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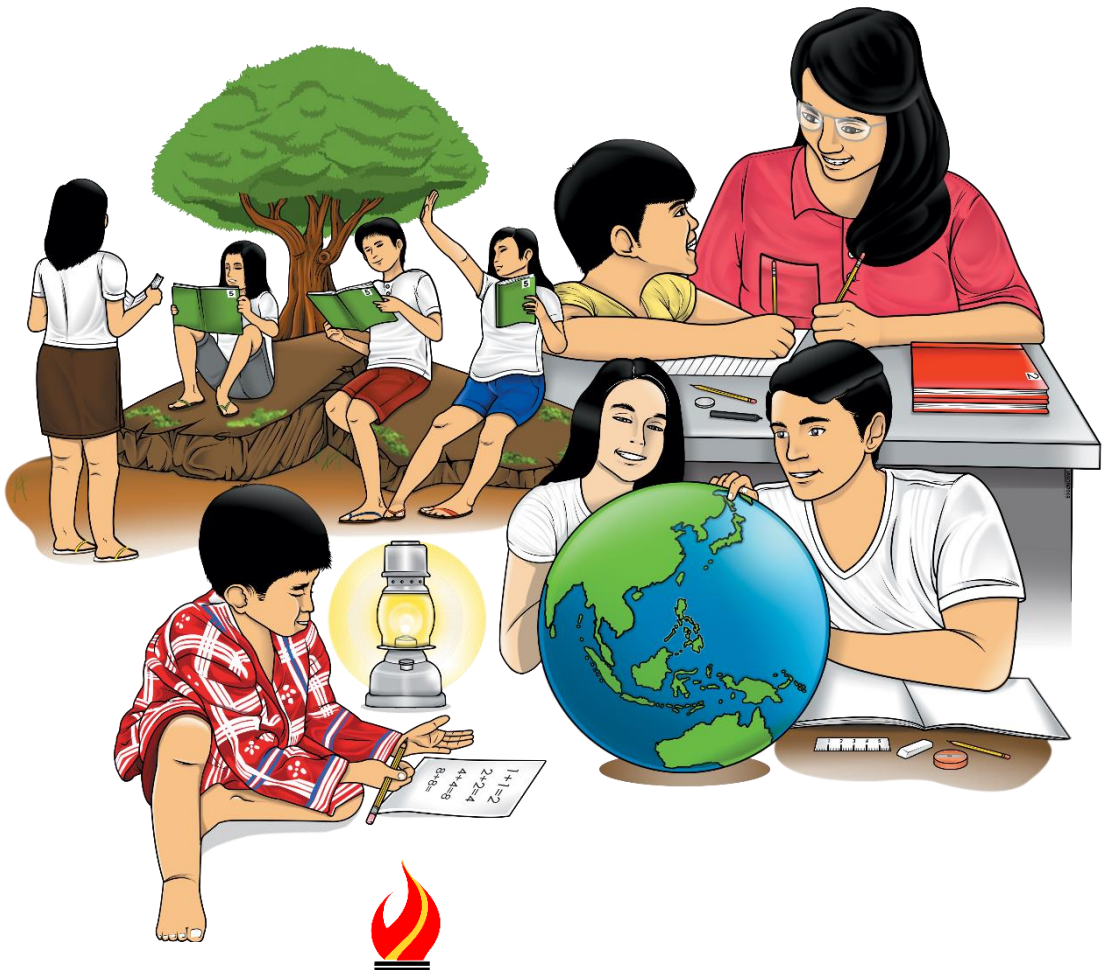
DEPARTMENT OF EDUCATION

Science
Quarter 2- Matter
Module 8: Percentage Composition of Compounds



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Secretary: Leonor Magtolis Briones
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Development Team of the Module

Writer:	Griel G. Viterbo
Editor:	Loreta E. Santos
Reviewers:	Aurora T. Alcazar, Anthony D. Angeles, Lonida A. Caiña, Mary Grace C. Dimacutac**,** Mary Grace G. Fuentes, Myla D. German, Myrla D. Guevarra, Heddy C. Portuguese, Rosemarie V. Rodanilla, Avie John Tesorero
Language: Elvira P.	Emerenciana, Nova V. Tarcena, Lilibeth M. De Lansig
Design and Layout:	Edgardo Q. Reyes Jr.
Layout Artist:	Griel G. Viterbo, Mark Joseph Y. Samarita, Ana Lisa M. Mesina
Management Team:	Malcolm S. Garma Genia V. Santos Dennis M. Mendoza Micah S. Pacheco Josefina M. Pablo Manolo C. Davantes Jr. Dalisay E. Esguerra Hilda C. Valencia

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Department of Education – National Capital Region

Office Address: Misamis St. BagoBantay, Quezon City
Telefax: (632)8929-0153
E-mail Address: depedncr@deped.gov.ph

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Science
Quarter 2- Matter
Module 8: Percentage Composition of Compounds

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

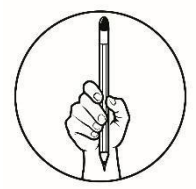
This module is designed and written with you in mind. It is here to help you master Percentage Composition of Compounds. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course, but the order in which you read them can be changed to correspond with the textbook you are now using.

The module focuses on achieving this learning competency:

Determine the percent composition of a compound given its chemical formula and vice versa. (S9MT-IIj-20)

After going through this module, you are expected to:

- determine the percentage composition of each element in a given compound;
- differentiate empirical from molecular formula;
- calculate for the empirical formula of a compound given its percentage composition; and
- calculate for the molecular formula of a compound given its percentage composition.



What I Know

Choose the letter of the best answer. Write your answer on a separate sheet of paper.

1. Which unit of measurement is used to represent the amount or quantity of a substance?
   A. amu
   B. m^3
   C. mg
   D. mol

2. Which formula tells the actual number of atoms in a molecule?
   A. Chemical formula
   B. Empirical formula
   C. Molecular formula
   D. None of the above

3. Which formula shows the smallest whole-number ratio of atoms of the elements in a compound?
   A. Formula mass
   B. Empirical formula
   C. Molecular formula
   D. Percent composition

4. Which quantity of matter is equivalent to the mass of 1 mole of any element?
   A. Atoms
   B. Compound
   C. Atomic mass
   D. Number of particles

5. What is the atomic mass of an atom that has 12 protons, 12 electrons, and 12 neutrons?
   A. 6 amu
   B. 12 amu
   C. 24 amu
   D. 48 amu

6. How can you apply knowledge on percentage composition?
   A. In maintaining the quality of food product.
   B. In checking the amount of sugar present in the soft drink.
   C. In identifying the correct amount of substance present in a sample.
   D. all of the above

7. How many percent of hydrogen (H) is present in water (H2O)?
    A. 12%
    B. 11%
    C. 13%
    D. 10%

8. Which of the following units is used in expressing the amount of substance in terms of the number of particles?
    A. Celsius
    B. gram
    C. liter
    D. mole

9. What do you expect to observe in a "Mole Exhibit of Different Substances?
    A. different kind of elements
    B. different colors of substances
    C. showcase of 1mole of different elements having different masses
    D. showcase of 1mole of different substances having the same masses

10. It is the sum of the masses of one mole of a substance in a compound.
    A. Compound
    B. Molar mass
    C. Mole
    D. Number of particles

11. Suppose you were asked to prepare 250-g chocolate mousse which is 35% chocolate, 30% cream and 20% milk, 10% sugar and 5% butter, how much cream do are you going to use?
    A. 75 g cream
    B. 60 g cream
    C. 73 g cream
    D. 62 g cream

12. Methane (CH_4 *Molar Mass* = 16.04 g/mol) is one of the greenhouse gases. If 32.08 g of CH_4 is released in the atmosphere, how many molecules of CH_4 are added in the atmosphere?
    A. 1.20×10^{24}
    B. 1.20×10^{23}
    C. 6.02×10^{24}
    D. 6.02×10^{23}

13. The label of the dark chocolate indicates that its mass is 150g and it is 70% cacao, if you consume the whole chocolate bar, how much cacao did you eat?
    A. 105 g cacao
    B. 45 g cacao
    C. 100 g cacao
    D. 50 g cacao

14. A bag of NPK fertilizer marked 16-4-8 contains 16% nitrogen, 4% phosphorous and 8% potassium, the other 72% is usually inert filler material, such as clay pellets or granular limestone. What is the mass of nitrogen present in 500g pack of NPK fertilizer?
    A. 80g
    B. 40g
    C. 20g
    D. 10g

15. How many particles are equal to 1 mole?
    A. 6.02×10^{22} particles
    B. 6.02×10^{23} particles
    C. 6.02×10^{24} particles
    D. 6.02×10^{25} particles

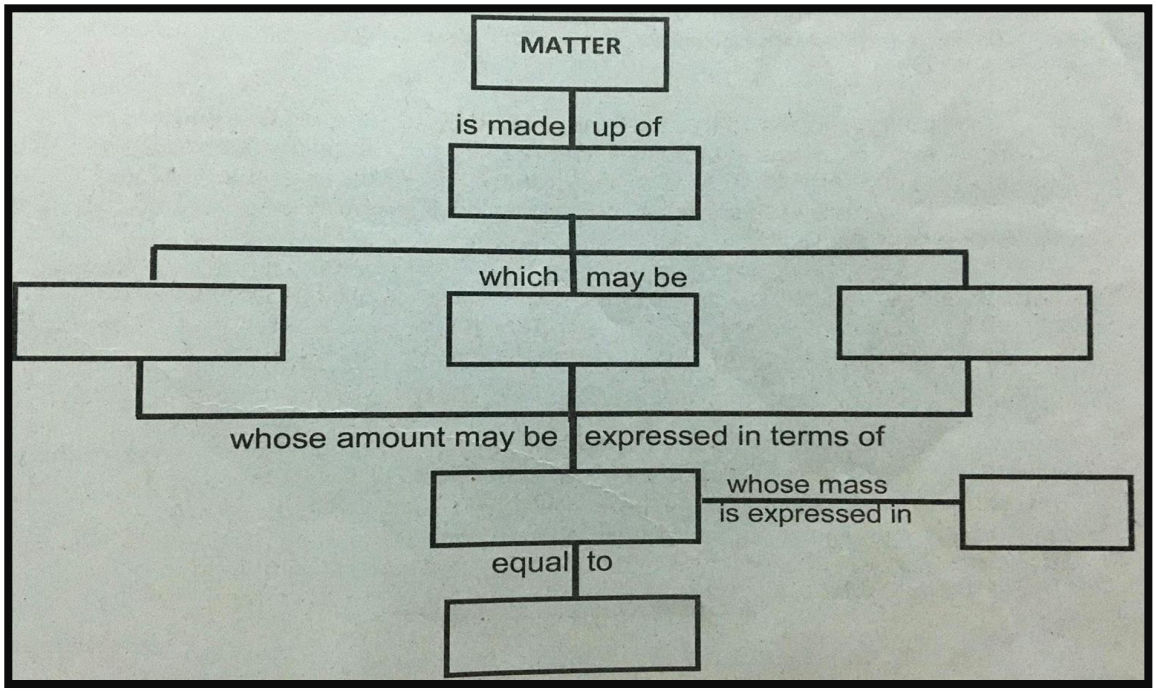
Lesson 1 Percentage Composition of Compounds

As discussed in the previous module, mole is the unit used to quantify the amount of substance or the number of particles (atom, molecule or ion) present. In this module you will learn to determine the percentage composition of each element in a given compound, differentiate empirical and molecular formula, calculate for the empirical formula and molecular of a compound given its percentage composition.

What's In

Complete the Concept map below with the appropriate words/terms found inside the box. Write your answer on a separate sheet of paper.

Complete the Concept map below with the appropriate words/terms found inside the box. Write your answer on a separate sheet of paper.	
Ions	Avogadro's number
Mole	Atoms
Molecules	particles
Mass	compound
g/mole(molar mass)	elements



What's New

Accomplishing the concept map means that you have understood the lessons you have gone through. Let's have the next topic.

Chemists are able to analyze an unknown substance by determining its percentage composition by mass. Percentage composition is set by expressing the mass of every element during a sample of the substance as a percentage of the mass of the full sample. The results of this analysis can then be compared with the share composition of known compounds to see the probable identity of the unknown substance.

It's Grocery Time!

Objectives:

- apply the concept of percentage composition in choosing grocery items; and
- realize that the amount of substance intake can be monitored with the use of percentage composition.

Materials:

Grocery items containers or package (food wrappers, can, bottles, etc.

Procedure:

1. Get three 3 samples of containers or packages of grocery items such as canned goods, snacks and beverages.
2. List the substances written as contents/ingredients on the label. Choose 2 substances from each type of grocery item.
3. Research from a chemistry book or from the internet the chemical formula of the substances on your list.
4. Compute for the percentage composition of the substances you have listed.

Guide Questions:

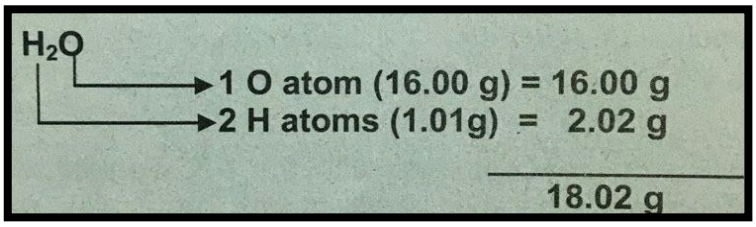
1. Based on this activity, what food do you regularly consume which gives your body a lot of carbon (C) atoms and sodium (Na) ions?
2. Are these good for your body? Why? Research on how much of these types of food are recommended for your age group.
3. In what other ways can you make use of the concept on percentage composition?

What is It

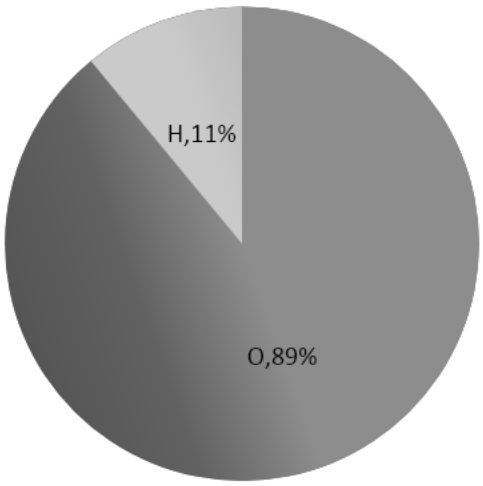
Percentage Composition of a Compound

Are you interested to know how much of an element is present in a compound? You can answer this question by determining percentage composition. The mass of each element in a compound compared to the entire mass of the compound multiplied by 100 percent is called the percentage composition of the compound. So, the percentage composition of a compound tells you the percentage of the mass made up by each element in a compound.

Let us compare it in a classroom situation. You are 50 in your section with 21 boys and 29 girls. If you will be asked what percent of the class are boys and what percent are girls, how are you going to compute for the answer? If your answer is 42% boys and 58% girls, you got it correctly! Let us have an example for the compound which is so important to all of us; water (H_2O). The computation below shows the molar mass of water. If you will be asked to compute for the percentage of oxygen and hydrogen in water, how are you going to do it?



Did you answer 89% oxygen and 11% hydrogen? Your answer is correct! To get the percent oxygen, mass of oxygen is divided by the mass of water multiplied by 100%. The same is true with hydrogen.



Percentage Composition of Water

The percentage composition of each element of a compound can be obtained by calculating using this formula:

$$\% \text{ element} = \frac{\text{Mass}_{\text{element}}}{\text{Total Mass}_{\text{compound}}} \times 100$$

Where is "x" in the formula?

Use sodium nitrate ($NaNO_3$) as an example.

Step 1: Find the molar mass of sodium nitrate ($NaNO_3$).

Na = 1 x 22.99 amu = 22.99 g NA

N = 1 x 14.01 amu = 14.01 g N

O = 3 x 16.00 amu = 48.00 g O

=85.00 g/mol $NaNO_3$

The molar mass of sodium nitrate ($NaNO_3$) is 85.00 grams.

85.00 g/mol $NaNO_3$

Step 2: Determine the percent composition of each element in the total compound.

$$\% \text{ Na} = \left(\frac{22.99\ g}{85.00\ g}\right) \times 100 = 27.05\% \text{ Na}$$

$$\%\text{N} = \left(\frac{14.01\ g}{85.00\ g}\right) \times 100 = 16.48\%$$

$$\%\text{O} = \left[\frac{3\ (16.00\ g}{85.00\ g}\right] \times 100 = 56.47\%$$

Check your answer by adding up the percentage of all elements. The sum should be close to 100.

27.05 % Na + 16.48% N + 56.47% O = 100.00% $NaNO_3$

Here's an example of computing for the percentage composition of a compound known to us all—water (H_2O). The computation below shows the molar mass of water:

H = 2 x 1.01 g = 2.02 g H

O = 1 x 16.00 g = 16.00 g O

= 18.02 g H_2O

The molar mass of water (H_2O) is 18.02 grams.

18.02 g/mol H_2O

We will then compute for the percentage of oxygen and hydrogen in water:

$$\% \text{ H} = \left(\frac{2.02\ g}{18.02\ g}\right) \text{ x } 100 = 11.21\% \text{ H}$$

$$\% \text{ O} = \left(\frac{16.00\ g}{18.02\ g}\right) \text{ x } 100 = 88.79\% \text{ O}$$

Thus, Hydrogen is 11.21% H and water is 88.79% O.

Empirical and Molecular Formulas

An empirical formula shows the simplest formula of acompound. Empirical formulas show the number of atoms of each element in a compound in the most simplified form using whole numbers.It does not indicate the actual number of atoms in the molecule of the compound.

Example:

Empirical Formula of Glucose: CH_2O

A molecular formula of a compound gives the relative or exact number of atoms and the type of atoms present in a molecule of a compound.

Example:

Molecular Formula of Glucose: $C_6H_{12}O_6$

Empirical and Molecular Formula of a Compound given its Percentage Composition

The bacterial fermentation of grain to produce ethanol forms a gas with a percent composition of 27.29% C and 72.71% O. What is the empirical formula for this gas?

Since the mass of a given element in grams is numerically equivalent to the element's mass percentage, it is most convenient to calculate the mass of elements present in a sample weighing 100 g.

$$27.29\% \text{ C} = \frac{27.29 \text{ g C}}{100 \text{ g compound}}$$

$$72.71\% \text{ O} = \frac{72.71 \text{ g O}}{100 \text{ g compound}}$$

Divide each element's mass by its molar mass:

$$27.29\%\ \text{C} \times \left(\frac{\text{mol C}}{12.01\ \text{g}}\right) = 2.272\ \text{mol C}$$

$$72.71\%\ \text{O} \times \left(\frac{\text{mol O}}{16.00\ \text{g}}\right) = 4.544\ \text{mol O}$$

Divide each molar amount by the smaller calculated molar amount:

$$\frac{2.272\ \text{g C}}{2.272} = 1$$

$$\frac{4.544\ \text{g O}}{2.272} = 2$$

The resulting ratio is one carbon to two oxygen atoms, thus the empirical formula is CO_2.

Sample Problem:

Chemical analyses show that a complex carbohydrate contains 40.0% C, 6.71% H, and 53.3% O by mass. Determine the empirical and molecular formulas of its carbohydrate if its molar mass is 870 g/mol.

Answer:

Step 1: Express mass percentage of each element as grams. That is,

40.0% C = 40.0 g C
6.71% H = 6.71 g H
53.3% O = 53.3 g O.

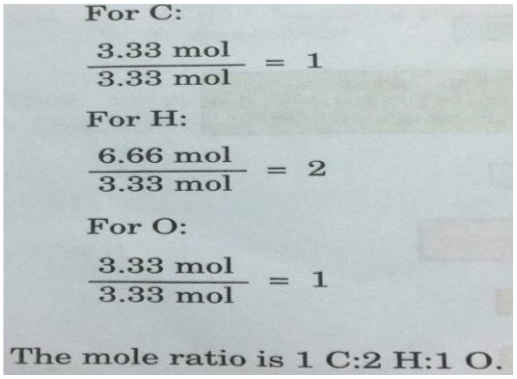
Step 2: Find the number of moles of each element.

For C:
$$40.0\ \text{g C} \times \frac{1\ \text{mol C}}{12.01\ \text{g C}} = 3.33\ \text{mol C}$$

For H:
$$6.71\ \text{g H} \times \frac{1\ \text{mol H}}{1.008\ \text{g H}} = 6.66\ \text{mol H}$$

For O:
$$53.3\ \text{g O} \times \frac{1\ \text{mol O}}{16.00\ \text{g O}} = 3.33\ \text{mol O}$$

Step 3: Determine the mole ratio of the elements by dividing each number of moles by the smallest number of moles. In this case, oxygen or carbon has the smallest number of moles (3.33mol).


For C:

$$\frac{3.33\ \text{mol}}{3.33\ \text{mol}} = 1$$

For H:

$$\frac{6.66\ \text{mol}}{3.33\ \text{mol}} = 2$$

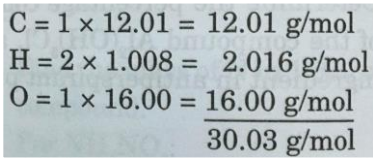
For O:

$$\frac{3.33\ \text{mol}}{3.33\ \text{mol}} = 1$$

The mole ratio is 1 C:2 H:1 O.

Step 4: Express the mole ratio as an empirical formula. The empirical formula of the complex carbohydrate is CH_2O.

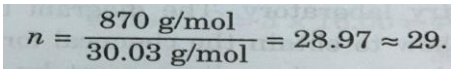
Step 5: Determine the molar mass of the empirical formula.


C = 1 × 12.01 = 12.01 g/mol
H = 2 × 1.008 = 2.016 g/mol
O = 1 × 16.00 = 16.00 g/mol
30.03 g/mol

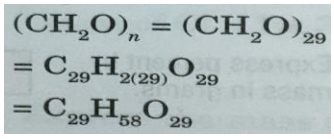
Step 6: Determine the factor that relates the empirical and molecular formulas. That is,

$$\frac{molar\ mass\ of\ molecular\ formula}{molar\ mass\ of\ empirical\ formula} = n$$

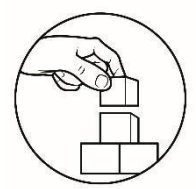
The given molar mass of the complex carbohydrate, 870 g/mol, and its molecular mass are expressed as


$$n = \frac{870\ \text{g/mol}}{30.03\ \text{g/mol}} = 28.97 \approx 29.$$

Step 7: Multiply the subscripts of the empirical formula by *n*.


$$(CH_2O)_n = (CH_2O)_{29}$$
$$= C_{29}H_{2(29)}O_{29}$$
$$= C_{29}H_{58}O_{29}$$

Therefore, the molecular formula of the complex carbohydrate is $C_{29}H_{58}O_{29}$.



What's More

Activity 1: Percentage Composition

Solve the problem scientifically by showing the complete solution. Write your answer on a separate sheet of paper.

1. Facial cream used to treat acne has a component of benzoyl peroxide $C_{14}H_{10}O_4$. What is its percentage composition?
2. Glucose or blood sugar ($C_6H_{12}O_6$) could be a six-carbon sugar (hexose). It serves as an energy source that fuels our body. What number percentage of carbon is present in glucose?

Activity 2: Molecular Formula for Nicotine

Nicotine is an alkaloid within the nightshade family of plants that's primarily responsible for the addictive nature of cigarettes. It has 74.02% C, 8.710% H, and 17.27% N. If 40.57 g of nicotine has 0.2500 mol nicotine, what is the molecular formula?

Activity 3: Problem Solving

On a separate sheet of paper, complete the solution below for the percentage composition of aluminum hydroxide Al $(OH)_3$, a component of antacid tablet.

Given: Al $(OH)_3$
Find: %Al, %O, %H
Solution:

Step 1:

Al = 1 x _____g = _____g
O = 3 x _____g = _____g
H = 3 x _____g = _____g
Formula Mass = _____g

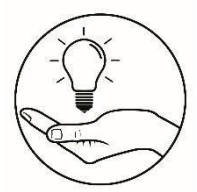
Step 2:

%Al = $\frac{amu}{amu}$ x 100 = _____%

%O = $\frac{amu}{amu}$ x 100 = _____%

%H = $\frac{amu}{amu}$ x 100 = _____%

2. What is the molecular formula of a compound with a percent composition of 49.47% C, 5.201% H, 28.84% N, and 16.48% O, and a molecular mass of 194.2 g?



What I Have Learned

1. _____ is a ratio of the amount of each element to the total mass of elements in a compound, multiplied with 100.

2. The _____ of each element of a compound can be obtained by calculating using this formula:

$$\% \text{ element} = \frac{\text{Mass}_{\text{element}}}{\text{Total Mass}_{\text{compound}}} \times 100$$

3. _____ number of atoms of each element in a compound in the most simplified form using whole numbers

4. _____ relative or exact number of atoms and the type of atoms present in a molecule of a compound; always an integer multiple of the empirical formula.

5. A compound's _____ provides the mass percentage of each element in the compound, and it is often experimentally determined and used to derive the compound's empirical formula.

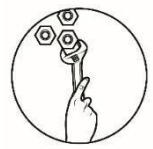
6. The empirical formula mass of a _____ may be compared to the compound's molecular or molar mass to derive a molecular formula.

7. _____ is the mass of one mole of a substance expressed in grams.

8. The molar mass of a monatomic element like Na, Li, Mg is numerically equal to its atomic mass expressed in _____.

9. The mass of the substance divided by its molar mass gives the number of moles of the _____.

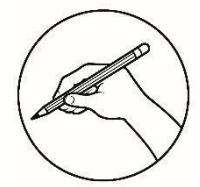
10. _____ of a compound tells you the percentage of the mass made up by each element in a compound



What I Can D

Soil that is already depleted of its nutrients needs fertilizer. One of the nutrients needed to replenish the soil is nitrogen. If you are an agricultural technician helping a farmer, which among these fertilizers are you going to use. Show your computations to convince the farmer of your choice.

A. ammonia (NH_3)
B. ammonium sulfate $(NH_4)_2SO_4$
C. ammonium nitrate, NH_4NO_3



Assessment

Choose the letter of the best answer. Write your answers on a separate sheet of paper.

1. Ammonium nitrate (NH_4NO_3 Molar Mass = 80.06g/mole) is a substance used to produce dinitrogen monoxide (N_2O), a dental anesthetic. Which of the following is the mass percent of N in ammonium nitrate?
   A. 35.00%
   B. 40.65%
   C. 39.50%
   D. 43.68%

2. People usually use hydrogen peroxide (H_2O_2Molar Mass = 34.02 g/mole) to clean their wounds. If Gloria used 1.0 g of H_2O_2 to clean her wound, how many mole of H_2O_2did she use?
   A. 0.035 mole
   B. 0.030 mole
   C. 0.029 mole
   D. 0.025 mole

3. In cold areas, many fish and insects, including the common housefly, produce large amounts of glycerol ($C_3H_8O_3$ Molar Mass = 92.11 g/mole) to lower the freezing point of their blood. How many percent of oxygen is present in glycerol?
   A. 52.11%
   B. 50.11%
   C. 51.11%
   D. 53.11%

4. Ethyl butanoate ($C_3H_7COOC_2H_5$) is the substance responsible for the aroma of pineapple. What is the molar mass of ethyl butanoate?
   A. 118.00 g/mole
   B. 117.12 g/mole
   C. 120.12 g/mole
   D. 116.18 g/mole

5. Calcium carbonate ($CaCO_3$ Molar Mass = 100.09 g/mole) is an antacid used to neutralize extra acid in the stomach. Lorie is prescribed by the doctor to take 250mg-tablet of $CaCO_3$ three times a day. How many moles of $CaCO_3$ will Lorie consume for 3 days?
   A. 0.0252 moles
   B. 0.0225 moles
   C. 0.0242 moles
   D. 0.0235 moles

6-8. Research the name and use of the substance which contains the chemical formula indicated in each number. Then calculate the percent composition of each substance.

6. $C_6H_8O_6$

7. $CuSO_4$

8. $C_5H_8NNaO_4$

9-10. What is the empirical and molecular formula of Allicin, the compound responsible for the characteristic smell of garlic. An analysis of the compound gives the following percent composition by mass: C: 44.4%; H: 6.21%; S: 39.5%; O: 9.86% (Molecular mass = 162.0 g/mol)?

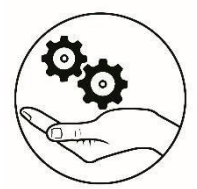
11. How many moles are there in 260 g of $CaCO_3$?
   A. 3.72 mol
   B. 3.25 mol
   C. 2.89 mol
   D. 2.60 mol

12. What is the formula mass of calcium carbonate in g/mol?
   A. 100
   B. 90
   C. 80
   D. 70

13. How many moles of water are present in 250g of ice?
   A. 13.9 mol H_2O
   B. 14.9 mol H_2O
   C. 15.9 mol H_2O
   D. 16.9 mol H_2O

14. Why is mole concept important?
    A. It is useful when converting between grams and atoms or molecules.
    B. It gives us a convenient way to express large numbers
    C. It can be applied to any type of particle representative
    D. All of the above

15. The presence of SO_2 in the atmosphere causes acid rain. How many percent of sulfur is present in SO_2 (Molar Mass = 64.07g/mole)?
    A. 40.00%
    B. 49.95%
    C. 60.00%
    D. 50.05%



Additional Activities

Chemical analyses show that a compound contains 87.5% N and 12.5% H by Mass. Determine the empirical and molecular formulas of the compound if its molar mass is 32.0 g/mol.

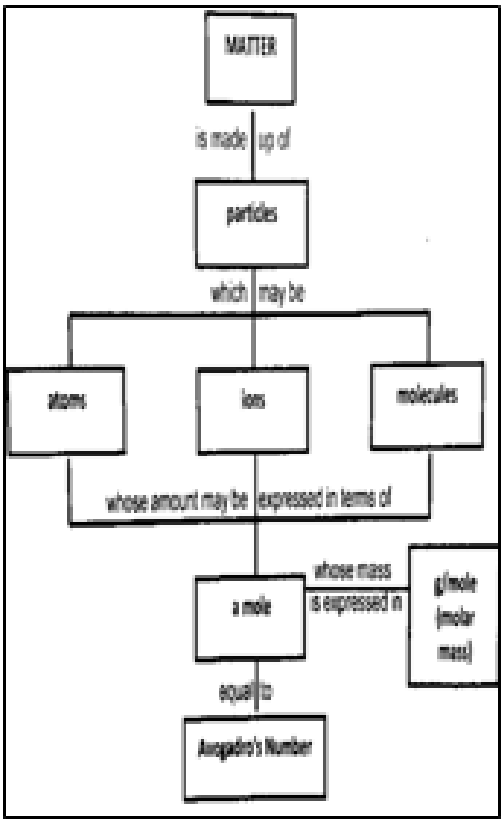
Answer Key

What I Know

1. D
2. C
3. B
4. C
5. C
6. D
7. B
8. D
9. C
10. B
11. A
12. A
13. A
14. A
15. B

What's In

Mole Map



What's New

It's Grocery Time!

1. The answer of the learners may vary depending on their food preferences. Generally speaking softdrinks, fruit juices in doy packs, cupcakes, and candies which contain sugar that is reported as carbohydrates in the nutrition facts will give them a lot of carbon atoms. On the other hand, grocery items commonly known as "junk food", such as crackers, potato chips, and corn chips and canned goods contain that provide sodium ions to their body.

2. Too much intake of those foods is not good for the body. The Food and Nutrition Research Institute has a recommended value intake to individuals of Junior High School (JHS) age.

3. The concept on percentage composition can be used in the preparation of food, production of paste, paint and alloy to name a few. There is a wide variety of application for the topic.

What's More

Activity 1: Percentage Composition

1. Given: $C_{14}H_{10}O_4$

Find: %C, %H, %O

Solution:

Step 1:

C= 14 x 12.01 amu = 168.1 amu

H = 10 x 1.01 amu = 10.1 amu

O = 4 x 16.00 amu = 64.00 amu

Formula Mass = 242.2 amu

Step 2:

$\%C = \frac{168.1\ amu}{242.2\ amu} \times 100 = 69.41\%$

$\%H = \frac{10.1\ amu}{242.2\ amu} \times 100 = 4.17\%$

$\%O = \frac{64.00\ amu}{242.2\ amu} \times 100 = 26.42\%$

69.41% + 4.17% + 26.42% = 100%

2. Given: $C_6H_{12}O_6$

Find: %C,

Solution:

Step 1:

C= 6 x 12.01 amu = 72.06amu

H = 12 x 1.01amu = 12.12amu

What's More

Activity 2: Molecular Formula for Nicotine

1. Nicotine

$(74.0g\ C) \times \frac{1\ mol\ C}{12.01\ g\ C} = 6.163\ mol\ C$

$(8.710g\ H) \times \frac{1\ mol\ H}{1.01\ g\ H} = 8.624\ mol\ H$

$(17.27g\ N) \times \frac{1\ mol\ N}{14.01\ g\ N} = 1.233\ mol\ N$

6.163 mol C/1.233 mol N = 5

8.264 mol H/1.233 mol N = 7

1.233 mol N/1.233 mol N = 1

$\frac{1.233}{1.233}$ 1.000 mol N

$\frac{6.163}{1.233}$ 4.998 mol C

$\frac{8.624}{1.233}$ 6.994 mol H

Empirical formula = C_5H_7N

Empirical formula mass = 81.13 g/mol

molar mass of nicotine:

$$\frac{40.57\ g\ nicotine}{0.2500\ g\ nicotine} = \frac{162.3\ g}{mol}$$

$$\frac{162.3\ g/mol}{81.13\ \frac{g}{formula\ unit}} = 2\ formula\ units/molecule$$

Multiply the empirical formula C_5H_7N by 2:

O = 6 x 16.00 amu = 96.00 amu

Formula Mass = 180.18amu

Step 2:

$\%C = \frac{72.06\ amu}{180.18\ amu} \times 100 = 39.99\%$

$(C_5H_7N)\ 2 = \mathbf{C_{10}H_{14}N_2}$

What I Can Do

A. ammonia (NH_3) = 82.22%

B. ammonium sulfate $(NH_4)_2SO_4$= 24.98%

C. ammonium nitrate, NH_4NO_3= 35.00%

What I Have Learned

1. Percentage Composition
2. Percentage Composition
3. Empirical Formula
4. Molecular Formula of a compound
5. Percent Composition
6. Covalent Compound
7. Molar Mass
8. Grams
9. Substance
10. Percentage Composition

What's More

Activity 3: Problem Solving

1. Given: $Al(OH)_3$
   Find: %Al, %O, %H
   Solution:

Step 1:

Al = 1 x 26.98 amu = 26.98 amu

O = 3 x 16.00 amu = 48.00 amu

H = 3 x 1.01 amu = 3.03 amu

Assessment

1. A
2. C
3. A
4. D
5. B

6. Vitamin C, supplement

Given: $C_6H_8O_6$
Find: %C, %H, %O
Solution:

Step 1:

C = 6 x 12 amu = 72 amu

Formula Mass = 78.01 amu

Step 2:

$\%Al = \frac{26.98\ amu}{78.01\ amu} \times 100 = 34.59\%$

$\%O = \frac{48.00\ amu}{78.01\ amu} \times 100 = 61.53\%$

$\%H = \frac{3.03\ amu}{78.01\ amu} \times 100 = 3.88\%$

2. $C_6H_{10}N_4O$

Additional Activities

1. The empirical formula of the compound is NH_2.

2. The molar mass of the empirical formula NH_2 is 16.0 g/mol. The number that relates the empirical and molecular formulas is

$$\frac{32.00\ g/mol}{16.0\ g/mol} = 2$$

3. The molecular formula of the compound, therefore, is N_2H_4

H = 8 x 1.01 amu = 8.08 amu

O = 6 x 16.00 amu = 96 amu

Formula Mass = 176.08 amu

Step 2:

$\%C = \frac{72\ amu}{176.08\ amu} \times 100 = 40.89\%$

$\%H = \frac{8.08\ amu}{176.08\ amu} \times 100 = 4.59\%$

$\%O = \frac{96\ amu}{176.08\ amu} \times 100 = 54.52\%$

7. Cupric sulfate, algaecide and rootkiller

Given: $CuSO_4$
Find: %CU, %S, %O
Solution:

Step 1:

Cu = 1 x 63.55 amu = 63.55 amu

S = 1 x 32.07 amu = 32.07 amu

O = 4 x 16.00 amu = 64 amu

Formula Mass = 159.62 amu

Step 2:

$\%C = \frac{63.55\ amu}{159.62\ amu} \times 100 = 39.81\%$

$\%H = \frac{32.07\ amu}{159.62\ amu} \times 100 = 20.09\%$

$\%O = \frac{64\ amu}{159.62\ amu} \times 100 = 40.1\%$

	8. Monosodium glutamate, flavor enhancer Given: $C_5H_8NNaO_4$ Find: %C, %H, %N, %Na, %O Solution: **Step 1:** C = 5 x 12.00 amu = 60.00 amu H = 8 x 1.01 amu = 8.08 amu N = 1 x 14.01 amu = 14.01 amu Na = 1 x 22.99 amu = 22.99 amu O = 4 x 16.00 amu = 64.00amu Formula Mass = 169.08amu **Step 2:** $\%C = \frac{60.00\ amu}{169.08\ amu} \times 100 = 35.49\%$ $\%H = \frac{8.08\ amu}{169.08\ amu} \times 100 = 4.78\%$ $\%N = \frac{14.01\ amu}{169.08\ amu} \times 100 = 8.29\%$ $\%Na = \frac{22.99\ amu}{169.08\ amu} \times 100 = 13.60\%$ $\%O = \frac{64.00\ amu}{169.08\ amu} \times 100 = 37.85\%$

9-10.

Moles of C = $\frac{\text{given mass of C}}{\text{molar mass of C}} = \frac{44.4g}{12g/mole} = 3.7moles$

Moles of H = $\frac{\text{given mass of H}}{\text{molar mass of H}} = \frac{6.21g}{1g/mole} = 6.21moles$

Moles of S = $\frac{\text{given mass of S}}{\text{molar mass of S}} = \frac{39.5g}{32g/mole} = 1.23moles$

Moles of O = $\frac{\text{given mass of O}}{\text{molar mass of O}} = \frac{9.86g}{16g/mole} = 0.62moles$

For C = $\frac{3.7}{0.62} = 5.96 \approx 6$

For H = $\frac{6.21}{0.62} = 10.01 \approx 10$

For S = $\frac{1.23}{0.62} = 1.98 \approx 2$

For O = $\frac{0.62}{0.62} = 1$

The ratio of C : H : S : O = 6 : 10 : 2 : 1

The Empirical formula = $C_6H_{10}S_2O_1$

$$x = \frac{\text{Molar mass}}{\text{Empirical formula mass}} = \frac{162\ g}{162\ g} = 1$$

Molecular formula is $C_6S_2OH_{10}$

11. D
12. A
13. A
14. D
15. D

References

Books:

Alvarez, Liza A., Dave G. Angeles, Hernan L. Apurada, Ma. Pillar P. Carmona, Oliver A., Lahorra, Judith f. Marcaida, Ma. Regaele A. Olarte. Science 9 - Learner's Module. DepEd - Instructional Materials Council Secretariat (DepEd-IMCS). Pasig city: FEP Printing Corporation, 2014.

Online Resources:

Grade 9 Learner's Module and Teacher's Guide retrieved from http://depedk12manuals.blogspot.com/2016/06/grade-9-learners-module-and-teachers.html

For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph