Al^{+3} PO_4^{-3}

Unit 7 Chemical Formulas and Reactions

Intro to Molar Mass & Percent Composition

Name Answer Key

Block ________

Molar Mass & Avogadro's Number

Amadeo Avogadro first proposed that the volume of a gas at a given pressure and temperature is proportional to the number of atoms or molecules, regardless of the type of gas. Although he did not determine the exact proportion, he is credited for the idea. **Avogadro's number** is defined as **6.022×10^{23}** atoms per mole. A **mole** is defined as amount of substance of a system that contains as many elementary entities as there are atoms in **12 g of carbon-12**. The **atomic masses** listed on the periodic table equal the number of **grams per mole** for each element.

For more information visit: https://courses.lumenlearning.com/boundless-chemistry/chapter/molar-mass/

Use the Periodic Table to list the molar mass of the following elements to three decimal places.

Hydrogen = 1.008 g/mol
Carbon = 12.011 g/mol
Oxygen = 15.999 g/mol
Sodium = 22.990 g/mol
Magnesium = 24.305 g/mol
Calcium = 40.080 g/mol
Phosphorus = 30.974 g/mol
Sulfur = 32.060 g/mol
Chlorine = 35.453 g/mol

Determine the molar mass of the following compounds. *Show your work.*

1) NaCl Na 22.990 + Cl 35.453 = 58.443 g/mol NaCl

2) MgSO4 = Mg 24.305 + S 32.060 + O 4(15.999) = 120.361 g/mol $MgSO_4$

3) CH_3CH_2OH C 2(12.011) + H 6(1.008) + O 15.999 = 46.069 g/mol CH_3CH_2OH

4) $Ca_3(PO_4)_2$ Ca 3(40.080) + P 2(30.974) + O 8(15.999) = 310.18 g/mol $Ca_3(PO_4)_2$

5) CO_2 C 12.011 + O 2(15.999) = 44.009 g/mol CO_2

Critical Thinking Questions. *Show your work.*

1.) What is the molar mass of calcium hydroxide?

$Ca^{+2} + OH^{-1} \rightarrow Ca(OH)_2$

40.080 + 2(15.999) + 2(1.008) = 74.094 g/mol $Ca(OH)_2$

2.) What is the molar mass of methane?

$CH_4 \rightarrow$ C 12.011 + H 4(1.008) = 16.043 g/mol CH_4

Name Answer Key

Block ________

Percent Composition & Combustion Analysis

The relative percent of each element in a compound is called the **Percent Composition**. The percent composition compares the mass of each element to the total mass of the compound. Chemists often use **Combustion Analysis,** an elemental analytical technique used on solid and liquid organic compounds, to determine the relative amounts of carbon, hydrogen, oxygen in compounds, and occasionally to identify the amounts nitrogen and sulfur in compounds. This technique was invented by **Joseph Louis Gay-Lussac**.

For more information, visit https://courses.lumenlearning.com/boundless-chemistry/chapter/compound-composition/

$$\frac{\textbf{Total Molar Mass of Element}}{\textbf{Molar Mass of Compound}} \times 100 = \textbf{Percent Composition}$$

Calculate the percent composition for each element in the following compounds. ***Show your work.***

1) NaCl

Na = 22.990 g/mol ÷ 58.443 g/mol × 100 = 39.337% Na

Cl = 35.453 g/mol ÷ 58.443 g/mol × 100 = 60.663% Cl

2) $MgSO_4$

Mg: $\frac{24.305}{120.361} \times 100 =$ 20.193% Mg

S: $\frac{32.060}{120.361} \times 100 =$ 26.637% S

O: $\frac{4(15.999)}{120.361} \times 100 =$ 53.17 O

3) CH_3CH_2OH

C: $\frac{2(12.011)}{46.069} \times 100 =$ 52.143% C

H: $\frac{6(1.008)}{46.069} \times 100 =$ 13.128% H

O: $\frac{15.999}{46.069} \times 100 =$ 34.728%

4) $Ca_3(PO_4)_2$

Ca: $\frac{3(40.080)}{310.18} \times 100 =$ 38.765 % Ca

P = $\frac{2(30.974)}{310.18} \times 100 =$ 19.972 % P

O = $\frac{8(15.999)}{310.18} \times 100 =$ 41.264% O

5) CO_2

C = $\frac{12.011}{44.009} \times 100 =$ 27.292% C

O = $\frac{2(15.999)}{44.009} \times 100 =$ 72.708% O

Critical Thinking Questions. ***Show Your Work.***

1. The percent of oxygen in a colorless liquid is determined to be 94.1%. Is this liquid water (H_2O) or hydrogen peroxide (H_2O_2)?

H_2O_2 = 2(1.008) + 2(15.999) = 34.014 g/mol

%O = $\frac{2(15.999)}{34.014} \times 100 =$ 94.07%

H_2O: 2(1.008) + 15.999 = 18.015 g/mol

%O = $\frac{15.999}{18.015} \times 100 =$ 88.809%

2. Using Combustion Analysis, chemists determined that Nicotine, the addictive drug in cigarettes, contains 74.0% carbon, 8.6% hydrogen, and 17.3% nitrogen. What mass of each element can be recovered from a 55.0 g sample of nicotine?

C: $\frac{74.0}{100} = \frac{x\,g\,C}{55\,g}$ → x = 40.7g C

H: $\frac{8.6}{100} = \frac{x\,g\,H}{55\,g}$ → x = 4.73g H

N: $\frac{17.3}{100} = \frac{x\,g\,N}{55\,g}$ → x = 9.52g N