ACTIVITY 5A / MATTER IN YOUR WORLD

GROUP ACTIVITY

MATERIALS

safety goggles
apron
a collection of different kinds of matter that are commonly found at school, at home, and in the workplace

CAUTION!

If these samples are in closed containers, do not open them and do not taste them, since they might be toxic. If you wish to smell any of these items, be sure to use the correct technique.

PROCEDURE

1. Put on your safety goggles and apron.
2. With three or four other students, examine the samples of matter your teacher has prepared.
3. Identify the samples of matter.
4. Work together to classify the samples into groups. Each sample in one group should have something in common with the other samples in that group. Agree on a name for each of the groups.
5. After you have finished examining and classifying the samples, wash your hands.
6. Prepare a chart in your learning journal so that you will have a record of your classification system. For example, you might list the groups in one column. In the second column, you might describe what the items in each group have in common.
7. Share your classification system with other groups of students in your class. Be prepared to describe the reasons behind your classification system.

DISCUSSION

1. Why was it necessary to wear safety goggles and an apron for this activity?
2. How was your group's classification system similar to those of the other groups in your class? How was it different?
3. Would your classification system work for all samples of matter? Why or why not? ❖

5.1 MEASURING

In Activity 5A, you examined many kinds of **matter**. They are just a small sample of all the matter in the world. Wherever you look, whether in a science classroom, your home, or outside, there are millions of different kinds of matter. Different as they are, all kinds of matter have two things in common: they all have mass, and they all have volume.

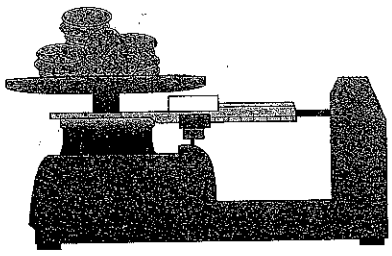


FIGURE 5.1
You can measure mass in grams by using a centigram balance.

MASS

The amount of matter in an object is called its **mass**. When you buy a package of crackers or a bag of raisins, you are buying a certain mass of the product (Figure 5.1). Small masses, such as the mass of a package of crackers, are often measured in grams. Larger masses, such as the

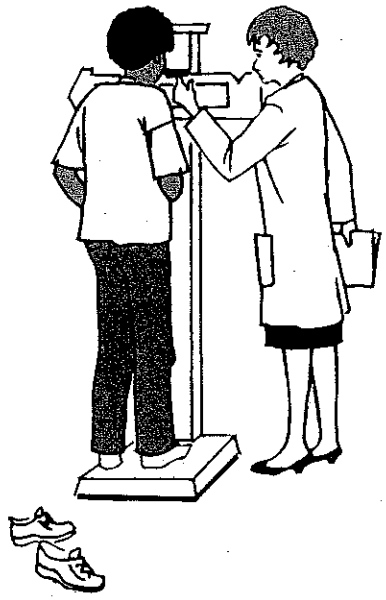


FIGURE 5.2
Balances like this one give masses in kilograms.

mass of a person, are often measured in kilograms ("kilo" means 1000) (Figure 5.2). Very small masses, such as amounts of certain medicines, are measured in milligrams ("milli" means one-thousandth, or 1/1(

1000 mg = 1 g
1000 g = 1 kg

When you measure the mass of an object on a balance or a scale, you are measuring it directly. This is an example of **direct measurement**. When you use direct measurement, you need to have only the measuring device and the object you are measuring.

Sometimes you need more than one step to measure matter. For example, to find the mass of a sample of a liquid, you would first need to find the mass of a dry, empty container. Then you would pour the liquid into the container and find the mass of the container with the liquid in it. Finally, you would subtract the mass of the empty container from the mass of the container with the liquid in it. This is an example of **indirect measurement**.

ACTIVITY 5B / ESTIMATING AND MEASURING MASS

In this activity, you will estimate the mass of several samples of matter and then measure their mass, using direct measurement.

MATERIALS

Parts I and II
safety goggles
apron
centigram balance

Part I
several solid objects

Part II
dry beaker
liquid sample A

PART I Mass of Solids

PROCEDURE

1. In your notebook, prepare a data table similar to Table 5.1. List the objects in the first column of your table.
2. Put on your safety goggles and apron.
3. Estimate the mass of the first object and record your estimate in your table.
4. Use the centigram balance to measure the mass of the object. Record the measured value in your table.
5. Repeat steps 3 and 4 for the other objects.

DISCUSSION

1. (a) Which of your estimates were most accurate?
   (b) Explain how your results in steps 3 and 4 could help you make more accurate estimates in step 5.
2. In your notebook, list several items at the grocery store that are purchased by mass.
3. Estimate the mass of
   (a) an apple,
   (b) your science textbook,
   (c) a penny,
   (d) any other small object (choose your own).

Object	Estimated mass (in grams)	Measured mass (to the nearest 0.01 gram)
1.		
2.		
3.		
4.		

TABLE 5.1
Sample Data Table for Activity 5B

4. What is your mass in kilograms?
5. Estimate approximately how many kilograms of food you eat in one week. In your notebook, show how you calculated this amount.
6. Cindy has a jar full of quarters. Suggest a method that she could use to estimate the number of quarters in the jar.

PART II Mass of a Liquid

PROCEDURE

1. Estimate the mass of liquid sample A and record your estimate in your notebook.
2. Plan how you could measure the mass of the sample. In your notebook, write the steps of the procedure. (Hint: You will need four steps.)
3. Carry out your procedure to determine the mass of the sample.

DISCUSSION

1. How close was your estimate to your measured value?
2. Estimate the mass of
   (a) a glass of water,
   (b) 1 L of milk,
   (c) a bathtub full of water.
3. Why is it important to be able to measure mass accurately?
4. Explain why accurate measurement of mass is important to
   (a) a shopper buying apples in the supermarket,
   (b) a pharmacist filling prescriptions in a drugstore,
   (c) a scientist working in a laboratory. ❖

VOLUME OF LIQUIDS

When you want to measure the space that an object occupies, you measure its volume. You also measure volume when you measure the space inside a container, such as a spoon, a glass, a room, or a swimming pool. **Volume** is the amount of space that a sample of matter occupies.

The basic unit for measuring the volume of liquids is the litre. Products such as those shown in Figure 5.3 are measured in litres and millilitres.

1000 mL = 1 L

You can measure small volumes of a liquid directly in a graduated cylinder. A graduated cylinder is a tall, narrow container with a scale of numbers on the side (Figure 5.4). To measure the volume of a liquid in a graduated cylinder, you read the scale of numbers. You must be sure to read from the bottom of the curved surface of the liquid, called the **meniscus**. For an accurate measurement, you should have your eye at this level, as shown in Figure 5.5.

FIGURE 5.3
A liquid product is measured by its volume, which is shown on the label. Check out some household products. Which are measured by mass? Which are measured by volume?

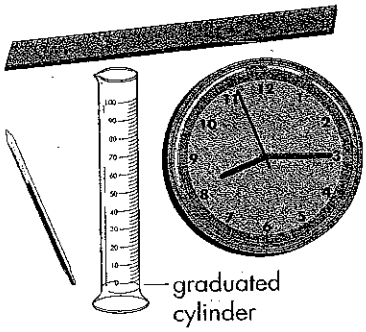


FIGURE 5.4
A graduated cylinder, like other measuring devices, has a scale of numbers printed on it. Not every number in the scale is written on the cylinder. How do you determine the values between the marks?

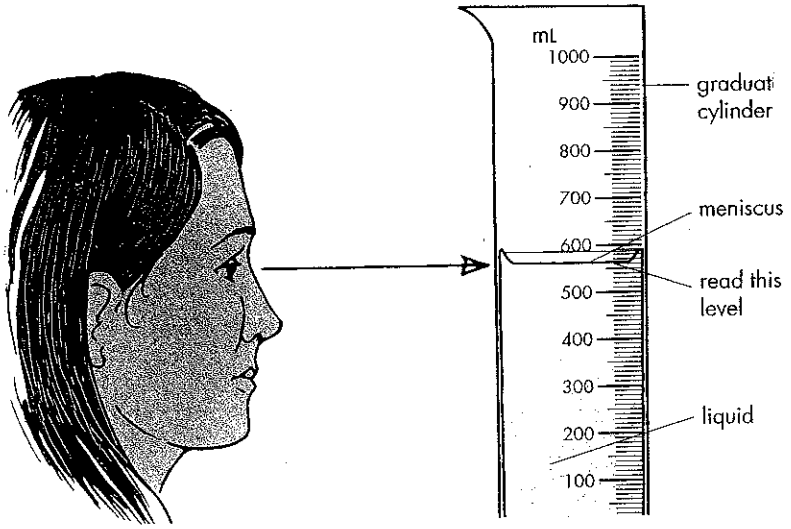


FIGURE 5.5
Reading the volume of a liquid accurately

ACTIVITY 5C / MEASURING THE VOLUME OF LIQUIDS

In this activity, you will use a graduated cylinder to directly measure the volume of several liquid samples.

MATERIALS

safety goggles
apron
several samples of coloured liquids, labelled A, B, C, and so on.
graduated cylinders of various sizes

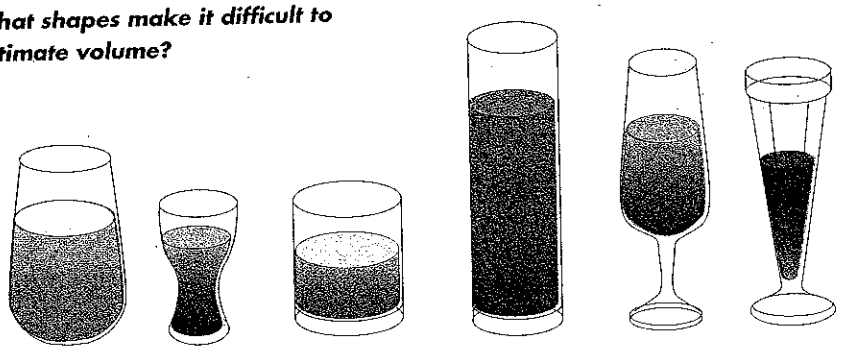
PROCEDURE

1. Prepare a table in your notebook to record the estimated and measured volumes of the liquid samples. List the samples in the first column of your table. Record your estimated volumes in the second column and the measured volumes in the third column.
2. Put on your safety goggles and apron.
3. Estimate the volume of each sample and record your estimate in your table.
4. Use a graduated cylinder to measure the volumes. Remember to read at the bottom of the meniscus. Record the volumes in your table.

DISCUSSION

1. (a) How close were your estimates to the actual volumes of the liquids?
   (b) For each of the various samples, state which size of graduated cylinder gives a more accurate measurement of volume. Explain your answer.
2. State the unit of measurement (mL, L) you would use to measure the volume of each of the following examples:
   (a) the air in your lungs
   (b) a soft drink in a bottle
   (c) shampoo in a squeezable tube
   (d) the gasoline in a car
3. Is measuring the volume of a liquid using a graduated cylinder an example of direct or indirect measurement? Explain your answer.
4. (a) Estimate the volume of water you use for all purposes (drinking, washing, and so on) in one day.
   (b) Using your estimate in (a), estimate how much water is used in one day by all the people in your home, in your school, in your town or city, and in all of Canada.
   (c) Suggest ways in which people could conserve water. ❖

FIGURE 5.6
What shapes make it difficult to estimate volume?



EXTENSION

■ Your teacher will provide a variety of drinking glasses like the ones in Figure 5.6. Estimate the volume of liquid that each could hold. Then use a graduated cylinder to check your estimates.

VOLUME OF SOLIDS

To calculate the volume of a solid object such as a box, multiply the length by the width by the height of the box:

volume = length × width × height

If all the sides are measured in centimetres, the volume will be in cubic centimetres (cm^3). If all the sides are measured in metres, the volume will be in cubic metres (m^3). For the small cubes shown in Figure 5.7, it is most convenient to measure the sides in centimetres. Here is how to calculate the volume in cubic centimetres:

volume = 1 cm × 1 cm × 1 cm = 1 cm^3

You cannot measure the length, width, and height of an irregularly shaped object such as a spoon or a piece of rock. You cannot directly measure its volume in a graduated cylinder either. For an object such as this, you must use indirect measurement.

One type of indirect measurement you could use is called **displacement of water**. With displacement of water, you measure a volume of water and then place the object to be measured in the water (Figure 5.8). You measure the volume of liquid again and subtract the original volume of the water. This difference is equal to the volume of the object.

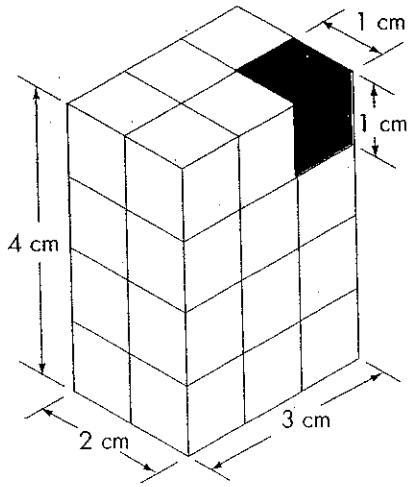


FIGURE 5.7
Count the number of 1 cm^3 blocks in the larger block. Then calculate the volume of the large block in cubic centimetres. Are the two numbers the same?

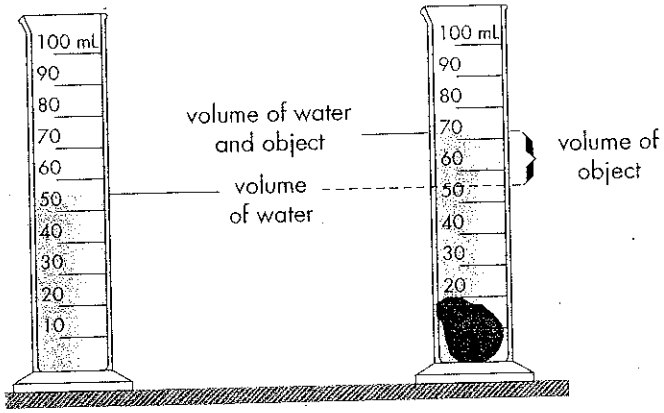


FIGURE 5.8 ◀
Measuring volume by displacement of water

ACTIVITY 5D / MEASURING THE VOLUME OF SOLID OBJECTS

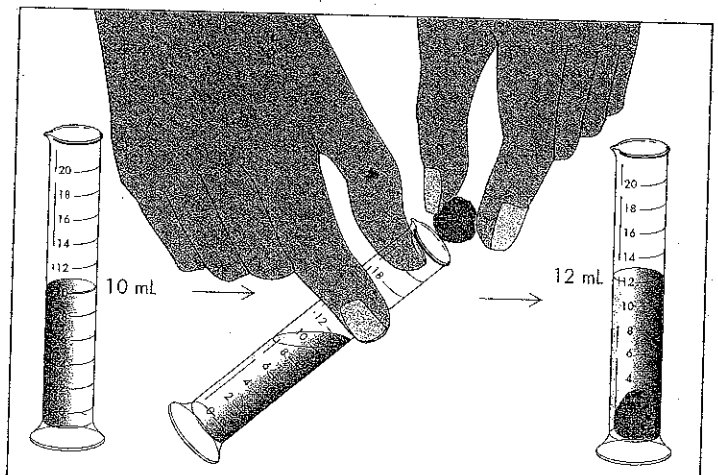
In this activity, you will use displacement of water to find the volume of irregularly shaped objects.

MATERIALS

safety goggles
apron
water
graduated cylinder
small objects such as erasers, spoons, stones

PROCEDURE

1. Put on your safety goggles and apron.
2. Pour some water into a graduated cylinder and measure its volume. Record the volume in your notebook.
3. Tilt the graduated cylinder a little, and gently slide a small object into it (Figure 5.9). Do not allow any water to splash out. Any loss of water will cause an error in your results.
4. In your notebook, record the total volume of the object and the water in the cylinder. Calculate the volume of the solid object as shown in Figure 5.9.
5. Repeat steps 2 to 4 for the other objects.



Volume of object = volume of water + solid object − original volume of water
= 12 mL − 10 mL
= 2 mL

DISCUSSION

1. (a) Suppose you are asked to compare the volume of an eraser and the volume of a pencil that is the same length as the eraser. Which do you predict has the larger volume?
   (b) Describe how you could test your prediction.
2. Estimate the volume of
   (a) an orange,
   (b) a grape,
   (c) a cup of tea,
   (d) yourself.
3. Think of different everyday situations in which measurement of volume is important. In your notebook, describe two or more of these situations. ❖

FIGURE 5.9 ◀
Why should you slide the object gently into the graduated cylinder?

EXTENSION

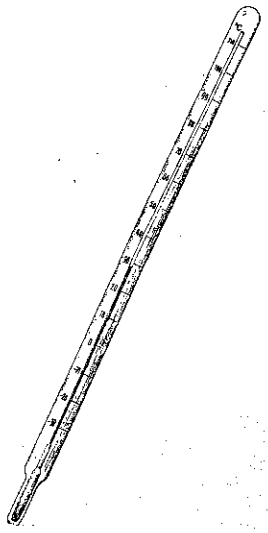
■ For a regularly shaped object such as a block of butter, determine the volume in two ways — by reading the volume marks on the package, and by displacement of water. Which method was more accurate?

TEMPERATURE

Temperature is a way of measuring how hot or how cold something is and of communicating that information. A "hot" cup of coffee is quite a different temperature from a "hot" bath, and both of those are hotter than the air on a "hot" day. A number scale makes it possible to give an accurate description.

A thermometer measures temperature. In a thermometer, the level of a small amount of liquid, usually mercury or alcohol, rises or falls in a narrow tube, depending on how hot or cold the liquid is. A scale of numbers is marked on the tube so that the position of the liquid can be described. One temperature scale was invented by Anders Celsius (1701–1744), a Swedish scientist. In this scale, 0°C (read as "zero degrees Celsius") is the temperature at which pure water freezes, and 100°C ("one hundred degrees Celsius") is the temperature at which pure water boils. Between these two temperatures, the scale is divided into 100 parts. The scale also extends above 100°C and below 0°C. Ordinary room temperature is usually around 20°C. A common type of laboratory thermometer is shown in Figure 5.10.

FIGURE 5.10
This thermometer is made of glass. Why should you handle it carefully?



ACTIVITY 5E / THE LABORATORY THERMOMETER

In this activity, you will observe and use a laboratory thermometer.

MATERIALS

laboratory thermometer
cold tap water

PROCEDURE

1. Examine the thermometer carefully. Draw a full-size diagram of the thermometer in the centre of a page of your notebook.
2. On your diagram, label:
   the liquid
   the bore (the narrow tube through which the liquid moves)
   the bulb (storage space for the liquid)
   the number scale
   0°C (freezing point of pure water at sea level)
   100°C (boiling point of pure water at sea level)
3. Look at the thermometer and record the temperature in your classroom in your notebook. Then put your thermometer into cold water from the tap. Record the temperature in your notebook.
4. (a) Wrap your hand gently around the middle of the thermometer and record what happens to the level of the liquid.
   (b) Wrap your hand gently around the bulb and describe what happens to the level of the liquid.
5. Label the temperature of the classroom and the temperature of the water on your drawing.

DISCUSSION

1. What do you think would happen if you put this thermometer into an oven at 300°C?
2. What do you think would happen if you placed the thermometer outside when the temperature is –70°C? ❖

SC 8___ ***DATE:_____***
NAME:_____

SECTION 5.1: "MEASURING"

****READ SECTION 5.1 ANSWER Q'S ON THIS SHEET IN POINT FORM**********

1.LIST 3 PLACES WHERE MATTER IS FOUND

2. WHAT 2 THINGS DOES ALL MATTER HAVE IN COMMON?

3. DEFINE MASS.

4. WHAT UNITS ARE SMALL MASSES MEASURED IN? LARGE MASSES?

5. DO THE FOLLOWING CONVERSIONS:

2000g=_____kg
200g=_____kg
_____g=5kg

6. DEFINE DIRECT MEASUREMENT OF MASS. WHAT 2 THINGS DO YOU NEED TO DIRECTLY MEASURE THE MASS OF SOME OBJECT?

7. DESCRIBE THE 3 STEPS INVOLVED IN CALCULATING THE MASS OF A LIQUID. WHAT IS THIS KIND OF MEASUREMENT CALLED?

8. DEFINE VOLUME. WHAT 2 UNITS ARE USED TO MEASURE VOLUME?

9. DO THE FOLLOWING CONVERSIONS.

1000ml=_____L
6000ml=_____L
_____ml=8L
500ml=_____L

10. HOW DO YOU MEASURE SMALL VOLUMES OF LIQUIDS?

11. DESCRIBE A GRADUATED CYLINDER.

12. WHAT'S A MENISCUS? WHERE DO YOU READ THE VOLUME FROM?

13. WHAT'S THE MATHEMATICAL FORMULA FOR MEASURING THE VOLUME OF A BOX? WHAT UNIT(S) ARE USED WHEN DISCUSSING THE VOLUME OF A BOX? WHAT'S THE VOLUME OF A BOX THAT HAS 2cm LONG SIDES?

14. WHY CAN'T YOU USE A MATHEMATICAL FORMULA TO CALCULATE THE VOLUME OF AN OBJECT LIKE A SPOON OR A ROCK?

15. DESCRIBE THE 3 STEPS INVOLVED IN USING "THE DISPLACEMENT OF WATER" TECHNIQUE TO MEASURE THE VOLUME OF AN IRREGULARLY SHAPED SOLID.

16. LOOK AT FIGURE 5.8 P.115. WHAT IS THE VOLUME OF THE ROCK?

17. DEFINE TEMPERATURE. WHAT INSTRUMENT IS USED TO MEASURE TEMPERATURE? WHAT TEMPERATURE SCALE IS USED IN CANADA?

18.AT WHAT TEMPERATURE DOES WATER FREEZE? BOIL? WHAT'S ROOM TEMPERATURE?