



## What Is This Module About?

Water is very important in our lives. But right now, the supply of water is becoming more scarce every day. That is why everyone must learn to conserve water. Many people store water in rectangular or cylindrical tanks. Others store it in plastic cylinders. How big are the water containers that you see in your community? Some of them are big while some are small. Can you estimate the volume of the tanks that you see? In this module, you will learn more about volume.

In this module you will learn what volume means. You will learn to identify the standard measures of volume. You will read and record the volume of different solids. You will also solve practical problems in computing the volume of rectangular solids, cubes and cylinders. You will also learn the indigenous measures of volume.

This module contains three lessons:

Lesson 1 – *Units of Volume*

Lesson 2 – *Measuring Volume*

Lesson 3 – *Indigenous Measures of Volume*



## What Will You Learn From This Module?

After studying this module, you should be able to:

- ◆ identify the units of volume;
- ◆ convert one unit of volume to another;
- ◆ use formulas in computing the volume of various solids;
- ◆ identify the appropriate formulas in solving the volume of different solids;
- ◆ solve problems that involve volume.

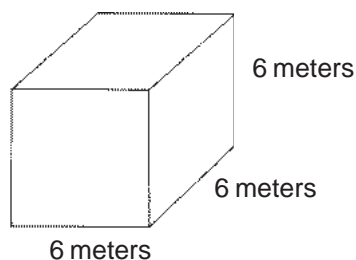


## Let's See What You Already Know

Before you start studying this module, find out first how well you know the topics to be discussed by taking the following test.

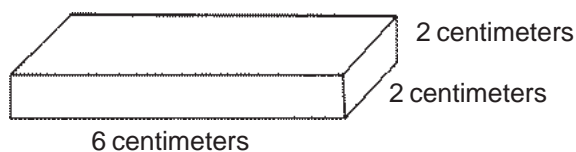
- A. Below are different kinds of solids with indicated measurements. Identify the units of measurement of volume used in each figure. Write your answers in the spaces provided. The first one has been done for you.

1.



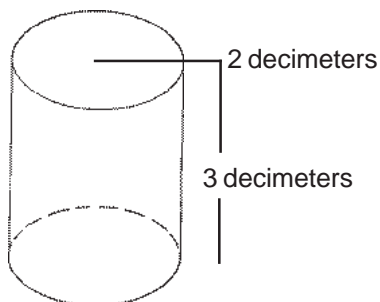
*Answer:* cubic meters

2.



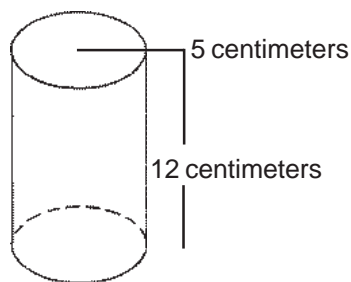
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3.



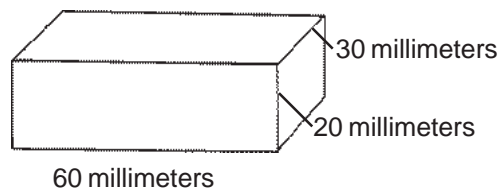
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4.



\_\_\_\_\_

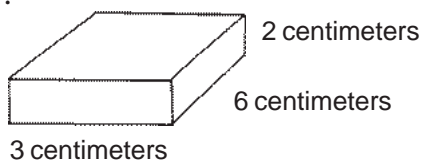
5.



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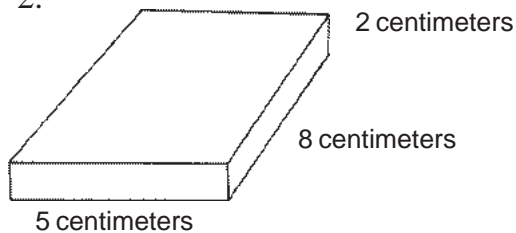
- B. Find the volume of each figure below and write your answer in the space provided. For cylinders, let  $\pi = 3.14$ .

1.

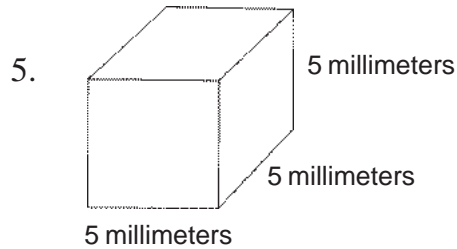
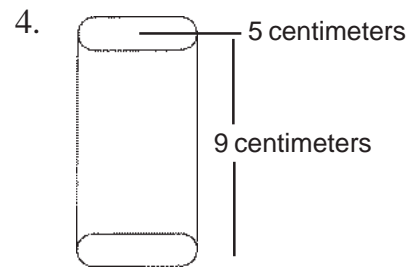
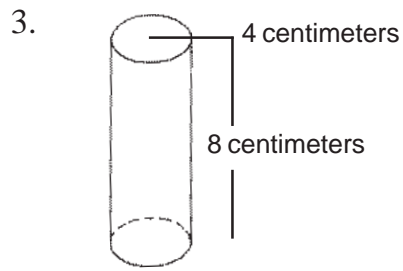


\_\_\_\_\_

2.



\_\_\_\_\_



C. Solve the following problems. Do not forget to include the appropriate units of measure.

1. Find the surface area of a square picture frame with an edge of 6 centimeters (cm).
2. A rectangular box is 12 cm long, 10 cm wide and 8 cm high. Find the volume of the rectangular box.
3. Find the volume of a cylinder with a radius of 2 cm and a height of 8 cm.

4. A cylinder has a radius of 6 cm and a height of 18 cm. What is its volume?
  
  
  
  
  
  
  
  
  
  
5. What is the volume of a rectangular solid that is 4 meters (m) long, 3 m wide and 6 m high?

Well, how was it? Do you think you fared well? Compare your answers with those in the *Answer Key* on page 29.

If all your answers are correct, very good! This shows that you already know much about the topics in this module. You may still study the module to review what you already know. Who knows, you might learn a few more new things as well.

If you got a low score, don't feel bad. This means that this module is for you. It will help you understand some important concepts that you can apply in your daily life. If you study this module carefully, you will learn the answers to all the items in the test and a lot more! Are you ready?

You may go now to the next page to begin Lesson 1.

## Units of Volume

You have learned that the standard unit of linear measure is the meter. You use the meter to indicate the length and width of your garden or your house. You also use it in finding the area of different types of surfaces. Can you still remember what you do to find the area? If you answered you multiply the length by the width, you are right.

How about solving this problem: Find the area of a rectangular garden that is 8 m long and 6 m wide. If you multiplied the length by the width, that is,  $8\text{ m} \times 6\text{ m} = 48\text{ m}^2$ , then you are correct! Always remember to put the appropriate unit of measure. In this case, the unit of measure used is  $\text{m}^2$ . How do you read  $\text{m}^2$ ? If you say square meters, then you are right.

In this lesson, you will learn the concept of volume and the units of volume. You will also learn to convert one unit of volume to another.

After studying this lesson, you should be able to:

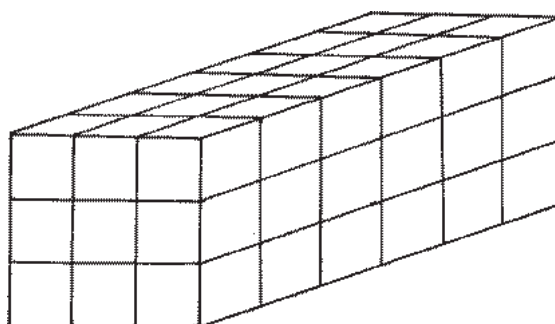
- ◆ explain what volume is;
- ◆ identify the units of volume; and
- ◆ convert nonstandard units of volume to standard units of volume.



### Let's Study and Analyze

By **volume** we mean the amount of **space** any form of solid or liquid matter occupies.

Let's study the figure below. These are wooden blocks piled on top of one another.



Let us look at the top layer. How many blocks are there on the shorter side or width of the figure? How many are there on the longer side or length? How many layers of blocks are there? Since there are 3 blocks on the width, 6 blocks on the length and 3 layers of blocks, how many blocks are there in all?

$$3 \times 6 \times 3 = 54 \text{ blocks}$$

Each block represents one cubic unit and if the blocks are placed in a box in which they just fit, the box will then have a volume of **54 cubic units**.

If the length of another box is 6 units and its width is 5 units, how many units will form one layer? If there are 4 layers, there will then be

$$(6 \times 5) \times 4 = 120 \text{ cubic units}$$

The box is said to have a volume of 120 cubic units.



## Let's Learn

Below is a table of measurements of volume in the metric system. From your observations, which of these units of measurement are often used? How do you read the symbols? How do you read  $\text{mm}^3$ ? If you said cubic millimeters, you are very good! Read these units of volume aloud several times to help you remember them and their equivalents.

### Measurements of Volume

$$1000 \text{ cubic millimeters (mm}^3\text{)} = 1 \text{ cubic centimeter (cm}^3\text{)}$$

$$1000 \text{ cubic centimeters (cm}^3\text{)} = 1 \text{ cubic decimeter (dm}^3\text{)}$$

$$1000 \text{ cubic decimeters (dm}^3\text{)} = 1 \text{ cubic meter (m}^3\text{)}$$

$$1 \text{ liter (L)} = 1 \text{ dm}^3 = 1000 \text{ cm}^3 = 1000 \text{ milliliters (mL)}$$

There are many items sold by the liter like gasoline, oil, fresh milk and paint. In the past, these items were sold by the gallon, but with the passage of the Batas Pambansa Blg. 8, the use of the metric system is now required in all business transactions in the Philippines.

Closely related to volume is capacity. Liquids are measured in units of capacity. Here are liquid measures of capacity.

### Units of Capacity—Liquid Volume Measure

$$8 \text{ fluid ounces (fl. oz.)} = 1 \text{ cup (c.)}$$

$$2 \text{ c.} = 1 \text{ pint (pt.)}$$

$$2 \text{ pt.} = 1 \text{ quart (qt.)}$$

$$4 \text{ qt.} = 1 \text{ gallon (gal.)}$$

$$1 \text{ L} = 0.2642 \text{ gal.}$$

Study the two tables. These will help you convert different measures of volume and capacity. Read each table aloud several times to help you remember them.



## Let's Try This

Now that you already know different units of volume, let us have some examples in converting standard units of volume. The tables of measurements can help you.

1. If  $1 \text{ cm}^3$  is equal to  $1000 \text{ mm}^3$ , how many cubic millimeters are there in  $3 \text{ cm}^3$ ?

If your answer is  $3000 \text{ mm}^3$ , then you are correct! But what did you do to get the answer? Compare your solution with mine.

**STEP 1** It is always important to remember **conversion factors**. In this case, the conversion factor that we are going to use is  **$1 \text{ cm}^3 = 1000 \text{ mm}^3$** .

**STEP 2** Keep in mind that we use conversion factors to convert the given unit of measurement to another unit of measurement. This implies that one of our units must cancel out. So what we should do is express the conversion factor as a ratio with  $1 \text{ cm}^3$  as the denominator. That is:

$$\frac{1000 \text{ mm}^3}{1 \text{ cm}^3}$$

**STEP 3** Multiply  $3 \text{ cm}^3$  by the conversion factor.

$$3 \cancel{\text{cm}^3} \times \frac{1000 \text{ mm}^3}{1 \cancel{\text{cm}^3}} = 3000 \text{ mm}^3$$

Remember to always include the appropriate units in your final answer. So did you get the right answer to this one? If you did not, don't feel bad. You can try this next example.

2. If  $1 \text{ L}$  is equal to  $1000 \text{ cm}^3$ , how many liters are there in  $2000 \text{ cm}^3$ ?

So what did you get? Let us compute for the answer by following the same steps that we did in number 1.

**STEP 1** Again, we have to use a conversion factor. For this example, our conversion factor is  **$1 \text{ L} = 1000 \text{ cm}^3$** .

**STEP 2** We now express the conversion factor as a ratio with  $1000 \text{ cm}^3$  as the denominator so that the unit  $\text{cm}^3$  will cancel out. That is,

$$\frac{1 \text{ L}}{1000 \text{ cm}^3}$$

**STEP 3** Now we multiply  $2000 \text{ cm}^3$  by the conversion factor, which we earlier converted to a ratio.

$$\cancel{2000}^2 \cancel{\text{cm}^3} \times \frac{1 \text{ L}}{\cancel{1000} \cancel{\text{cm}^3}} = 2 \text{ L}$$

So did you get the same answer? If you did, that's very good! If you did not, here is another example to further help you understand the process of conversion.

3. How many pints are there in 1 quart?

Again, follow the step-by-step process to solve this problem.

**STEP 1** We will again use a conversion factor. Using the table of units of liquid measure, **2 pints = 1 quart.**

**STEP 2** Then we will convert our conversion factor into a ratio so that one unit will cancel out. In this example, since the answer should be in pints, we will put 1 quart in the denominator:

$$\frac{2 \text{ pints}}{1 \text{ quart}}$$

**STEP 3** Now we will multiply 2 quarts by the conversion factor to compute for the answer.

$$2 \cancel{\text{quarts}} \times \frac{2 \text{ pints}}{1 \cancel{\text{quart}}} = 4 \text{ pints}$$

Did you get the right answer? If you did, that's excellent! If not, here is your last chance to get it right.

4. Find the number of quarts in 8 pints.

Let us solve for this by answering the following questions.

- ◆ What conversion factor do we need to use?
- ◆ How will you express the conversion factor as a ratio?
- ◆ What operation will you use to compute for the answer?

Write your answers here:

- ◆ \_\_\_\_\_
- ◆ \_\_\_\_\_
- ◆ \_\_\_\_\_

Now compare your answers with mine:

- ◆ The conversion factor that we need is 1 quart = 2 pints.
- ◆ The conversion factor in ratio form is  $\frac{1 \text{ quart}}{2 \text{ pints}}$ .
- ◆ We now multiply 8 pints by the conversion factor in ratio form:

$$\overset{4}{8} \cancel{\text{pints}} \times \frac{1 \text{ quart}}{2 \cancel{\text{pints}}} = 4 \text{ quarts}$$

Did you get the same answer I did? Do you think you can now solve other problems following the steps in number 4? Try answering the next exercises on your own.





## Let's Try This

Solve the first problem by showing the step-by-step process.

1. Mang Jose filled a small tank with  $5 \text{ dm}^3$  of water. How many  $\text{cm}^3$  does the tank hold?

**STEP 1** The conversion factor needed is \_\_\_\_\_.

**STEP 2** The conversion factor when expressed as a ratio is  
\_\_\_\_\_.

**STEP 3** We \_\_\_\_\_  $5 \text{ dm}^3$  by the conversion factor to compute for the answer.

Solve the following problems by writing your answers on the lines provided.

2. A bottle contains  $1000 \text{ cm}^3$  of juice. How many liters does the bottle contain?

◆ \_\_\_\_\_  
◆ \_\_\_\_\_  
◆ \_\_\_\_\_

3. A painter used 2 quarts of paint in painting a cabinet. How many gallons of paint did he use?

◆ \_\_\_\_\_  
◆ \_\_\_\_\_  
◆ \_\_\_\_\_

Compare your answers with those in the *Answer Key* on pages 29 and 30.



## Let's See What You Have Learned

Convert the following units of volume to the indicated units.

1.  $10 \text{ mL} = \underline{\hspace{1cm}} \text{ cm}^3$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$
2.  $2 \text{ cm}^3 = \underline{\hspace{1cm}} \text{ mm}^3$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$
3.  $10 \text{ L} = \underline{\hspace{1cm}} \text{ dm}^3$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$
4.  $4 \text{ dm}^3 = \underline{\hspace{1cm}} \text{ cm}^3$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$
5.  $3000 \text{ dm}^3 = \underline{\hspace{1cm}} \text{ m}^3$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$
6.  $16 \text{ pt.} = \underline{\hspace{1cm}} \text{ qt.}$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$
7.  $2 \text{ qt.} = \underline{\hspace{1cm}} \text{ pt.}$ 
  - conversion factor:  $\underline{\hspace{2cm}}$
  - conversion ratio:  $\underline{\hspace{2cm}}$
  - computation for the answer:  $\underline{\hspace{2cm}}$

8. 2 gal. = \_\_\_\_ qt.
- conversion factor: \_\_\_\_\_
  - conversion ratio: \_\_\_\_\_
  - computation for the answer: \_\_\_\_\_
9. 32 fl. oz. = \_\_\_\_ c.
- conversion factor: \_\_\_\_\_
  - conversion ratio: \_\_\_\_\_
  - computation for the answer: \_\_\_\_\_
10. 0.5284 gal. = \_\_\_\_ L
- conversion factor: \_\_\_\_\_
  - conversion ratio: \_\_\_\_\_
  - computation for the answer: \_\_\_\_\_

Compare your answers with those in the *Answer Key* on pages 30 and 31. Did you get a perfect score? If you did, that's very good! If you did not, don't worry. Just review the parts of the lesson that you did not understand very well before you proceed to Lesson 2.



## Let's Remember

- ◆ Volume is the amount of space any form of solid or liquid matter occupies.
- ◆ Volume is expressed in cubic units, such as  $\text{cm}^3$  and  $\text{m}^3$  in the metric system and in units of liquid measure such as pint, quart and fluid ounce.
- ◆ Conversion factors for the units of volume are:

### Measurements of Volume

$$1000 \text{ cubic millimeters (mm}^3\text{)} = 1 \text{ cubic centimeter (cm}^3\text{)}$$

$$1000 \text{ cubic centimeters (cm}^3\text{)} = 1 \text{ cubic decimeter (dm}^3\text{)}$$

$$1000 \text{ cubic decimeters (dm}^3\text{)} = 1 \text{ cubic meter (m}^3\text{)}$$

$$1 \text{ liter (L)} = 1 \text{ dm}^3 = 1000 \text{ cm}^3 = 1000 \text{ milliliters (mL)}$$

- ◆ Conversion factors for units of liquid measure:

### Liquid Measures

$$8 \text{ fluid ounces (fl. oz.)} = 1 \text{ cup (c.)}$$

$$2 \text{ c.} = 1 \text{ pint (pt.)}$$

$$2 \text{ pt.} = 1 \text{ quart (qt.)}$$

$$4 \text{ qt.} = 1 \text{ gallon (gal.)}$$

$$1 \text{ L} = 0.2642 \text{ gal.}$$

## Measuring Volume

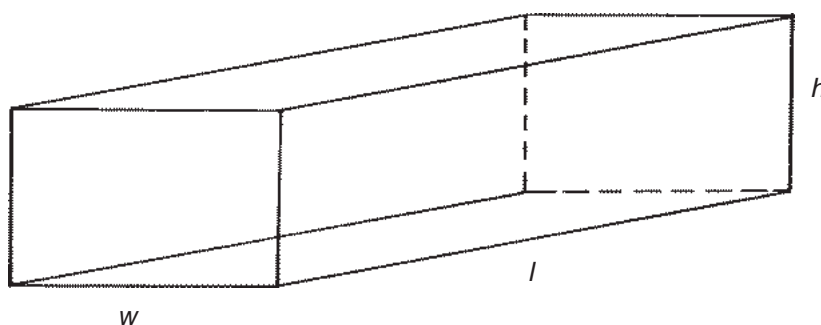
In this lesson, you will get a chance to do exercises in computing the volume of different spatial figures so that you should be able to:

- ♦ use formulas in computing the volume of various solids; and
- ♦ identify the appropriate formulas in solving problems involving the volume of different spatial figures.



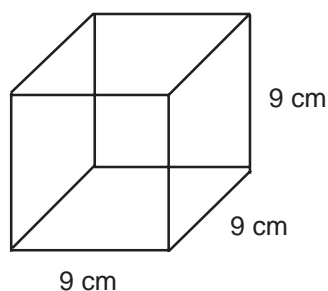
### Let's Study and Analyze

In studying volume, we'll be dealing with spatial figures such as the following:



**Rectangular solid**

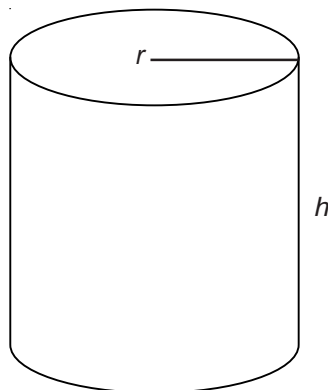
Also referred to as a rectangular prism, the rectangular solid has three dimensions, namely length ( $l$ ), width ( $w$ ) and height ( $h$ ). How many rectangles do you see? A rectangular solid has 6 rectangles which are called **faces**. Some examples of a rectangular solid are the *balikbayan* box and other rectangular boxes, rice dispensers, refrigerators and freezers. Can you give other examples of rectangular solids that you often see in your home and community?



**Cube**

The **cube** is a rectangular solid whose dimensions are equal:  $l = w = h$ .

Each dimension is called an **edge**. In the preceding figure, the cube has an edge of 9 cm. How many faces does it have? A cube has 6 faces which are all **squares**. Can you give some examples of cubes that you see in your home and community?



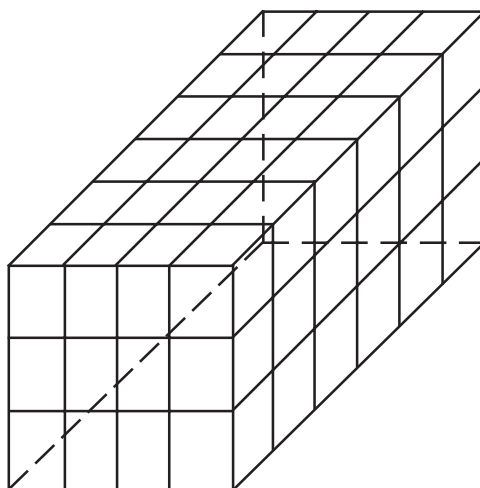
**Circular cylinder**

A circular cylinder is another spatial figure. It has a circular base and sides that are perpendicular to the base. Examples of this are the tin cans of powdered milk, circular water tanks and drinking glasses.



## Let's Learn

How do we compute the volume of a rectangular solid?



Remember what we did in the previous lesson to get the volume of a rectangular solid? We multiplied the area of one layer by the number of layers or the height.

$$\text{Volume} = \text{area}_{\text{one layer}} \times \text{height}$$

That is, we took the product of the length, width and height.

$$\text{Volume}_{\text{rectangular solid}} = \text{length} \times \text{width} \times \text{height}$$

Note that your answer should be in cubic units. In this case, the volume should be in cubic centimeters ( $\text{cm}^3$ ).

$$\begin{array}{rcl} \text{Area of one layer: } l & & 6 \text{ cm} \\ & \times & \\ w & \times & 4 \text{ cm} \\ \hline & & 24 \text{ cm}^2 \\ & \times & \\ h & \times & 3 \text{ cm} \\ \hline V & & 72 \text{ cm}^3 \end{array}$$

Another way of doing this is shown below:

$$\begin{aligned} V &= l \times w \times h \\ &= 6 \text{ cm} \times 4 \text{ cm} \times 3 \text{ cm} \\ &= 72 \text{ cm}^3 \end{aligned}$$



## Let's Try This

Now let us try solving some problems involving the volume of rectangular solids.

### Problem:

A rice dispenser is 3 dm long, 3 dm wide and 5 dm high.

- a. Using the formula  $V = bh$ , where  $b$  is the area of the base, you get:

$$\begin{aligned} b &= l \times w \\ &= 3 \text{ dm} \times \underline{\hspace{1cm}} \\ &= \underline{\hspace{1cm}} \\ V &= \underline{\hspace{1cm}} \times 5 \text{ dm} = \underline{\hspace{1cm}} \end{aligned}$$

- b. Following the formula  $V = l \times w \times h$

$$V = 3 \text{ dm} \times 3 \text{ dm} \times \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$$

### Solution:

- a. To get the area of the base, we need to get the length and the width first. The length is 3 dm and the width is 3 dm. Therefore, the area of the base is  $3 \text{ dm} \times 3 \text{ dm} = 9 \text{ dm}^2$

Now that we know the area of the base and the height, we can now get the volume of the rice dispenser by substituting the appropriate values in the formula  $V = b \times h$ .

$$V = 9 \text{ dm}^2 \times 5 \text{ dm} = 45 \text{ dm}^3$$

- b. Now let us try using the variation of our formula. Since in the problem we are already given the length, width and height, we can directly substitute the values in the formula.

$$V = 3 \text{ dm} \times 3 \text{ dm} \times 5 \text{ dm} = 45 \text{ dm}^3$$



## Let's Review

Solve the problems below by using the formula in getting the volume of a rectangular solid.

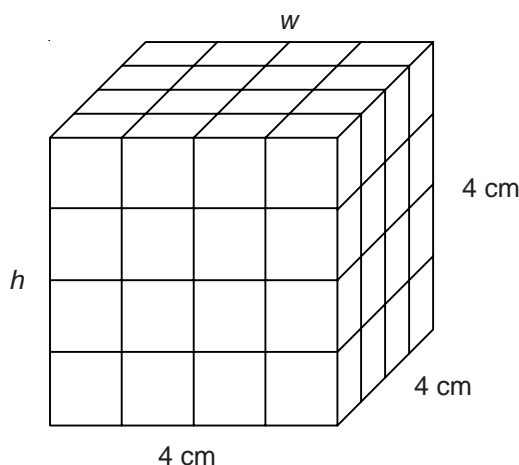
1. A rectangular block is 5 cm long, 4 cm wide and 3 cm high. Find its volume.
2. Tina bought a rectangular box of biscuits from the supermarket. The rectangular box was 12 cm long, 8 cm wide and 4 cm high. Find its volume.

Compare your answers with those in the *Answer Key* on page 32.



## Let's Learn

We know that the cube is a special rectangular solid that has equal dimensions. So how do we solve for the volume of a cube?



The figure above is a cube. Recall that in a cube, all the edges (length, width and height) are equal. If we compute for the volume of the figure above, with each edge ( $e$ ) equal to 4 cm, we will have:

$$V = e^3 = 4^3 \text{ cm} = 64 \text{ cm}^3$$

Were you able to get the same answer? If you did, that means you are a fast learner. If you did not, here is another example.

What is the volume of a box that has an edge measuring 12 inches?

Using the formula given above,

$$V = e^3 = 12^3 \text{ in.}^3 = 1728 \text{ in.}^3$$

How do you read  $\text{in.}^3$ ? If you said cubic inches, you are right.



### Let's Try This

Try to work on the following problems alone. Use the spaces provided for your computations.

1. A balikbayan box has an edge of 5 dm. What is the highest number of cubic decimeters that can be placed in the box?
  
  
  
  
  
  
  
  
  
  
2. Find the volume of a cubic wooden box that has an edge of 8 cm.

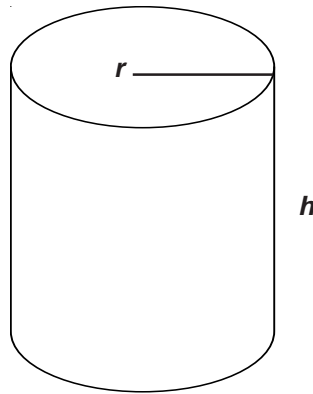
Compare your answers with those found in the *Answer Key* on page 32.





## Let's Learn

A circular cylinder is a spatial figure that has two circular bases and sides which are perpendicular to the bases (refer to the figure below).



Recall that in getting the volume of a solid, we first get the area of one base and then multiply it by the height. And since in the case of a circular cylinder we have a circular base, we get the area of the base using the formula

$$b = \pi r^2$$

Thus, following the formula for volume:

$$\begin{aligned}\text{Volume}_{\text{cylinder}} &= \text{Area of the base} \times \text{height} \\ &= b \times h = \pi r^2 h\end{aligned}$$

where  $b$  = area of the base

$$\pi = 3.14$$

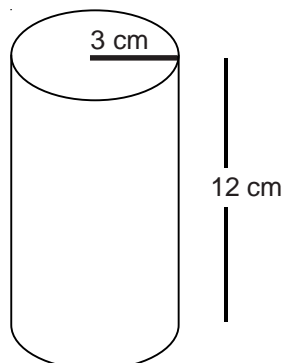
$r$  = radius of the base

$h$  = height

Now that you know the formula for the volume of a cylinder, let us try solving a few problems.

### Sample Problem 1:

A can of orange juice has a radius of 3 cm and a height of 12 cm. What is its volume?



**Solution:**

$r$  = radius of the base = 3 cm

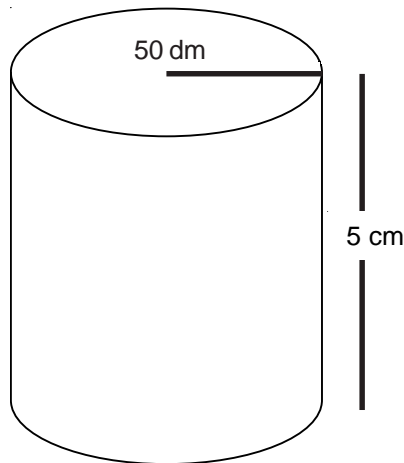
$h$  = height = 12 cm

$$\begin{aligned} V &= bh = \pi r^2 h \\ &= 3.14 \times (3 \text{ cm})^2 \times 12 \text{ cm} \\ &= 339.12 \text{ cm}^3 \end{aligned}$$

Were you able to get the same answer? If you did, that's very good! You are a fast learner. If you did not, do not be discouraged. Here is another example for you to solve:

**Sample Problem 2:**

Every morning Kiko and Pong fill their cylindrical tank with water. Their tank has a radius of 50 dm and a height of 200 dm. How much water do Kiko and Pong fetch every morning to fill their tank?



**Solution:**

$r$  = radius of the base = 5 dm

$h$  = height = 200 dm

$$\begin{aligned} v &= bh = \pi r^2 h \\ &= 3.14 \times (5 \text{ dm})^2 \times 200 \text{ dm} \\ &= 15700 \text{ dm}^3 \end{aligned}$$

Did you get the same answer? If you did, very good! If you did not, I suggest that you study the examples again and then answer the following exercises.



## Let's Try This

Solve the following problems by yourself. Write your computations in the spaces provided.

1. Candy was playing hide-and-seek with her friends. She decided to hide herself inside a cylindrical drum that had a radius of 500 cm and a height of 1500 cm. Find the volume of the drum in which Candy hid herself.
2. Kris brought a sand bucket to the beach. The cylindrical bucket has a radius of 2 dm and a height of 3 dm. If Kris is to fill her bucket with sand, how much sand can the pail contain?

Compare your answers with those in the *Answer Key* on page 33.



## Let's Review

Solve the following problems. Write your computations in the spaces provided.

1. Find the volume of an aquarium that is 5 dm long, 20 dm wide and 3 dm high.
2. If a cylinder has a radius of 5 cm and a height of 12 cm, what is its volume?
3. Mang Jose is digging in his backyard to make a small pond for his pet fish. If the pond is to have an edge of 30 dm, how much water does Mang Jose need to fill the pond?

Compare your answers with those in the *Answer Key* on page 33.



## Let's See What You Have Learned

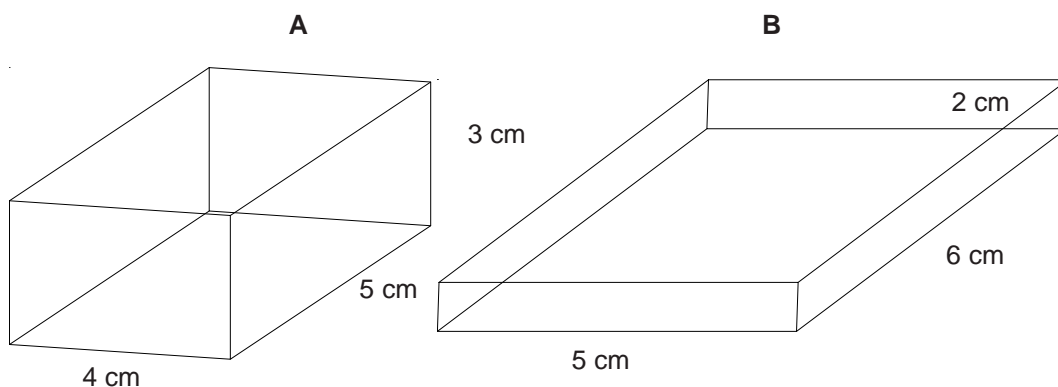
- A. Study the table below. Complete the table by computing the volumes of the given rectangular solids.

	1. A jar	2. A box	3. A tank
Length	14 cm	8 m	10 dm
Width	8 cm	6 m	8 dm
Height	7 cm	4 m	12 dm
Volume	_____	_____	_____

- B. Analyze and solve the following problems.

1. If a pitcher has a base area of  $15.7 \text{ cm}^2$  and a height of 5 cm, how much water can it contain?
2. A water tank is cylindrical. The radius of the base is 5 meters and the height is 10 meters. Find the volume of the tank.
3. Kuya Bong made a metal box for his tools. The box he made is 15 cm wide, 20 cm long and 25 cm high. What is the volume of the box?

4. Look at the two boxes below. Find out which box has a smaller volume.



Volume of Box A: \_\_\_\_\_

Volume of Box B: \_\_\_\_\_

5. Find the volume of each figure described:
- A cube with an edge of 8 cm
  - A cylinder with a radius of 7 cm and a height of 6 cm

Compare your answers with those in the *Answer Key* on page 33. Did you get a perfect score? If you did, that's very good. If you did not, don't worry. Just review the parts of the lesson you did not understand very well before you move on to Lesson 3.



## Let's Remember

- ◆ You use the formula  $\text{volume} = \text{base area} \times \text{height} = \text{length} \times \text{width} \times \text{height}$  to compute the volume of rectangular solids.
- ◆ You use the formula  $\text{volume} = (\text{edge})^3$  in finding the volume of a cube.
- ◆ In the case of a cylinder, you use the formula  $\text{volume} = \text{base area} \times \text{height} = \pi r^2 h$ , where  $\pi = 3.14$  and  $r$  is the radius.
- ◆ We have associated volume with capacity, so whenever you get the volume of a solid, you are actually measuring the amount of matter that solid can hold.

## Indigenous Measures of Volume

Have you ever wondered how things were measured in the past when there were still no standard units of measurement? Can you imagine just how people were able to build houses and other structures without knowing what meters are? How were kerosene, oil and other liquids measured and sold at that time? You will find the answers to these questions in this lesson.

In this lesson, you will learn about some indigenous or native measures of volume. These measures are termed **indigenous** because they are used only here in our country. This lesson will also enable you to compare measuring instruments used in the past with those used at present. You will also learn the advantages and disadvantages of using indigenous measures. Lastly, this lesson will help you solve problems that are related to ratio and volume.

After studying this lesson, you should be able to:

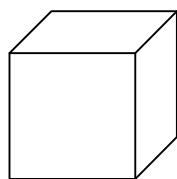
- ◆ use indigenous measures of volume when standard units of measurement are not available; and
- ◆ solve problems related to ratios and volumes.



### Let's Learn

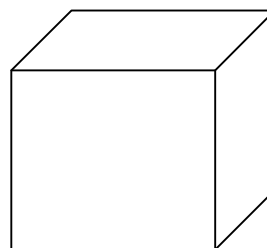
Aling Sela has a *sari-sari* store. She always tells her customers that selling liquids like oil and kerosene was very hard in the past because back then there were still no standard units of measure. Only the *dangkal* and *dipa* were used for measuring length. For measuring items like rice, corn and other cereals, the *ganta*, *litro* and *ochava* were used. Have you heard of similar stories from your parents? The *ganta* and the *litro* were made of wood while the *ochava* or *chupa* was an empty can of milk.

Now that we have standard units of measure, rice, corn and other cereals are sold by the kilogram. One *ganta* of rice is roughly 2 kilograms.



**Litro**

Litro is  $\frac{1}{3}$  of a ganta.



**Ganta**

Look at the indigenous measures of volume again. If a litro is  $\frac{1}{3}$  of a ganta, how many litros are there in one ganta? If you say 3 litros, then you are right! Our grandparents would usually express it in Spanish as *tres litros*.

You could probably ask your grandparents about other units of length and volume which our great-grandparents have used in the past.



## Let's Try This

A. How are the items below measured?

Item	In the Past	At Present
1. rice		
2. salt		
3. palay		
4. coconut oil		
5. kerosene		

B. Write the best unit for measuring the volume of the following items.

1. balikbayan box
  
  
  
  
  
  
  
2. gasoline
  
  
  
  
  
  
  
3. swimming pool
  
  
  
  
  
  
  
4. aquarium
  
  
  
  
  
  
  
5. shoe box

Compare your answers with those in the *Answer Key* on pages 33 and 34.





## Let's Think About This

The ingenuity of the early Filipinos should be appreciated especially by the younger generation. Their resourcefulness and initiative contributed a lot to the kind of life they had. The use of *dipa*, *dangkal*, *ganta* and other measures shows us how resourceful our forefathers were.

Even in the early stages of our history, Filipinos already engaged in trade, which was known as the barter system. They exchange goods for other goods with no money involved. Trade flourished even with the use of indigenous measures of volume.

Today, even though we already have standard units of measure, some people who live in places where there are no weighing scales still use the indigenous system of measures. They still use biscuit cans for measuring amounts of palay. They use *lapad* for measuring oil. They use the *takal* for selling salt, mungo and corn.

But what do you think are the disadvantages of using indigenous measures? If you say that these units are not accurate and measurements based on these units are not precise, then you are right. If one uses an indigenous measure, there are more chances of making mistakes because the measurements are not accurate and precise.



## Let's See What You Have Learned

Name some indigenous measures of volume. Would you recommend using these measures? Why? Why not?

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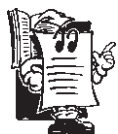
Compare your answers with those in the *Answer Key* on page 34. If you got a perfect score, that's very good. If you did not, that's okay. Just review the parts of the lesson you did not understand very well before you move on to the next part of the module.



## Let's Remember

Before standard units of measurement were developed, Filipinos used indigenous measures for determining mass, volume and length. The ganta, litro and ochava or chupa were the measures of volume.

You have now reached the end of the module. Congratulations! Did you enjoy studying this module? Did you learn a lot from it? The following is a summary of its main points to help you remember them better.



## Let's Sum Up

This module tells us that:

- ◆ Volume is the amount of space any form of solid or liquid matter occupies.
- ◆ Volume is expressed in cubic units, like  $\text{cm}^3$ ,  $\text{m}^3$ , mL, etc. in the metric system and in liquid measurements like pint, quart, fl. oz. etc.
- ◆ The following formulas are used in computing the volume of different spatial figures:
  - Rectangular solid:  $V = b \times h = l \times w \times h$
  - Cube:  $V = e^3$  where  $e$  is the edge of the cube
  - Cylinder:  $V = b \times h = \pi r^2 h$   
where  $\pi = 3.14$  and  $r$  is the radius
- ◆ Indigenous or native measures of volume include the ganta, litro and ochova or chupa.



## What Have You Learned?

A. Write your answers in the spaces provided.

1. Write three examples of indigenous measures of volume and give an example of what they measure.

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2. What are the advantages and disadvantages of using these indigenous measures?

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B. Solve the following problems and include the appropriate units of measure.

1. a. Lynne is making a papier-mâché box for her jewelry. The box she is making has a width of 4 dm, a length of 6 dm and a height of 2 dm. What is the volume of the box that Lynne is making?

- b. What will be the volume of the box if Lynne decides to double the height of the box?

2. Rico and his friends are playing Monopoly. They used two dice, each with an edge of 2 cm. What is the combined volume of the two dice?

3. Aling Sita is selling canned sardines. Each can has a radius of 4 cm and a height of 10 cm. If Aling Sita is selling 30 cans of sardines, what is the combined volume of all the cans of sardines?
  
4.
  - a. Dino bought a block of wood for his project in school. The wood has a width of 10 dm, a length of 10 dm and a height of 5 dm. What is the volume of the wood?
  
  - b. If Dino only needs to make a cylinder that has a radius of 4 dm and a height of 5 dm, how much of the wood will be left unused?
  
5. What is the difference between the volume of a box that is 2 cm wide, 3 cm long and 5 cm high, and a cylinder that has a radius of 2 cm and a height of 5 cm?

Compare your answers with those in the *Answer Key* on page 34.

If you got a score of:

- 0 – 4 You should study the whole module again.
- 5 – 7 Good! Just review the parts of the module you did not understand very well.
- 8 – 9 Very good! You learned a lot from this module. You are now ready for the next module.



## Answer Key

### A. Let's See What You Already Know (*pages 2–4*)

- A.
1. cubic centimeters
  2. cubic decimeters
  3. cubic centimeters
  4. cubic millimeters
- B.
1. 36 cubic centimeters
  2. 112 cubic centimeters
  3. 401.92 cubic centimeters
  4. 706.5 cubic centimeters
  5. 125 cubic millimeters
- C.
1.  $216 \text{ cm}^3$
  2.  $960 \text{ cm}^3$
  3.  $100.48 \text{ cm}^3$
  4.  $2034.72 \text{ cm}^3$
  5.  $72 \text{ m}^3$

### B. Lesson 1

*Let's Try This (page 9)*

1. **STEP 1** The conversion factor needed is  $1 \text{ dm}^3 = 1000 \text{ cm}^3$
- STEP 2** The conversion factor when expressed as a ratio is  $\frac{1000 \text{ cm}^3}{1 \text{ dm}^3}$ .
- STEP 3** We **multiply**  $5 \text{ dm}^3$  by the conversion factor in ratio form to compute for the answer.

$$5 \text{ dm}^3 \times \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} = 5000 \text{ cm}^3$$

2. ♦  $1 \text{ L} = 1000 \text{ cm}^3$ 
  - ♦  $\frac{1 \text{ L}}{1000 \text{ cm}^3}$
  - ♦  $\frac{1}{\cancel{1000 \text{ cm}^3}} \times \frac{1 \text{ L}}{\cancel{1000 \text{ cm}^3}} = 1 \text{ L}$
3. ♦  $1 \text{ gallon} = 4 \text{ quarts}$ 
  - ♦  $\frac{1 \text{ gal.}}{4 \text{ qt.}}$
  - ♦  $\frac{2 \cancel{\text{quarts}}}{4 \cancel{\text{quarts}}} \times \frac{1 \text{ gal.}}{4 \cancel{\text{quarts}}} = \frac{2}{4} \text{ or } \frac{1}{2} \text{ gal.}$

*Let's See What You Have Learned (pages 10-11)*

1. • conversion factor:  $1000 \text{ cm}^3 = 1000 \text{ mL}$ 
  - conversion ratio:  $1000 \text{ cm}^3/1000 \text{ mL}$
  - computation for the answer:  $10 \cancel{\text{mL}} \times \frac{1}{\cancel{1000 \text{ mL}}} \times \frac{1000 \text{ cm}^3}{\cancel{1000 \text{ mL}}} = 10 \text{ mL}$
2. • conversion factor:  $1000 \text{ mm}^3 = 1 \text{ cm}^3$ 
  - conversion ratio:  $1000 \text{ mm}^3/1 \text{ cm}^3$
  - computation for the answer:  $2 \cancel{\text{cm}^3} \times \frac{1000 \text{ mm}^3}{1 \cancel{\text{cm}^3}} = 2000 \text{ mm}^3$
3. • conversion factor:  $1 \text{ L} = 1 \text{ dm}^3$ 
  - conversion ratio:  $1 \text{ dm}^3/1 \text{ L}$
  - computation for the answer:  $10 \cancel{\text{L}} \times \frac{1 \text{ dm}^3}{1 \cancel{\text{L}}} = 10 \text{ dm}^3$
4. • conversion factor:  $1000 \text{ cm}^3 = 1 \text{ dm}^3$ 
  - conversion ratio:  $1000 \text{ cm}^3/1 \text{ dm}^3$
  - computation for the answer:  $4 \cancel{\text{dm}^3} \times \frac{1000 \text{ cm}^3}{1 \cancel{\text{dm}^3}} = 4000 \text{ cm}^3$

5.
  - conversion factor:  $1000 \text{ dm}^3 = 1 \text{ m}^3$
  - conversion ratio:  $1 \text{ m}^3/1000 \text{ dm}^3$
  - computation for the answer:  $\overset{3}{\cancel{3000 \text{ dm}^3}} \times \frac{1 \text{ m}^3}{\cancel{1000 \text{ dm}^3}} = 3 \text{ m}^3$
6.
  - conversion factor: 2 pints = 1 quart
  - conversion ratio: 1 quart/2 pints
  - computation for the answer:  $\overset{8}{\cancel{16 \text{ pints}}} \times \frac{1 \text{ quart}}{\cancel{2 \text{ pints}}} = 8 \text{ quarts}$
7.
  - conversion factor: 2 pints = 1 quart
  - conversion ratio: 2 pints/1 quart
  - computation for the answer:  $\cancel{2 \text{ quart}} \times \frac{2 \text{ pints}}{\cancel{1 \text{ quart}}} = 4 \text{ quarts}$
8.
  - conversion factor: 4 quarts = 1 gallon
  - conversion ratio: 4 quarts/1 gallon
  - computation for the answer:  $\cancel{2 \text{ gal.}} \times \frac{4 \text{ quarts}}{\cancel{1 \text{ gal.}}} = 8 \text{ quarts}$
9.
  - conversion factor: 8 fl. oz. = 1 cup
  - conversion ratio: 1 cup/8 fl. oz.
  - computation for the answer:  $\overset{4}{\cancel{32 \text{ fl. oz.}}} \times \frac{1 \text{ cup}}{\cancel{8 \text{ fl. oz.}}} = 4 \text{ cups}$
10.
  - conversion factor: 1 L = 0.2642 gallons
  - conversion ratio: 1 L/0.2642 gallons
  - computation for the answer:  $\overset{2}{\cancel{0.5284 \text{ gal.}}} \times \frac{1 \text{ L}}{\cancel{0.2642 \text{ gal.}}} = 2 \text{ L}$

## C. Lesson 2

*Let's Review (page 15)*

1. **Solution:**

Since we are already given the length, width and height, we can substitute the values in the formula.

$$\begin{aligned}V &= l \times w \times h \\&= 5 \text{ cm} \times 4 \text{ cm} \times 3 \text{ cm} \\&= 60 \text{ cm}^3\end{aligned}$$

2. **Solution:**

In the problem, we are already given the length, width and height of the rectangular box so we substitute the values in the formula.

$$\begin{aligned}V &= l \times w \times h \\&= 12 \text{ cm} \times 8 \text{ cm} \times 4 \text{ cm} = 384 \text{ cm}^3\end{aligned}$$

*Let's Try This (page 16)*

1. We are already given the edge so we will just substitute it in the formula.

$$V = e^3 = 5^3 \text{ dm}^3 = 125 \text{ dm}^3$$

2. Since we already know the measure of one edge, we can already compute for the volume.

$$V = e^3 = 8^3 \text{ cm}^3 = 512 \text{ cm}^3$$

*Let's Try This (page 19)*

1. In this item we are asked to find the volume of the cylindrical drum inside which Candy hid herself. From the problem, we know that the drum has a radius of 500 cm and a height of 1500 cm. Using the formula in finding the volume of a cylinder, we substitute the values given to us. That is,

$$\begin{aligned}V &= bh = \pi r^2 h = 3.14 \times (500 \text{ cm})^2 \times 1500 \text{ cm} \\&= 3.14 \times 250000 \text{ cm}^2 \times 1500 \text{ cm} \\&= 1177500000 \text{ cm}^3\end{aligned}$$

2. We are told that Kris's sand bucket is a cylinder and has a radius of 2 dm and a height of 3 dm. Computing now for the volume of the pail,

$$V = bh = \pi r^2 h = 3.14 \times (2 \text{ dm})^2 \times 3 \text{ dm} = 37.68 \text{ dm}^3$$



*Let's Review (page 20)*

1.  $V = l \times w \times h = 5 \text{ dm} \times 20 \text{ dm} \times 3 \text{ dm} = 300 \text{ dm}^3$
2.  $V = \pi r^2 h = 3.14 \times (5 \text{ cm})^2 \times 12 \text{ cm} = 942 \text{ cm}^3$
3.  $V = e^3 = (30 \text{ dm})^3 = 27000 \text{ dm}^3$

*Let's See What You Have Learned (pages 21–22)*

A. Use the formula  $V = l \times w \times h$  for each item.

1.  $784 \text{ cm}^3$
2.  $192 \text{ m}^3$
3.  $960 \text{ dm}^3$
4.  $25 \text{ m}^3$

- B.
1.  $V = b \times h$   
 $= 15.7 \text{ cm}^2 \times 5 \text{ cm}$   
 $= 78.5 \text{ cm}^3$
  2.  $V = \pi r^2 h$   
 $= 3.14 \times (5 \text{ m})^2 \times 10 \text{ m}$   
 $= 785 \text{ m}^3$
  3.  $V = l \times w \times h$   
 $= 15 \text{ cm} \times 20 \text{ cm} \times 25 \text{ cm} = 7500 \text{ cm}^3$
  4. They have the same volume because  
Volume of box A =  $3 \text{ cm} \times 5 \text{ cm} \times 4 \text{ cm} = 60 \text{ cm}^3$   
Volume of box B =  $6 \text{ cm} \times 5 \text{ cm} \times 2 \text{ cm} = 60 \text{ cm}^3$
  5. a.  $V = e^3 = (8 \text{ cm})^3 = 512 \text{ cm}^3$   
b.  $V = \pi r^2 h = 3.14 \times (7 \text{ cm})^2 \times 6 \text{ cm} = 923.16 \text{ cm}^3$

### D. Lesson 3

*Let's Try This (page 24)*

A.	Item	In the Past	At Present
1.	rice	ganta	kilogram
2.	salt	takal	kilogram
3.	palay	cans or sacks	kilogram
4.	coconut oil	bottles	liters
5.	kerosene	bottles	liters

- B. 1. cubic centimeter or cubic meter
2. liter
3. cubic meter
4. cubic centimeter
5. cubic centimeter

*Let's See What You Have Learned (page 25)*

Answers will vary. Have your answer checked by your Instructional Manager or Facilitator.

### **E. What Have You Learned?** (pages 27–28)

- A. 1. The answers may vary. Choose three from the following:
  - ganta — rice, corn
  - litro — rice, corn
  - chupa — cereals
  - takal — mongo, salt
  - lapad — oil, vinegar
2. The advantage of using indigenous measures is that it enables us to measure the volume of different things in the absence of standard units of measurement. On the other hand, the disadvantage of using indigenous measures is that each measure differs in every locality, which may lead to big errors and/or differences in measurements.
- B. 1. a.  $V = l \times w \times h = 6 \text{ dm} \times 4 \text{ dm} \times 2 \text{ dm} = 48 \text{ dm}^3$   
 b.  $V = l \times w \times h = 6 \text{ dm} \times 4 \text{ dm} \times 4 \text{ dm} = 96 \text{ dm}^3$
2. Volume of one die  $= e^3 = (2 \text{ cm})^3 = 8 \text{ cm}^3$   
 Combined volume  $= 2 \times 8 \text{ cm}^3 = 16 \text{ cm}^3$
3. Volume of a can of sardines  $= \pi r^2 h = 3.14 \times (4 \text{ cm})^2 \times 10 \text{ cm}$   
 $= 502.4 \text{ cm}^3$   
 Combined volume of cans of sardines  $= 30 \times 502.4 \text{ cm}^3 = 1507.2 \text{ cm}^3$
4. a.  $V_{\text{box}} = 10 \text{ dm} \times 10 \text{ dm} \times 5 \text{ dm} = 500 \text{ dm}^3$   
 b.  $V_{\text{cylinder}} = 3.14 \times (4 \text{ dm})^2 \times 5 \text{ dm} = 251.2 \text{ dm}^3$   
 $V_{\text{left unused}} = 500 \text{ dm}^3 - 251.2 \text{ dm}^3 = 248.8 \text{ dm}^3$
5.  $V_{\text{box}} = 2 \text{ cm} \times 3 \text{ cm} \times 5 \text{ cm} = 30 \text{ cm}^3$   
 $V_{\text{cylinder}} = 3.14 \times (2 \text{ cm})^2 \times 5 \text{ cm} = 62.8 \text{ cm}^3$   
 Difference  $= V_{\text{cylinder}} - V_{\text{box}} = 62.8 \text{ cm}^3 - 30 \text{ cm}^3 = 32.8 \text{ cm}^3$



## Glossary

**Cube** A prism whose faces are all squares.

**Cylinder** A solid figure with two bases which are circular, parallel and congruent.

**Edge** The border or side; part of a figure that is farthest from the middle of the figure.

**Radius** The distance from the center of a circle to a point on the circle.

**Rectangular solid** A figure that has three dimensions, namely length, width and height, and adjacent sides that are perpendicular to each other.

**Volume** A number given in cubic units that indicates the size of the space inside a solid.