CHAPTER 4

Matter can be described using properties.

KEY IDEAS

- Matter can be described using observable properties.
- Matter can be described using measurable properties.
- Matter is anything that has mass and volume.

LEARNING TIP

As you read the first two paragraphs, try to answer the questions using what you already know.

Eulachons (or oolichans) are sometimes called candlefish because a dried eulachon can be burned like a candle. They are also called oilfish because their bodies are 20% oil by weight. For hundreds of years, many Aboriginal peoples have collected and used the oil—often called grease—from eulachons. How would you describe the eulachon grease in the photograph? Is it a solid or a liquid? What colour is it?

Aboriginal peoples use eulachon grease to season food, preserve fruit, and lubricate tools. They also use it as a medicine. They had practical knowledge of the chemical characteristics or properties of eulachon grease that allow it to be collected and used in these ways. Scientists explain the scientific principles behind people's working knowledge of things. In this chapter, you will learn how all matter—from eulachon grease to the air you breathe—can be described scientifically.

Properties of Matter

4.1

When you choose your clothes, your lunch, and even your toothpaste, you are making choices based on the properties of matter. A **property** is a characteristic that may help to identify a substance. You can observe properties using your five senses, or you can determine properties using simple tests and measurements.

LEARNING TIP

Before reading this section, "walk" through it and make a note of the headings and subheadings. Use these to take point form notes as you read.

Properties You Can Observe with Your Senses

You can use your five senses—sight, touch, hearing, smell, and taste—to observe matter (**Figure 1**).

Figure 1
Which senses would you use to describe the properties of an ice-cream sundae?

Some of the properties you can observe with your senses are summarized in **Table 1**.

Table 1 Properties Observed with the Senses

Property	Describing the property
colour	Is it black, white, colourless, red, blue, greenish-yellow …?
taste	Is it sweet, sour, salty, bitter …?
texture	Is it fine, coarse, smooth, gritty …?
odour	Is it odourless, spicy, sharp, burnt …?
lustre	Is it shiny, dull …?
clarity	Is it clear, cloudy, opaque, translucent …?

States of Matter

You can also use your five senses to observe whether a substance is a solid, a liquid, or a gas. These are called the **states** of matter. A substance may be found in all three states. For example, water can be found as a solid (ice), a liquid (water), or a gas (water vapour in the air), depending on the temperature. You can easily observe the state of a substance at room temperature.

TRY THIS: ***OBSERVE PROPERTIES***

Skills Focus: observing, communicating

Play "I spy" with a partner using the observable properties of matter. Use the format, "I spy something that is (pick a state) and is (pick one or more properties from **Table 1**) ..." For example, "I spy something that is a solid, and is blue and shiny. What is it?"

Check with your teacher before you taste anything other than your own lunch.

Properties You Can Measure

Some properties can be determined using simple tests and measurements. For example, you could put a substance in water to see if it dissolves. You could also put a variety of substances in water to see which ones float and which ones sink. Later in this unit, you will measure properties of matter using both of these tests.

LEARNING TIP

The key vocabulary words in this section are illustrated with photographs.

Melting and Boiling Points

One of the properties of matter that can be measured is the temperature at which a substance changes state. Most substances have two temperatures at which they change state.

The **melting point** of a substance is the temperature at which the solid form of the substance changes to a liquid (**Figure 2**). For example, water changes from solid ice to liquid water at 0°C. Thus, the melting point of solid water (ice) is 0°C.

Figure 2
The melting point of ice is 0°C.

The **freezing point** of a substance is the temperature at which the liquid form changes to a solid. If water is cooled, it will freeze at 0°C. The freezing point of a substance is the same as its melting point.

The **boiling point** of a substance is the temperature at which the liquid form of the substance changes to a gas. For example, at the boiling point of water, 100°C, liquid water changes to water vapour, a gas (**Figure 3**).

Figure 3
The boiling point of water is 100°C.

Melting point and boiling point are properties that can be used to help identify a substance.

CHECK YOUR *UNDERSTANDING*

1. Make a chart, like the one below, that lists properties you can observe using your senses and properties you can observe using simple measurements.

1. Using your senses	Using simple measurements

2. Describe what happens to the state of a substance when it reaches
a) its melting point
b) its freezing point
c) its boiling point

4.2 Conduct an Investigation

SKILLS MENU

- ○ Questioning
- ● Predicting
- ● Hypothesizing
- ○ Designing Experiments
- ○ Controlling Variables
- ○ Creating Models
- ● Observing
- ● Measuring
- ○ Classifying
- ○ Inferring
- ● Interpreting Data
- ● Communicating

LEARNING TIP

To review line graphs and writing a hypothesis see the Skills Handbook sections "Graphing Data" and "Hypothesizing."

Ice to Water to Steam

Suppose that you leave an ice cube at room temperature (20°C). Heat from the surrounding air will melt the ice and turn it into water. Then, if you heat the water enough, it will boil and change into water vapour. In this investigation, you will explore what happens to the temperature of water as it changes state (**Figure 1**).

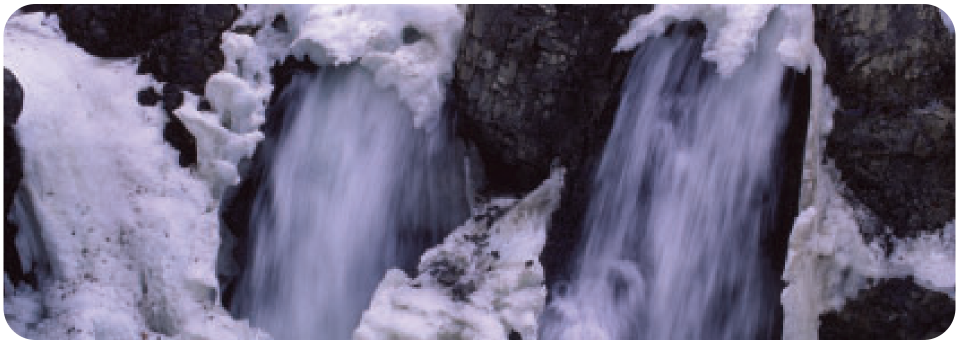
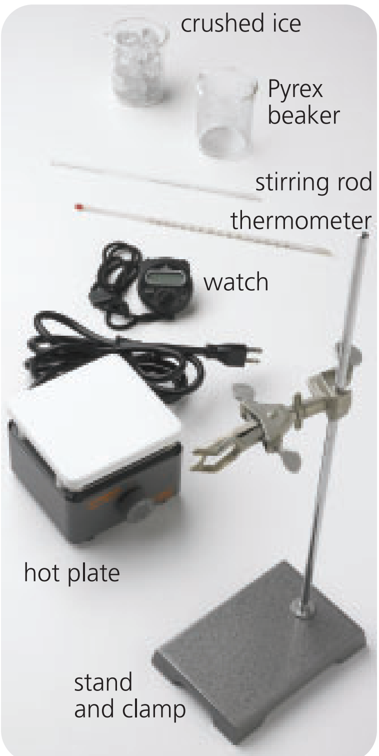


Figure 1

In winter, you can easily find water in all three states. Look at this photo of Pine Creek Falls in northern British Columbia. Solid water is found as ice and snow, liquid water runs under the ice, and some gaseous water (water vapour or steam) is always present in the air.



Question

What will happen to the temperature of water as it changes state? Make a prediction by drawing a line graph of temperature versus time. Put temperature on the y-axis and time on the x-axis. Use your graph to predict what you think will happen to the temperature of water as it is heated from ice to liquid to water vapour. Make sure that your graph includes any important temperature values.

Hypothesis

Write a hypothesis based on your prediction. Use the form "If … then …."

Materials

- 250 mL crushed ice
- 250-mL Pyrex beaker
- stirring rod
- thermometer
- watch or clock that displays minutes and seconds
- hot plate
- stand and clamp apparatus

Procedure

Part 1: Ice to Water

1 In your notebook, draw a table like the one below.

Data Table for Investigation 4.2

Time (min)	Temperature (°C)	Other observations
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

Thermometers break easily. Remove the thermometer from the beaker before stirring the ice. Do not let the thermometer touch the bottom of the beaker. Do not leave the thermometer in the beaker, as it may be too heavy and tip the beaker.

2 Place the crushed ice in the beaker. Stir the ice with the stirring rod. Place the thermometer in the beaker, and measure the temperature. Record this temperature in your table as the temperature at 0 min. Remove the thermometer. Record your observations of any changes you see in the right-hand column of your table.

3 After 1 min, stir the ice again. Then measure and record the temperature. Record your observations of any changes you see in the right-hand column of your table.

4 Repeat step 3 every minute, until 5 min after all the ice has melted. Record your observations of any changes you see in the right-hand column of your table.

Part 2: Water to Steam (Teacher Demonstration)

5 To find out what happens to the temperature of water as it boils, your teacher will do a demonstration, as shown on the left. Record the temperature every minute as the water is heated and for at least 5 min after it begins to boil. Record your observations of any changes.

Analyze

1. Use your data to create a line graph of temperature versus time. Describe the shape of your graph.
2. Describe how temperature changes as ice melts. Describe how temperature changes as water boils.
3. Predict what your graph would look like if you could continue to heat the water vapour.

Write a Conclusion

4. How did your predicted graph compare with your actual graph? Was your hypothesis correct? Why or why not? Did your observations support, partly support, or not support your hypothesis? Write a conclusion for your investigation.

Apply and Extend

5. Based on your observations, do you agree with the following statement? Explain your answer.

   "When heat is added to a solid, it can cause a change of state or an increase in temperature."

6. Suppose that you are camping in the fall. You leave some water in a pail overnight. The next morning, you notice a layer of ice on the top of the water. What is the temperature of the water just below the ice?

7. In section 4.1, you learned about boiling point and melting point. Melting point is the temperature at which a solid changes to a liquid. Boiling point is the temperature at which a liquid changes to a gas. **Table 2** lists the boiling points and melting points of some common substances.

   What was the melting point of your ice in this investigation? What was the boiling point of your water? If your values are different from those in **Table 2**, what are some possible reasons for the difference?

Table 2 Melting Points and Boiling Points of Some Common Substances

Substance	Melting point (°C)	Boiling point (°C)
ethanol	–114	78
copper	1084	2336
oxygen	–218	–183
sodium chloride (table salt)	801	1465
sulfur	113	445
water	0	100

CHECK YOUR UNDERSTANDING

1. Why did you need to stir the ice-water mixture?
2. Where did you put the bulb of the thermometer to get the most accurate reading? Why?
3. Why was it important to measure the temperature at regular intervals?

Tech.CONNECT

Plasma

A gas that has electricity running through it is called plasma. Plasma is sometimes considered to be a fourth state of matter. It is found mainly in the stars and nebulas within our universe.

Figure 1
The northern lights (aurora borealis)

Figure 2
Neon lights contain plasma.

Plasma has fascinated people for thousands of years. The northern lights (aurora borealis) are an example of plasma in nature (**Figure 1**). In ancient times, the Inuit people believed that the northern lights were the torches of spirits guiding souls to a land of happiness and plenty.

Today you can find plasma in many manufactured items, such as fluorescent lights, neon signs (**Figure 2**), and plasma balls (**Figure 3**). The wonder that you experience when looking at a plasma ball is like the wonder the ancient Inuit people experienced when looking at the northern lights.

Plasma can even be used to cut and shape metal. Plasma cutters (**Figure 4**) were developed almost 50 years ago, during World War II, to help speed up the process of cutting and welding metal together to build airplanes for the war. Plasma cutters are now used to shape car frames, to cut large beams of metal at construction sites, and are even used by artists to cut and shape metal for sculptures.

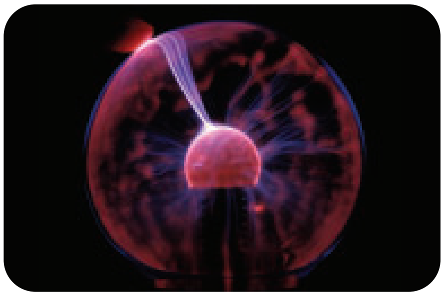


Figure 3
You can see plasma balls at science centres or science stores.

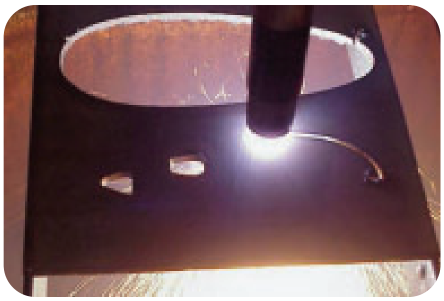


Figure 4
A plasma cutter cutting metal.

Television screens are one of the newest technologies that involve plasma. Plasma displays are not a new invention—research on plasma displays dates back a decade or more. It is only recently, however, that the technology has been developed to manufacture plasma displays at a lower cost.

So how does a plasma screen television work? A plasma screen is quite different from a regular television screen. A plasma screen works by suspending an inert (inactive) gas, such as neon or xenon [ZEE-non], between two panes of transistor-covered glass that are meshed together. An electric charge is applied to the gas, turning it into plasma. This creates ultraviolet light. The ultraviolet light illuminates phosphors that are built into the glass, creating light that you can see (**Figure 5**).

In less scientific terms, think about one million very small light bulbs arranged between two glass plates. The light bulbs are lit by plasma and produce the spectrum of colour needed to view an image. The light bulbs are turned on or off by the television's processor.

Why do so many people wish to have a plasma screen television? Plasma screen televisions are so thin and light that they can be hung on a wall (**Figure 6**). This means you can get a clear view of a plasma screen from almost any angle in a room. As well, there is very little reflection off a plasma screen. These characteristics make plasma screen televisions very desirable.

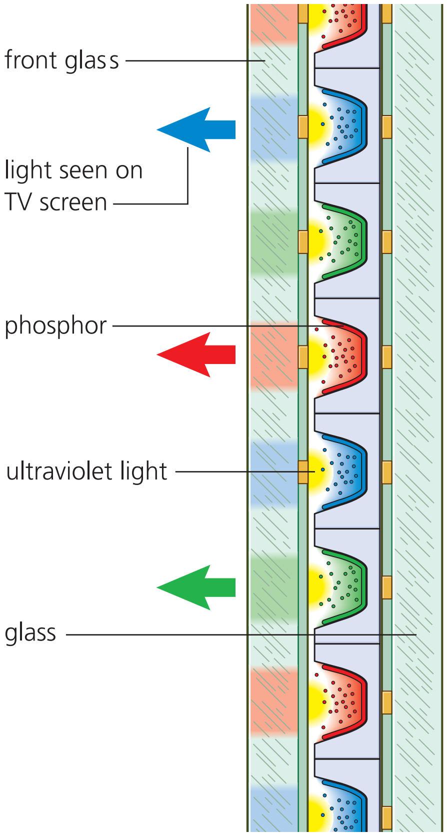


Figure 5
How a plasma screen works

Figure 6
Plasma screen televisions are very light and very thin.

4.3 Mass and Volume

LEARNING TIP

The word "matter" comes from the Latin word *materia*, which means "material" or "stuff."

In this chapter, you are investigating some of the properties of matter. Everything in the world, including you, is made of matter. What exactly is matter? **Matter** is anything that has mass and occupies space. In this section, you will learn about mass and volume.

Mass

The **mass** of an object is a measure of the amount of matter in the object. An object's mass stays constant everywhere in the universe.

Mass is used to measure many things, from food to people (**Figure 1**). For example, when you buy a bag of potato chips, you are buying a certain mass of potato chips. Small masses, such as the mass of a bag of potato chips, are often measured in grams. Larger masses, such as the mass of people or vehicles, are often measured in kilograms (*kilo* means "1000"). Very small masses, such as the amounts of some medicines, are measured in milligrams (*milli* means "one-thousandth," or "$\frac{1}{1000}$").

$$1 \text{ mg} = \frac{1}{1000} \text{ g}$$

$$1 \text{ kg} = 1000 \text{ g}$$

Figure 1
The mass of objects with different amounts of matter can be measured in different units.

Prefix	kilo		centi	milli
Multiple	1000		$\frac{1}{100}$	$\frac{1}{1000}$
Length	kilometre (km)	**metre (m)**	centimetre (cm)	millimetre (mm)
Mass	kilogram (kg)	**gram (g)**	centigram (cg)	milligram (mg)
Volume		**litre (L)**		millilitre (mL)

LEARNING TIP

The International System of Units, or metric system, is commonly referred to as SI. SI comes from the French name, *Le Système internationale d'unités*.

Measuring Mass

When you measure the mass of an object on a balance or a scale, you are measuring the mass directly. Therefore, this is an example of direct measurement.

Sometimes, you need to use a more complicated method to measure mass. For example, to find the mass of a quantity of water, you first need to find the mass of an empty, dry container. Then you pour the water into the container and find the mass of the container and the water. Finally, you subtract the mass of the empty container from the mass of the container with the water in it. The formula is

Mass of water = (mass of container + water) − mass of container

This is an example of indirect measurement.

Volume

As well as having mass, matter occupies space. **Volume** is a measure of the amount of space that is occupied by matter.

Measuring the Volume of a Liquid

You can measure a small volume 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 2**).

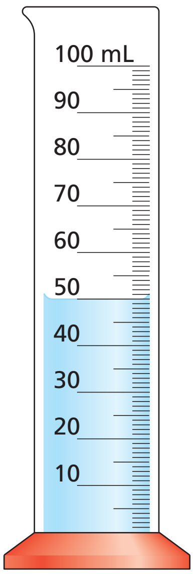


Figure 2
A graduated cylinder is marked out in steps (graduations) to enable measurement.

To measure the volume of a liquid in a graduated cylinder, you read the scale of numbers. When you look at a liquid in a graduated cylinder from the side, you will notice that the top surface has a slight curve where the liquid touches the cylinder. This curved surface is called the meniscus. For an accurate measurement, you should have your eye level with the meniscus, as shown in **Figure 3**. Then you read the volume at the bottom of the meniscus.

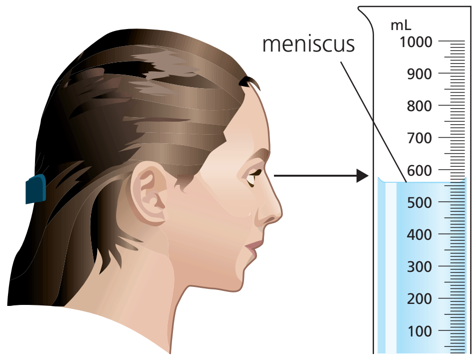


Figure 3
Read the volume of a liquid from the bottom of the meniscus.

The volume of a liquid is generally measured in litres (L) or millilitres (mL). (A millilitre is $\frac{1}{1000}$ of a litre.) You will be familiar with measurements of volume from containers of milk or soft drinks.

Calculating the Volume of a Rectangular Solid

You can measure a rectangular solid with a ruler and then calculate its volume using the following formula:

$$\text{Volume} = \text{length} \times \text{width} \times \text{height}$$

If you measure all the sides in centimetres, then the volume will be in cubic centimetres (cm^3). If you measure all the sides in metres, then the volume will be in cubic metres (m^3).

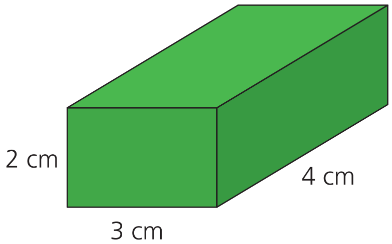


Figure 4

The volume of a rectangular solid with a length of 3 cm, a width of 4 cm, and a height of 2 cm (**Figure 4**) is calculated as follows:

$$\begin{aligned}\text{Volume} &= \text{length} \times \text{width} \times \text{height}\\ &= 3\text{ cm} \times 4\text{ cm} \times 2\text{ cm}\\ &= 24\text{ cm}^3\end{aligned}$$

The volume of a solid is usually given in cubic centimetres (cm^3). The volume of a liquid is usually given in millilitres (mL). Recipes, however, usually use millilitres for both solid and liquid volumes. This works because 1 cm^3 is the same as 1 mL, and 1000 cm^3 is the same as 1 L. Thus, in the calculation above, the volume could also be stated as 24 mL.

Measuring the Volume of an Irregular Solid

Sometimes, you cannot measure the length, width, and height of a solid because the sides are not regular. The volume of a small, irregular solid, such as a jagged rock, must be measured by displacement. To do this, choose a container (such as a graduated cylinder) that the irregular solid will fit inside. Pour water into the empty container until it is about half full. Record the volume of water in the container, and then carefully add the solid. Make sure that the solid is completely submerged in the water. Record the volume of the water plus the solid (**Figure 5**). Calculate the volume of the solid using the following formula:

$$\text{Volume of solid} = (\text{volume of water} + \text{solid}) - \text{volume of water}$$

LEARNING TIP

For review in measuring mass and volume, see "Measurement and Measuring Tools" in the Skills Handbook.

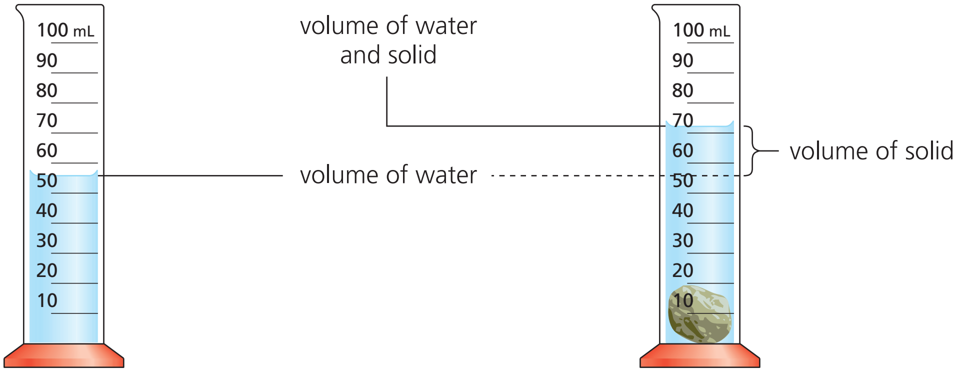
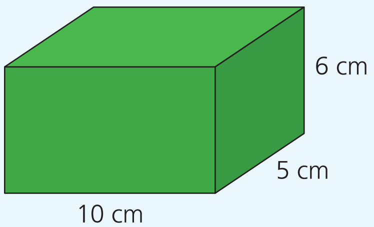


Figure 5
Measuring volume by the displacement of water

CHECK YOUR UNDERSTANDING

1. Define mass and volume. State the units that are used to measure each.
2. Name two pieces of equipment that can be used to measure mass and volume. How do these pieces of equipment improve our ability to communicate with each other?
3. What is the correct way to read the volume of a liquid in a graduated cylinder?
4. Determine the volume of the following box.



4.4 Conduct an Investigation

SKILLS MENU

○ Questioning	● Observing
● Predicting	● Measuring
○ Hypothesizing	○ Classifying
○ Designing Experiments	○ Inferring
○ Controlling Variables	● Interpreting Data
○ Creating Models	● Communicating

Measuring Mass and Volume

In this investigation, you will use what you learned in section 4.3 to determine the mass and volume of some common classroom objects (**Figure 1**). First you will estimate the mass and volume of these objects. Then you will check your estimates using direct measurement or the displacement of water.

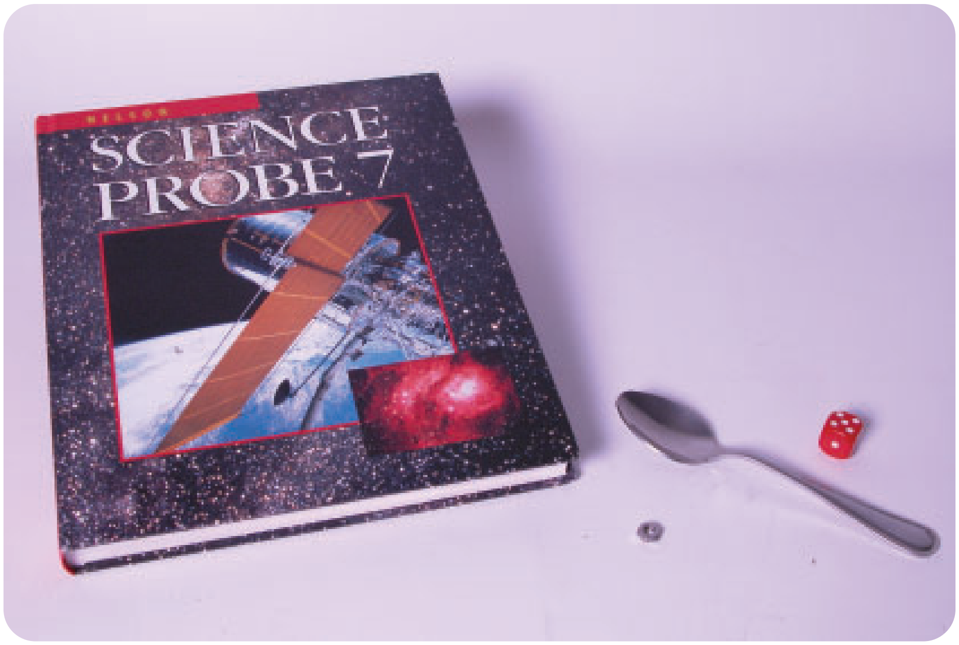


Figure 1
How would you determine the mass and volume of these objects?

Question

What is the mass and volume of common classroom objects?

Materials

- safety goggles
- variety of regular solids (for example, textbook, dice, and block of wood)
- variety of small irregular solids (for example, small rock, small spoon, and metal nut)
- balance or scale
- ruler
- 100-mL graduated cylinder or large measuring cup
- water

Procedure

1 Estimate the mass of each object in grams. Record your estimates in your notebook in a table like the one below.

Data Table for Investigation 4.4

Object	Estimated mass (g)	Actual mass (g)	Estimated volume (cm^3 or mL)	Actual volume (cm^3 or mL)
textbook				
eraser				

2 Use the balance or scale to determine the actual mass of each object in grams. Record your results in your table, under "Actual mass."

3 Estimate the volume of each object in either cm^3 or mL. Record your estimates in your table.

4 Determine the actual volume of each rectangular solid in cm^3. Record your measurements, calculations, and results on your table, under "Actual volume."

5 Determine the actual volume of each irregular solid in mL using displacement. Remember to tilt the graduated cylinder or measuring cup and gently slide the solid into the water.

Record your measurements, calculations, and results in your table, under "Actual volume."

Analyze and Evaluate

1. Which masses or volumes were you able to estimate most accurately? Why?
2. Which masses or volumes did you estimate least accurately? Why?
3. You used the displacement of water to measure the volumes of irregular solids.
   a) Explain why "displacement of water" is an appropriate name for this method.
   b) Why is this method an example of indirect measurement?

Apply and Extend

4. Describe two everyday situations in which the measurement of mass or volume is important.
5. Imagine that you are provided with a scale, a sample of modelling clay, a piece of string, a graduated cylinder, and some water (**Figure 2**). How could you use these materials to prove that you can change the shape of the clay without changing the volume of the clay?

Figure 2

CHECK YOUR UNDERSTANDING

1. Why did you slide each object into the graduated cylinder rather than dropping it in? Would your results have changed if you had not slid all the objects into the cylinder in the same way? Would you have still obtained fair measurements? Explain your answer.
2. When would the displacement of water not be a good method for finding the volume of an irregular object?

Calculating Density

4.5

Look at **Figures 1** and **2**. In both photos, the oil is floating on the water. This property of oil makes it possible to clean up an oil spill and to skim the oil from a boiling pot of eulachons [YOO-luh-kons]. Why does oil float? Oil must be lighter than water, but what does this mean? A litre of oil is certainly not lighter than a glass of water.

To compare fluids using the words "light" and "heavy," you must examine the same volume of each fluid. Thus, a litre of oil is lighter (has less mass) than a litre of water. When you compare the masses of the same volume of different substances, you are comparing their densities. **Density** is the mass per unit volume of a substance. Oil floats on water because it is less dense than water.

LEARNING TIP

Make connections to your prior knowledge. Ask yourself, "What do I already know about floating and sinking? How does this information fit with what I already know?"

Figure 1
An oil spill being contained.

Figure 2
Eulachon oil being skimmed from a pot.

TRY THIS: RANK BY DENSITY

Skills Focus: observing, predicting, measuring

1. Find six identical opaque containers, such as plastic film containers. Fill the containers with different materials, such as water, sand, tiny pebbles, syrup, shampoo, and wood chips (**Figure 3**).
2. Close the containers and mix them up so you do not know which one is which. Number the containers.
3. Rank the containers in order from highest density to lowest density. You may use any method you choose to determine your ranking, but you cannot open the containers. Record your ranking.
4. Which densities were you able to estimate quite accurately? Which were harder to estimate? Why?

Figure 3

Using Density

Density is a property of matter that can be calculated. It is the mass of a substance per unit volume of this substance. It is expressed as grams per cubic centimetre (g/cm^3) or grams per millilitre (g/mL).

Density is calculated by dividing the mass of an amount of substance by its volume. The formula is

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Each substance has its own unique density. Water has a density of 1.0 g/mL. Liquids and solids that float on water have a density of less than 1.0 g/mL. Liquids or solids that sink in water have densities of more than 1.0 g/mL.

Table 1 lists the densities of some common substances. Notice that western red cedar has a lower density than water. Therefore, western red cedar floats in water, as do most types of wood (Figure 4). Crude oil also has a lower density than water, which is why oil spills stay afloat in the ocean. Copper has a higher density, however, so it sinks in water. The densities of two substances can be used to predict which will float and which will sink.

LEARNING TIP

Make connections to your prior knowledge. Ask yourself, "How does this information on density fit with what I already know?"

Table 1 Densities of Some Common Substances

Substance	Density (g/mL)
wood (western red cedar)	0.37 (approximate)
crude oil	0.86–0.88 (approximate)
pure water	1.00
copper	8.92

Figure 4
What property of wood allows forest companies to transport logs in this way?

CHECK YOUR UNDERSTANDING

1. What is density? How is it calculated?
2. Use the "Actual mass" and "Actual volume" columns of your data table for Investigation 4.4 to calculate the density of each object.
3. Calculate the density of each kind of wood.
   a) a child's block made of birch wood with a volume of 510 cm^3 and a mass of 306 g
   b) a pine log with a mass of 96 000 g and a volume of 240 000 cm^3
   c) a sculpture made of ebony with a volume of 81 cm^3 and a mass of 96 g

4.6 Conduct an Investigation

▶ SKILLS MENU

○ Questioning	● Observing
● Predicting	● Measuring
○ Hypothesizing	● Classifying
○ Designing Experiments	○ Inferring
○ Controlling Variables	● Interpreting Data
○ Creating Models	● Communicating

Will It Float or Sink?

Will a rock float in water? Will a cork float in alcohol? Will alcohol float on glycerine? In this investigation, you will predict whether various solids will float or sink in three liquids. Then you will test your predictions. You will also predict and test what will happen when you combine the three liquids.

Question

Which materials will float or sink in rubbing alcohol, water, and glycerine?

Materials

- safety goggles
- apron
- small pieces of various solids (such as cork, wood, and rock)
- ruler
- graduated cylinder
- balance
- 3 250-mL beakers or small glass jars
- rubbing alcohol (isopropyl alcohol, density 0.8 g/mL)
- water (density 1.0 g/mL)
- glycerine (density 1.3 g/mL)
- 3 colours of food colouring

Procedure

1 Calculate the density of each solid. You may have to use indirect measurement to determine the volumes of some of the solids. Record the densities in your notebook in a table like the one below.

Data Table for Investigation 4.6

Materials tested	Mass	Volume	Density (g/cm^3)	Will it float or sink ...? in rubbing alcohol	in water	in glycerine
ice						
wax						

2 Use your densities to predict which solids will float in each liquid. Write your predictions as "yes" or "no" in your table.

3 Put on your apron and safety goggles.

Rubbing alcohol can harm your eyes. Wear safety goggles at all times.

4 Fill each beaker three-quarters full with one of the liquids. Test your predictions by placing each solid in the three liquids. Use a check mark (4) or an (8) to indicate whether or not each prediction is correct.

5 Pour half of the water out of your beaker. Use a drop of food colouring to make each liquid a different colour. In your notebook, predict what will happen if you combine the three liquids. **Gently** pour some of the alcohol and then some of the glycerine into the water. Record your observations.

Analyze and Evaluate

1. Summarize your results in a few sentences.
2. Explain how you can use density to predict whether or not one substance will float on another substance.

Apply and Extend

3. Which substance that you tested is the most dense? Which is the least dense? Give one use for each substance that relies on its density.
4. In the last step of the procedure, you combined different liquids. Describe the final appearance of the combined liquids. What can you conclude about the densities of the three liquids?

5. **Table 2** gives the densities of several metals. Mercury is the only metal that is a liquid at room temperature. Mercury is very toxic. You should never touch it or inhale its vapours. Use **Table 2** to determine which metals would float and which would sink in liquid mercury (**Figure 1**).

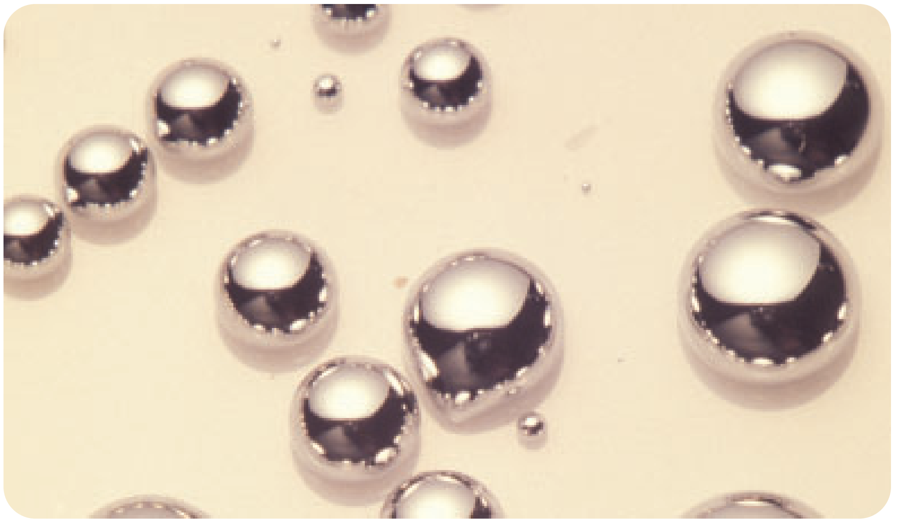


Figure 1
Mercury is a silvery-white, liquid metal.

Table 2 Densities of Some Common Metals

Metal	Density (g/mL or g/cm^3)
aluminum	2.7
chromium	7.2
copper	8.95
gold	19.3
iron	7.86
lead	11.34
mercury	13.6
silver	10.5
tin	7.31
zinc	7.13

CHECK YOUR UNDERSTANDING

1. How could mistakes in your measurements or calculations have affected the accuracy of your predictions?
2. Could the food colouring you added to the liquids in step 5 have affected the densities of the liquids? Explain.

Chapter Review 4

Matter can be described using properties.

Key Idea: Matter can be described using observable properties.

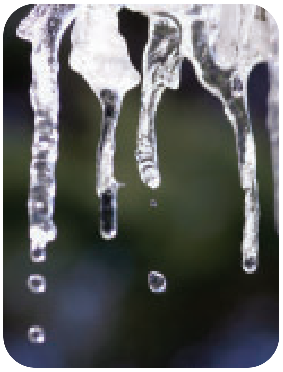
You can use your senses to describe the colour, texture, and state of this sundae.

Vocabulary

property p. 91

states p. 92

Key Idea: Matter can be described using measurable properties.



Melting point

Boiling point

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Density

Vocabulary

melting point p. 92

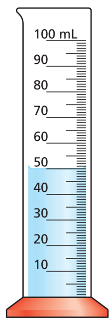
freezing point p. 93

boiling point p. 93

density p. 107

Key Idea: Matter is anything that has mass and volume.

- Mass is a measure of the amount of matter in an object.
- Volume is a measure of the amount of space that is occupied by matter.



Vocabulary

matter p. 100

mass p. 100

volume p. 101

Review Key Ideas and Vocabulary

When answering the questions, remember to use vocabulary from the chapter.

1. List properties that you can observe using only your senses. Choose an object in your classroom, and describe it using these properties.
2. Name two properties that require measurements.
3. Describe both the equipment you would need and the steps you would take to measure
   a) the volume of a ring
   b) the mass of a sample of liquid
   c) the volume of a cement block
   d) the mass of a stone
   e) the volume of a sample of liquid
4. Define density. Why is density considered to be a property of matter, but length is not?

Use What You've Learned

5. Vinegar and water are both clear liquids at room temperature (**Figure 1**). What properties could you use to tell them apart?

Figure 1

6. If a substance is a solid at room temperature (20°C), what can you say about its melting point?
7. Look at the melting and boiling points of mercury and ethanol (**Table 1**). Which substance would be better to use in an outdoor thermometer in the Arctic? Why?

Table 1 Melting Points and Boiling Points of Two Substances

Substance	Melting point (°C)	Boiling point (°C)
mercury	−38.9	356.6
ethanol	−114.3	78.5

8. For each substance, state which is the larger value.
   a) 340 mL or 1 L of apple juice
   b) 100 g or 0.5 kg of laundry soap
   c) 50 L or 500 mL of water in a bathtub
   d) 2 kg or 500 g of potatoes
9. The mass of a dry, empty beaker is 250 g. The mass of the beaker and a liquid is 475 g. What is the mass of the liquid?
10. A classroom measures 11.0 m by 9.0 m by 3.0 m. What is the approximate volume of air in the classroom?
11. A graduated cylinder contains 40 mL of water. A stone is carefully slipped into the cylinder. The level of the water reaches 57 mL. What is the volume of the stone?
12. a) Suppose that you tried to use the displacement of water to find the volume of a sugar cube. What problem could you have? What could you do to solve this problem?
    b) List two other objects whose volumes you could not measure using the displacement of water. Explain why.
13. Describe a method you could use to determine the volume of your body.

14. An ice cube is placed on one balance pan of an equal-arm balance. Masses totalling 3.5 g are placed on the opposite pan to level the balance (**Figure 2**). If the ice cube is allowed to melt, do you expect the balance to stay level? Explain.

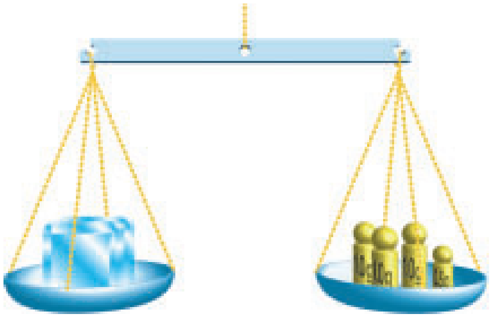


Figure 2

15. Investigate methods that are used by Aboriginal peoples to obtain the oil from eulachons (**Figure 3**). Identify the properties of oil that are used in these methods.

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Figure 3

16. A hydrometer can be used to measure density of liquids (**Figure 4**). Conduct research to find out what a hydrometer is and how it measures density.

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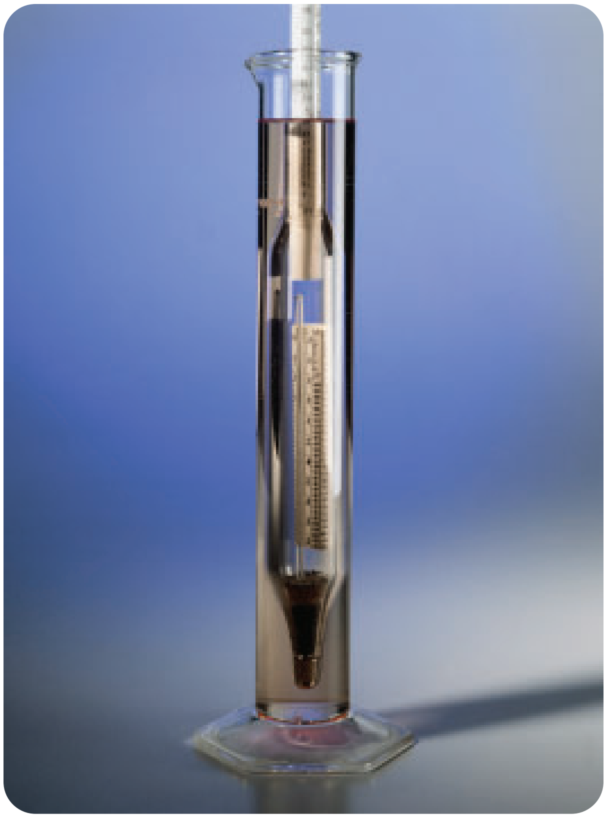

Figure 4

Think Critically

17. During a class discussion, one student states that solids are always denser than liquids. Several other students disagree with this statement. Which position would you take? Give examples to support your position.

Reflect on Your Learning

18. You have learned a lot about matter in this chapter. Think back to the beginning of this chapter. How have your ideas about matter changed?