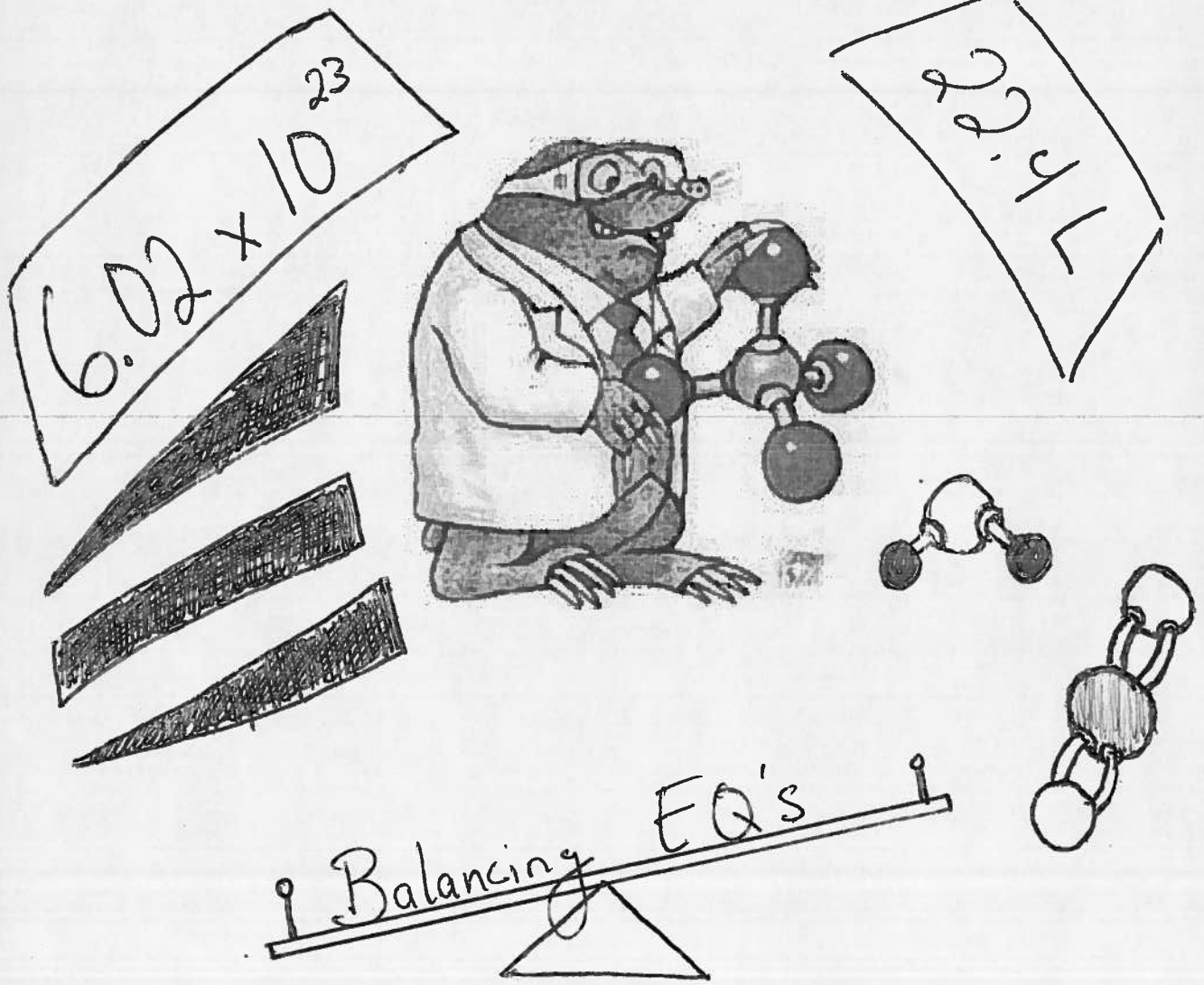
*STUDENT* *STUDENT*

G.F.M.

Regents Chemistry

# PRACTICE PACKET

## Unit 5: Moles & Stoichiometry



## GFM (Molar Mass) Calculations – SHOW ALL WORK!

Calculate the gram formula mass of the following chemicals:

1) $Br_2$
2) $CsOH$

3) $BaCl_2$

4) $FeF_3$

5) $AlCl_3$

6) $Al_2O_3$

7) $SO_3$

8) $HNO_3$

9) $(NH_4)_2CO_3$

10) $Mg_3(PO_4)_2$

11) $Pb(CH_3COO)_2$

*Be sure to label with the correct units – either grams or amu.

1) What is the gram formula mass of zinc?

2) What is the formula mass of neon?

3) Methylene chloride ($CH_2Cl_2$) is used as a solvent in paint strippers. What is the gram formula mass of methylene chloride?

4) Sodium chloride (NaCl) is common table salt. What is the formula mass of NaCl?

5) Ammonia ($NH_3$) is a common household cleaning agent. What is the gram formula mass for ammonia?

6) Nitric acid ($HNO_3$) is a strong acid. What is the formula mass of nitric acid?

7) Sodium hypochlorite (NaClO) is the active ingredient in household bleach. What is the gram formula mass of NaClO?

8) Determine the number of atoms of each of the elements in a molecule of methylamine, $CH_3NH_2$.

9) Determine the number of moles of atoms of each of the elements in a mole of methylamine, $CH_3NH_2$.

Following -3- HW # 1

# Percent Composition

| Compound | GFM | % comp | % comp | % comp |
|---|---|---|---|---|
| $H_2SO_4$ | | % H | % S | % O |
| $CaCl_2$ | | % Ca | % Cl | |
| $H_2O$ | | % H | % O | |
| $CuCO_3$ | | % Cu | % C | % O |
| NaCl | | % Na | % Cl | |
| $Al_2(PO_4)_3$ | | % Al | % P | % O |
| KOH | | % K | % O | % H |

Following -4- HW #2

# Percent Composition

| | | | | |
|---|---|---|---|---|
| $C_2H_6$ | | % C | % H | |
| $ZnI_2$ | | % Zn | % I | |
| $CO_2$ | | % C | % O | |
| CaO | | % Ca | % O | |
| NO | | % N | % O | |
| $Fe_2O_3$ | | % Fe | % O | |
| $H_2O_2$ | | % H | % O | |
| $CuSO_4 \cdot 5H_2O$ | | % Cu | % $CuSO_4$ | % $H_2O$ |

Following -5- HW #2.

## Grams to Moles & Moles to Grams

Convert the following from grams to moles:

1) 15.0 g $C_6H_{12}O_6$

2) 25.0 g NaOH

3) 54.0 g HCl

4) 13.0 g $H_2O$

5) 23.0 g $Ca(NO_3)_2$

6) 1.00 g $H_2SO_4$

7) 0.105 g $O_2$

Convert the following from moles to grams:

1) 0.500 moles LiF

2) 0.1188 moles NaOH

3) 4.00 moles KCl

4) 10.0 moles $H_2O_2$

5) 13.0 moles $Na_2CO_3$

6) 28.0 moles $H_2O$

7) 0.800 moles $NH_3$

Following -8- H.W. #3

## Balancing Equations

Balance the following equations in the space provided:

1) ___ $C_2H_4O_2$ + ___ $O_2$ → ___ $CO_2$ + ___ $H_2O$

2) ___ $AgI$ + ___ $Fe_2(CO_3)_3$ → ___ $FeI_3$ + ___ $Ag_2CO_3$

3) ___ $V_2O_5$ + ___ $CaS$ → ___ $CaO$ + ___ $V_2S_5$

4) ___ $NaNO_3$ + ___ $PbO$ → ___ $Pb(NO_3)_2$ + ___ $Na_2O$

5) ___ $AgBr$ + ___ $GaPO_4$ → ___ $Ag_3PO_4$ + ___ $GaBr_3$

Following



HW # 4

6) ___ $H_2SO_4$ + ___ $B(OH)_3$ → __ $B_2(SO_4)_3$ + ___ $H_2O$

7) ___ $S_8$ + ___ $O_2$ → ___ $SO_2$

8) ___ $Fe$ + ___ $AgNO_3$ → ___ $Fe(NO_3)_2$ + ___ $Ag$

9) ___ $Fe_2O_3$ + ___ $H_2$ → ___ $Fe$ + ___ $H_2O$

10) ___ $Li$ + ___ $N_2$ → ___ $Li_3N$

11) ___ $Zn$ + ___ $HCl$ → ___ $ZnCl_2$ + ___ $H_2$

12) ___ $Mg$ + ___ $N_2$ → ___ $Mg_3N_2$

Following  HW # 4

13) ___ $Ca_3P_2$ → ___ Ca + ___ P

14) ___ HCl + ___ $F_2$ → ___ HF + ___ $Cl_2$

15) ___ NaCl → ___ Na + ___ $Cl_2$

16) ___ $H_2O$ → ___ $H_2$ + ___ $O_2$

17) ___ $N_2$ + ___ $H_2$ → ___ $NH_3$

18) ___ Ag + ___ $AuCl_3$ → ___ AgCl + ___ Au

19) ___ $Pb(NO_3)_2$ + ___ NaCl → ___ $PbCl_2$ + ___ $NaNO_3$

Following - 13 - H.W. # 4

20) ___ $Na_3PO_4$ + ___ $AgNO_3$ → ___ $Ag_3PO_4$ + ___ $NaNO_3$

21) ___ $C_3H_8$ + ___ $O_2$ → ___ $CO_2$ + ___ $H_2O$

22) ___ $CH_4$ + ___ $O_2$ → ___ $CO_2$ + ___ $H_2O$

23) ___ $H_2$ + ___ $Cl_2$ → ___ $HCl$

24) ___ $Na$ + ___ $H_2O$ → ___ $NaOH$ + ___ $H_2$

## Identifying Reaction Types

**Determine if the following are synthesis (S), decomposition (D), single replacement (SR), or double replacement (DR) reactions.**

1. $2NaClO_3 \rightarrow 2NaCl + 3O_2$ _____

2. $2AgNO_3 + Ni \rightarrow Ni(NO_3)_2 + 2Ag$ _____

3. $H_2CO_3 \rightarrow H_2O + CO_2$ _____

4. $BaCO_3 \rightarrow BaO + CO_2$ _____

5. $4Cr + 3\ O_2 \rightarrow 2\ Cr_2O_3$ _____

6. $Ca + 2HCl \rightarrow CaCl_2 + H_2$ _____

7. $Ca(C_2H_3O_2)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaC_2H_3O_2$ _____

8. $Cu(OH)_2 + 2HC_2H_3O_2 \rightarrow Cu(C_2H_3O_2)_2 + 2H_2O$ _____

9. $8Cu + S_8 \rightarrow 8CuS$ _____

10. $P_4 + 5\ O_2 \rightarrow 2\ P_2O_5$ _____

11. $2K + 2H_2O \rightarrow 2KOH + H_2$ _____

12. $3AgNO_3 + K_3PO_4 \rightarrow Ag_3PO_4 + 3KNO_3$ _____

13. $H_2 + Cl_2 \rightarrow 2HCl$ _____

14. $NaOH + HCl \rightarrow NaCl + H_2O$ _____

15. $Fe_2O_3 + H_2O \rightarrow 2FeO{\bullet}OH$ _____

16. $2NH_3 \rightarrow N_2 + 3H_2$ _____

17. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ _____

18. $F_2 + 2HBr \rightarrow Br_2 + 2HF$ _____

19. $Zn(NO_3)_2 + CaCO_3 \rightarrow Ca(NO_3)_2 + ZnCO_3$ _____

20. $4Al + 3O_2 \rightarrow 2Al_2O_3$ _____

Following



H.W. #5

21. $CuSO_4 \cdot 5H_2O \rightarrow CuO + H_2SO_4 + 4H_2O$ _____

22. $SiF_6 + 6Xe \rightarrow SiXe_6 + 3F_2$ _____

**Determine if the following reactions are synthesis (S), decomposition (D), single replacement (SR), or double replacement (DR) reactions.**

1) $H_2 + Cl_2 \rightarrow 2HCl$

2) $NaOH + HCl \rightarrow NaCl + H_2O$

3) $2NH_3 \rightarrow N_2 + 3H_2$

4) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

5) $Zn(NO_3)_2 + CaCO_3 \rightarrow Ca(NO_3)_2 + ZnCO_3$

6) $4Al + 3O_2 \rightarrow 2Al_2O_3$

7) $CuSO_4 \cdot 5H_2O \rightarrow CuO + H_2SO_4 + 4H_2O$

8) $SiF_6 + 6Xe \rightarrow SiXe_6 + 3F_2$

**Directions: Identify the type of chemical reaction for each of the following:**

1. $2\ NaClO_3 \rightarrow 2\ NaCl + 3\ O_2$ _____

2. $2\ AgNO_3 + Ni \rightarrow Ni(NO_3)_2 + 2\ Ag$ _____

3. $H_2CO_3 \rightarrow H_2O + CO_2$ _____

4. $BaCO_3 \rightarrow BaO + CO_2$ _____

5. $4\ Cr + 3\ O_2 \rightarrow 2\ Cr_2O_3$ _____

6. $Ca + 2\ HCl \rightarrow CaCl_2 + H_2$ _____

7. $Ca(C_2H_3O_2)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2\ NaC_2H_3O_2$ _____

8. $Cu(OH)_2 + 2\ HC_2H_3O_2 \rightarrow Cu(C_2H_3O_2)_2 + 2\ H_2O$ _____

9. $8\ Cu + S_8 \rightarrow 8\ CuS$ _____

Following 16 - H.W. # 5

## Balancing Different Types of Reactions

Balance the following equations and indicate the type of reaction taking place:

1) ____ $NaBr$ + ____ $H_3PO_4$ → ____ $Na_3PO_4$ + ____ $HBr$

Type of reaction: _____

2) ____ $Ca(OH)_2$ + ____ $Al_2(SO_4)_3$ → ____ $CaSO_4$ + ____ $Al(OH)_3$

Type of reaction: _____

3) ____ $Mg$ + ____ $Fe_2O_3$ → ____ $Fe$ + ____ $MgO$

Type of reaction: _____

4) ____ $C_2H_4$ + ____ $O_2$ → ____ $CO_2$ + ____ $H_2O$

Type of reaction: _____

Following



H.W #5

5) ____ $PbSO_4$ → ____ $PbSO_3$ + ____ $O_2$

Type of reaction: _____

6) ____ $NH_3$ + ____ $I_2$ → ____ $N_2I_6$ + ____ $H_2$

Type of reaction: _____

7) ____ $H_2O$ + ____ $SO_3$ → ____ $H_2SO_4$

Type of reaction: _____

8) ____ $H_2SO_4$ + ____ $NH_4OH$ → ____ $H_2O$ + ____ $(NH_4)_2SO_4$

Type of reaction: _____

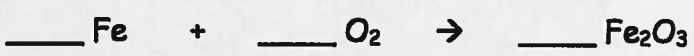
Following



HW # 5

## Mole in Reactions Problems - all mixed up!

Use the following equation to answer questions 1-5 below:




moles:

mass:

1) How many moles of Fe must react to produce 10 moles of $Fe_2O_3$?

2) How many grams of Fe are needed to produce 960 g of $Fe_2O_3$?

3) How many moles of $O_2$ are needed to completely react with 2.5 moles of Fe?

4) What mass of $O_2$ is needed to completely react with 500 g of Fe?

5) If you have 10 moles of Fe and 10 moles of $O_2$, what is the maximum number of moles of $Fe_2O_3$ that can be produced?

Following - 20 - HW # 6

Use the following equation to answer the questions below:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

1) If 2.5 moles of $N_2$ react completely, how many moles of $NH_3$ are formed?

2) If 9 moles of $NH_3$ are formed, how many moles of $H_2$ reacted?

3) If 3.5 moles of $NH_3$ are formed, how many moles of $N_2$ reacted?

4) How many grams of $N_2$ are reacted when 3.5 moles of $NH_3$ are formed?

Following - 21 - H.W. #6

*(For any gas @STP 1 mol = 22.4 L)*

$$2\ CO_{(g)} + O_{2(g)} \rightarrow 2\ CO_{2(g)}$$

1) How many liters of $CO_2$ are produced if 30 L of $O_2$ react completely?

2) If 9 L of $CO$ reacts completely, how many liters of $O_2$ reacts with it?

3) How many liters of $CO$ must react to produce $1.0 \times 10^3$ L of $CO_2$?

Following



HW # 6

# MORE MIXED UP MOLES in REACTIONS PROBLEMS

1) Given the reaction: $2CO + O_2 \rightarrow 2CO_2$

What is the minimum number of moles of $O_2$ required to produce one mole of $CO_2$?

2) In the reaction $Zn + 2HCl \rightarrow ZnCl_2 + H_2$, how many moles of hydrogen will be formed when 4 moles of HCl are consumed?

3) Given the reaction: $4Al + 3O_2 \rightarrow 2Al_2O_3$

How many moles of $Al_2O_3$ will be formed when 27 grams of Al reacts completely with $O_2$?

4) In the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, how many grams of hydrogen are needed to produce exactly 1 mole of ammonia?

5) Given the balanced equation: $NaOH + HCl \rightarrow NaCl + H_2O$

What is the total number of grams of $H_2O$ produced when 116 grams of the product, NaCl, is formed?

6) Given the reaction: $4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$

At constant pressure, how many liters of $O_{2(g)}$ would be required to produce 40. liters of $NO_{(g)}$?

7) Given the reaction: $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

How many liters of $H_{2(g)}$ are required to produce a total of 10. liters of $H_2O_{(g)}$?

Following



H.W # 6

Use the balanced reaction below and the relationship that "1 mole of a compound = the gram formula mass of that compound" to answer the questions below.

$$2H_2O \rightarrow 2H_2 + O_2$$

The gram formula masses for the three species seen in the reaction above are as follows: $H_2O$ = 18 g $H_2$ = 2 g $O_2$ = 32 g

1) How many moles are present in 54 grams of $H_2O$? (Remember: one mole of $H_2O$ is <u>ALWAYS</u> equal to 18 grams)

2) What is the ratio of $H_2O$ to $H_2$ moles according to the balanced reaction above?

3) Using the reaction above (remember, it is just like a recipe!), how many moles of $H_2$ would be produced if 4 moles of $H_2O$ are used?

4) How many grams of $H_2$ are present in 4 moles of $H_2$?

5) What is the ratio of $H_2$ to $O_2$ in the reaction above?

6) If you have 2.5 moles of $H_2O$, how many moles of $O_2$ will be produced?

7) What is the ratio of $H_2O$ to $O_2$ in the reaction above?

8) If you produce 0.25 moles of $O_2$, how many moles of $H_2O$ did you react?

9) Convert 0.35 moles of $H_2O$ to grams.

10) Convert 0.6 grams of $H_2$ to moles.

11) What type of reaction (of the four you have learned) is the reaction above?

Following



HW # 6

Use the balanced reaction below and the relationship that "1 mole of a compound = the gram formula mass of that compound" to answer the questions below.

$$2NH_3 \rightarrow N_2 + 3H_2$$

The gram formula masses for the three species seen in the reaction above are as follows: $NH_3 = 17\ g$ $N_2 = 28\ g$ $H_2 = 2\ g$

1) How many moles are present in 34 grams of $NH_3$? (Remember: one mole of $NH_3$ is <u>ALWAYS</u> equal to 17 grams)

2) What is the ratio of $NH_3$ to $H_2$ moles according to the balanced reaction above?

3) Using the reaction above (remember, it is just like a recipe!), how many moles of $H_2$ would be produced if 2 moles of $NH_3$ are used?

4) How many grams of $H_2$ are present in 6 moles of $H_2$?

5) What is the ratio of $NH_3$ to $N_2$ in the reaction above?

6) If you have 1.2 moles of $NH_3$, how many moles of $N_2$ are present?

7) What is the ratio of $N_2$ to $H_2$ in the reaction above?

8) If you have 0.05 moles of $N_2$, how many moles of $H_2$ are present?

9) Convert 0.15 moles of $H_2$ to grams.

10) Convert 0.6 moles of $N_2$ to grams.

11) What type of reaction (of the four you have learned) is the reaction above?

Following



H.W. #6

## Determining Empirical Formulas based on Given mole ratios

1) Cu = 1.15 moles, S = 1.15 moles, O = 4.60 moles

2) Na = 0.67 moles, N = 0.67 moles, O = 2.01 moles

3) Ag = 3.6 moles, P = 1.2 moles, O = 3.6 moles

4) Zn = 1.53 moles, Cl = 3.06 moles

5) Si = 0.52 moles, F = 3.12 moles

6) C = 3 moles, O = 6 moles

7) H = 3.61 moles, O = 1.8 moles

8) Al = 1.2 moles ,O = 3.6 moles, H = 3.6 moles

9) Na = 0.82 moles, Cl = 0.82 moles

10) Zn = 21.1 moles, N = 42.2 moles, O = 126.6 moles

Following  H.W. #7

## Empirical Formula from Percent Composition

1) 92.24% C; 7.76% H

2) 36.48% Na; 25.44% S; 38.08% O

3) 49.99% C; 5.61% H; 44.40% O

4) 38.76% Ca; 19.97% P; 41.27% O

5) A compound composed of 0.556g carbon and 0.0933g hydrogen.

Following



HW # 7

## Molecular Formula from Empirical Formula and Percent Composition

1) Calculate the molecular formula for the following:
   a.) empirical formula CH, molar mass = 78 g/mol

   b.) empirical formula $NO_2$, molar mass = 46.01 g/mol

   c.) caffeine, 49.5% C, 5.15% H, 28.9% N, 16.5% O by mass, molar mass = 195 g

2) A compound analyzes as 79.08% C; 5.54% H and 15.38% N. What is the molecular formula if the molar mass is 273.36 g/mol?

Following

## REVIEW OF MOLES - SHOW ALL WORK!

1 mol = gram formula mass = 22.4L @ STP = $6.02 \times 10^{23}$ molecules

1. How many atoms are in each of the following compounds?

   Sodium sulfate _____ ammonium carbonate _____

   Calcium nitrate _____ potassium acetate _____

2. Write a Double Replacement reaction between calcium nitrate and ammonium carbonate.

3. How many molecules of water are in 3.6 g of water?

4. What is the mass of $9.0 \times 10^{23}$ molecules of sulfur dioxide?

5. What is the mass of 0.25 moles of acetic acid?

6. How many grams are in 0.56 mol of sodium hydrogen carbonate?

7. How many moles of NaCl are in 1.28g of NaCl?

8. How many mL of butane, $C_4H_{10}$ , are in 35.0g of butane?

9. What is the percentage of oxygen in sodium sulfate?

10. What is the percentage of water in the crystal hydrate, sodium carbonate decahydrate? Deca=10

11. Which of the following has the highest percentage of oxygen?

$H_2O$ or $H_2O_2$ $\qquad$ $N_2O$ or $NO$

$NO_2$ or $NO$ $\qquad$ $CO_2$ or $CO$

12. A student needs to mass out 0.24 mol of sulfuric acid. Using the factor label method, calculate how many grams of sulfuric acid is needed.

13. A tank of Helium is used to blow up balloon at the summer festival. The tank of Helium weighed 86.5 pounds at the beginning of the day and 78.2 pounds at the end of the day. 1 pound is equal to 454g. How many moles of He were used? If each balloon holds 12L of gas, how many balloons were filled?

14. What is the mass of 1.32 moles of copper (II) nitrate?

15. What is the volume of 11.0g of carbon dioxide?

## MORE REVIEW OF MOLES!

1. Freons are gaseous compounds that we used to use in air conditioners and refrigerators. Freon contains 9.93% carbon, 58.6% chlorine and 31.4% fluorine by mass. What is the empirical formula?

2. Find the empirical formula for a compound made of 0.295g of Ca, 0.236g of S, and 0.469g of O.

3. The molecular mass of benzene is 78 amu and its empirical formula is CH. What is the molecular formula for benzene?

4. Vitamin C, formally known as ascorbic acid, contains 40.9% carbon, 4.58% hydrogen and 54.5 % oxygen. It has a molecular mass of 176.1 amu. What is its molecular formula? (Hint: first, find its empirical formula).

5. Find the formula for a crystal hydrate containing 76.9% CaSO and 23.1% water. Name it also!

6. What is the percent by mass of water in sodium carbonate decahydrate, $Na_2CO_3 \cdot 10H_2O$?

7. A compound has an empirical formula of $CH_2$ and a molecular mass of 42 amu. What is the molecular formula?

8. How many atoms of oxygen are in 0.5 moles of sodium sulfate? (Hint: write the formula first)

## Mass-Mass Reaction Problems

1) Given the reaction: $N_2 + 3H_2 \rightarrow 2NH_3$, what is the total number of grams of $H_2$ that reacts when 14 grams of $N_2$ are completely consumed?

2) Given the reaction: $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$, what is the total mass of $H_2O$ produced when 32 grams of Cu is completely consumed?