FORMULAS

Name _____

What is the empirical formula (lowest whole number ratio) of the compounds below?

1. 75% carbon, 25% hydrogen

C $\frac{75 \text{ g} \mid 1 \text{ mol}}{12.01} = 6.24 = 1$

H $\frac{25 \mid 1 \text{ mol}}{1.01}$ $\frac{19.6}{6.24}$ 3

CH_3

2. 52.7% potassium, 47.3% chlorine

K $\frac{52.7 \text{ K} \mid 1 \text{ mol}}{39.09} = 1.35 = 1$

Cl $\frac{47.3 \text{ Cl} \mid 1 \text{ mol}}{35.45} = 1.33 = 1$

KCl

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

Al $\frac{22.1 \mid 1}{26.98}$ .82 = 1

P $\frac{25.4 \mid 1}{30.97} = .82 = 1$

O $\frac{52.5 \text{ g} \mid 1}{16} = 3.28$ 4

$AlPO_4$

4. 13% magnesium, 87% bromine

Mg $\frac{13 \text{ g} \mid 1 \text{ mol}}{24.31}$ .53 = 1

Br $\frac{87 \text{ g Br} \mid 1 \text{ mol}}{79.90} = 1$ 2

$MgBr_2$

5. 32.4% sodium, 22.5% sulfur, 45.1% oxygen

Na $\frac{32.4 \mid 1}{22.99} = 1.41 = 2$

S $\frac{22.5 \mid 1}{32.06}$ .70 = 1

O $\frac{45.1 \mid 1}{16}$ 2.8 = 4

Na_2SO_4

6. 25.3% copper, 12.9% sulfur, 25.7% oxygen, 36.1% water

Cu $\frac{25.3 \mid 1 \text{ mol}}{63.55} = .398 = 1$

S $\frac{12.9 \text{ g} \mid 1 \text{ mol}}{32.06} = .402 = 1$

$CuSO_4(H_2O)_5$

DETERMINING MOLECULAR FORMULAS (TRUE FORMULAS)

Name _____

Solve the problems below.

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

EFM = 46.06 $\frac{92}{46.06} = 2$

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?

EFM = 14.03 $\frac{70}{14.03}$ 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?

EFM : $CH_2O = 30.02$

$\frac{60}{30} = 2$

$C_2H_4O_2$

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?

EFM = $C_4H_{10}O = \frac{74.1}{74.1}$

Same EFM & MF

$C_4H_{10}O$

5. A compound is 54.5% carbon, 9.1% hydrogen and 36.4% oxygen. Its molecular mass is 88 g/mol. What is its molecular formula?

EFM = $C_2H_4O = 44.04$

$\frac{88}{44.04}$

$C_4H_8O_2$

(6)

(3) O $\frac{25.7 \text{ g} \mid 1}{16 \text{ g}} = 1.60 = 4$

H_2O $\frac{36.1 \text{ g} \mid 1 \text{ mol}}{18.02} = 2 = 5$

C $\frac{40.0 \mid 1}{12.01} = 3.33$

H $\frac{6.7 \text{ H} \mid}{1.01} = 6.63$

O $\frac{53.5 \mid 1 \text{ mol}}{16} = 3.33$

(4) C $\frac{64.9 \mid 1}{12.01} = 5.4 = 4$

H $\frac{13.5 \mid 1}{1.01} = 13.4 = 10$

O $\frac{21.6 \mid 1}{16} = 1.35$

C $\frac{54.5 \mid}{12}$ 4

H $\frac{9.1 \mid}{1.01}$

O $\frac{36.4 \mid}{16}$