SKILLS HANDBOOK

THINKING AS A SCIENTIST

WORKING AS A SCIENTIST

READING FOR INFORMATION

COMMUNICATING IN SCIENCE


Work Like a Scientist

THINKING AS A SCIENTIST

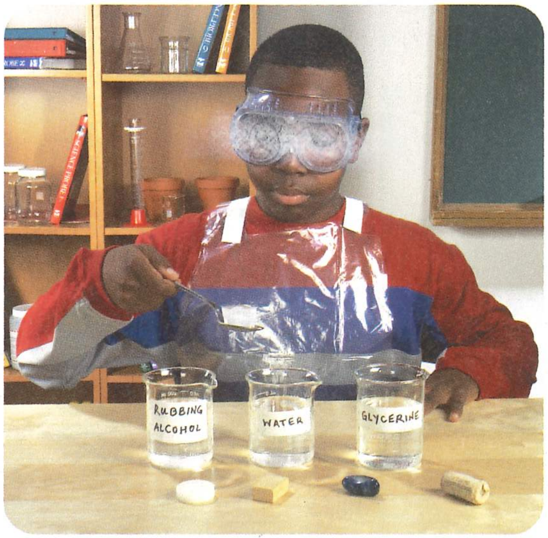
You may not think you're a scientist, but you are! You investigate the world around you, just like scientists do. When you investigate, you are looking for answers. Imagine that you are planning to buy a mountain bike. You want to find out which model is the best buy. First, you write a list of questions. Then you visit stores, check print and Internet sources, and talk to your friends to find the answers. You are conducting an investigation.

Scientists conduct investigations for different purposes:

- *Scientists investigate the natural world in order to describe it.* For example, scientists study rocks to find out what their properties are, how they were formed, and how they are still changing today.

- *Scientists investigate how objects and organisms can be classified.* For example, scientists examine substances and classify them as pure substances or mixtures.

- *Scientists investigate to test their ideas about the natural world.* Scientists ask cause-and-effect questions about what they observe. They propose hypotheses to answer their questions. Then they design experiments to test their hypotheses.



CONDUCTING AN INVESTIGATION

When you conduct an investigation or design an experiment, you will use a variety of skills. Refer to this section when you have questions about how to use any of the following investigation skills and processes.

- Questioning
- Predicting
- Hypothesizing
- Controlling Variables
- Observing
- Measuring
- Classifying
- Inferring
- Interpreting Data
- Communicating
- Creating Models

Questioning

Scientific investigations start with good questions. To write a good question, you must first decide what you want to know. This will help you think of, or formulate, a question that will lead you to the information you want.

You must think carefully about what you want to know in order to develop a good question. The question should include the information you want to find out.

Sometimes an investigation starts with a special type of question, called a cause-and-effect question. A cause-and-effect question asks whether something is causing something else. It might start in one of the following ways:
What causes ...?
How does ... affect ...?
What would happen if ...?

When an investigation starts with a cause-and-effect question, it also has a hypothesis. Read "Hypothesizing" on page 270 to find out more about hypotheses.

PRACTICE

Think of some everyday examples of cause and effect, and write statements about them. Here's one example: "When I stay up too late, I'm tired the next day." Then turn your statements into cause-and-effect questions: for example, "What would happen if I stayed up late?"

Predicting

A prediction states what is likely to happen based on what is already known. Scientists base their predictions on their observations. They look for patterns in the data they gather to help them see what might happen next or in a similar situation. This is how meteorologists come up with weather forecasts.

Remember that predictions are not guesses. They are based on solid evidence and careful observations. You must be able to give reasons for your predictions. You must also be able to test them by doing experiments.

Hypothesizing

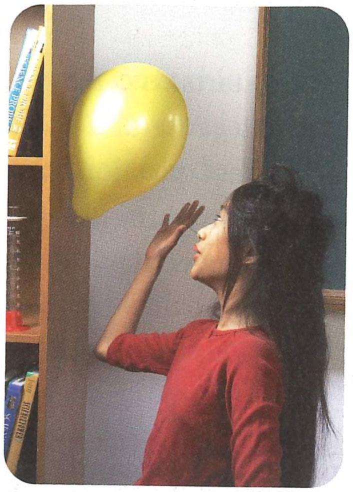


Figure 1
This student is conducting an investigation to test this hypothesis: if the number of times the balloon is rubbed against hair increases, then the length of time it will stick to the wall will increase.

To test your questions and predictions scientifically, you need to conduct an investigation. Use a question or prediction to create a cause-and-effect statement that can be tested. This kind of statement is called a **hypothesis**.

An easy way to make sure that your hypothesis is a cause-and-effect statement is to use the form "If … then …." If the independent variable (cause) is changed, then the dependent variable (effect) will change in a specific way (**Figure 1**). For example, "If the number of times a balloon is rubbed against hair (the cause or independent variable) is increased, then the length of time it sticks to a wall (the effect or dependent variable) increases." Read "Controlling Variables" below to find out more about independent and dependent variables.

Questions, predictions, and hypotheses go hand in hand. For example, your question might be "Does a balloon stick better if you rub it more times on your hair?" Your prediction might be "A balloon will stick to a wall longer the more times it is rubbed on your hair." Your hypothesis might be "If the number of times you rub a balloon on your hair is increased, then the length of time it sticks to a wall will increase." If you prove that your hypothesis is correct, then you have confirmed your prediction.

You can create more than one hypothesis from the same question or prediction. Another student might test the hypothesis "If the number of times you rub a balloon on your hair is increased, then the length of time it sticks to a wall will be unchanged."

Of course, both of you cannot be correct. When you conduct an investigation, you do not always prove that your hypothesis is correct. Sometimes you prove that your hypothesis is incorrect. An investigation that proves your hypothesis to be incorrect is not a bad investigation or a waste of time. It has contributed to your scientific knowledge. You can re-evaluate your hypothesis and design a new experiment.

PRACTICE

Write hypotheses for questions or predictions about rubbing a balloon on your hair and sticking it to a wall. Start with the questions above, and then write your own questions. For example, if your question is "Does the balloon stick better if you rub it more times?", then your hypothesis might be "If the number of times you rub the balloon on your hair is increased, then the length of time it sticks to the wall is increased."

Controlling Variables

When you are planning an investigation, you need to make sure that your results will be reliable by conducting a fair test. To make sure that an investigation is a fair test, scientists identify all the variables that might affect their results. Then they make sure that they change only one variable at a time. This way they know that their results are caused by the variable they changed and not by any other variables (**Figure 2**).

- The variable that is changed in an investigation is called the **independent variable.**
- The variable that is affected by a change is called the **dependent variable.** This is the variable you measure to see how it was affected by the independent variable.
- All the other conditions that remain unchanged in an experiment, so that you know they did not have any effect on the outcome, are called **controlled variables.**

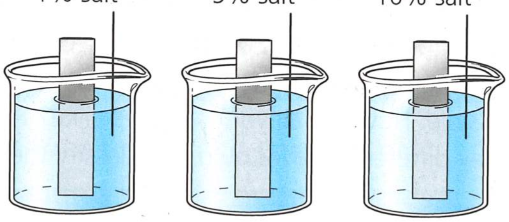


Figure 2

This investigation was designed to find out if the amount of salt in a solution has an effect on the rusting of metal.

- The amount of salt in each solution is the independent variable.
- The amount of rust on the pieces of metal is the dependent variable.
- The amount of water in each beaker and the amount of time the metal strip stays in the water are two of the controlled variables.

PRACTICE

Suppose that you have noticed mould growing on an orange. You want to know what is causing the mould. What variables will you have to consider in order to design a fair test? Which variable will you try changing in your test? What is this variable called? What will your dependent variable be? What will your controlled variables be?

Observing

When you observe something, you use your senses to learn about the world around you. You can also use tools, such as a balance, metre stick, and microscope.

Some observations are measurable. They can be expressed in numbers. Observations of time, temperature, volume, and distance can all be measured. These types of observations are called **quantitative observations.**

Other observations describe qualities that cannot be measured. The smell of a fungus, the shape of a flower petal, or the texture of soil are all examples of qualities that cannot be put in numbers. These types of observations are called **qualitative observations.** Qualitative observations also include colour, taste, clarity, and state of matter.

The colour and shape of this box are qualitative observations. The measurements of its height, depth, and width are quantitative observations.

PRACTICE

Make a table with two columns, one for quantitative observations and the other for qualitative observations. Find a rock that you think is interesting. See if you can make 10 observations about the rock. Record your observations in your table.

Measuring

Measuring is an important part of observation. When you measure an object, you can describe it precisely and keep track of any changes. To learn about using measuring tools, turn to "Measurement and Measuring Tools" on page 285.

Measuring accurately requires care.

Classifying

You classify things when you sort them into groups based on their similarities and differences. When you sort clothes, sporting equipment, or books, you are using a classification system. To be helpful to other people, a classification system must make sense to them. If, for example, your local supermarket sorted all the products in alphabetical order, so that soap, soup, and soy sauce were all on the same shelf, no one would be able to find anything!

Classification is an important skill in science. Scientists try to group objects, organisms, and events in order to understand the nature of life (**Figure 3**).

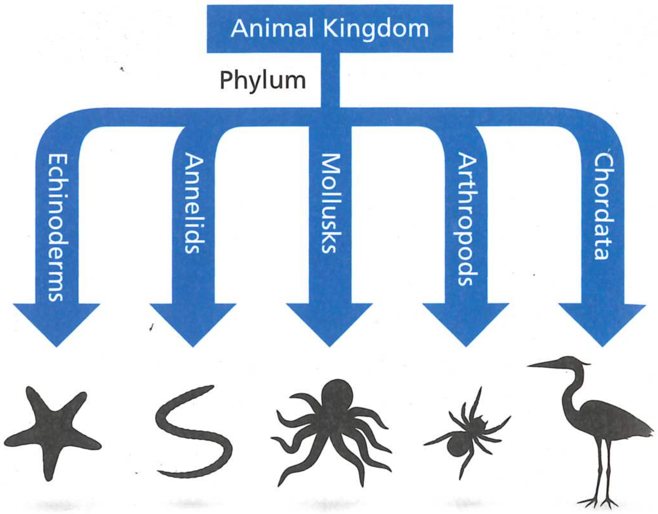


Figure 3
To help classify animals, scientists divide the animal kingdom into five smaller groups called *phyla* (singular *phylum*).

PRACTICE

Gather photos of 15 to 20 different insects, seashells, or flowers. Try to include as much variety as possible. How are all your samples alike? How are they different? How could you classify them?

Inferring

An inference is a possible explanation of something you observe. It is an educated guess based on your experience, knowledge, and observations. You can test your inferences by doing experiments.

It is important to remember that an inference is only an educated guess. There is always some uncertainty. For example, if you hear a dog barking but do not see the dog, you may infer that it is your neighbour's dog. It may, however, be some other dog that sounds the same. An observation, on the other hand, is based on what you discover with your senses and measuring tools. If you say that you heard a dog barking, you are making an observation.

PRACTICE

Decide whether each of these statements is an observation or an inference.

a) You see a bottle filled with clear liquid. You conclude that the liquid is water.

b) You notice that your head is stuffed up and you feel hot. You decide that you must have a cold.

c) You tell a friend that three new houses are being built in your neighbourhood.

d) You see a wasp crawling on the ground instead of flying. You conclude that it must be sick.

e) You notice that you are thirsty after playing sports.

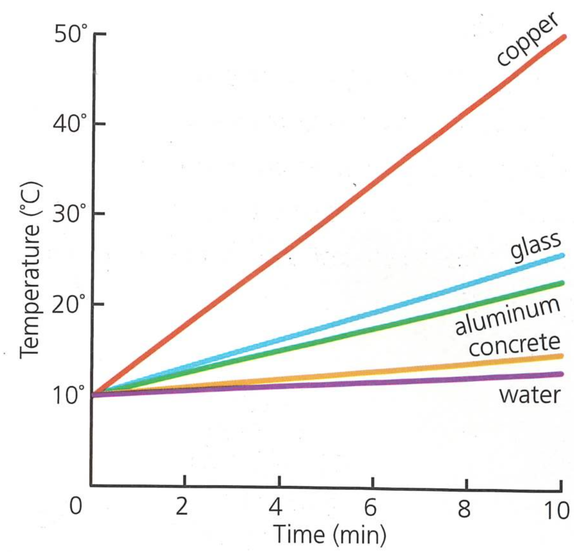


Figure 4

This graph shows data from an investigation about the heating rates of different materials. What patterns and relationships can you see from this data?

Interpreting Data

When you interpret data from an investigation, you make sense of it. You examine and compare the measurements you have made. You look for patterns and relationships that will help you explain your results and give you new information about the question you are investigating. Once you have interpreted your data, you can tell whether your predictions or hypothesis are correct. You may even come up with a new hypothesis that can be tested in a new experiment.

Often, making tables or graphs of your data will help you see patterns and relationships more easily (**Figure 4**). Turn to "Communicating in Science" on page 297 to learn more about creating data tables and graphing your results.

Communicating

Scientists learn from one another by sharing their observations and conclusions. They present their data in charts, tables, or graphs and in written reports. In this student text, each investigation or activity tells you how to prepare and present your results. To learn more about communicating in a written report, turn to "Writing a Lab Report" on page 300.

Creating Models

Have you ever seen a model of the solar system? Many teachers use a small model of the solar system when teaching about space because it shows how the nine planets orbit the Sun. The concept of how planets orbit the Sun is very difficult to imagine without being able to see it.

A scientific model is an idea, illustration, or object that represents something in the natural world (**Figure 5** on page 274). Models allow you to examine and investigate things that are very large, very small, very complicated, very dangerous, or hidden from view. They also allow you to investigate processes that happen too slowly to be observed directly. You can model, in a few minutes, processes that take months or even millions of years to occur.

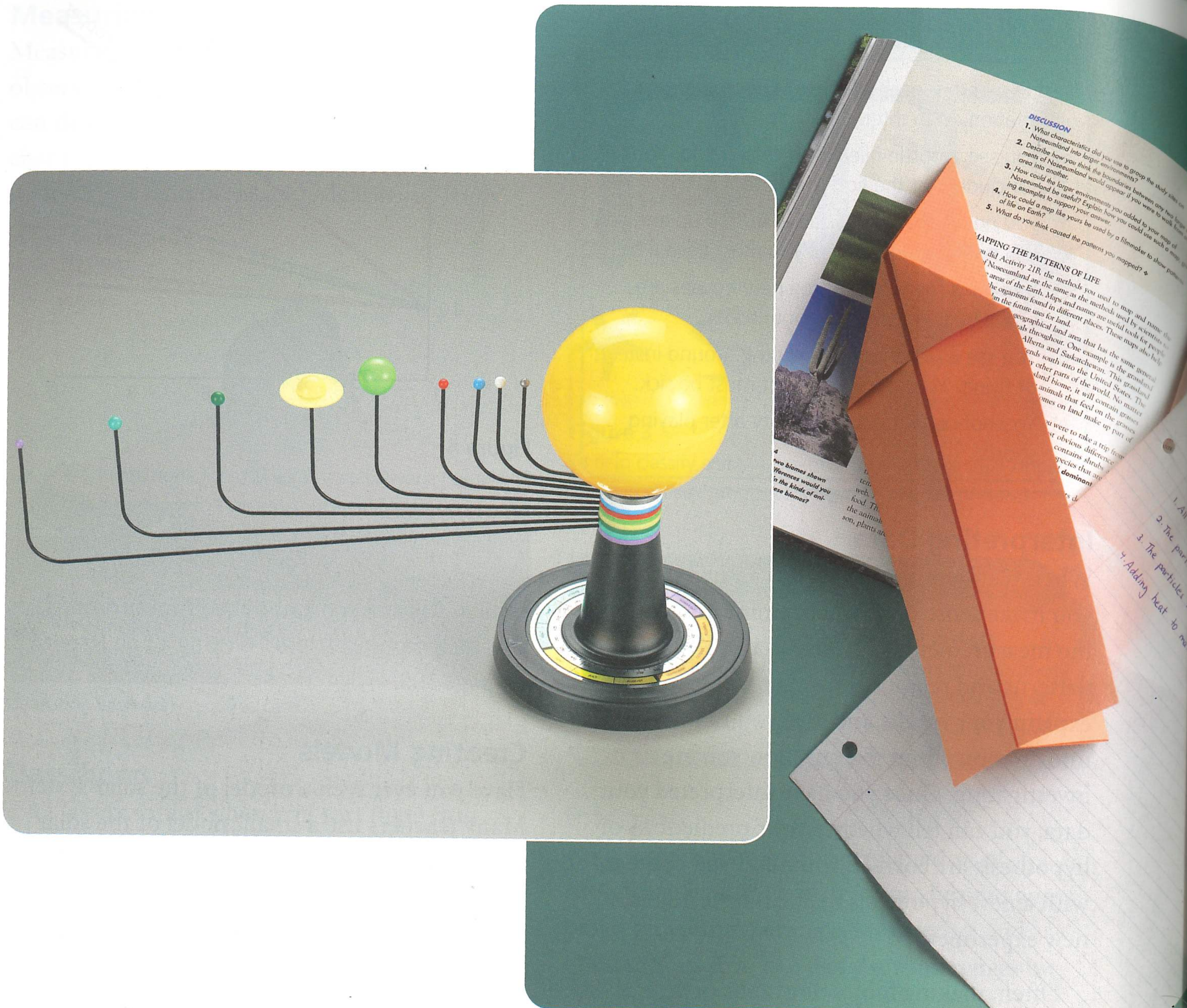
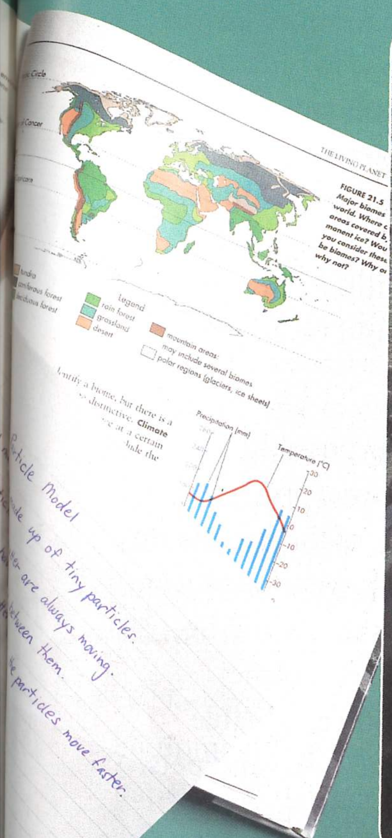


Figure 5

Why do we use these models? How are they different from what they represent? Are there any limitations or disadvantages to using them? Think of another model you could make to represent each of these things.

A model of the solar system is an example of a physical model. You can create physical models from very simple materials. Have you ever thrown a paper airplane? If so, you were actually testing a model of a real airplane. You could use paper airplane models to test different airplane designs.

Illustrations are also models. A map of Earth, showing all the biomes, is a model. So is a drawing of a particle of water. Models can be created from ideas and words, as well. Some Aboriginal stories communicate models of interconnected ecosystems and the appropriate place of humans in nature. The particle model explains, in words, what matter



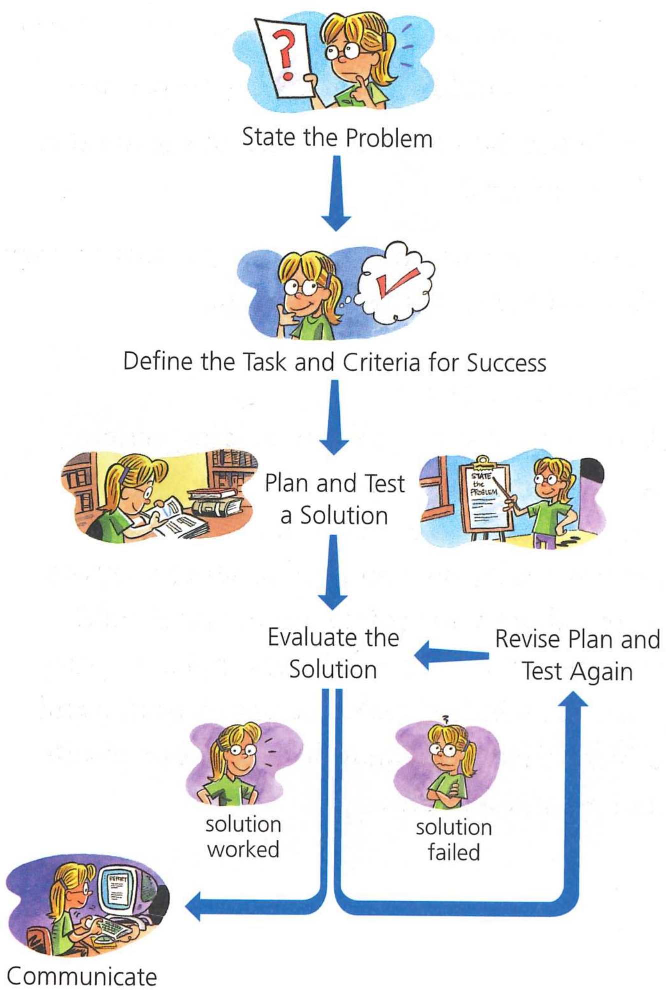
is made from and why different substances behave as they do.

Although models have many advantages, they also have some disadvantages. They are usually more simple than what they represent.

Models change over time as scientists make new observations. For example, models of Earth have changed. Long ago, European people thought that Earth was flat. They thought that if they sailed far enough out to sea, they would fall off the edge. Central American people thought that Earth was held up by a turtle. When the turtle moved, Earth rumbled. As scientists made more and more observations over time, they revised their model of Earth.

SOLVING A PROBLEM

Refer to this section when you are doing a "Solve a Problem" activity.



State the Problem

The first step in solving a problem is to state what the problem is. Imagine, for example, that you are part of a group that is investigating how to reduce the risk of people getting the West Nile Virus. People can become very sick from this virus.

When you are trying to understand a problem, ask yourself these questions:

- What is the problem? How can I state it as a problem?
- What do I already know about the problem?
- What do I need to know to solve the problem?

Define the Task and the Criteria for Success

Once you understand the problem, you can define the task. The task is what you need to do to find a solution. For the West Nile Virus problem, you may need to find a way to reduce the number of mosquitoes in your community because they could be carrying the West Nile Virus.

Before you start to consider possible solutions, you need to know what you want your solution to achieve. One of the criteria for success is fewer mosquitoes. Not every solution that would help you achieve success will be acceptable, however. For example, some chemical solutions may kill other, valuable insects or may be poisonous to birds and pets. The solution should not be worse than the problem it is meant to solve. As well, there are limits on your choices. These limits may include the cost of the solution, the availability of materials, and safety.

Use the following questions to help you define your task and your criteria for success:

- What do I want my solution to achieve?
- What criteria should my solution meet?
- What are the limits on my solution?

Plan and Test a Solution

The planning stage is when you look at possible solutions and decide which solution is most likely to work. This stage usually starts with brainstorming possible solutions. When you are looking for solutions, let your imagination go. Keep a record of your ideas. Include sketches, word webs, and other graphic organizers to help you.

As you examine the possible solutions, you may find new questions that need to be researched. You may want to do library and Internet research, interview experts, and talk to people in your community about the problem.

Choose one solution to try. For the West Nile Virus problem, you may decide to inspect your community for wet areas where mosquitoes breed, and try to eliminate as many of these wet areas as possible. You have discovered, through your research, that this solution is highly effective for reducing mosquito populations. It also has the advantage of not involving chemicals and costing very little.

Now make a list of the materials and equipment you will need. Develop your plan on paper so that other people can examine it and add suggestions. Make your plan as thorough as possible so that you have a blueprint for how you are going to carry out your solution. Show your plan to your teacher for approval.

Once your teacher has approved your plan, you need to test it. Testing allows you to see how well your plan works and to decide whether it meets your criteria for success. Testing also tells you what you might need to do to improve your solution.

Evaluate the Solution

The evaluating stage is when you consider how well your solution worked. Use these questions to help you evaluate your solution:

- What worked well? What did not work well?
- What would I do differently next time?
- What did I learn that I can apply to other problems?

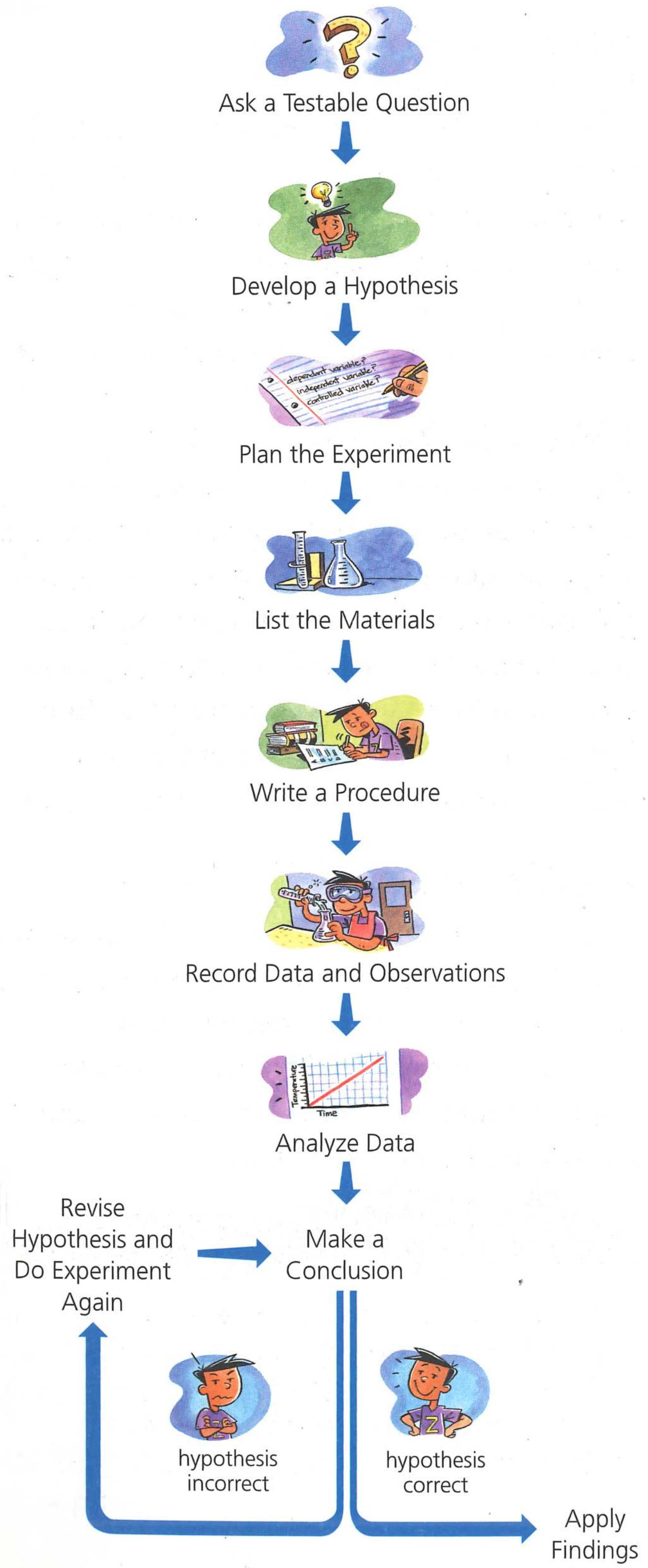
If your solution did not work, go back to your plan and revise it. Then test again.

Communicate

At the end of your problem-solving activity, you should have a recommendation to share with others. To communicate your recommendation, you need to write a report. Think about what information you should include in your report. For example, you may want to include visuals, such as diagrams and tables, to help others understand your results and recommendation.

DESIGNING YOUR OWN EXPERIMENT

Refer to this section when you are designing your own experiment.



After observing the difference between his lunch and Dal's, Simon wondered why his food was not as fresh as Dal's.

Scientists design experiments to test their ideas about the things they observe. They follow the same steps you will follow when you design an experiment.

Ask a Testable Question

The first thing you need is a testable question. A testable question is a question that you can answer by conducting a test. A good, precise question will help you design your experiment. What question do you think Simon, in the picture above, would ask?

A testable question is often a cause-and-effect question. Turn to "Questioning" on page 269 to learn how to formulate a cause-and-effect question.

Develop a Hypothesis

Next, use your past experiences and observations to formulate a hypothesis. Your hypothesis should provide an answer to your question and briefly explain why you think the answer is correct. It should be testable through an experiment. What do you think Simon's hypothesis would be? Turn to "Hypothesizing" on page 270 to learn how to formulate a hypothesis.

Plan the Experiment

Now you need to plan how you will conduct your experiment. Remember that your experiment must be a fair test. Also remember that you must only change one independent variable at a time. You need to know what your dependent variable will be and what variables you will control. What do you think Simon's independent variable would be? What do you think his dependent variable would be? What variables would he need to control? Turn to "Controlling Variables" on page 270 to learn about fair tests and variables.

List the Materials

Make a list of all the materials you will need to conduct your experiment. Your list must include specific quantities and sizes, where needed. As well, you should draw a diagram to show how you will set up the equipment. What materials would Simon need to complete his experiment?

Write a Procedure

The procedure is a step-by-step description of how you will perform your experiment. It must be clear enough for someone else to follow exactly. It must explain how you will deal with each of the variables in your experiment. As well, it must include any safety precautions. Your teacher must approve your procedure and list of materials. What steps and safety precautions should Simon include?

Record Data and Observations

You need to make careful observations, so that you can be sure about the effects of the independent variable. Record your observations, both qualitative and quantitative, in a data table, tally chart, or graph. How would Simon record his observations?

Turn to "Observing" on page 271 to read about qualitative and quantitative observations. Turn to "Creating Data Tables" on page 297 to read about creating data tables.

Analyze Data

If your experiment is a fair test, you can use your observations to determine the effects of the independent variable. You can analyze your observations to find out how the independent and dependent variables are related. Scientists often conduct the same test several times to make sure that their observations are accurate.

Make a Conclusion

When you have analyzed your observations, you can use the results to answer your question and determine if your hypothesis was correct. You can feel confident about your conclusion if your experiment was a fair test and there was little room for error. If you proved that your hypothesis was incorrect, you can revise your hypothesis and perform the experiment again.

Apply Findings

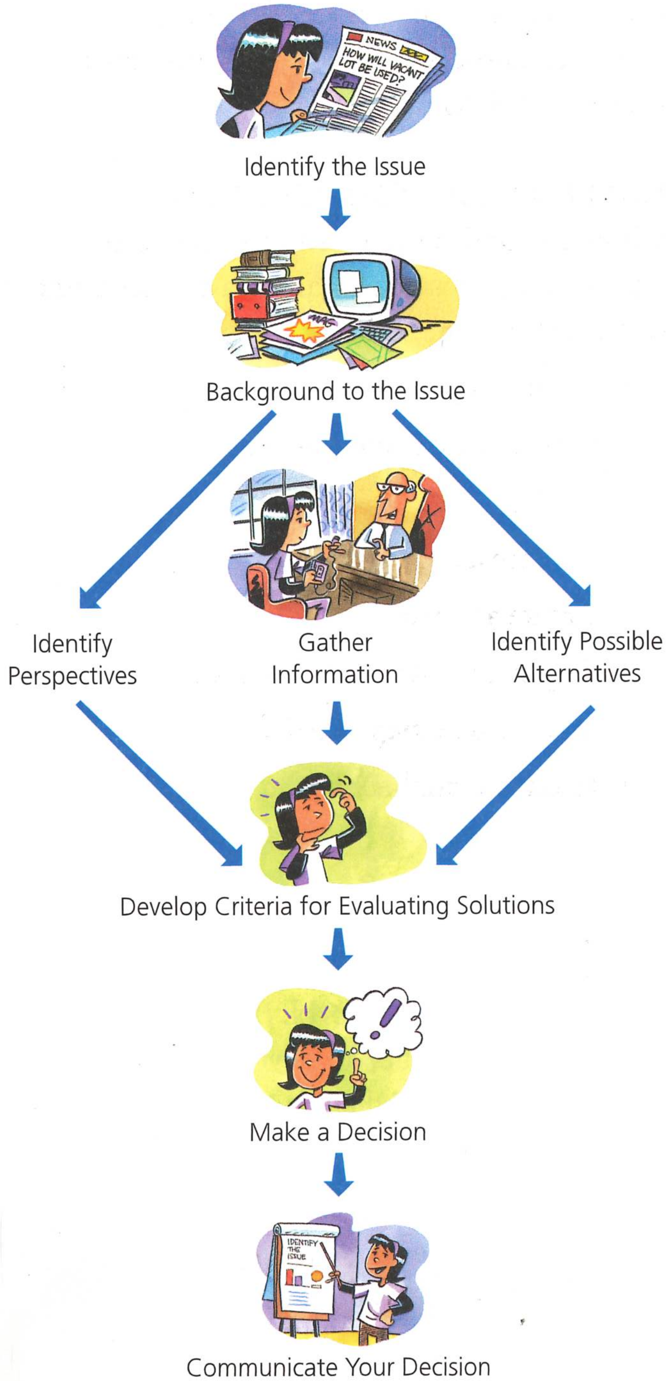
The results of scientific experiments add to our knowledge about the world. For example, the results may be applied to develop new technologies and medicines, which help to improve our lives. How do you think Simon could use what he discovered?

PRACTICE

You are a tennis player. You observe that your tennis ball bounces differently when the court is wet. Design a fair test to investigate your observation. Use the headings in this section.

EXPLORING AN ISSUE

Use this section when you are doing an "Explore an Issue" activity.



An issue is a situation in which several points of view need to be considered in order to make a decision. Often what different people think is the best decision is based on what they think is important or on what they value. Often, it is difficult to come to a decision that everyone agrees with.

When a decision has an impact on many people or on the environment, it is important to explore the issue carefully. This means thinking about all the possible solutions and trying to understand all the different points of view—not just your own point of view. It also means researching and investigating your ideas, and talking to and listening to others.

Identify the Issue

The first step in exploring an issue is to identify what the issue is. An issue has more than one solution, and there are different points of view about which solution is the best. Try stating the issue as a question: "What should ...?

Background to the Issue

The background to the issue is all the information that needs to be gathered and considered before a decision can be made.

- *Identify perspectives.* There are always different points of view on an issue. That's what makes it an issue. For example, suppose that your municipal council is trying to decide how to use some vacant land next to your school. You and other students have asked the council to zone the land as a nature park. Another group is proposing that the land be used to build a seniors' home because there is a shortage of this kind of housing. Some school administrators would like to use the land to build a track for runners and sporting events.
- *Gather information.* The decision you reach must be based on a good understanding of

the issue. You must be in a position to choose the most appropriate solution. To do this, you need to gather factual information that represents all the different points of view. Watch out for biased information, presenting only one side of the issue. Develop good questions and a plan for your research. Your research may include talking to people, reading about the issue, and doing Internet research. For the land-use issue, you may also want to visit the site to make observations.

- *Identify possible alternatives.* After identifying points of view and gathering information, you can now generate a list of possible solutions. You might, for example, come up with the following solutions for the land-use issue:
  - Turn the land into a nature park for the community and the school.
  - Use the land as a playing field and track for the community and the school.
  - Create a combination park and playing field.
  - Use the land to build a seniors' home, with a "nature" garden.

Develop Criteria for Evaluating Solutions

Develop criteria to evaluate each possible solution. For example, should the solution be the one that has the most community support? Should it be the one that protects the environment? You need to decide which criteria you will use to evaluate the solutions so that you can decide which solution is the best.

Make a Decision

This is the stage where everyone gets a chance to share his or her ideas and the information he or she gathered about the issue. Then the group needs to evaluate all the possible solutions and decide on one solution based on the list of criteria.

Communicate Your Decision

Choose a method to communicate your decision. For example, you could choose one of the following methods:

- Write a report.
- Give an oral presentation.
- Design a poster.
- Prepare a slide show.
- Create a video.
- Organize a panel presentation.
- Write a newspaper article.
- Hold a formal debate.

WORKING AS A SCIENTIST

GETTING OFF TO A SAFE START

Science activities and investigations can be a lot of fun. You have the chance to work with new equipment and substances. These can be dangerous, however, so you have to pay attention! You also have to know and follow special rules. Here are the most important rules to remember.

1 Follow your teacher's directions.	2 Act responsibly.	3 Be science-ready.
• Listen to your teacher's directions, and follow them carefully. • Ask your teacher for directions if you are not sure what to do. • Never change anything, or start an activity on your own, without your teacher's approval. • Get your teacher's approval before you start an experiment that you have designed yourself.	• Pay attention to your own safety and the safety of others. • Tell your teacher immediately if you see a safety hazard, such as broken glass or a spill. Also tell your teacher if you see another student doing something that you think is dangerous. • Tell your teacher about any allergies or medical problems you have, or about anything else your teacher should know. • Do not wear contact lenses while doing experiments. • Read all written instructions carefully before you start an activity. • Clean up and put away any equipment after you are finished.	• Come prepared with your student text, notebook, pencil, worksheets, and anything else you need for an activity or investigation. • Keep yourself and your work area tidy and clean. • Wash your hands carefully with soap and water at the end of each activity or investigation. • Never eat, drink, or chew gum in the science classroom. • Wear safety goggles or other safety equipment when instructed by your teacher. • Keep your clothing and hair out of the way. Roll up your sleeves, tuck in loose clothing, and tie back loose hair. Remove any loose jewellery.

SAFE SCIENCE

Follow these instructions to use chemicals and equipment safely in the science classroom.

HANDLE WITH CARE

HEAT, FIRE, AND ELECTRICITY

- Never heat anything without your teacher's permission.
- Always wear safety goggles when you are working with fire.
- Keep yourself, and anything else that can burn, away from heat or flames.
- Never reach across a flame.
- Before you heat a test tube or another container, point it away from yourself and others. Liquid inside can splash or boil over when heated.
- Never heat a liquid in a closed container.
- Use tongs or heat-resistant gloves to pick up a hot object.
- Test an object that has been heated before you touch it. Slowly bring the back of your hand toward the object to make sure that it is not hot.
- Know where the fire extinguisher and fire blanket are kept in your classroom.
- Never touch an electrical appliance or outlet with wet hands.
- Keep water away from electrical equipment.

CHEMICALS

- If you spill a chemical (or anything else), tell your teacher immediately.
- Never taste, smell, touch, or mix chemicals without your teacher's permission.
- Never put your nose directly over a chemical to smell it. Gently wave your hand over the chemical until you can smell the fumes.
- Keep the lids on chemicals you are not using tightly closed.
- Wash your hands well with soap after handling chemicals.
- Never pour anything into a sink without your teacher's permission.
- If any part of your body comes in contact with a chemical, wash the area immediately and thoroughly with water. If your eyes are affected, do not touch them but wash them immediately and continuously with cool water for at least 15 min. Inform your teacher.

GLASS AND SHARP OBJECTS

- Handle glassware, knives, and other sharp instruments with extra care.
- If you break glassware or cut yourself, tell your teacher immediately.
- Never work with cracked or chipped glassware. Give it to your teacher.
- Use knives and other cutting instruments carefully. Never point a knife or sharp object at another person.
- When cutting, make sure that you cut away from yourself and others.

LIVING THINGS

- Treat all living things with care and respect.
- Never treat an animal in a way that would cause it pain or injury.
- Touch animals only when necessary. Follow your teacher's directions.
- Always wash your hands with soap after working with animals or touching their cages or containers.

Caution Symbols

The activities and investigations in *B.C. Science Probe 7* are safe to perform, but accidents can happen. This is why potential safety hazards are identified with caution symbols and red type (**Figure 1**). Make sure you read the cautions carefully and understand what they mean. Check with your teacher if you are unsure.

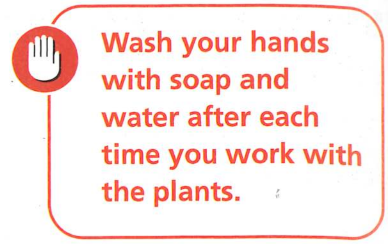


Figure 1
Potential safety hazards are identified with caution symbols and red type.

Safety Symbols

The following safety symbols are used throughout Canada to identify products that can be hazardous (**Figures 2** and **3**). Make sure that you know what each symbol means. Always use extra care when you see any of these symbols in your classroom or anywhere else.

Figure 2
Hazardous Household Product Symbols (HHPS) appear on many products that are used in the home. Different shapes show the level of danger.

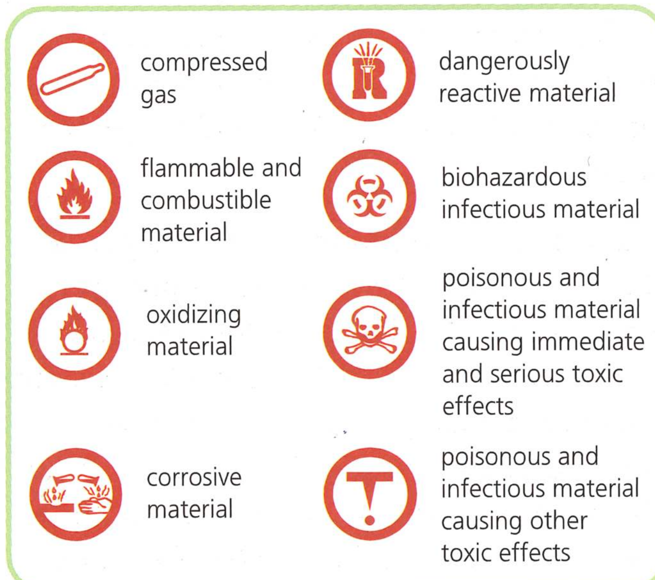


Figure 3
Workplace Hazardous Materials Information System (WHMIS) symbols identify dangerous materials that are used in all workplaces, including schools.

PRACTICE

In a group, create a safety poster for your classroom. For example, you could create a map of the route your class should follow when a fire alarm sounds, a map of where safety materials (such as a fire extinguisher and a first-aid kit) are located in your classroom, information about the safe use of a specific tool, or a list of safety rules.

MEASUREMENT AND MEASURING TOOLS

Refer to this section when you need help with taking measurements.

Measuring is an important part of doing science. Measurements allow you to give exact information when you are describing something.

These are the most commonly used measurements:

- Length
- Mass
- Volume
- Temperature

The science community and most countries in the world, including Canada, use the SI system. The SI system is commonly called the metric system.

The metric system is based on multiples of 10. Larger and smaller units are created by multiplying or dividing the value of the base units by multiples of 10. For example, the prefix *kilo-* means "multiplied by 1000." Therefore, one kilometre is equal to one thousand metres. The prefix *milli-* means "divided by 1000," so one millimetre is equal to 1/1000 of a metre. Some common SI prefixes are listed in **Table 1**.

Table 1 Common SI Prefixes

Prefix	Symbol	Factor by which unit is multiplied	Example
kilo	k	1000	1 km = 1000 m
hecto	h	100	1 hm = 100 m
deca	da	10	1 dam = 10 m
		1	
deci	d	0.1	1 dm = 0.1 m
centi	c	0.01	1 cm = 0.01 m
milli	m	0.001	1 mm = 0.001 m

To convert from one unit to another, you simply multiply by a conversion factor. For example, to convert 12.4 m (metres) to centimetres (cm), you use the relationship 1 cm = 0.01 m, or 1 cm = $\frac{1}{100}$ m.

$$12.4 \text{ m} = ? \text{ cm}$$

$$1 \text{ cm} = 0.01 \text{ m}$$

$$(12.4 \cancel{\text{m}})\left(\frac{1 \text{ cm}}{0.01 \cancel{\text{m}}}\right) = 1240 \text{ cm}$$

Any conversion between quantities with the same base unit can be done like this, once you know the conversion factor.

PRACTICE

a) Convert 23 km (kilometres) to metres (m) and to millimetres (mm).

b) Convert 675 mL (millilitres) to litres (L).

c) Convert 450 g (grams) to kilograms (kg) and to milligrams (mg).

If you are not sure which conversion factor you need, look at the information in the box below and in the boxes on pages 286 and 287.

Measuring Length

Length is the distance between two points. Four units can be used to measure length: kilometres (km), metres (m), centimetres (cm), and millimetres (mm).

10 mm = 1 cm
1000 mm = 1 m
100 cm = 1 m
1000 m = 1 km

You measure length when you want to find out how long something is. You also measure length when you want to know how deep, how tall, how far, or how wide something is. The metre is the basic unit of length (**Figure 4** on the next page).

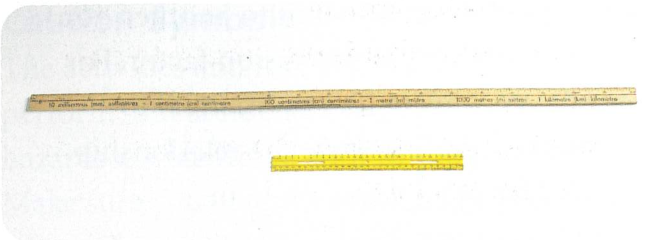


Figure 4
Metric rulers are used to measure lengths in millimetres and centimetres, up to 30 cm. Metre sticks measure longer lengths, up to 100 cm.

PRACTICE

Which unit—millimetres, centimetres, metres, or kilometres—would you use to measure each quantity?

a) the width of a scar or mole on your body
b) the length that your toenails grow in one month
c) your height
d) the length that your hair grows in one month
e) the distance between your home and Calgary
f) the distance between two planets

Tips for Measuring Length

- Always start measuring from the zero mark on a ruler, not from the edge of the ruler.
- Look directly at the lines on the ruler. If you try to read the ruler at an angle, you will get an incorrect measurement.
- To measure something that is not in a straight line, use a piece of string (**Figure 5**). Cut or mark the string. Then use a ruler to measure the length of the string. You could also use a tape measure made from fabric.

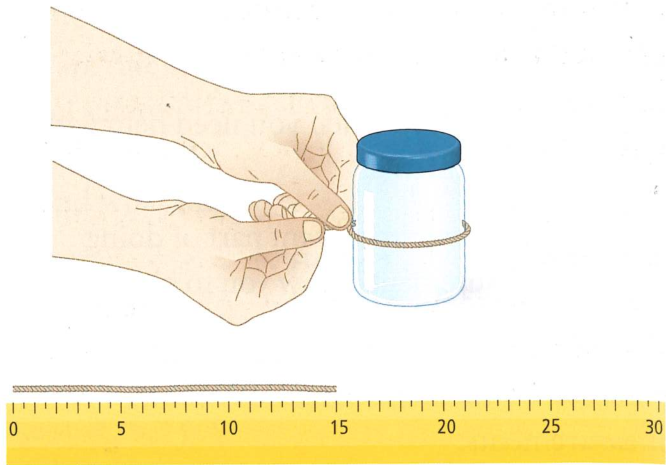


Figure 5

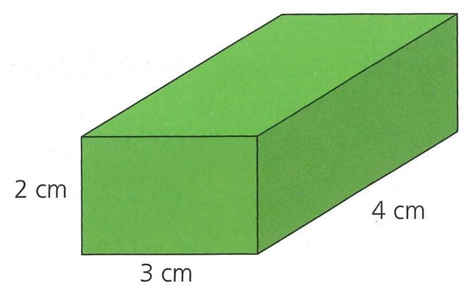
Measuring Volume

Volume is the amount of space that something takes up. The volume of a solid is usually measured in cubic metres (m^3) or cubic centimetres (cm^3). The volume of a liquid is usually measured in litres (L) or millilitres (mL).

1000 mL = 1 L	1 L = 1000 cm^3
1 cm^3 = 1 mL	1000 L = 1 m^3

The volume of a rectangular solid is calculated by measuring the length, width, and height of the solid and then by using the formula

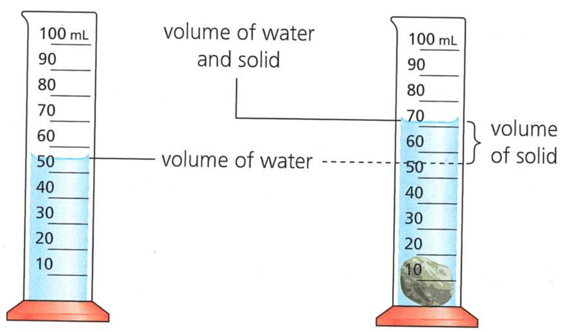
$$\text{Volume} = \text{length} \times \text{width} \times \text{height}$$



Volume is also used to measure the amount of liquid in a container. Scientists use special containers, such as beakers and graduated cylinders, to get precise measurements of volume.

You can also use liquid to help measure the volume of irregularly shaped solids, such as rocks. To measure the volume of an irregularly shaped solid, 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. Calculate the volume of the solid using the following formula:

Volume of solid = (volume of water + solid) − volume of water



Tips for Measuring Volume

- Use a beaker that is big enough to hold twice as much liquid as you need. You want a lot of space so that you can get an accurate reading.
- To measure liquid in a graduated cylinder (or a beaker or a measuring cup), make sure that your eyes are at the same level as the top of the liquid. You will see that the surface of the liquid curves downward. This downward curve is called the **meniscus**. You need to measure the volume from the bottom of the meniscus (**Figure 6**).

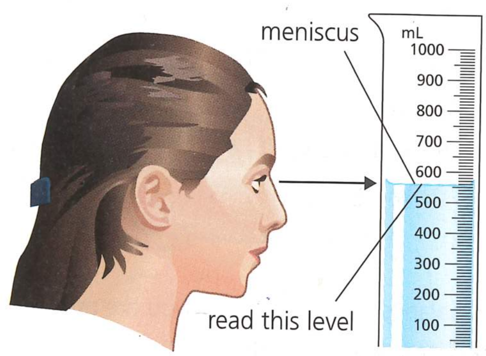


Figure 6
Reading the measurement of a liquid correctly

- Use a graduated cylinder to get the most accurate measurement of volume.

PRACTICE

What volume of liquids do you drink in an average day? Use the illustrations of volume measurements to help you answer this question.

measuring cup 500 mL | milk carton 1 L | tablespoon 15 mL | pop bottle 2 L

Measuring Mass

Mass is the amount of matter in an object. In everyday life, weight is often confused with mass. For example, you probably state your weight in kilograms. In fact, what you are really stating is your mass. The units that are used to measure mass are grams (g), milligrams (mg), kilograms (kg), and metric tonnes (t).

1000 g = 1 kg
1000 mg = 1 g
1000 kg = 1 t

Scientists use balances to measure mass. Two types of balances are the triple-beam balance (**Figure 7**) and the platform, or equal-arm, balance (**Figure 8**).

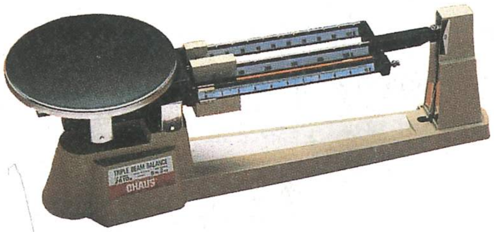


Figure 7
A triple-beam balance: Place the object you are measuring on the pan. Adjust the weights on each beam (starting with the largest) until the pointer on the right side is level with the zero mark. Then add the values of each beam to find the measurement.

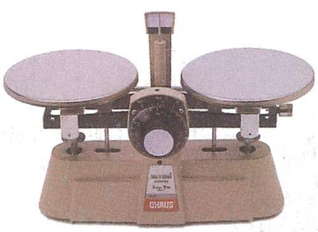


Figure 8
A platform balance: Place the object you are measuring on one pan. Add weights to the other pan until the two pans are level. Then add the values of the weights you added. The total will be equal to the mass of the object you are measuring.

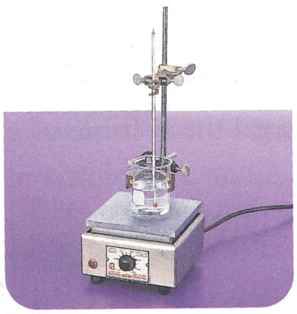
Tips for Measuring Mass

- To measure the mass of a liquid, first measure the mass of a suitable container. Then measure the mass of the liquid in the container. Subtract the mass of the container from the mass of the liquid and the container.
- To measure the mass of a powder or crystals, first determine the mass of a sheet of paper. Then place the sample on the sheet of paper, and measure the mass of both. Subtract the mass of the paper from the mass of the sample and the sheet of paper.

Measuring Temperature

Temperature is the degree of hotness or coldness of an object. In science, temperature is measured in degrees Celsius.

0°C = freezing point of water
20°C = warm spring day
37.6°C = normal body temperature
65°C = water hot to touch
100°C = boiling point of water



Measuring the temperature of water

Each mark on a Celsius thermometer is equal to one degree Celsius. The glass contains a coloured liquid—usually mercury or alcohol. When you place the thermometer in a substance, the liquid in the thermometer moves to indicate the temperature.

Tips for Measuring Temperature

- Make sure that the coloured liquid has stopped moving before you take your reading.
- Hold the thermometer at eye level to be sure that your reading is accurate.

READING FOR INFORMATION

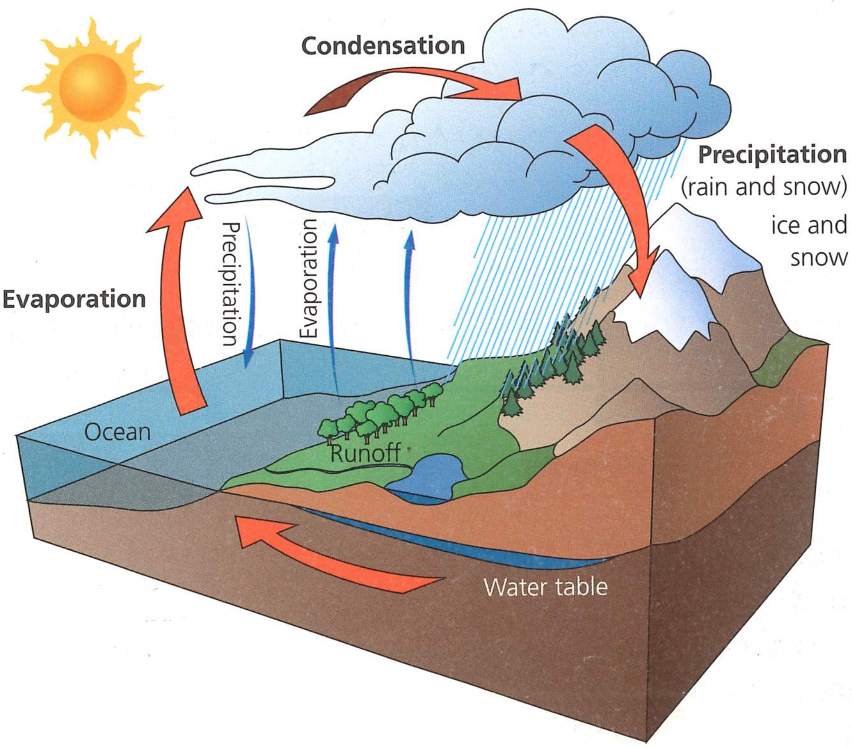
USING GRAPHIC ORGANIZERS

Diagrams that are used to organize and display ideas visually are called graphic organizers. A graphic organizer can help you see connections and patterns among different ideas. Different graphic organizers are used for different purposes.

- To Show Processes
- To Organize Ideas and Thinking
- To Compare and Contrast
- To Show Properties or Characteristics

To Show Processes

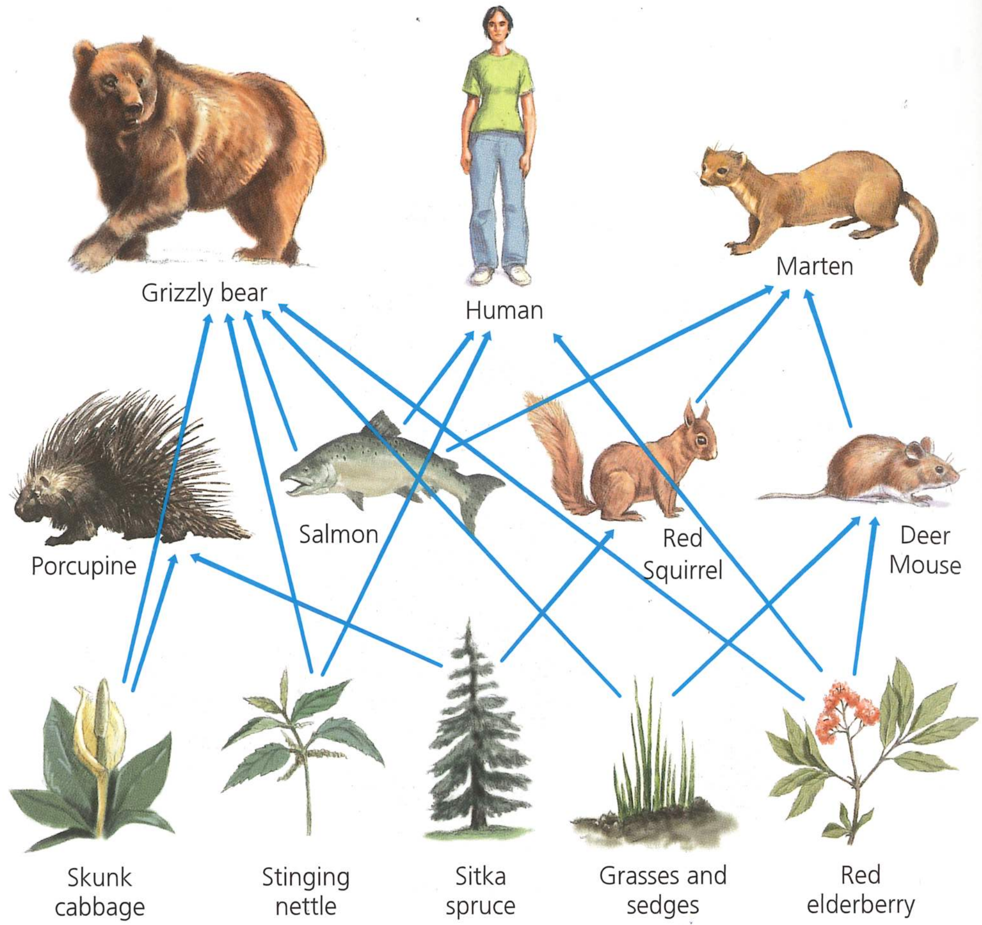
You can use a **flow chart** to show a sequence of steps or a time line.



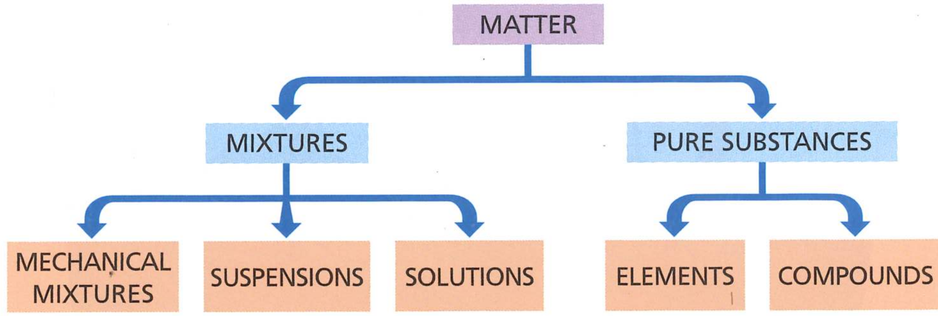
You can use a **cycle map** to show cycles in nature.

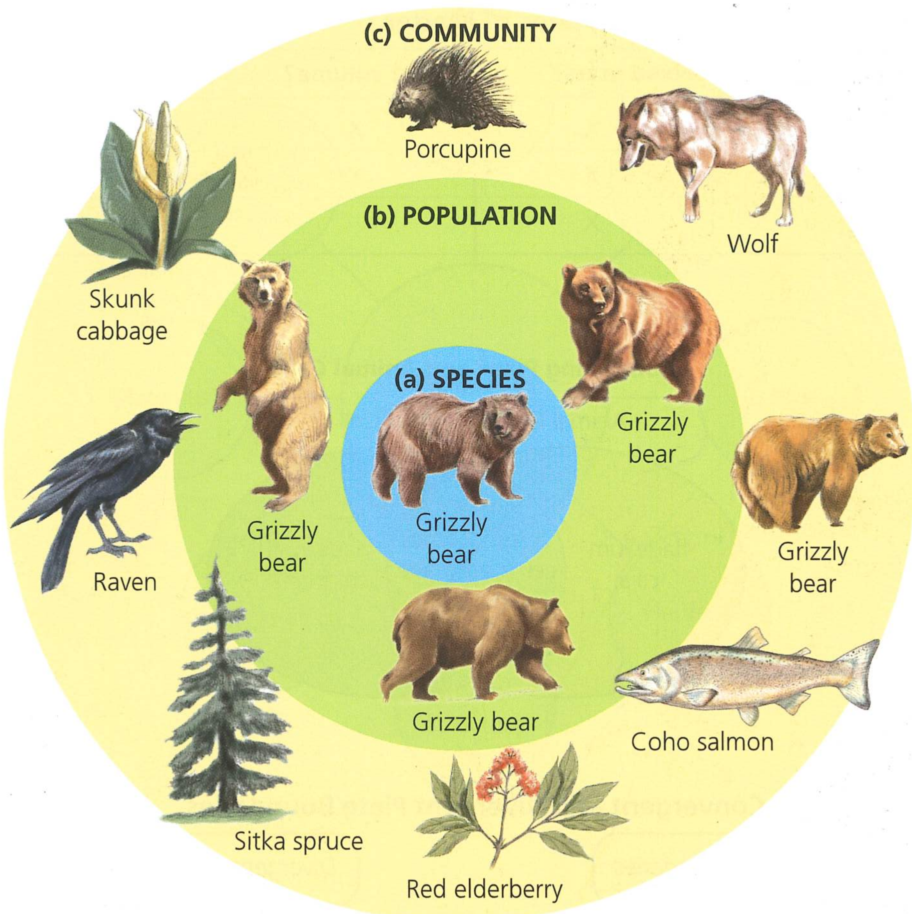
To Organize Ideas and Thinking

A **concept map** is a collection of words or pictures, or both, connected with lines or arrows. You can write on the lines or arrows to explain the connections. You can use a concept map to brainstorm what you already know, to mind map your thinking, or to summarize what you have learned.



You can use a **tree diagram** to show concepts that can be broken down into smaller categories.





You can use a **nested circle diagram** to show parts within a whole.

To Compare and Contrast

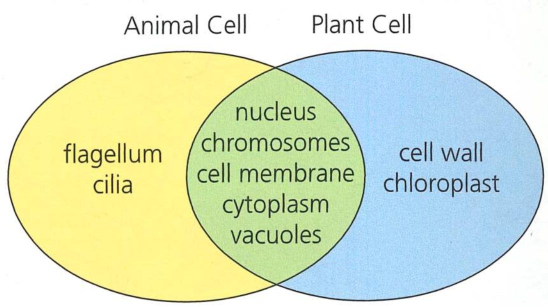
You can use a **comparison matrix** to record and compare observations or results.

Comparison of the Three States of Matter

State	Fixed mass?	Fixed volume?	Fixed shape?
solid	X	X	X
liquid	X	X	
gas	X		

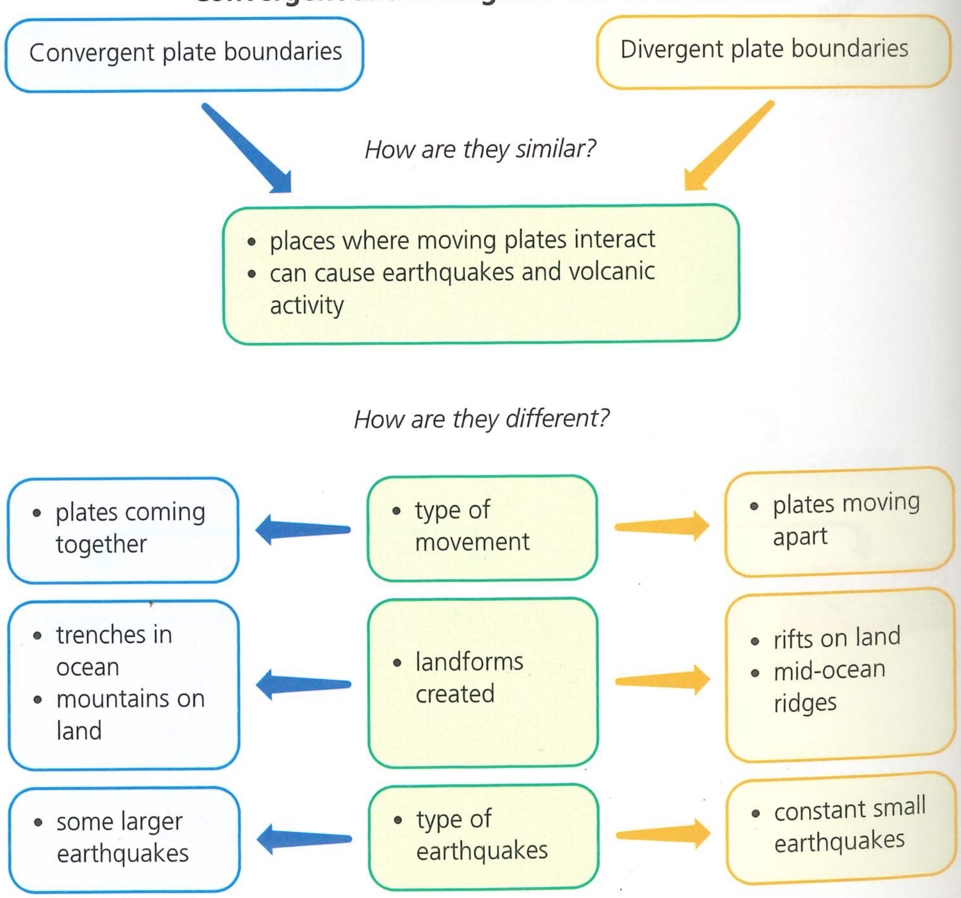
You can use a **Venn diagram** to show similarities and differences. Similarities go in the middle section.

Comparing Plant and Animal Cells

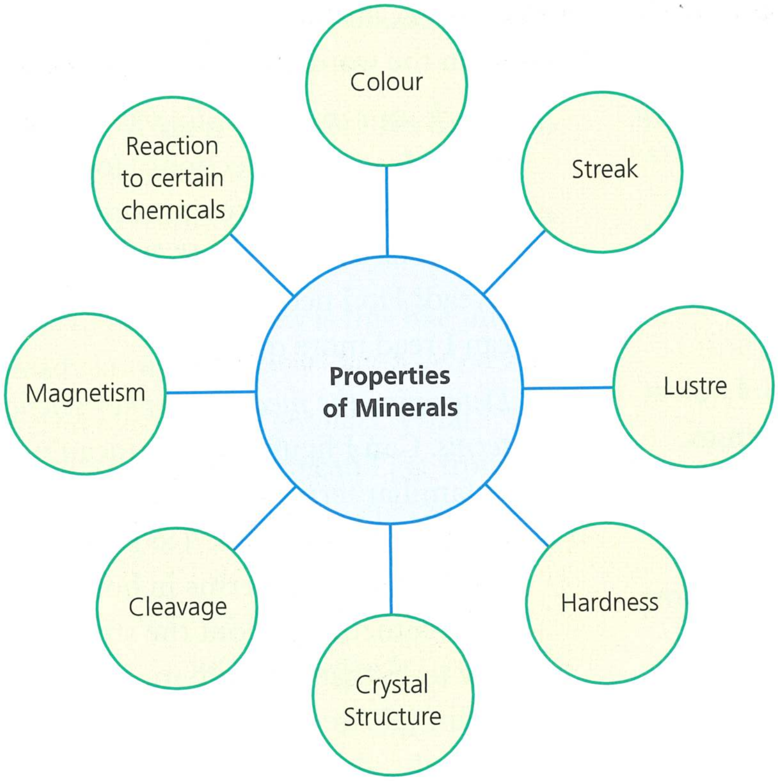


You can use a **compare and contrast chart** to show both similarities and differences.

Convergent and Divergent Plate Boundaries



To Show Properties or Characteristics



You can use a **bubble map** to show properties.

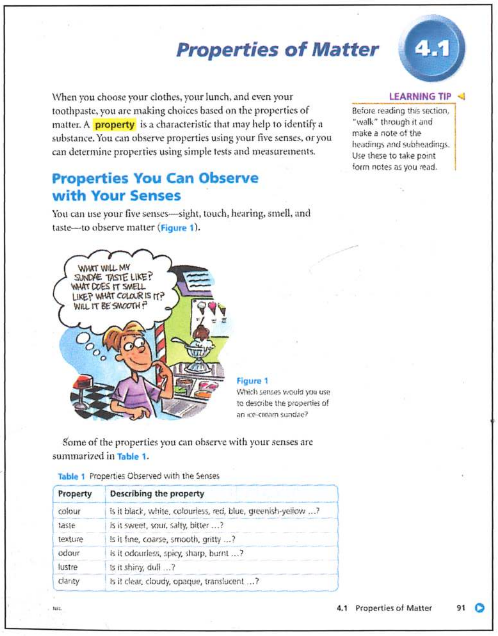
READING STRATEGIES

The skills and strategies you use to help you read can differ, depending on the type of material you are reading. Reading a science text is different from reading a novel. When you are reading a science text, you are reading for information. Here are some strategies to help you read for information.

Before Reading

Skim the section you are going to read. Look at the illustrations, headings, and subheadings.

- *Preview.* What is this section about? How is it organized?
- *Make connections.* What do I already know about the topic? How is it connected to other topics I have already learned?
- *Predict.* What information will I find in this section? Which parts will give me the most information?
- *Set a purpose.* What questions do I have about the topic?



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 ...?

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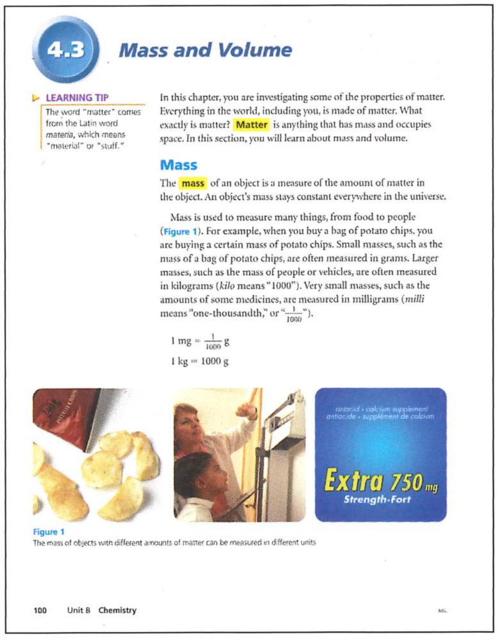
During Reading

Pause and think as you read. Spend time on the photographs, illustrations, tables, and graphs, as well as on the words.

- *Check your understanding.* What are the main ideas in this section? How would I explain them in my own words? What questions do I still have? Do I need to reread? Do I need to read more slowly, or can I read more quickly?
- *Determine the meanings of key science terms.* Can I figure out the meaning of unfamiliar terms from context clues in words or illustrations? Do I understand the definitions of terms in bold type? Is there something about the structure of a new term that will help me remember its meaning? Are there terms I should look up in the glossary?



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

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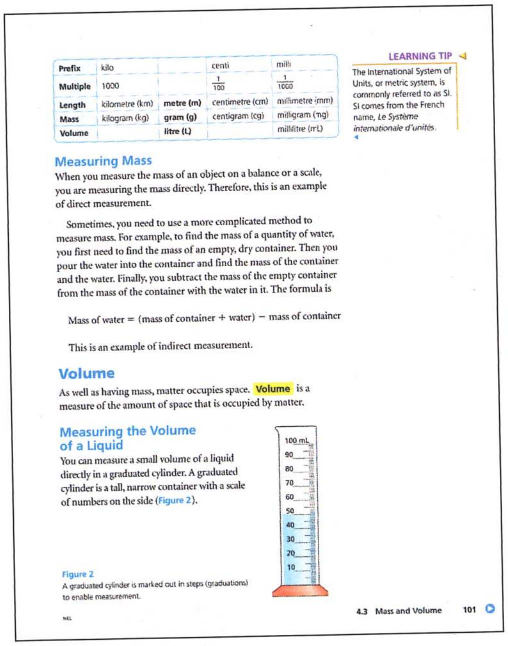
- *Make inferences.* What conclusions can I make from what I am reading? Can I make any conclusions by "reading between the lines"?
- *Visualize.* What mental pictures can I make to help me understand and remember what I am reading? Would it help to make a sketch?
- *Make connections.* How is this like things I already know?
- *Interpret visuals and graphics.* What additional information can I get from the photographs, illustrations, charts, or graphs?



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.

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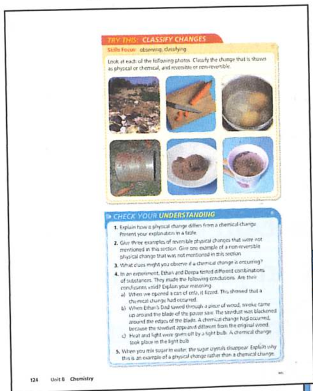
After Reading

Many of the strategies you use during reading can be used after reading as well. For example, in this text, there are questions to answer after you read. These questions will help you check your understanding and make connections.

- *Locate needed information.* Where can I find the information I need to answer the questions? Under what heading might I find the information? What terms in bold type should I skim for? What details do I need to include in my answers?
- *Synthesize.* How can I organize this information? What graphic organizer could I use? What headings or categories could I use?
- *React.* What are my opinions about this information? How does it, or might it, affect my life or my community? Do other students agree with my reactions?
- *Evaluate information.* What do I know now that I did not know before? Have any of my ideas changed as a result of what I have read? What questions do I still have?



TRY THIS: CLASSIFY CHANGES

Skills Focus: observing, classifying

Look at each of the following photos. Classify the change that is shown as physical or chemical, and reversible or non-reversible.

CHECK YOUR UNDERSTANDING

1. Explain how a physical change differs from a chemical change. Present your explanation in a table.
2. Give three examples of reversible physical changes that were not mentioned in this section. Give one example of a non-reversible physical change that was not mentioned in this section.
3. What clues might you observe if a chemical change is occurring?
4. In an experiment, Ethan and Deepa tested different combinations of substances. They made the following conclusions. Are their conclusions valid? Explain your reasoning.
   a) When we opened a can of cola, it fizzed. This showed that a chemical change had occurred.
   b) When Ethan's Dad sawed through a piece of wood, smoke came up around the blade of the power saw. The sawdust was blackened around the edges of the blade. A chemical change had occurred, because the sawdust appeared different from the original wood.
   c) Heat and light were given off by a light bulb. A chemical change took place in the light bulb.
5. When you mix sugar in water, the sugar crystals disappear. Explain why this is an example of a physical change rather than a chemical change.

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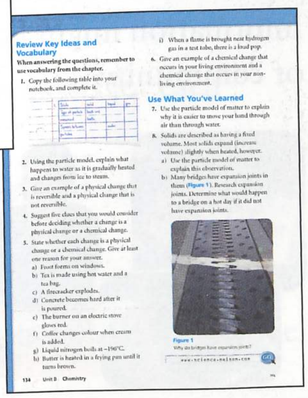

Review Key Ideas and Vocabulary

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

1. Copy the following table into your notebook, and complete it.
2. Using the particle model, explain what happens to water as it is gradually heated and changes from ice to steam.
3. Give an example of a physical change that is reversible and a physical change that is not reversible.
4. Suggest five clues that you would consider before deciding whether a change is a physical change or a chemical change.
5. State whether each change is a physical change or a chemical change. Give at least one reason for your answer.
   a) Frost forms on windows.
   b) Tea is made using hot water and a tea bag.
   c) A firecracker explodes.
   d) Concrete becomes hard after it is poured.
   e) The burner on an electric stove glows red.
   f) Coffee changes colour when cream is added.
   g) Liquid nitrogen boils at −196°C.
   h) Butter is heated in a frying pan until it turns brown.
   i) When a flame is brought near hydrogen gas in a test tube, there is a loud pop.
6. Give an example of a chemical change that occurs in your living environment and a chemical change that occurs in your non-living environment.

Use What You've Learned

7. Use the particle model of matter to explain why it is easier to move your hand through air than through water.
8. Solids are described as having a fixed volume. Most solids expand (increase volume) slightly when heated, however.
   a) Use the particle model of matter to explain this observation.
   b) Many bridges have expansion joints in them (Figure 1). Research expansion joints. Determine what would happen to a bridge on a hot day if it did not have expansion joints.

Figure 1

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RESEARCHING

There is an incredible amount of scientific information that is available to you. Here are some tips on how to gather scientific information efficiently.

- Identify the Information You Need
- Find Sources of Information
- Evaluate the Sources of Information
- Record and Organize the Information
- Communicate the Information

Identify the Information You Need

Identify your research topic. Identify the purpose of your research.

Identify what you, or your group, already know about your topic. Also identify what you do not know. Develop a list of key questions that you need to answer. Identify categories based on your key questions. Use these categories to identify key search words.

Find Sources of Information

Identify all the places where you could look for information about your topic. These places might include videotapes of science programs on television, people in your community, print sources (such as books, magazines, and newspapers), and electronic sources (such as CD-ROMs and Internet sites). The sources of information might be in your school, home, or community.

Evaluate the Sources of Information

Preview your sources of information, and decide whether they are useful. Here are four things to consider.

- *Authority:* Who wrote or developed the information or sponsors the Web site? What are their qualifications?
- *Accuracy:* Are there any obvious errors or inconsistencies in the information? Does the information agree with other reliable sources?
- *Currency:* Is the information up to date? Has recent scientific information been included?
- *Suitability:* Does the information make sense to someone your age? Do you understand it? Is it organized in a way that you understand?

Record and Organize the Information

Identify categories or headings for note taking. Record information, in your own words, under each category or heading, perhaps in point form. If you quote a source, use quotation marks.

Record the sources to show where you got your information. Include the title, author, publisher, page number, and date. For Web sites, record the URL (Web site address).

If necessary, add to your list of questions as you find new information.

Communicate the Information

Choose a format for communication that suits your audience, your purpose, and the information.

COMMUNICATING IN SCIENCE

CREATING DATA TABLES

Data tables are an effective way to record both qualitative and quantitative observations. Making a data table should be one of your first steps when conducting an investigation. You may decide that a data table is enough to communicate your data, or you may decide to use your data to draw a graph. A graph will help you analyze your data. (See "Graphing Data," on page 298, for more information about graphs.)

Sometimes you may use a data table to record your observations in words, as shown below.

Data table for Investigation 7.2

Mineral number	Colour	Streak	Lustre	Hardness	Magnetism	Reaction with vinegar	Cleavage	Name
1	grey-black	reddish brown	metallic					

Sometimes you may use a data table to record the values of the independent variable (the cause) and the dependent variables (the effects), as shown to the left. (Remember that there can be more than one dependent variable in an investigation.)

Average Monthly Temperatures in Cities A and B

Month	Temperature (°C) in City A	Temperature (°C) in City B
January	-7	-6
February	-6	-6
March	-1	-2
April	6	4
May	12	9
June	17	15

Follow these guidelines to make a data table:

- Use a ruler to make your table.
- Write a title that describes your data as precisely as you can.
- Include the units of measurements for each variable, when appropriate.
- List the values of the independent variable in the left-hand column of your table.
- List the values of the dependent variable(s) in the column(s) to the right of the independent variable.

GRAPHING DATA

When you conduct an investigation or do research, you often collect a lot of data. Sometimes the patterns or relationships in the data are difficult to see. For example, look at the data in **Table 1**.

Table 1 Average Rainfall in Campbell River

Month	Rainfall (mm)
January	142
February	125
March	128
April	73
May	59
June	50
July	40
August	43
September	62
October	154
November	210
December	197

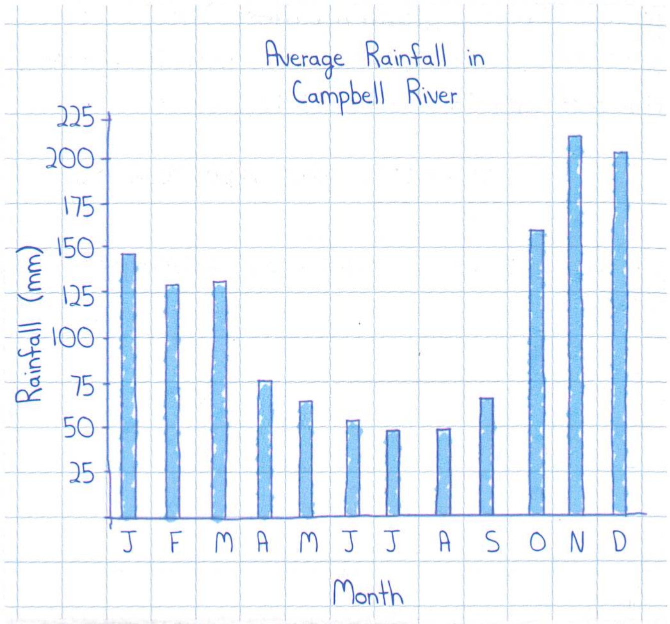
One way to arrange your data so that it is easy to read and understand is to draw a graph. A graph shows numerical data in the form of a diagram. There are three kinds of graphs that are commonly used:

- bar graphs
- line graphs
- circle (pie) graphs.

Each kind of graph has its own special uses. You need to identify which type of graph is best for the data you have collected.

Bar Graphs

A **bar graph** helps you make comparisons and see relationships when one of two variables is in numbers and the other is not. The following bar graph was created from the data in **Table 1**. It clearly shows the rainfall in different months of the year and makes comparison easy.

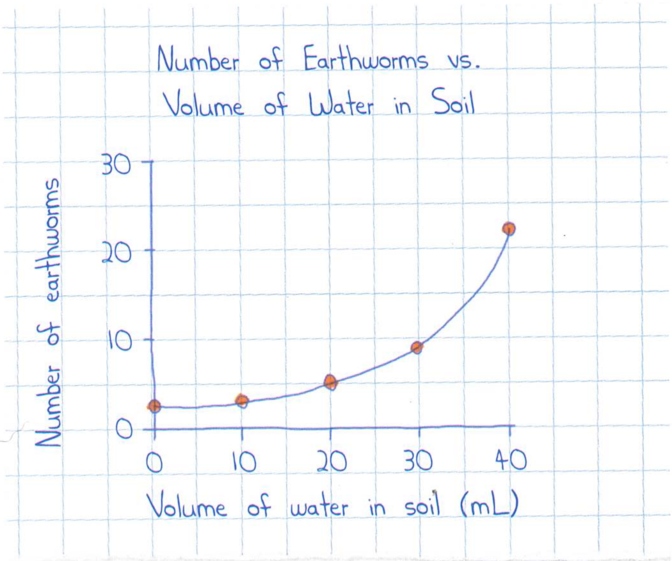


Line Graphs

A **line graph** is useful when you have two variables in numbers. It shows changes in measurement. It helps you decide whether there is a relationship between two sets of numbers: for example, "if this happens, then that happens." Table 2 gives the number of earthworms found in specific volumes of water in soil. The line graph for these data helps you see that the number of earthworms increases as the volume of water in soil increases.

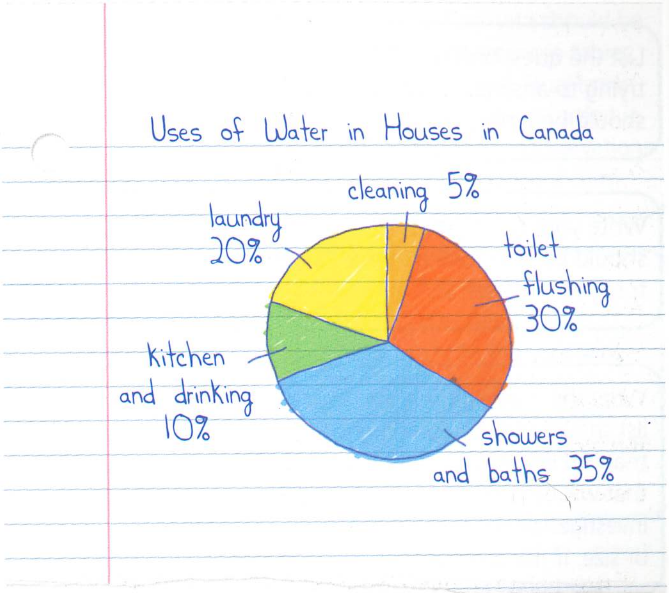
Table 2 Number of Earthworms per Volume of Water in Soil

Volume of water in soil (mL)	Number of earthworms
0	3
10	4
20	5
30	9
40	22



Circle Graphs

A **circle graph** (or pie graph) shows the whole of something divided into all its parts. A circle graph is round and shows how large a share of the circle belongs to different things. You can use circle graphs to see how the different things compare in size or quantity. It is a good way to graph data that are percentages or can be changed to percentages.



WRITING A LAB REPORT

When you design and conduct your own experiment, it is important to report your findings. Other people may want to repeat your experiment, or they may want to use or apply your findings to another situation. Your write-up, or report, should reflect the process of scientific inquiry that you used in your experiment.

Write the title of your experiment at the top of the page.

List the question(s) you were trying to answer. This section should be written in sentences.

Write your hypothesis. It should be a sentence in the form "If … then …."

Write the materials in a list. Your list should include equipment that will be reused and things that will be used up in the investigation. Give the amount or size, if this is important.

Describe the procedure using numbered steps. Each step should start on a new line and, if possible, it should start with a verb. Make sure that your steps are clear so that someone else could repeat your experiment and get the same results. Include any safety precautions.

Draw a large diagram with labels to show how you will set up the equipment. Use a ruler for straight lines.

Conductivity of Water

Question

Which type of water – pure water, water with dissolved sugar, or water with dissolved salt – conducts electricity the best?

Hypothesis

If water is very pure, like distilled water with no solutes, then it will conduct electricity better than water with sugar or salt dissolved in it.

Materials

- 3 clean glass jars
- distilled water
- sugar
- salt
- 3 short strips of masking tape
- pen
- 2 D-cell batteries
- battery holder
- 1 piece of wire, 25 cm long
- 2 pieces of wire, each 10 cm long
- wire strippers
- light-bulb holder
- small light bulb (such as a flashlight bulb)

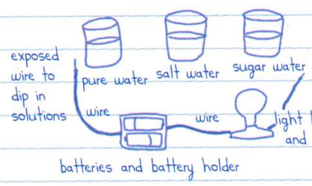
Procedure

1. Put 250 mL of distilled water in each clean jar. Do not add anything to the first jar. Add 30 mL of salt to the second jar, and mix. Add 30 mL of sugar to the third jar, and mix. Label the jars "pure water," "salt water," and "sugar water."
2. Put the batteries in the holder.
3. Strip the plastic coating off the last centimetre at the ends of all three wires, using the wire strippers.

CAUTION: Always pull the wire strippers away from your body.

4. Attach one end of the 25-cm wire to the knobby end of the battery by tucking it in the battery holder. The other end of the wire should hang free for now.
5. Attach one end of a 10-cm wire to the flat part of the battery. Attach the other end to the clip in the light-bulb holder.

6. Place the light bulb in the holder.
7. Attach one end of the other 10-cm wire to the clip in the light-bulb holder. Let the other end hang free for now.
8. Dip the loose wire ends into the distilled water. Observe whether the light bulb goes on. Record "yes" or "no."
9. Repeat step 8 for the other two types of water.



Data and Observations

Type of water	Does the light bulb go on?
distilled water	no
water with salt	yes
water with sugar	no

Analysis

The salt water was the only type of water that turned on the light bulb. Something in the salt must help to conduct electricity. Since the distilled water did not turn on the light bulb, this must mean that it cannot conduct electricity. Something is missing from the distilled water. The sugar water did not conduct electricity either, so it must also be missing the ingredient that helps to conduct electricity.

Conclusion

Pure (distilled) water does not conduct electricity. The hypothesis is not supported by the data, so it is incorrect. Salt water conducts electricity.

Applications

Knowing that salt water conducts electricity might help scientists recover materials from seawater by running electricity through it. Also, I think the water in the human body has salt and other things dissolved in it. It would conduct electricity well, so people should be careful about electricity.

Present your observations in a form that is easily understood. The data should be recorded in one or more tables, with units included. Qualitative observations can be recorded in words or drawings. Observations in words can be in point form.

Interpret and analyze your results. If you have made graphs, include and explain them here. Answer any questions from the student text here. Your answers should include the questions.

A conclusion is a statement that explains the results of an experiment. Your conclusion should refer back to your hypothesis. Was your hypothesis correct, partly correct, or incorrect? Explain how you arrived at your conclusion. This section should be written in sentences.

Describe how the new information you gained from doing your experiment relates to real-life situations. How can this information be used?

GLOSSARY

A

acid a compound that forms a sour-tasting solution, which reacts with metals and can cause serious burns on skin; a solution that is acidic turns blue litmus paper red

acidic a term used to describe a solution that has a value below 7 on the pH scale; the more acidic a solution, the lower its pH value

aftershocks smaller tremors that may occur after an earthquake as pressure in Earth's crust is gradually released; may occur at any time for months after an earthquake

B

base a compound that forms a bitter-tasting solution, which feels slippery, reacts with fats and oils, and can cause serious burns on skin; a solution that is basic turns red litmus paper blue

basic a term used to describe a solution that has a value above 7 on the pH scale; the more basic a solution, the higher its pH value

biodiversity the variety of plant and animal life within an ecosystem; the greater the number of different types of plants and animals, the greater the biodiversity

biological weathering weathering that is aided by living things, such as plants, animals, and microorganisms

biome large regions of Earth where temperature and precipitation are the same and similar plants and animals are found

biosphere the parts of Earth where life can be found, from mountaintops to the deepest parts of the ocean

boiling point the temperature at which the liquid form of a substance changes to a gas; for example, liquid water changes to water vapour (a gas) at 100°C

C

carnivore a consumer that eats other animals; for example, wolves and orca are carnivores

chemical change a reaction in which the original substance is changed into one or more different substances with different properties; clues that a chemical change has occurred include the production of heat or light, gas bubbles, a colour change, and the formation of new substances

chemical weathering weathering that is caused by a chemical reaction between water, air, or another substance and the materials in rocks

community a group that is made up of two or more populations of different species in an ecosystem

compound a pure substance that is made up of two or more different elements; consists of only one kind of particle

concentration the amount of a substance (the solute) that is dissolved in a given quantity of the substance it is dissolved in (the solvent); the more solute dissolved, the greater the concentration; for example, the concentration of an orange-drink solution depends on the amount of orange-drink crystals dissolved in a given amount of water

condensation the change in the state of a substance from a gas to a liquid; happens when a gas cools and its particles move slower; the opposite of evaporation

consumer an organism, such as an animal, that must obtain its food by eating other organisms in its environment

continental crust the parts of Earth's crust that have continents on them

convergent boundary an area of Earth's crust between plates that are moving toward each other and colliding

crust the "shell" of rock that makes up the hard outermost layer of Earth; "floats" on the inner layers of Earth because it is made of lighter materials than the lower layers

cycle anything that happens over and over again; for example, the seasons of the year and the phases of the moon are both cycles

D

decomposer an organism that gets its food energy by breaking down the final remains of living things, such as dead animals and plants and animal waste; for example, bacteria and fungi are decomposers

delta deposits of sediment in the shape of a triangle at the mouth of a river

density the mass of a substance per unit volume of the substance; expressed as grams per cubic centimeter (g/cm^3) or grams per millilitre (g/mL)

deposition the settling of eroded rock materials on Earth's surface

detrivore an organism that feeds on large bits of dead and decaying plant and animal matter; for example, earthworms, dung beetles, and wolverines are detrivores

dilute a solution that has a low concentration of the dissolved substance (the solute); for example, lemonade with a small amount of dissolved sugar is a more dilute solution than lemonade with a lot of dissolved sugar

dissolve to completely mix one substance (the solute) in another (the solvent) to form a solution; for example, if you add sugar to water, the sugar dissolves in the water

divergent boundary an area of Earth's crust between plates that are moving apart

E

earthquake a vibration of Earth's crust, caused by the sudden release of accumulated energy from plate movement

ecological pyramid a model that shows the effects of the loss of energy in a food chain; at each higher level of the pyramid, the amount of available energy and the number of organisms decrease

ecosystem the network of interactions that link together the living and non-living parts of an environment

element a pure substance that cannot be broken down into any other pure substance; consists of only one kind of particle

emulsion a special kind of suspension that has been treated to prevent the parts of the mixture from separating; for example, homogenized milk is an emulsion

erosion the movement of weathered rock material from one place to another

evaporation the change in the state of a substance from a liquid to a gas; happens when a liquid is heated enough for its particles to break free of each other; the opposite of condensation

extrusive igneous rock igneous rock that is formed on Earth's surface when lava cools

F

fiord a long and narrow inlet of the sea that is formed when valleys become filled with seawater

food chain a model that shows how food energy is passed from one organism to another in a feeding pathway

food web a model that represents several interconnected food chains

fossil rock-like cast, impression, or actual remains of an organism that was buried when it died, before it could decompose

fossil record the history of changes to life on Earth as shown by fossils

freezing (or solidification) the change in the state of a substance from a liquid to a solid; happens when a liquid cools and its particles move more slowly until they settle into fixed positions in a pattern; the opposite of melting

freezing point the temperature at which the liquid form of a substance changes to a solid; for example, liquid water changes to solid ice at 0°C; the freezing point of a substance is the same as its melting point

G

gas a substance with no fixed volume or shape; will fill any container it is in, taking on the container's shape

geologic time scale a time line of the changes to life on Earth

H

habitat the physical space where a certain species lives

herbivore a consumer that eats only plants

hot spot part of the mantle where the temperature is much higher than normal; the magma melts the rock above it and rises to the surface of Earth

I

ice wedging the widening or splitting of cracks in rocks as rainwater freezes and expands

igneous rock rock that forms from the cooling and hardening of liquid magma; most of Earth's crust is composed of igneous rock

indigenous knowledge understandings, values, and beliefs about the natural world that are unique to a particular group or culture who have lived for a very long time in a particular area. This specialized knowledge is passed from generation to generation in the form of stories told, experiences shared, or songs sung by Elders or other people

inner core the innermost layer of Earth, which is made up of iron and nickel

intrusive igneous rock igneous rock that is formed when magma cools below Earth's surface

L

lava magma that is forced out of cracks onto Earth's surface

liquid a substance with a fixed volume but no fixed shape; takes the shape of the container it is in; particles can move around more freely in a liquid than they can in a solid

M

magma hot molten rock; cools to form igneous rock

mantle the layer of Earth between the crust and the outer core; a hot, thick layer of solid and partly melted rock

mass a measurement of the amount of matter in an object; usually measured in milligrams (mg), grams (g), or kilograms (kg); an object's mass stays constant everywhere in the universe

matter anything that has mass and volume (occupies space)

mechanical mixture a mixture in which two or more different parts can be seen with the unaided eye; for example, granola cereal is a mechanical mixture

mechanical weathering weathering caused by a physical force such as ice, wind, or water

melting the change in the state of a substance from a solid to a liquid; happens when a solid is heated enough to free its particles from their fixed positions; the opposite of freezing

melting point the temperature at which the solid form of a substance changes to a liquid; for example, water changes from solid ice to liquid water at 0°C; the melting point of a substance is the same as its freezing point

metamorphic rock rock that is formed below Earth's surface when heat and pressure cause the characteristics of the existing rock to change

micro-organism a living thing that is too small to be seen without the help of a microscope; for example, bacteria and some algae are micro-organisms

mid-ocean ridge the long underwater mountain range that runs through the middle of the oceans

mineral pure, naturally occurring substance that is found in Earth's crust; the building block of rock; for example, diamonds, graphite, and talc are minerals

mixture any substance that contains two or more pure substances and therefore has two or more kinds of particles; properties of mixtures can be different in different samples

mountain a landmass that rises significantly from the surrounding level of Earth's surface

N

neutral neither an acid nor a base; on the pH scale, a neutral substance or solution has a value of 7

niche the way that an organism fits into an ecosystem, in terms of where it lives, how it obtains its food, and how it interacts with other organisms

non-reversible change a change in a substance that cannot be reversed; for example, wood sawed into pieces cannot be put together to form the original piece of wood again

O

oceanic crust the parts of Earth's crust that have only ocean floor on them

omnivore a consumer that eats both plants and animals

organism a living thing, such as a plant or an animal

outer core a dense, hot layer of Earth between the mantle and the inner core; made up of mostly liquid iron and some nickel

P

Pangaea the name of a hypothetical supercontinent proposed by Alfred Wegener

particle model a scientific model that describes matter as made up of tiny particles with spaces between the particles; the particles are always moving, and adding heat makes them move faster

pH a scale that measures the acidity of substances; has numbers from 0 (strongly acidic) to 7 (neutral) to 14 (strongly basic)

photosynthesis the process in which the Sun's energy is used by plants to produce simple sugars from carbon dioxide and water; oxygen is released in this process

physical change a change in the properties of a substance, such as its form or state; the substance itself does not change; for example, a piece of wood cut into pieces is still wood, and melted wax is still wax

plain a level area of land; usually in the interior of a continent

plateau a large area of high, fairly flat ground

plate tectonics the theory that the surface of Earth consists of approximately a dozen large plates that are continually moving

population all the members of one particular species living in a given area

predator an organism that hunts another living thing for food

preserve to maintain something in its existing state; for example, you can help to preserve an ecosystem by working to keep it in its current state

prey an organism that is hunted by a predator

producer an organism that can make its own food from non-living materials

property a characteristic of a material that can be observed (colour or lustre) or determined through simple tests and measurements (density or melting point)

pure substance a substance that contains only one kind of particle throughout and therefore always has the same properties; there are two kinds of pure substances: elements and compounds

R

reversible change a change in a substance that can be reversed; for example, melted wax can be cooled to form solid wax again

rock cycle the changing of igneous, sedimentary, and metamorphic rocks from one into another over a long period of time

S

saturated a solution in which no more of one substance (the solute) can be dissolved in another substance (the solvent); for example, when you cannot dissolve any more drink crystals in water, the solution is saturated

sediment solid particles (such as rock particles, clay, mud, sand, gravel, and boulders) that are carried by moving water and gradually settle onto the floor of a lake or ocean

sedimentary rock rock that is formed by the breaking down, depositing, compacting, and cementing of sediment

seismic wave an energy wave that is caused by an earthquake

solid a substance with a fixed shape and a fixed volume; the particles in a solid only move a little—they vibrate back and forth but remain in a fixed position in a pattern

solubility the ability of a substance (the solute) to dissolve in another substance (the solvent); temperature plays an important role in solubility; for example, you can dissolve more orange-drink crystals in warm water than in cold water

solution a mixture of two or more substances that appears to be made up of only one substance; for example, clear apple juice (a liquid), clean air (a gas), and stainless steel (a solid mixture of metals) are all solutions

species a term used to describe each different kind of organism; for example, all dogs (from toy poodles to great Danes) belong to the same species because they can mate and reproduce fertile offspring; cats belong to a different species than dogs

state a property describing whether a substance is a solid, a liquid, or a gas; for example, water can be found as a solid (ice), a liquid (water), or a gas (water vapour in the air)

stewardship taking personal responsibility for something; for example, by caretaking in an ecosystem

subduction zone an area of Earth's crust where one plate is sinking below another

sublimation the change in state of a substance from a solid to a gas without first becoming a liquid; happens when particles of a solid gain enough energy to break completely away from the other particles, forming a gas

supersaturated a solution that is more than saturated; contains more of the dissolved substance (the solute) than would normally be found in a saturated solution

suspension a cloudy mixture in which clumps of a solid or droplets of a liquid are scattered throughout a liquid or gas; for example, muddy water is a suspension

sustainability the ability of ecosystems to bear the impact of the human population over a long period of time, through the replacement of resources and the recycling of waste

T

transform fault boundary an area of Earth's crust between plates that are slipping past each other

tsunami an ocean wave that is caused by an earthquake or an underwater volcano

U

unsaturated a solution in which more of one substance (the solute) can still be dissolved in another substance (the solvent); for example, when you can still dissolve drink crystals in water, the solution is unsaturated

V

valley a low region of land between hills or mountains

volcano any opening in Earth's crust through which molten rock and other materials erupt

volume a measure of the amount of space that is occupied by matter; the volume of a liquid is generally measured in millilitres (mL) or litres (L); the volume of a solid is usually measured in cubic centimetres (cm^3); 1 cm^3 is the same as 1 mL, and 1000 cm^3 equals 1 L

W

weathering the process that slowly breaks down natural materials (such as rocks and boulders) into smaller pieces