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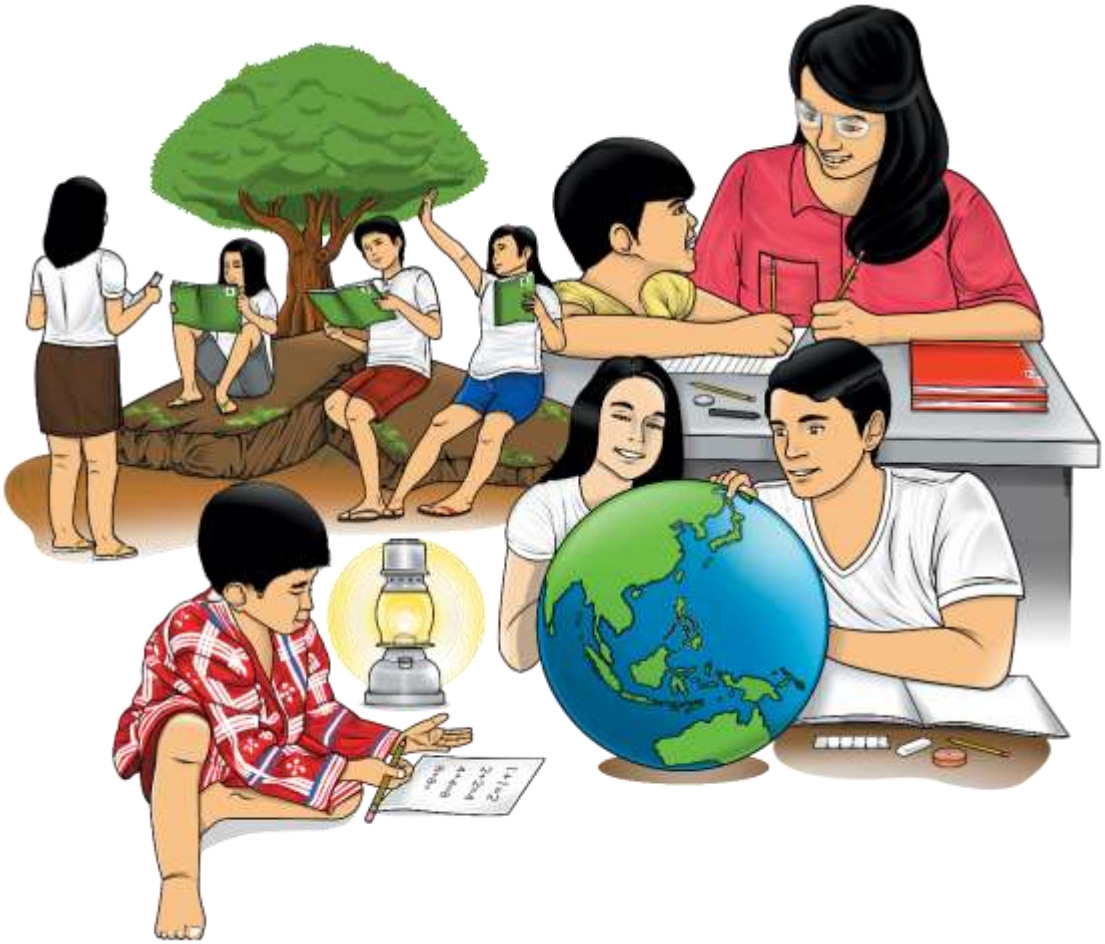
DEPARTMENT OF EDUCATION

Science

Quarter 1 – Module 5:
Quantity Really Matters



CO_Q1_Science7_Module5

ALTERNATIVE DELIVERY MODE
ADM

Science – Grade 7
Alternative Delivery Mode
Quarter 1 – Module 5: Quantity Really Matters
First Edition, 2020

Published by the Department of Education
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Undersecretary: Diosdado M. San Antonio

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Printed in the Philippines by _____

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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, exercise, 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 the 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. Note 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 necessary 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

Good day kids! How are you doing today? Do you know we can express the concentration of solution qualitatively or quantitatively? Yes, by simply describing their appearance or by its exact number of components of solute and solvent.

You always notice in buying commercial products in a grocery store such as alcohol or beverages (e.g. wine), there are writings in its labels like 70% or 40% isopropyl alcohol or else 12.5% ethanol. But, what does it mean? In this module, you will learn how to solve problems involving the concentration of solutions. You will also learn how to compute problems in a step by step process that will lead to an accurate answer. Knowing these skills is very essential in your future use especially in the field of science.

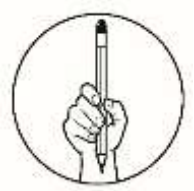
How to express the concentration of the solution quantitatively? What are the quantitative descriptions of concentrations?

The module is divided into two activities, specifically:

- Activity 1: Percent by Volume
- Activity 2: Percent by Mass

After going through this module, you are expected to:

- solve the mass of solute, volume of solution or the concentration of the solution giving two variables.



What I Know

Directions: Read each item carefully. Write only the letter of the correct answer for each question. Use a separate sheet for your answers.

1. In a chemistry class, Gabby prepared a solution by mixing 25 gram (g) of sugar in 80g of water. What are the concentrations of the solute and solvent in percent (%) by mass?
    a. solute: 34% ; solvent: 60%
    b. solute: 14% ; solvent: 86%
    c. solute: 24% ; solvent: 76%
    d. solute: 44% ; solvent: 56%

2. How many parts of copper and gold needed to produce 18 Karat (K) jewelry?
    a. 18 parts is made up of copper and 6 parts is gold
    b. 18 parts is made up of gold and 6 parts is copper
    c. 18 parts is made up of gold and 9 parts is copper
    d. 18 parts of the jewelry is made up of finest gold suited for the purpose.

3. What is the percentage concentration in the following solution given that 5g sucrose in 90g water?
    a. 4 %
    b. 5 %
    c. 6 %
    d. 7%

4. A beverage contains 3% alcohol which means that:
    a. The solution contains 3mL of alcohol in 97mL of water.
    b. The solution contains 30mL of alcohol in 70mL of water.
    c. The solution contains 300mL of alcohol in 700mL of water.
    d. The solution contains 100mL of alcohol in 100mL of water.

5. Sterling silver contains 95% silver. If a necklace made of sterling silver weighs 15g, what is the mass of silver dissolved in the necklace?
    a. 1.6g
    b. 6.2g
    c. 9.0g
    d. 14.25g

6. What is the percent by volume of isopropanol in a 90ml solution that contains 25mL isopropanol?
    a. 26.8 % isopropanol
    b. 26.9 % isopropanol
    c. 27.8 % isopropanol

d. 27.9 % isopropanol

7. What is the volume of a 20% methyl solution that contains 15mL of methyl?
    a. 6 mL of methyl
    b. 4 mL of methyl
    c. 5 mL of methyl
    d. 3mL of methyl

8. What is the percent by mass concentration of a solution that contains 30.0g of sugar dissolved in 150g of water?
    a. 16.5%
    b. 16.7%
    c. 17.6 %
    d. 17.7%

9. A genuine sterling silver items is 92.5% silver by mass. This means that:
    a. 92.5 g is silver and 7.5g is another metal (usually copper)
    b. 0.5 g is silver and 92.5g is another metal (usually copper)
    c. 46.25g is silver and 46.25g is another metal (usually copper)
    d. 92.5g of the jewelry is made up of pure silver

10. The following are quantitative descriptions of concentrations, **EXCEPT**:
    a. percent by mass
    b. polarity
    c. dilute solution
    d. PPM

Lesson 1 Quantity Matters

What's In

Hello kids! In the previous module, you have learned what we meant by concentration of solutions and learned that we can express it qualitatively.

As you can remember, a solution has two types of components: the solute and the solvent. The component present in small amount is called **solute**, such as, sugar, salt, powdered juice, and milk powder. Usually, the **solvent** is the dissolving medium or the component that comes in greater quantity, like water.

Let's try if you can describe the following solutions qualitatively:

WHAT TO DO:

1. These are the everyday items used at home (coffee, salt, sugar, water) combine and make a solution.
2. Write your answer using the data given below.

	Type of Solution	**Appearance**
A. Poured 1 tablespoon of salt to 1 glass of water and stir.		
B. Mixed 3 sticks of coffee powder in 1 small cup of water and stir.		
C. Add 5 tablespoon of sugar in cup of water and stir. It was too sweet		

As we go along with our lesson, activities will be more exciting and thrilling. Are you ready? Let's start the ball rolling.

What's New

Are you now interested with our lesson? I hope that you can apply your analytical and mathematical skills to the activities we will discuss in this module. Are you excited? Let us start!

But before we are going to proceed with the activity, let us know first how to express the concentration of solution quantitatively.

Sometimes, we express the concentration as a percent of one component in the solution by volume. In such cases, it is the volume percentage. It is given as:

Volume % of A = Volume of component A ÷Total Volume

For instance, if a solution of sugar in water is said to be 10% by volume that means a 100mL solution will contain 10mL sugar.

Now, let us check your understanding with our lesson.

ACTIVITY 1: COUNT ME IN!

What to Do:

1. Read and analyze the situations below.
2. Answer and solve what is asked in each problem.

SITUATION #1: One way to prevent the pandemic COVID-19 is to wash our hands with soap and applying alcohol as a disinfectant. The active ingredient in alcohol is ethanol. As you read the label of the alcohol, it is 70% ethyl alcohol in a 250mL bottle. With your curious mind, you want to know how many mL of ethyl alcohol is present in a 250mL. What would you do?

Question #1: What is the volume of a 70% ethyl alcohol solution in a 250mL bottle to fight COVID-19 in situation #1?

What is It

What are quantitative methods of expressing concentration of solutions?

You can describe the concentration of solutions qualitatively (by simply observing their appearance) and quantitatively (by comparing the number of drops per volume of water). Therefore, we need more exact, quantitative methods of expressing concentration.

You can express concentration in other ways such as:

1) **percent by volume,** it is defined as the volume of solute present in 100 mL of solution (% v/v)

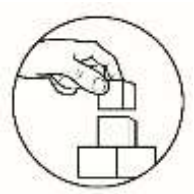
$$percent\ by\ volume\ = \frac{volume\ of\ solute}{volume\ of\ solution} \times 100$$

Example 1:

The active ingredient in wines and other alcoholic beverages is ethanol. A 300mL sample of wine was found to contain 37.5mL of ethanol. What is the percentage by volume concentration of ethanol in the wine sample?

Given:	*Solution:*
volume of solute= 37.5 mL volume of solution= 300 mL % by volume= ?	$percent\ by\ volume = \frac{volume\ of\ solute}{volume\ of\ solution} x\ 100$ $= \frac{37.5\ \cancel{mL}}{300\ \cancel{mL}} x\ 100$ $= 0.125\ x\ 100$ $= \mathbf{12.5}\%$

Take note! The volumes of the solute, solvent, and solution must be expressed in the same units.



What's More

Are you getting familiar with the whole process? Let us have more practice exercises to enhance your mathematical skill. I prepare this problem solving for you, hope you like it. Let's start!

Show the complete process of computation to obtain a correct answer.

Problem #1: What is the percent by volume of a solution formed by mixing 25mL of isopropanol with 45mL water?

Problem #2: A photographic "stop bath" contains 160mL of pure acetic acid, $HC_2H_3O_{2(l)}$ in 650mL solution. What is the v/v concentration of acetic acid in the stop bath?

What I Have Learned

Now that you have learned a lot from our module, let us test your familiarity with our lesson by simply answering our mind cracking problem. Are you ready? Let us start the ball rolling.

1. If I make a solution by adding water to 75mL of ethanol until the total volume of the solution is 375mL, what is the percent by volume of ethanol in the solution?

2. Rubbing alcohol is sold as a 70% (v/v) solution of isopropyl alcohol in water. What volume of isopropyl alcohol is used to make 500mL of rubbing alcohol?

3. A bottle of hydrogen peroxide also known as agua oxigenada is labeled 3% (v/v). How many mL of agua oxigenada are in a 400mL bottle of this solution?

What's New

Good job! You made it! In the previous activity, you were able to analyze and compute the problem which involves percent by volume. I hope you can use the same skills in the activities we will discuss in this module. Are you excited? Let's start!

But before we are going to advance with the next activity, let us also know how to express the concentration of solution quantitatively by percent by volume.

When we express the concentration of a solution as the percent one component in the solution, we call it the mass percentage (w/w). Assume, we have a solution containing component A as the solute and B as the solvent, then its mass percentage is expressed as:

Mass % of A = Mass of component A ÷ Total Mass

For example, we have a 10% solution of sugar by mass means that 10 grams of sugar are present in 100grams of the solution.

Let us try this one.

Activity 2: SUM IT UP!

What to Do:

1. Read and analyze the situations below.

2. Answer and solve what is asked in each problem.

SITUATION #1: Every morning we drink milk to strengthen our bones. You prepare a 100mL with a 5% powdered milk mix solution for your mother. She asks you how many grams of milk you used for her drinks. What would be your response to her question?

Question #1: In situation #2, how many grams of powdered milk did you use to prepare 100mL of a 5% powdered milk mix solution?

What is It

From Part 1 of the activity, you were able to express concentration using percent by volume. Another way to express concentration is through:

1. **percent by mass –** it is defined as the amount of solute in each mass of solvents. It is expressed as grams of solute per 100 grams of solution (% m/m).

$$Eq.\,1: percent\ by\ mass = \frac{mass\ of\ solute}{mass\ of\ solution} x\ 100$$

or

$$Eq.\,2: percent\ by\ mass = \frac{mass\ of\ solute}{mass\ of\ solute + mass\ of\ solvent} x\ 100$$

Example 2:
What is the percent by mass concentration of a solution that contains 5.30 g of salt dissolved in 19.7 g of water?

Given:

mass of solute= 5.30 g

mass of solvent= 19.7 g

Solution:

$$percent\ by\ mass = \frac{mass\ of\ solute}{mass\ of\ solute + mass\ of\ solvent} x\ 100$$

$$= \frac{5.30\cancel{g}}{5.30\cancel{g}+19.7\cancel{g}} x\ 100$$

$$= \frac{5.30\cancel{g}}{25.0\cancel{g}} x\ 100$$

$$= 21.2\%$$

Take note! The masses of the solute, solvent, and solution must be expressed in the same units.

Labels of products sold often show the concentration of solute expressed as percent (%) by volume or mass. The alcohol used as a disinfectant is a solution of 70% ethyl or isopropyl alcohol, meaning 70mL alcohol. There are also solutions sold as 40% ethyl or isopropyl alcohol.

Vinegar is often labeled as "5% acidity," which means that it contains 5 grams of acetic acid in 100 g of vinegar.

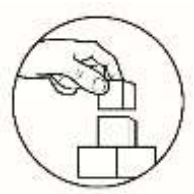
Pure gold is referred to as 24 karats. Jewelry that is said to be 18 karats contains 18g of gold for every 24g of the material, the remaining 6g consist of the other metal like copper or silver. This material has a concentration of 75% gold, that is, [18/24(100)]. 14 karat (14K) gold contains 14g gold and 10 g of another metal, making it 58.3% gold.

Concentration determines by the formula:

concentration = amount of solute ÷ amount of solution

Solution = solute + solvent
1kg = 1000g
1L = 1000mL

I am so happy that you did a great job in every challenge. Now, let us assess how far you have gone with our topic. Be ready with your mind and brain to answer every task. Good luck!



What's More

Show the complete process of computation to obtain a correct answer.

Problem #1: What is the percent by mass concentration of a solution that contains 5.30g of salt dissolved in 19.7g of water?

Problem #2: How many grams of glucose ($C_6H_{12}O_6$) are needed to prepare 400mL of a 5% glucose solution?

What I Have Learned

Excellent! It truly shows how much you enjoyed and learned our lesson. Are you ready to have some more? Let us start the ball rolling.

1. What is the percent by mass if 8.0g copper is added to enough zinc to produce 100g an alloy?

2. You have 200g or a solution that contains 30g of hydrochloric acid (HCl), what percentage of your solution is made up of HCl acid?

3. Suppose you want to make 2000g of a solution of glucose in water that has 2.8% (m/m) concentration. How much glucose should you use?

What I Can Do

Congratulations! You are fantastic and really enjoyed your exploration in the world of chemistry. Here is your final challenge to prove what you got.

1. Why do health practitioners recommend us to use 70% alcohol than 40% alcohol as disinfectant to fight the pandemic COVID- 19?

2. Why is it that food manufacturer places the *Nutritional Label* on the container of every bit of processed food sold by the grocery store?

Assessment

Directions: Read each item carefully. Write only the letter of the correct answer for each question. Use your activity notebook for your answers.

1. How many grams of glucose are needed to prepare 400mL of 5% glucose solution?
   a. 5g
   b. 10g
   c. 14g
   d. 20g

2. What is the percentage concentration in the following solution given 2g sucrose in 80g water?
   a. 2.4%
   b. 2.5%
   c. 4.0%
   d. 97.6%

3. Sterling silver contains 95% silver. If a necklace made of sterling silver weighs 15g, what is the mass of the silver dissolved in the necklace?
   a. 1.6g
   b. 6.2g
   c. 9.0g
   d. 14.25g

4. What is the percent by mass concentration of a solution that contains 6.0g of sugar dissolved in 20.7g of water?
   a. 21.21%
   b. 22.21%
   c. 22.47%
   d. 22.74%

5. Brass is a copper- zinc alloy. If the concentration of zinc is relatively low, the brass has a golden color and is often used for inexpensive jewelry. If a 35.0g pendant contains 1.7g of zinc, what is the % by mass of zinc in brass?
   a. 4.7%
   b. 4.8%
   c. 4.9%
   d. 10%

6. A solution of benzene and toluene was prepared by adding toluene to benzene until the total volume becomes 135mL. By volume, the solution is 30.0% benzene. How much benzene, in mL, is in the solution?
   a. 39.5mL of benzene
   b. 40.5mL of benzene
   c. 41.5mL of benzene
   d. 42.5mL of benzene

7. A solution is prepared by mixing a 20g of sodium chloride in 80g of water. What are the concentrations of the solute and solvent in % by mass?
    a. solute: 10% ; solvent: 90%
    b. solute: 20% ; solvent: 80%
    c. solute: 30% ; solvent: 70%
    d. solute: 40% ; solvent: 60%

8. What is the volume of a 25% methyl solution that contains 20mL of methyl?
    a. 6.25mL
    b. 7.25mL
    c. 8.25mL
    d. 9.25mL

9. You bought an 18 karats ring which contains 18g of gold. What is the % by mass of gold in a ring?
    a. 65%
    b. 75%
    c. 85%
    d. 95%

10. What is the % M/M if 10.0g of copper is added to enough zinc to produce 110g of an alloy?
    a. 9.05%
    b. 9.09%
    c. 9.10**%**
    d. 10.00%

Additional Activities

Good job! You have come this far. I know that you are knowledgeable enough with our lesson. For your additional learning, try to answer this one:

Your mother has a jewelry box full of gold jewels. She wants to give the 10- karat gold necklace to your aunt and a 14- karat gold bracelet to your sister. Your aunt and your sister want to find out the percentage of gold on the jewels they had received by trying to pawn it in a pawnshop.

Try to help the teller in finding out the percent by mass of gold on the jewels.

To help you, here is an additional information. The composition of gold jewelry is expressed in karats. Gold has 24 parts of the solution (alloy). The alloying metal is usually copper. Identify the percent by mass of gold in the following composition:

A. 10-karat gold

B. 14- karat gold

Answer Key

Assessment
1. D
2. A
3. D
4. C
5. C
6. B
7. B
8. A
9. B
10. B

What I Know
1. C
2. B
3. B
4. A
5. D
6. C
7. D
8. B
9. A
10. C

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