Name Key Date ______ Class ______

10.3 PERCENT COMPOSITION AND CHEMICAL FORMULAS

Section Review

Objectives

- Calculate the percent by mass of an element in a compound
- Interpret an empirical formula
- Compare and contrast empirical and molecular formulas

Vocabulary

- percent composition
- empirical formula

Key Equation

- $\% \text{ mass of element} = \frac{\text{mass of element}}{\text{mass of compound}} \times 100\%$

Part A Completion

Use this completion exercise to check your knowledge of the terms and your understanding of the concepts introduced in this section. Each blank can be completed with a term, short phrase, or number.

The __1__ of a compound is the percent by mass of each element in a compound. The percent by mass of an element in a compound is the number of grams of the element per __2__ g of the compound, multiplied by 100%. To calculate the percent by mass of an element in a known compound, divide the mass of the element in one mole by the __3__ and multiply by 100%.

A(n) __4__ formula represents the lowest __5__ ratio of the elements in a compound. It can be calculated from a compound's percent composition. The __6__ formula of a compound is either the same as its empirical formula, or it is some whole-number multiple of it.

1. % Composition
2. 100
3. Atomic Mass
4. Empirical Formula
5. Whole Number
6. Molecular

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

ST 7. It is necessary to know the formula of a compound in order to calculate its percent composition.

AT 8. If the percent by mass of carbon in methane, CH_4, is 75%, then 100 grams of methane contain 25.0 grams of hydrogen.

AT 9. The formula for methane, CH_4, is both a molecular and an empirical formula.

NT 10. The empirical formula for glucose, $C_6H_{12}O_6$, is $C_2H_4O_2$. → CH_2O

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
C 11. percent composition	a. describes the actual number of atoms of each element in a molecule of a compound
B 12. empirical formula	b. the lowest whole-number ratio of atoms of the elements in a compound
A 13. molecular formula	c. the percent by mass of each element in a compound

Part D Problems

Solve the following problems in the space provided. Show your work.

14. What is the percent composition of each of the following?

a. Cr_2O_3

c. HgS

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b. $Mn_2P_2O_7$

d. $Ca(NO_3)_2$

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15. Determine the empirical formula of the compound with the percent composition of 29.1% Na, 40.5% S, and 30.4% O.

16. How many kilograms of iron can be recovered from 639 kilograms of the ore Fe_2O_3?

Part D

(14)

A) Cr_2O_3

Total Molar Mass Cr_2O_3

$(52 \cdot 2) + (16 \times 3) = 152\ g/mol$

$\% Cr = \frac{104\ g\ Cr}{152\ g\ Cr_2O_3} \times 100 = 68.4\%$

$\% O = \frac{48\ g\ O}{152\ g\ Cr_2O_3} \times 100 = 31.6\%$

% Comp. Cr_2O_3

68.4% Cr

31.6% O

B) $Mn_2P_2O_7$

Total Molar Mass $Mn_2P_2O_7$

$(55 \times 2) + (31 \times 2) + (16 \times 7) = \frac{284\ g\ Mn_2P_2O_7}{1\ mole\ Mn_2P_2O_7}$

$\% Mn = \frac{110\ g\ Mn}{284\ g\ Mn_2P_2O_7} \times 100 = 38.7\%$

$\% P = \frac{62\ g\ P}{284\ g\ Mn_2P_2O_7} \times 100 = 21.8\%$

$\% O = \frac{112\ g\ O}{284\ g\ Mn_2P_2O_7} \times 100 = 39.4\%$

% Comp. $Mn_2P_2O_7$

% Mn = 38.7%

% P = 21.8%

% O = 39.4%

C) HgS

Total Molar Mass HgS

$(200.59) + (32) = \frac{232.59\text{ g HgS}}{1\text{ mole HgS}}$

$\%Hg = \frac{200.59\text{ g Hg}}{232.59\text{ g HgS}} \times 100 = 86.2\%\ Hg$

$\%S = \frac{32\text{ g S}}{232.59\text{ g S}} \times 100 = 13.8\%\ S$

% Comp. HgS

% Hg = 86.2%

% S = 13.8%

D) $Ca(NO_3)_2$

if you are having issues working through what is present in a given chemical formula, remember a subscript indicates how much is present of whatever comes directly before the subscript so....

in $Ca(NO_3)_2$ we have 1 Ca and 2 (NO_3)

Total Molar Mass $= (40) + (2 \times 14) + (6 \times 16) = \frac{164\text{ g } Ca(NO_3)_2}{1\text{ mole } Ca(NO_3)_2}$

$\%Ca = \frac{40\text{ g Ca}}{164\text{ g } Ca(NO_3)_2} \times 100 = 24.4\%$

$\%N = \frac{28\text{ g N}}{164\text{ g } Ca(NO_3)_2} \times 100 = 17.1\%$

$\%O = \frac{96\text{ g O}}{164\text{ g } Ca(NO_3)_2} \times 100 = 58.5\%$

% Comp $Ca(NO_3)_2$

% Ca = 24.4%

% N = 17.1%

% O = 58.5%

15 | Emp. Formula for a Compound that is

29.1% Na
40.5% S
30.4% O

We are trying to find the Subscripts for the formula $Na_x S_y O_z$. Remember all Subscrips must be Whole Numbers.

– Assume you have 100g of the compound. –

So we have

- $\frac{29.1 g\ Na}{1} \times \frac{1.00\ mol\ Na}{14 g\ Na} = 1.27\ Mol\ Na$

- $\frac{40.5 g\ S}{1} \times \frac{1.00\ mol\ S}{32 g\ S} = 1.27\ mol\ S$

- $\frac{30.4 g\ O}{1} \times \frac{1.00\ mol\ O}{16 g\ O} = 1.90\ mol\ O$

So we have $Na_{1.27} S_{1.27} O_{1.9}$ ⇒ Not whole #'s

- Divide by 1.27

Gives $Na_1 S_1 O_{1.5}$ ⇒ Still Not whole #'s

↓ multiply each by 2

$Na_2 S_2 O_3$ ⇒ empirical formula

(16) How Much Fe is in 639g Fe_2O_3

~~[illegible]~~

- Find % Comp. Fe -

Molar Mass Fe_2O_3

$$(56 \times 2) + (16 \times 3) = \frac{160g\ Fe_2O_3}{1\ mole\ Fe_2O_3}$$

$$\%\ Fe = \frac{112g\ Fe}{160g\ Fe_2O_3} \times 100 = 70\%\ Fe$$

So if The mass of Fe_2O_3 is 70% Iron

~~[illegible]~~

then $$\frac{639g\ Fe_2O_3}{1} \times \frac{70g\ Fe}{100g\ Fe_2O_3} = \boxed{447g\ Fe}$$