# Guide to the Skills Toolkits

## SCIENCE SKILLS TOOLKITS



## NUMERACY SKILLS TOOLKITS



## LITERACY SKILLS TOOLKITS

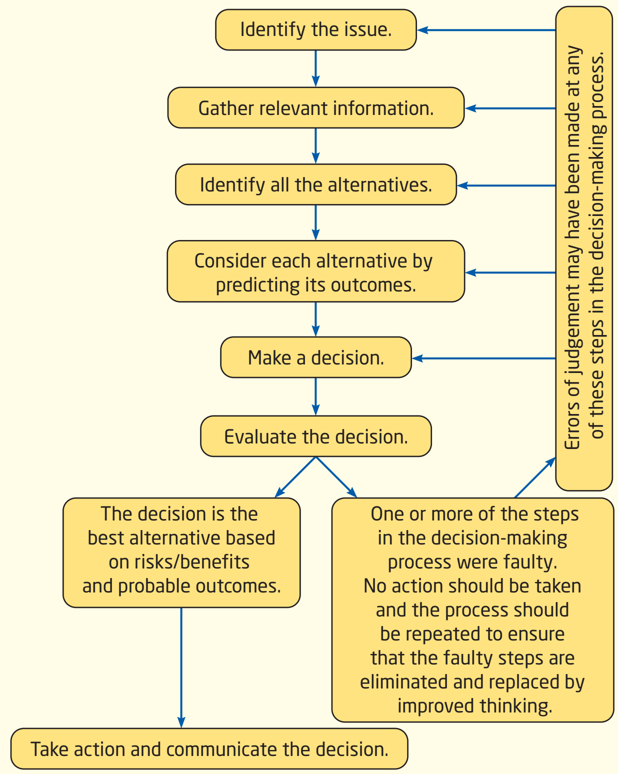
## Analyzing Issues—Science, Technology, Society, and the Environment

Can you think of an issue that involves science, technology, society, and the environment? An **issue** is a topic that can be seen from more than one point of view. How about the use of salt to de-ice roads in the winter? Roads are safer in winter when they are clear of ice and snow.

In a conversation with a friend, however, you find out that road salt may damage the environment. How might you use science and technology to solve this problem?

Suppose your town council is in the process of deciding whether to expand its road salting program. How will you analyze this issue and determine what action to take? The concept map on this page shows a process to help you focus your thinking and stay on track.

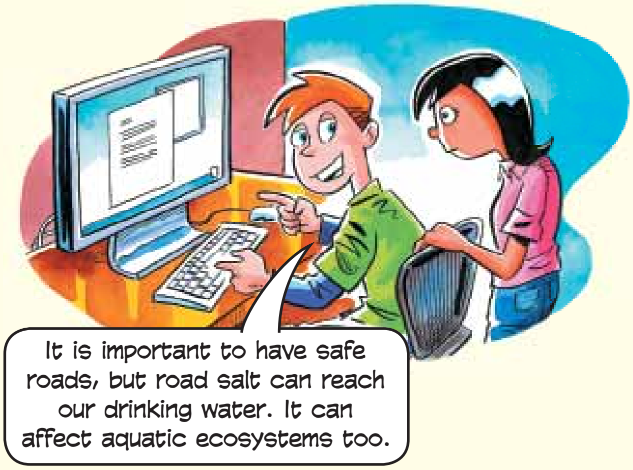
**A Process for Analyzing Issues**




### Identifying the Issue

Soon after talking with your friend about road salting, you go to your friend's house. You find your friend sitting in front of the computer, writing a letter to the town council. In it, your friend is asking that the salting program not be expanded to your area.

### Gathering Information




Once you have identified the issue, you will need to find out more information.


The Internet and other sources, such as books or experts, are great places to find information about an issue. One thing that is important to do when gathering information is to look for bias.

**Bias** is a personal and possibly unreasonable judgement of an issue. For example, a person who makes his or her living putting salt on the roads may have a bias that salt does not harm the environment. It is important to check the source of information to determine whether it is unbiased. Refer to **Science Skills Toolkit 7** for more information about how to research information.

Another important part of gathering information is taking notes so that you can analyze what you have learned. You may read about different viewpoints or solutions and advantages and disadvantages for each one. It is helpful to be able to organize your notes in the form of a graphic organizer such as a concept map, a flowchart, or a Venn diagram. You will find information on using graphic organizers in **Literacy Skills Toolkit 5**.

### Identifying and Considering Alternatives

Your research may lead you to ask new questions about alternative solutions and how successful they might be. For example, you might think about how a combination of salt and sand would work to keep roads clear of ice. Would this be a safer environmental alternative? Answering these questions often leads to more research or possibly doing your own scientific inquiry.

## Making a Decision

When you have all of the information that your research can provide, you will need to weigh the pros and cons of each option and make a decision. Sometimes it helps to organize your thoughts in a PMI chart that lists the pros and cons of an issue, or a t-chart that compares two possible solutions. You will find more information on using these charts in **Literacy Skills Toolkit 5**. It might even be helpful to rate how important you feel each point (pro or con) is.

**PMI Chart for Salt Use**

| Plus | Minus | Interesting |
|---|---|---|
| • very effective<br>• relatively inexpensive<br>•<br>• | • may contaminate drinking water<br>•<br>• | •<br>• |

**t-chart Comparing Salt and Sand**

| Salt | Sand |
|---|---|
| • more effective than sand<br>•<br>• | • not as harmful to organisms as salt<br>•<br>• |

Your decision will still involve some very human and personal elements. People have strong feelings about the social and environmental issues that affect them. Depending on their point of view, other people may feel differently than you do about an issue. Something that seems obvious to you might not be so obvious to them, and vice versa. Even the unbiased scientific evidence you found during your research might not change people's minds. If you are going to encourage a group to make what you consider a good decision, you have to find ways to persuade the group to think as you do.

## Evaluating the Decision

After you have made a decision, it is important to evaluate your decision. Is the decision the best alternative considering the risks and benefits? Have you thought about the possible consequences of the decision and how you might respond to them? If you determine that your decision-making process was faulty—if, for example, you based your decision on information that you later learned was false—you should begin again. If you find that you are comfortable with your decision, the next step is to take action.

## Taking Action

Issues rarely have easy answers. People who are affected have differing, valid points of view. It is easier for you to act as an individual, but if you can persuade a group to act, you will have greater influence. In the issue discussed here, you might write a letter to your town council. As a compromise, you might suggest a combination of salt and sand on the roads. Your research can provide you with appropriate statistics. As a group, you could attend a town council meeting or sign a petition to make your views known.

Over time, you can assess the effects of your actions: Are there fewer accidents if less salt is used on roads? Does less salt end up in the water than when more salt alone is used?

Sometimes taking action involves changing the way you do things. After you have presented your findings to the town council, one of your friends makes you stop and think. "I have noticed you putting a lot of salt out on your sidewalk," your friend says. "You could use a bit of time and muscle power to chip away the ice, but that is not the choice you make."


You realize your friend is right—it is not only up to the town council or any other group to act responsibly; it is also up to you and your friends. How easy is it for you to give up an easy way of doing a task in order to make an environmentally responsible decision?

### Instant Practice—Analyzing Issues

The Alberta oil sands are a source of energy in the form of fossil fuels. They also have created many jobs in Alberta. However, some people are concerned about the environmental damage caused by harvesting oil from the oil sands and the impact on global climate. Complete the following exercise in a group of four.

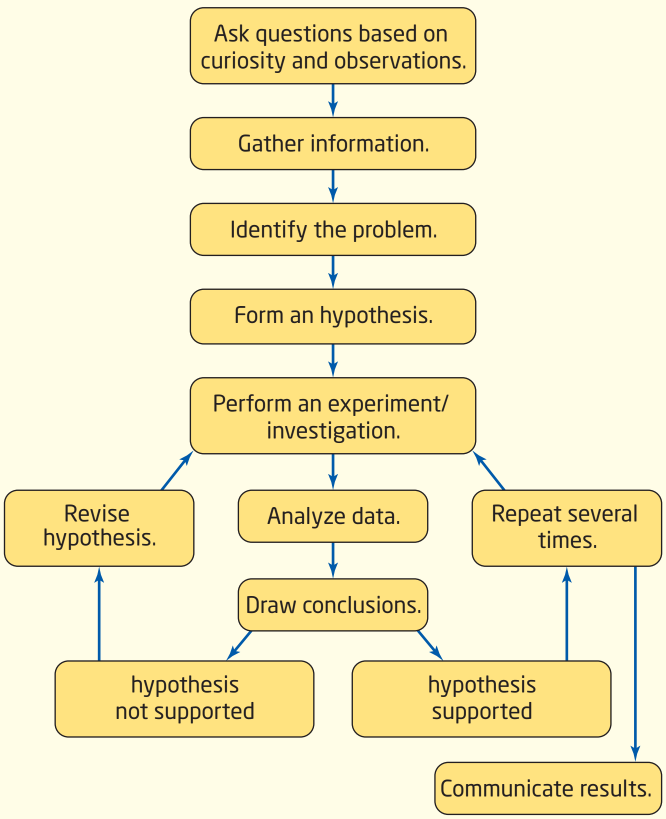
1. Start by dividing your group into two pairs.
2. One pair will research and record the advantages of the oil sands development and how this development has affected members of our society in a positive way.
3. The second pair will research and record the disadvantages of the oil sands development and its negative impacts on society.
4. The pairs will then regroup, and both sides can present their findings. Record key points on a PMI chart or a t-chart for comparison.
5. Determine which pair has the more convincing evidence for its point of view concerning the oil sands.
6. As a group, research alternative energy sources, including advantages and disadvantages of each. Think about economic and social advantages and disadvantages, as well as environmental ones. How do these alternative sources compare to the Alberta oil sands? Determine the best alternative, based on the information you found in steps 2 and 3 above.

# Science Skills Toolkit 2

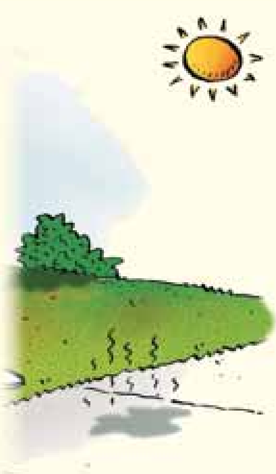
## Scientific Inquiry

Scientific inquiry is a process that involves many steps, including making observations, asking questions, performing investigations, and drawing conclusions. These steps may not happen in the same order in each inquiry. However, one model of the scientific inquiry process is shown here:

**The Scientific Inquiry Process**




### Making Observations and Asking Questions



The rain has stopped, and the Sun is out. You notice that a puddle of water has disappeared from the sidewalk.


You may have an idea about what happened to the puddle, but you need evidence that supports your idea. In order to test your idea, you need to carry out a scientific inquiry.

### Gathering Information and Identifying the Problem

First, you might observe what happens to some other puddles. You would watch them closely until they disappeared and record what you observed.

One observation you might make is "The puddle is almost all gone." That would be a **qualitative observation**, an observation in which numbers are not used. A little later, you might also say, "It took five hours for the puddle to disappear completely." You have made a **quantitative observation**, an observation that uses numbers.

Although the two puddles were the same size, one disappeared (evaporated) much more quickly than the other one did. Your quantitative observations tell you that one evaporated in 4 h, whereas the other one took 5 h. Your qualitative observations tell you that the one that evaporated more quickly was in the sunlight. The one that evaporated more slowly was in the shade. You now have identified one problem to solve: Does water always evaporate more quickly in the sunlight than in the shade?

**Instant Practice—Making Qualitative and Quantitative Observations**

Copy the observations below in your notebook. Beside each observation, write "Qual" if you think it is a qualitative observation and "Quan" if you think it is a quantitative observation.

1. **a.** The cup of tea was very hot.
   **b.** The refrigerator cooled the orange juice by 18°C.
2. **a.** The chemical indicator turned the liquid pink.
   **b.** The electric guitar was louder than the acoustic guitar.
3. **a.** The experiment required 50 mL of acid.
   **b.** Water boils at 100°C.
4. **a.** The speed of light is faster than the speed of sound.
   **b.** The speed limit in a school zone is 40 km/h.
5. **a.** The solution was slightly acidic.
   **b.** The solution had a pH of 5.2 when measured.
6. **a.** It took 6 min to travel to the store.
   **b.** The car was faster than the truck.

### Stating an Hypothesis

Now you are ready to make an **hypothesis**, a statement about an idea that you can test, based on your observations. Your test will involve comparing two things to find the relationship between them. You know that the Sun is a source of heat energy, so you might use that knowledge to make this hypothesis: If a puddle of water is in the sunlight, then the water will evaporate faster than if the puddle is in the shade.

**Instant Practice—Stating an Hypothesis**

Write an hypothesis for each of the following situations. You may wish to use an "If…then…" format. For example: *If* temperature affects bacterial growth, *then* bacterial culture plates at a higher temperature will have more bacterial colonies than those at a lower temperature.

1. The relationship between pollution and asthma
2. The effect of antacid tablets on stomach pH
3. The relationship between average global temperature and the size of the polar ice cap
4. The amount light rays are bent by different types of glass.

As you prepare to make your observations, you can make a **prediction**, a forecast about what you expect to observe. In this case, you might predict that puddles A, B, and C will dry up more quickly than puddles X, Y, and Z. A prediction will help you to decide whether your hypothesis is correct. In the case of the puddles, if puddles A, B, and C do not dry up more quickly than puddles X, Y, and Z, you'll know that your hypothesis was likely incorrect.


## Performing an Investigation

As you know, there are several steps involved in performing a scientific investigation, including identifying variables, designing a fair test, and organizing and analyzing data.

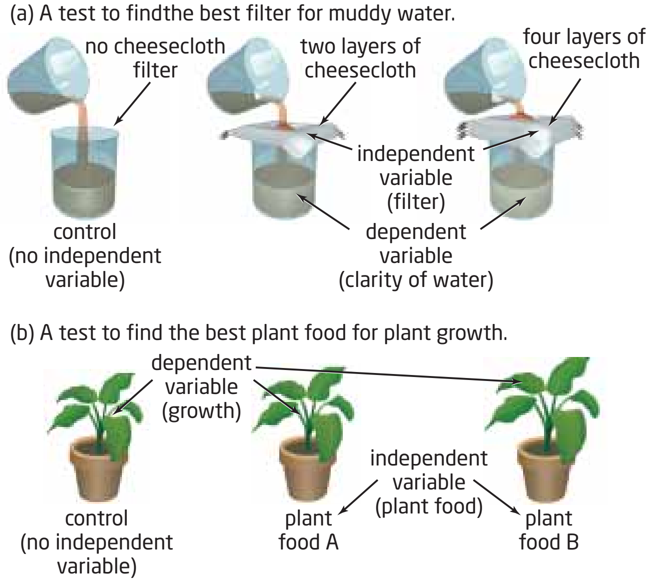
### Identifying Variables


The breeze is one factor that could affect evaporation. The Sun is another factor that could affect evaporation. Scientists think about every possible factor that could affect tests they conduct. These factors are called **variables**.
It is important to test only one variable at a time.

You need to control your variables. This means that you change only one variable at a time. The variable that you change is called the **independent variable** (also called the manipulated variable). In this case, the independent variable is the condition under which you observe the puddle (one variable would be sunlight; another would be wind).

According to your hypothesis, sunlight will change the time it takes for the puddle to evaporate. The time in this case is called the **dependent variable** (also called the responding variable).

Often, experiments have a **control**. This is a test that you carry out with no variables, so that you can observe whether your independent variable does indeed cause a change. Look at the illustration below to see some examples of controls and variables.




The control plant is given no additional plant food–only water.

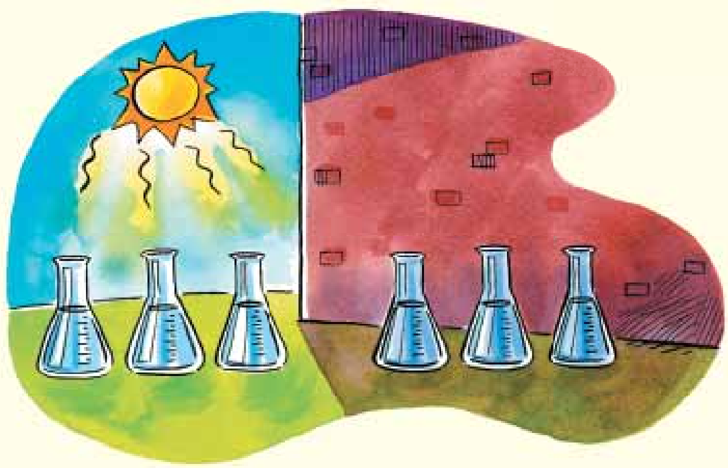
### Instant Practice—Identifying Variables

For each of the following questions, state your control, your independent variable, and your dependent variable.

1. Does smoking have an effect on lung tissue?
2. Which kind of household cleaner is most effective?
3. How does an increase in water temperature affect the growth of algae?
4. Do LCD TVs or plasma TVs produce clearer images?

**Controlling Variables for a Fair Test** A controlled experiment tests only one variable at a time, while keeping all other variables constant. If you consider more than one variable in a test, you are not conducting a **fair test** (one that is valid and unbiased), and your results will not be useful. You will not know whether the breeze or the Sun made the water evaporate.

As you have been reading, a question may have occurred to you: How is it possible to do a fair test on puddles? How can you be sure that they are the same size? In situations such as this one, scientists often use **models**. A model can be a mental picture, a diagram, a working model, or even a mathematical expression. To make sure your test is fair, you can prepare model puddles that you know are all exactly the same.



You can then place the puddles in controlled conditions, where all variables *except* for sunlight remain constant. For instance, you might construct a cardboard wall around your model puddles to ensure that the wind conditions will be the same for all puddles. You might even carry out your test in a laboratory, using a lamp as a model Sun. **Science Skills Toolkit 6** gives you more information on using models.

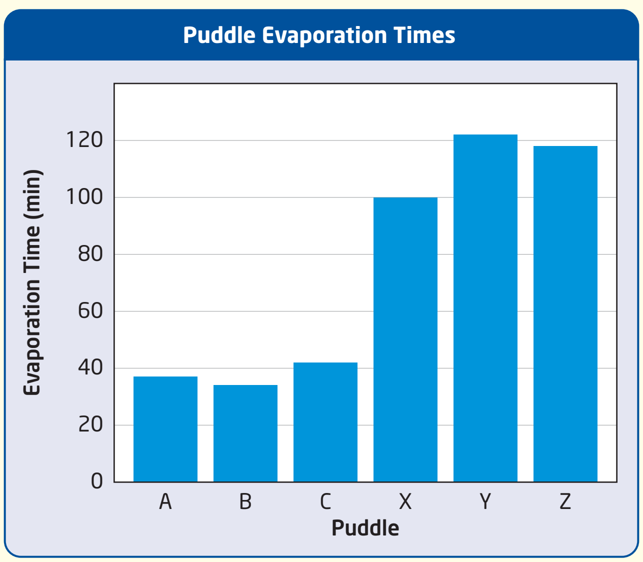
Before you begin your investigation, review safety procedures and identify what safety equipment you may need. Refer to page **xii** in this textbook for more information on safety.

**Recording and Organizing Data** Another step in performing an investigation is recording and organizing your data. Often, you can record your data in a table like the one shown below. Refer to **Science Skills Toolkit 8** for more information on making tables.

**Table 1** Puddle Evaporation Times

| Puddle | Evaporation Time (min) |
| --- | --- |
| A | 37 |
| B | 34 |
| C | 42 |
| X | 100 |
| Y | 122 |
| Z | 118 |

**Analyzing and Presenting Data** After recording your data, the next step is to present your data in a format so that you can analyze it. Often, scientists make a graph, such as the bar graph below. For more information on constructing graphs, refer to **Numeracy Skills Toolkit 2**.




## Forming a Conclusion

Many investigations are much more complex than the one described here, and there are many more possibilities for error. That is why it is so important to record careful qualitative and quantitative observations.

After you have completed all your observations, you are ready to analyze your data and draw a **conclusion**. A conclusion is a statement that indicates whether your results support or do not support your hypothesis. First you need to consider whether your predictions were correct. Then you should ask yourself whether you have considered all of the variables. Then you can decide whether your results support your hypothesis. If you had hypothesized that sunlight would have no effect on the evaporation of water, your results would not support your hypothesis. An hypothesis gives you a place to start and helps you design your experiment. If your results do not support your hypothesis, you use what you have learned in the experiment to come up with a new hypothesis to test.

Scientists often set up experiments without knowing what will happen. Sometimes they deliberately set out to show that something will *not* happen in a particular situation.

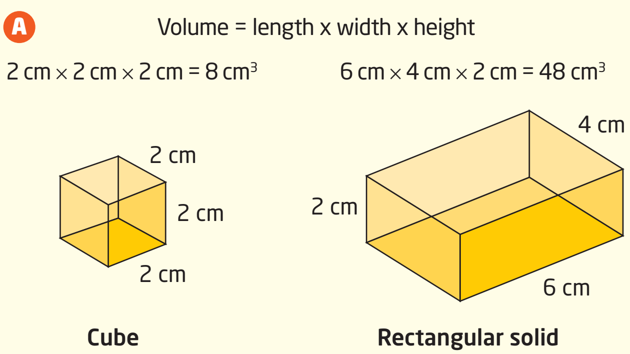
Eventually, when an hypothesis has been thoroughly tested and nearly all scientists agree that the results support the hypothesis, it becomes a **theory**.

# Measuring

## Measuring Volume

The **volume** of an object is the amount of space that the object occupies. There are several ways of measuring volume, depending on the kind of object you want to measure.

As you can see in Diagram A below, the volume of a regularly shaped solid object can be measured directly. You can calculate the volume of a cube by multiplying its sides, as shown on the left in Diagram A. You can calculate the volume of a rectangular solid by multiplying its length × width × height, as shown on the right in Diagram A.




Measuring the volume of a regularly shaped solid

If all the sides of a solid object are measured in millimetres (mm), the volume will be in cubic millimetres ($mm^3$). If all the sides are measured in centimetres (cm), the volume will be in cubic centimetres ($cm^3$). The units for measuring the volume of a solid are called cubic units.

The units used to measure the volume of liquids are called capacity units. The basic unit of volume for liquids is the litre (L). Recall that 1 L = 1000 mL.

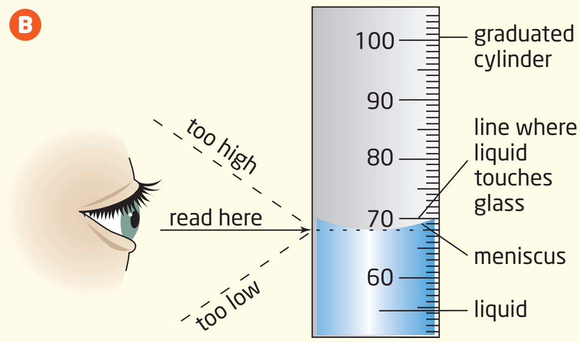
Cubic units and capacity units are interchangeable. For example,

$1\ cm^3 = 1\ mL$

$1\ dm^3 = 1\ L$

$1\ m^3 = 1\ kL$

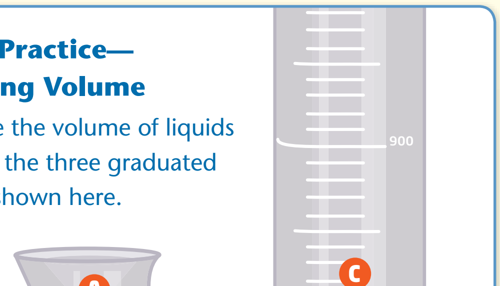
The volume of a liquid can be measured directly, as shown in Diagram B. Make sure you measure to the bottom of the **meniscus**, the slight curve where the liquid touches the sides of the container. To measure accurately, make sure your eye is at the same level as the bottom of the meniscus.




Measuring the volume of a liquid

### Instant Practice—Measuring Volume

Determine the volume of liquids present in the three graduated cylinders shown here.



The volume of an irregularly shaped solid object, however, must be measured indirectly, as shown in Diagram C below. This is done by measuring the volume of a liquid it displaces.

When a solid object is placed in liquid, the liquid level will rise. The liquid is displaced, or moved from the place it was originally. The volume of the displaced liquid is equal to the volume of the solid.

**C**

1. Record the volume of the liquid.
2. Carefully lower the object into the cylinder containing the liquid. Record the volume again.
3. The volume of the object is equal to the difference between the two volumes of the liquid. The equation below the photographs shows you how to calculate this volume.


Measuring the volume of an irregularly shaped solid

volume of object = volume of water with object – original volume of water
= 85 mL – 60 mL
= 25 mL

## Measuring Mass

Is your backpack heavier than your friend's backpack? You can check by holding a backpack in each hand. The **mass** of an object is the amount of matter in a substance or object. Mass is measured in milligrams, grams, kilograms, and tonnes. You need a balance for measuring mass.

How can you find the mass of a certain quantity of a substance, such as table salt, that you have added to a beaker? First, find the mass of the beaker. Next, pour the salt into the beaker and find the mass of the beaker and salt together. To find the mass of the salt, simply subtract the beaker's mass from the combined mass of the beaker and salt.

If you are using an electronic balance, you will not need to do any calculations to subtract the mass of the beaker. The balance will do the calculation for you. To measure the contents of a beaker, you can place the empty beaker on the balance and hit the "Tare", "Zero", or "Re-Zero" button to reset the balance to zero. Then add the material to be measured into the beaker. The balance subtracts the mass of the beaker before the contents are even added, so it reports only the mass of the contents.

### Instant Practice—Measuring Mass

Use the following information to determine the mass of the table salt. The mass of a beaker is 160 g. The mass of the table salt and beaker together is 230 g.

## Measuring Angles

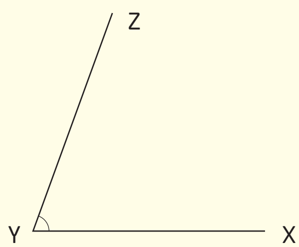
You can use a protractor to measure angles. Protractors usually have an inner scale and an outer scale. The scale you use depends on how you place the protractor on an angle (symbol = ∠). Look at the following examples to learn how to use a protractor.

**Example 1**

What is the measure of ∠XYZ?

**Solution**

Place the centre of the protractor on point Y. The 0° 180° line should lie along the line YX so that YX crosses 0° on the inner scale. YZ crosses 70° on the inner scale. So ∠XYZ is equal to 70°.

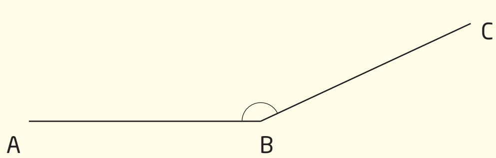



**Example 2**

Draw ∠ABC = 155°.

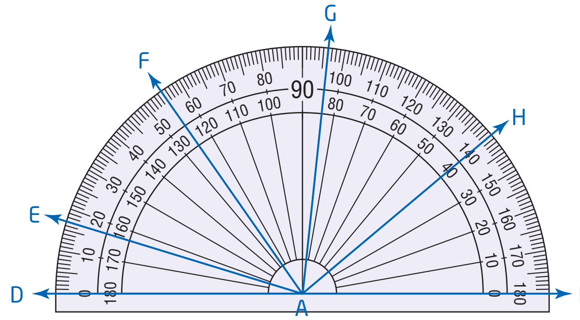
**Solution**

First, draw a straight line, AB. Place the centre of the protractor on B and line up AB with 0° on the outer scale. Mark C at 155° on the outer scale. Join BC. The angle you have drawn, ∠ABC, is equal to 155°.




### Instant Practice—Measuring Angles

1. State the measure of each of the following angles using the following diagram.
   - **a.** DAF
   - **b.** DAH
   - **c.** IAG
   - **d.** HAF
   - **e.** GAD
   - **f.** DAI
   - **g.** EAG
   - **h.** EAI




2. Use a protractor to draw angles with the following measurements. Label each angle.
   - **a.** ABC 30°
   - **b.** QRS 125°
   - **c.** XYZ 8°
   - **d.** JKL 74°
   - **e.** HAL 155°

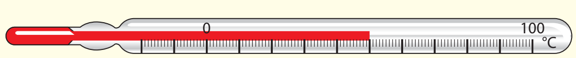
## Measuring Temperature

**Temperature** is a measure of the thermal (heat) energy of the particles of a substance. In the very simplest terms, you can think of temperature as a measure of how hot or how cold something is. The temperature of a material is measured with a thermometer.

For most scientific work, temperature is measured on the Celsius scale. On this scale, the freezing point of water is zero degrees (0°C) and the boiling point of water is 100 degrees (100°C). Between these points, the scale is divided into 100 equal divisions. Each division represents one degree Celsius. On the Celsius scale, average human body temperature is 37°C, and a typical room temperature may be between 20°C and 25°C.

Sometimes scientists use a different unit of temperature called the kelvin (K). Zero on the Kelvin scale (0 K) is the coldest possible temperature. This temperature is also known as absolute zero. It is equivalent to –273°C, which is about 273 degrees below the freezing point of water. Notice that degree symbols are not used with the Kelvin scale.

Most laboratory thermometers are marked only with the Celsius scale. Because the divisions on the two scales are the same size, the Kelvin temperature can be found by adding 273 to the Celsius reading. This means that on the Kelvin scale, water freezes at 273 K and boils at 373 K.




### Tips for Using a Thermometer

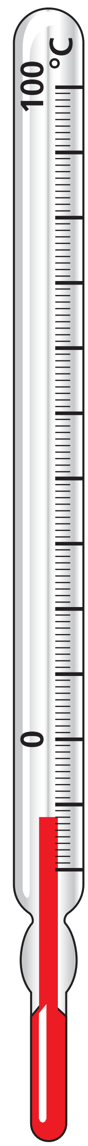
When using a thermometer to measure the temperature of a substance, here are three important tips to remember.

- Handle the thermometer extremely carefully. It is made of glass and can break easily.
- Do not use the thermometer as a stirring rod.
- Do not let the bulb of the thermometer touch the walls of the container.

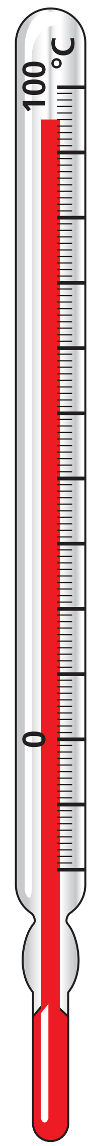
### Instant Practice—Measuring Temperature

Read the temperature, in °C, from the thermometer in each question. Convert your Celsius reading into Kelvin units.

1.




2.

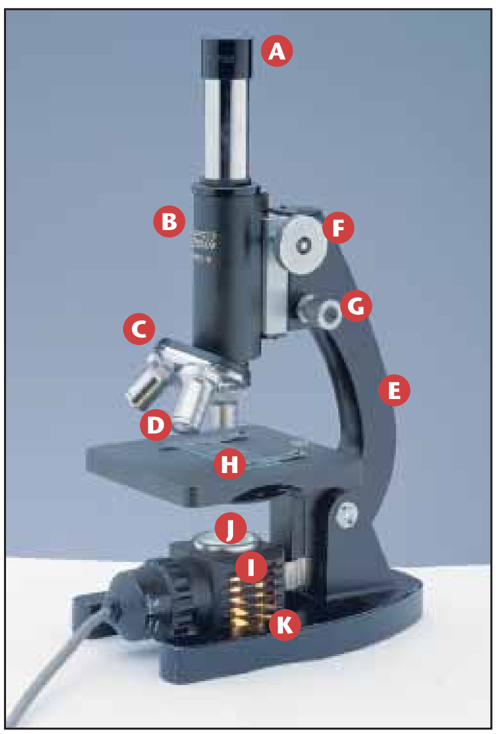


## Using a Microscope

The light microscope is an optical instrument that greatly increases our powers of observation by magnifying objects that are usually too small to be seen with the unaided eye. The microscope you will use is called a compound light microscope because it uses a series of lenses (rather than only one, as in a magnifying glass) and it uses light to view the object.

A microscope is a delicate instrument, so you must use proper procedure and care. This Science Skills Toolkit reviews the skills that you will need to use a microscope effectively. Before you use your microscope, you need to know the parts of a microscope and their functions.

**A Eyepiece (or Ocular Lens)**
You look through the eyepiece. It has a lens that magnifies the object, usually by 10 times (10×). The magnifying power is engraved on the side of the eyepiece.




**B Tube**
The tube holds the eyepiece and the objective lenses at the proper working distance from each other.

**C Revolving Nosepiece**
This rotating disk holds two or more objective lenses. Turn it to change lenses. Each lens clicks into place.

**D Objective Lenses**
The objective lenses magnify the object. Each lens has a different power of magnification, such as 4×, 10×, and 40×. (Your microscope may instead have 10×, 40×, and 100× objective lenses.) The objective lenses are referred to as low, medium, and high power. The magnifying power is engraved on the side of each objective lens. Be sure you can identify each lens.

**E Arm**
The arm connects the base and the tube. Use the arm for carrying the microscope.

**K Light Source**
Shining a light through the object being viewed makes it easier to see the details. If your microscope has a mirror instead of a light, adjust the mirror to direct light through the lenses. CAUTION: Use an electric light, not sunlight, as the light source for focussing your mirror.

**F Coarse-adjustment Knob**
The coarse-adjustment knob moves the tube up and down to bring the object into focus. Use it only with the low-power objective lens.

**G Fine-adjustment Knob**
Use the fine-adjustment knob with medium- and high-power magnification to bring the object into sharper focus.

**H Stage**
The stage supports the microscope slide. Stage clips hold the slide in position. An opening in the centre of the stage allows light from the light source to pass through the slide.

**I Condenser Lens**
The condenser lens directs light to the object being viewed.

**J Diaphragm**
The diaphragm controls the amount of light reaching the object being viewed.

### Troubleshooting

You may encounter difficulties when using your microscope. The following list details the more common problems and how you can deal with them.

- *You cannot see anything.* Make sure the microscope is plugged in and the light is turned on. If the microscope has no light, adjust your mirror.
- *Are you having trouble finding anything on the slide?* Be patient. Make sure the object being viewed is in the middle of the stage opening. While watching from the side, lower the low-power objective as far as it will go. Then look through the ocular lens and slowly raise the objective lens using the coarse-adjustment knob.
- *Are you having trouble focussing, or is the image very faint?* Try closing the diaphragm slightly. Some objects are almost transparent. If there is too much light, a specimen may be difficult to see or will appear "washed out."
- *Do you see lines and specks floating across the slide?* These are probably structures in the fluid of your eyeball that you see when you move your eyes. Do not worry; this is normal.
- *Do you see a double image?* Check that the objective lens is properly clicked into place.
- *Do you close one eye while you look through the microscope with the other eye?* You might try keeping both eyes open. This will help prevent eye fatigue. It also lets you sketch an object while you are looking at it.
- Always place the part of the slide you are interested in at the centre of the field of view before changing to a higher-power objective lens. Otherwise, when you turn to medium and high power, you may not see the object you were viewing under low power.

### Instant Practice—Viewing a Slide

Try this procedure to familiarize yourself with using a microscope.

1. Carry a microscope to your work area using both hands. One hand should hold the arm of the microscope firmly and the other should support the base.
2. Plug in the electric cord for the light source and use lens paper to clean the light source and the lenses. Do not touch the lenses with your fingers.
3. The microscope should always be left with the low-power objective lens in position. If it is not, rotate the revolving nosepiece until the low power objective lens clicks into place.
4. Use the coarse-adjustment knob to lower the objective lens until the lens is about 1 cm from the stage.
5. Look through the eyepiece (ocular lens) and adjust the diaphragm until the view is as bright as possible.
6. Place a prepared slide on the stage. Make sure the object to be viewed is centred over the opening.
7. Look through the eyepiece and slowly turn the coarse-adjustment knob until the object is in focus. Use the fine adjustment knob to sharpen the focus.
8. Watch from the side and rotate the revolving nosepiece to the medium-power objective lens. Do not change the focus first. **CAUTION:** Do NOT use the coarse-adjustment knob with the medium- or high-power objective lens.
9. After the medium-power objective lens has clicked into place, adjust the focus using ONLY the fine-adjustment knob.
10. The object may be viewed under the high-power objective lens using the same process as in steps 8 and 9.
11. When you have finished viewing the object, carefully turn the nosepiece back to the low-power objective lens and remove the slide.

# Science Skills Toolkit 5

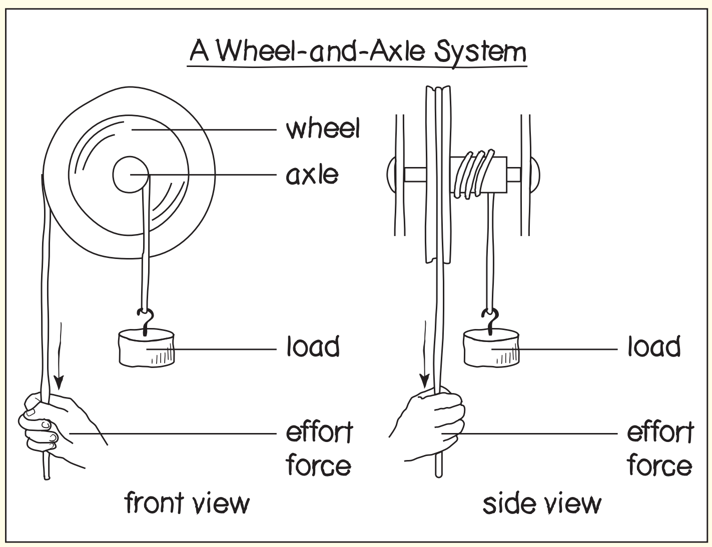
## Scientific Drawing

Have you ever used a drawing to explain something that was too difficult to explain in words? A clear drawing can often assist or replace words in a scientific explanation. Drawings are especially important when you are trying to explain difficult concepts or describe something that contains a lot of detail. It is important to make scientific drawings clear, neat, and accurate.

### Making a Scientific Drawing

Follow these steps to make a good scientific drawing.

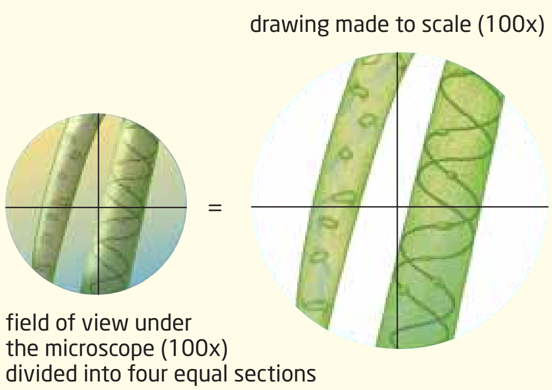
1. Use unlined paper and a sharp pencil with an eraser.
2. Give yourself plenty of space on the paper. You need to make sure that your drawing will be large enough to show all necessary details. You also need to allow space for labels. Labels identify parts of the object you are drawing. Place all of your labels to the right of your drawing, unless there are so many labels that your drawing looks cluttered.
3. Carefully study the object that you will be drawing. Make sure you know what you need to include.
4. Draw only what you see, and keep your drawing simple. Do not try to indicate parts of the object that are not visible from the angle of observation. If you think it is important to show another part of the object, do a second drawing, and indicate the angle from which each drawing is viewed. The diagram to the right includes both a front view and a side view of a wheel-and-axle system.
5. Shading or colouring is not usually used in scientific drawings. If you want to indicate a darker area, you can use stippling (a series of dots). You can use double lines to indicate thick parts of the object.
6. If you do use colour, try to be as accurate as you can. Choose colours that are as close as possible to the colours in the object you are observing.
7. Label your drawing carefully and completely, using lower-case (small) letters. Think about what you would need to know if you were looking at the object for the first time. If you are comparing two objects, label each object and use labels to indicate the points of comparison between them. Remember to place all your labels to the right of the drawing, if possible. Use a ruler to draw a horizontal line from the label to the part you are identifying. Make sure that none of your label lines cross.
8. Give your drawing a title. The drawing shown below is from a student's notebook. This student used horizontal label lines for the parts viewed, and a title—all elements of an excellent final drawing.



## Drawing to Scale

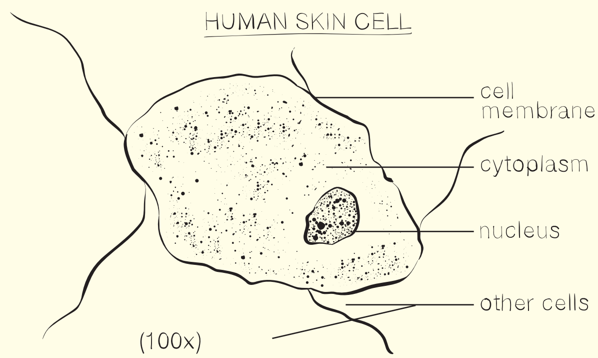
When you draw objects seen through a microscope, the size of your drawing is important. Your drawing should be in proportion to the size of the object as the object appears when viewed through the microscope. This type of drawing is called a **scale drawing**. A scale drawing allows you to compare the sizes of different objects and to estimate the actual size of the object being viewed. Here are some steps to follow when making scale drawings of magnified objects.

1. The circle that you see through the eyepiece is the microscope's **field of view**. Choose an appropriate size for your drawing so that the details that are visible in the microscope's field of view can be clearly seen in the drawing.
2. Imagine the space you have chosen for your drawing is divided into four equal sections (see the diagram below). Use a pencil and a ruler to draw these sections faintly in your drawing, as shown below.




3. Using low or medium power, locate an object under the microscope. Imagine that the field of view is also divided into four equal sections.
4. Observe how much of the field of view is taken up by the object. Note the location of the object in the field of view.
5. Draw the object. Position the object in about the same part of the drawing as it appears in the field of view. Draw the object so that it takes up about the same amount of the drawing space as it takes up in the field of view, as shown in the diagram in step 2.

The drawing of a human skin cell shown below is from a student's notebook. This student used stippling to show darker areas in the cell and, at the bottom of the drawing, included the magnification used to view the cell. These are important features in biological diagrams.




The stippling on this drawing of a human skin cell shows that some areas are darker than others.

### Instant Practice—Scientific Drawing

1. Design a scale model of your classroom. Use the shape of the floor to represent the field of view. Include scale drawings of the furniture and other large objects in your classroom. Label your model to show where you and your classmates sit. Also label any safety equipment in your classroom, as well as doors and windows.
2. Draw and label a diagram of a skateboard. Someone who has never seen a skateboard before should be able to use your diagram to understand how the skateboard works. Remember to use stippling or double lines rather than shading to show darker or thicker parts of the skateboard.

# Science Skills Toolkit 6

## Using Models and Analogies in Science

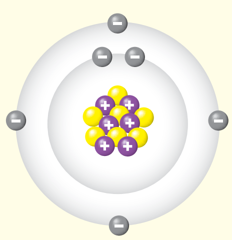
Scientists often use models and analogies to help communicate their ideas to other scientists or to students.

### Using Models

When you think of a model, you might think of a toy such as a model airplane. Is a model airplane similar to a scientific model? If building a model airplane helps you learn about flight, then you could say it is a scientific model.

In science, a model is anything that helps you better understand a scientific concept. A model can be a picture, a mental image, a structure, or even a mathematical formula.

Sometimes, you need a model because the objects you are studying are too small to see with the unaided eye. In previous science courses, for example, you used models to represent atoms.



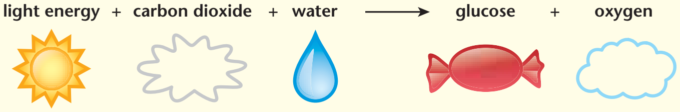
Atoms are so tiny that you cannot see them, even with the strongest of microscopes. A model of an atom can help you to form a mental picture that helps you understand the parts of the atom, even though it doesn't show exactly what an atom looks like.

Sometimes a model is useful because the objects you are studying are extremely large—the planets in our solar system, for example. In other cases, the object may be hidden from view, like the interior of Earth or the inside of a living organism.

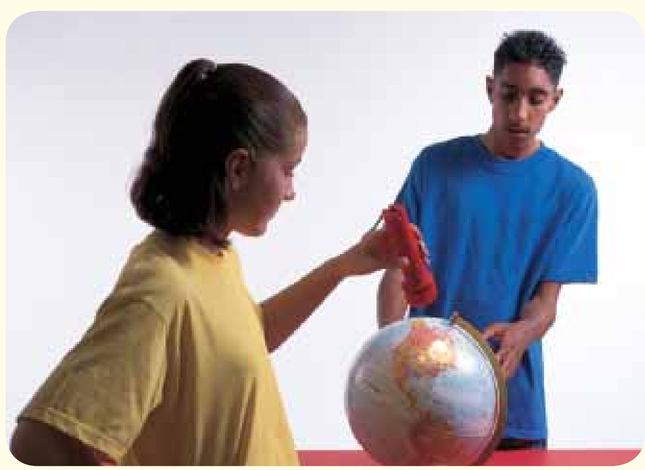
A mathematical model can show you how to perform a calculation. If you wanted to explain addition and subtraction to a young child, you might use cookies as a model. By eating a cookie, you could demonstrate subtraction.

Chemical equations are models that are often used in science to help explain how a chemical reaction or series of reactions takes place. An equation is often used to represent the process of photosynthesis. Photosynthesis is a complicated process that involves many chemical reactions. An equation helps you to think about the starting materials and end products of the process.

light energy + carbon dioxide + water → glucose + oxygen



Scientists often use models to test an idea, to find out if an hypothesis is supported, and to plan new experiments in order to learn more about the subject they are studying. Sometimes, scientists discover so much new information that they have to modify their models. Examine the model shown in the photograph below. How can this model help you learn about science?



You can learn about day and night by using a globe and a flashlight to model Earth and the Sun.

**Instant Practice—Using Models**

Describe a model that you could use to represent each of the following:

**a.** 5 – 2 = 3

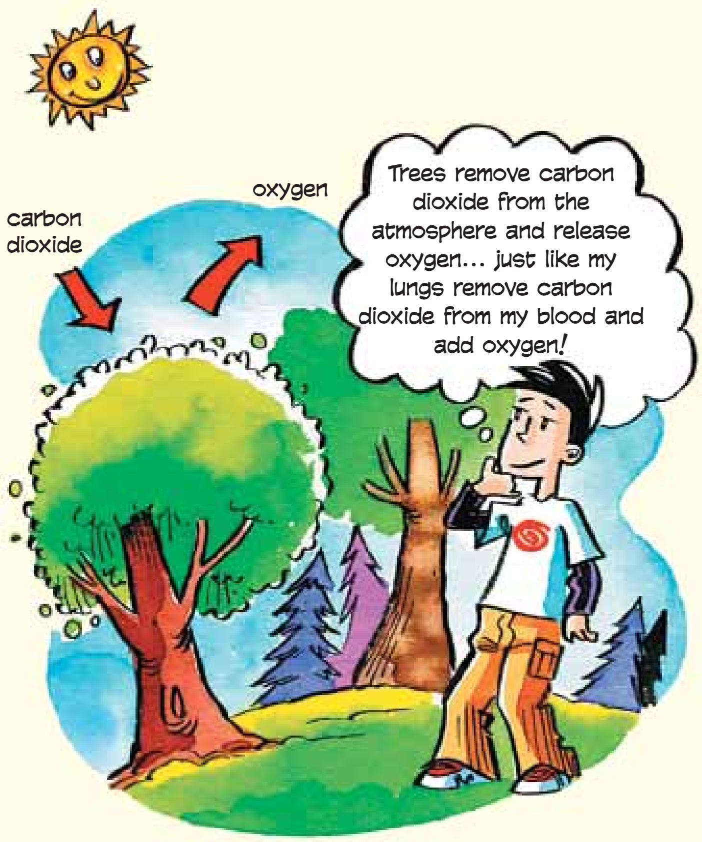
**b.** a cell

**c.** the human body

## Using Analogies

An **analogy** is a comparison between two things that have some characteristic in common. Scientists use analogies to help explain difficult concepts. For example, scientists sometimes refer to plants as the lungs of Earth. Recall that plants take in carbon dioxide ($CO_2$) from the atmosphere to use during photosynthesis. Plants then release the oxygen ($O_2$) produced by photosynthesis back into the atmosphere.

In a sense, the plants are "breathing" for Earth. When animals breathe, they take oxygen into their lungs and give off carbon dioxide.




Thinking about photosynthesis in this way may help you to understand the function that plants have in ecosystems. This analogy will only work, though, if you have an idea what lungs do. If you don't know anything about lungs or what they do, an analogy involving lungs won't help you to understand photosynthesis.

Analogies use familiar situations to help explain unfamiliar situations. Picturing an everyday situation, such as the way water moves through a hose, may help you to picture an unfamiliar concept, such as how charge flows through an electric circuit. This is a useful analogy because most people have seen or used a hose, and have an understanding of how water moves through it.

Negative charges are pushed through a circuit in a similar way to how water is pushed through a hose.

### Instant Practice—Using Analogies

1. Use an analogy to explain the levels of organization in an organism.
2. Find two analogies that are used in this textbook.

# Science Skills Toolkit 7

## How to Do a Research-Based Project

Imagine if your teacher simply stated that he or she wanted you to complete a research-based project on endangered species.

**How do I get started?**

This is a really big topic, and it is now your job to decide which smaller part of the topic you will research. One way to approach a research project is to break it up into four stages—exploring, investigating, processing, and creating.

### Explore—Pick a Topic and Ask Questions

You need to start by finding out some general things about endangered species. Make a list of questions as you conduct your initial research, such as, What factors cause species to become endangered? Why does it matter? What types of species are endangered? Once you've done some research, you need to focus your topic into a research question.

**What is a good research question?**

Your research question needs to be specific enough that you can provide a thorough answer within the limits of your project (and in the time you have available). But it shouldn't be so specific that you can answer it in one paragraph!

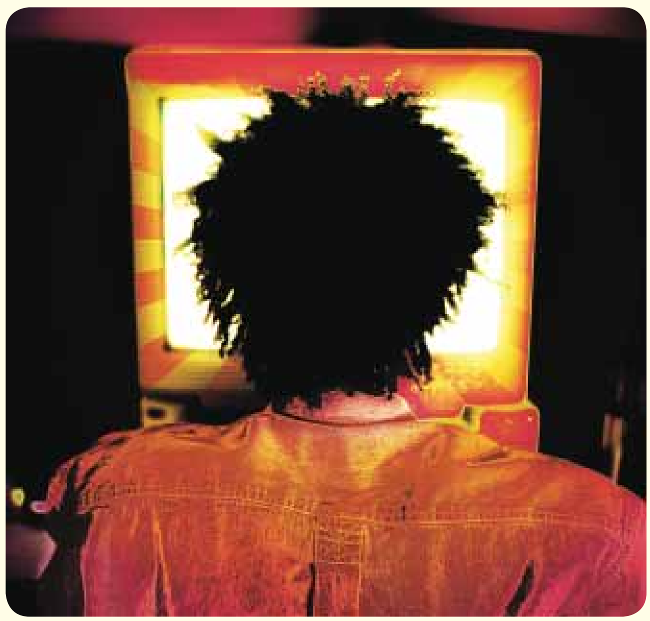
Suppose, in the course of your research, you decided to learn more about polar bears. A good research question about polar bears would be, Why are polar bears endangered? An even better question could be, What can I do to help prevent polar bear extinction? Both of these questions are deep and can be subdivided into many subtopics.

### Investigate—Research Your Topic

When putting together a research project, it is important to find reliable sources to help you answer your question. Before you decide to use a source that you find, you should consider whether it is reliable or whether it shows any bias.

**Find Sources of Information** There are many sources of information. For example, you can use a print resource, such as an encyclopedia from the reference section of the library.

Another approach is to go on-line and check the Internet. When you use the Internet, be careful about which sites you choose to search for information. You need to be able to determine the validity of a website before you trust the information you find on it.



**How can I decide which websites to use?**

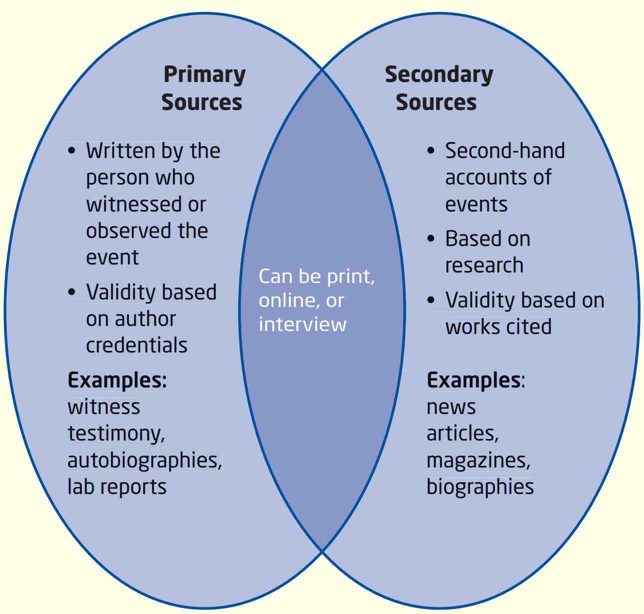
To do this, check that the author is identified, a recent publication date is given, and the source of facts or quotations is identified. It is also important that the website is published by a well-known company or organization, such as a college, university, or government agency.

### What if I can't find any sources of information?

If you are having trouble finding *any* information about your topic, or if the only information you can find is on wiki or personal sites, you may want to consider changing your topic. You may also want to contact an expert on your topic. A credible expert has credentials showing his or her expertise in an area. For example, an expert may be a doctor or have a master's degree. Alternatively, an expert could have many years of experience in a specific career or field of study.

No matter which sources you use, it is your responsibility to be a critical consumer of information and to find trustworthy sources for your research.

You should also ask yourself if the sources you are using are primary or secondary. It is okay to use secondary sources, but you should try to include information from primary sources wherever possible.




### How do I decide whether a source is reliable and unbiased?

Two other things to check for in a source are reliability and bias. To check for reliability, try to find the same "fact" in two other sources. But keep in mind that even if you cannot find the same idea somewhere else, the source may still be reliable if it is a research paper or if it was written by an author with strong credentials. To check for bias, look for judgemental statements. Does the author tend to favour one side of an issue more than another? Are all sides of an issue treated equally? A good source shows little bias.

| Source | Information | Reliability | Bias | Questions I Have |
|---|---|---|---|---|
| The Canadian Encyclopedia website | Polar bears inhabit ice and coastlines of arctic seas. | • author: Brian Knudsen<br>• secondary source<br>• has links to external sites that are reliable | only lists facts | • Why do they live on ice?<br>• Why don't they move south? |
| Polar Bears International website | shrinking sea ice habitat | • date at bottom of page 2009<br>• non-profit organization | designed to save the polar bear | • Why is the ice shrinking? |

### Record Information

**How can I organize my research?**

As you find information, jot it down on sticky notes or use a chart similar to the one shown above. Sticky notes are useful because you can move them around, group similar ideas together, and reorganize your ideas easily. Using a different colour for each sub-question is even better! Remember to write the source of your information on each sticky note. In addition to writing down information that you find as you research, you should also write down any questions you think of as you go along.

## Process—Ask More Questions and Revise Your Work

Now that you have done some research, what sub-questions have you asked? These are the subtopics of your research. Use the subtopics to find more specific information.

**What if I have too much information—or not enough?**

If you find that you have two or three sub-questions that have a lot of research supporting them and a few that do not have much research, do not be afraid to "toss out" some of the less important questions or ideas.

**Don't steal ideas!**

**Avoid Plagiarism** Copying information word-for-word and then presenting it as though it is your own work is called *plagiarism*. When you refer to your notes to write your project, put the information in your own words. It is also important to give credit to the original source of an idea.

### Reveal your source!

**Record Source Information** Research papers always include a bibliography—a list of relevant information sources the authors consulted while preparing them. Bibliographic entries give the author, title, and facts of publication for each information source. Facts of publication include the publication year, the name of the publisher, and the city in which the publisher is located. For online resources, you should also record the site URL, the name of the site, and the date on which you retrieved the information.

Remember to record source information while you're taking notes so you won't need to go back and search it out again! Ask your teacher about the preferred style for your references.

## Create—Present Your Work

### What if my research doesn't answer my question?

Before you choose a format for your final project, consider whether your researched information has answered the question you originally asked.

If you have not answered this question, you need to either refine your original question or do some more research! As long as your question still meets the criteria of your original assignment, it is okay to change the question so it focusses on the research you have already done. After all, you don't want your hard work to go to waste!

### How should I present my work?

Check the guidelines that your teacher gave you. There may be specific instructions or criteria that will help you decide how to present your work. You also need to consider who the audience is for your project. How you format your final project will be very different if it is meant for a Grade 2 class compared to the president of a company or a government official. You could present your project as a poster, graphic organizer, blog, graphic novel, video, or research paper.

**Instant Practice**

1. Describe the steps you should follow in preparing a project on the topic of optical technologies and their impact on society.
2. The following example is not an effective question on which to base a research project: *What is global warming?* Modify the question to make it an effective research question.
3. Assume that the target audience for your project is a group of Grade 1 students from a local elementary school. What aspects of your project would you need to modify so that you are reaching the intended audience? What would be the best format to use to present your project to your audience?

## Creating Data Tables

Scientific investigation is about collecting information to help you answer a question. In many cases, you will develop an hypothesis and collect data to see if your hypothesis is supported. An important part of any successful investigation includes recording and organizing your data. Often, scientists create tables in which to record data.

**Planning to Record Your Data** Suppose you are doing an investigation on the water quality of a stream that runs near your school. You will take samples of the numbers and types of organisms at two different locations along the stream. You need to decide how to record and organize your data. Begin by making a list of what you need to record. For this experiment, you will need to record the sample site, the pH of the water at each sample site, the types of organisms found at each sample site, and how many of each type of organism you collected.

**Creating Your Data Table** Your data table must allow you to record your data neatly. To do this you need to create

- headings to show what you are recording
- columns and rows that you will fill with data
- enough cells to record all the data
- a title for the table

In this investigation, you will find multiple organisms at each site, so you must make space for multiple recordings at each site. This means every row representing a sample site will have at least three rows associated with it for the different organisms.

If you think you might need extra space, create a special section. In this investigation, leave space at the bottom of your table, in case you find more than three organisms at a sample site. Remember, if you use the extra rows, make sure you identify which sample site the extra data are from.

Finally, give your table an appropriate title and a number. The title should appear above your table. Your data table might look like the one below.

**Table 1** **Observations Made at Two Sample Stream Sites**

headings show what is being recorded

columns and rows contain data

| Sample Site | pH | Type of Organism | Number of Organisms |
|---|---|---|---|
| 1 | | beetle | 3 |
| | | snail | 1 |
| | | dragonfly larva | 8 |
| 2 | | beetle | 6 |
| | | dragonfly larva | 7 |
| | | | |
| | | | |

extra rows to collect data in case you need to add observations

### Instant Practice—Creating Data Tables

1. You are interested in how weeds grow in a garden. You decide to collect data from your garden every week for a month. You will identify the weeds and count how many there are of each type of weed. Design and draw a data table that you could use to record your data.
2. Many investigations have several different experimental treatments. Copy the following data table into your notebook and fill in the missing title and headings. The investigation tests the effect of increased fertilizer on plant height. There are four plants, and measurements are being taken every two days.

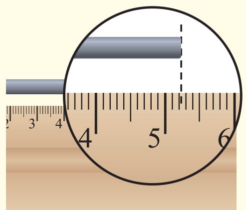
| | | | |
|---|---|---|---|
| Day 1 | Plant 1 | 5 mL | |
| | Plant 2 | 10 mL | 10 cm |
| | | 15 mL | |
| | | 20 mL | |

# Numeracy Skills Toolkit 1

## Significant Digits and Rounding

### Significant Digits

**Significant digits** represent the amount of uncertainty in a measurement. The significant digits in a measurement include all the certain digits plus the first uncertain digit. In the example below, the length of the rod is between 5.2 cm and 5.3 cm. Suppose we estimate the length to be 5.23 cm. The first two digits (5 and 2) are certain (we can see those marks), but the last digit (0.03) was estimated, so it is uncertain. The measurement 5.23 cm has three significant digits.




Use these rules to determine the number of significant digits (s.d.) in a measurement.

1. All non-zero digits (1–9) are considered significant.

   **Examples:**
   - 123 m (3 s.d.); 23.56 km (4 s.d.)

2. Zeros between non-zero digits are also significant.

   **Examples:**
   - 1207 m (4 s.d.); 120.5 km/h (4 s.d.)

3. Any zero that follows a non-zero digit *and* is to the right of the decimal point is significant.

   **Examples:**
   - 12.50 $m^2$ (4 s.d.); 60.00 km (4 s.d.)

4. Zeros used to indicate the position of the decimal are *not* significant. These zeros are sometimes called spacers.

   **Examples:**
   - 500 km (1 s.d.); 0.325 m (3 s.d.); 0.000 34 km (2 s.d.)

5. All counting numbers have an infinite (never-ending) number of significant digits.

   **Examples:**
   - 6 apples (infinite s.d.); 125 people (infinite s.d.)

### Using Significant Digits in Mathematical Operations

When you use measured values in calculations, the calculated answer cannot be more certain than the measurements on which it is based. The answer on your calculator may have to be rounded to the correct number of significant digits.

#### Rules for Rounding

1. When the first digit to be dropped is less than 5, the digit before it is not changed.

   **Example:** 6.723 m rounded to two significant digits is 6.7 m.

2. When the first digit to be dropped is 5 or greater, increase the digit before it by one.

   **Example:** 7.237 m rounded to three significant digits is 7.24 m. The digit after the 3 is greater than 5, so the 3 is increased by one.

#### Adding or Subtracting Measurements

Perform the mathematical operation, and then round off the answer to the value having the fewest *decimal places*.

**Example:** $x = 2.3 \text{ cm} + 6.47 \text{ cm} + 13.689 \text{ cm}$
$= 22.459 \text{ cm}$
$= 22.5 \text{ cm}$

Since 2.3 cm has only one decimal place, the answer can have only one decimal place.

#### Multiplying or Dividing Measurements

Perform the mathematical operation, and then round off the answer to the least number of *significant digits* of the data values.

**Example:** $x = (2.342 \text{ m})(0.063 \text{ m})(306 \text{ m})$
$= 45.149\ 076 \text{ m}^3$
$= 45 \text{ m}^3$

Since 0.063 m has only two significant digits, the answer must have two significant digits.

# Numeracy Skills Toolkit 2

## Organizing and Communicating Scientific Results with Graphs

In your investigations, you will collect information, often in numerical form. To analyze and report the information, you will need a clear, concise way to organize and communicate the data.

A graph is a visual way to present data. A graph can help you to see patterns and relationships among the data. The type of graph you choose depends on the type of data you have and how you want to present them. You can use line graphs, bar graphs, and pie graphs (pie charts).

The instructions given here describe how to make graphs using paper and pencil. Computer software provides another way to generate graphs. Whether you make them on paper or on the computer, however, the graphs you make should have the features described in the following pages.

### Drawing a Line Graph

A line graph is used to show the relationship between two variables. The following example will demonstrate how to draw a line graph from a data table.

**Example**

Suppose you have conducted a survey to find out how many students in your school are recycling drink containers. Out of 65 students that you surveyed, 28 are recycling cans and bottles. To find out if more recycling bins would encourage students to recycle cans and bottles, you add one recycling bin per week at different locations around the school. In follow-up surveys, you obtain the data shown in **Table 1**. Compare the steps in the procedure with the graph on the next page to learn how to make a line graph to display your findings.

**Table 1** Students Using Recycling Bins

| Number of Recycling Bins | Number of Students Using Recycling Bins |
|---|---|
| 1 | 28 |
| 2 | 36 |
| 3 | 48 |
| 4 | 60 |

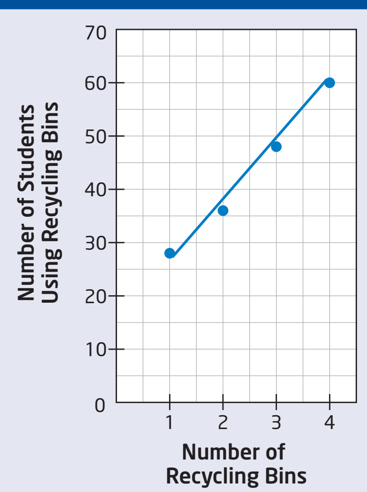
**Procedure**

1. With a ruler, draw an $x$-axis and a $y$-axis on a piece of graph paper. (The horizontal line is the $x$-axis, and the vertical line is the $y$-axis.)
2. The independent (manipulated) variable is usually shown on the $x$-axis, while the dependent (responding) variable is shown on the $y$-axis. To label the axes, write "Number of Recycling Bins" along the $x$-axis and "Number of Students Using Recycling Bins" along the $y$-axis.
3. Now you have to decide what scale to use. You are working with two numbers (number of students and number of bins). You need to show how many students use the existing bin and how many would recycle if there were a second, a third, and a fourth bin. The scale on the $x$-axis will go from 0 to 4. There are 65 students, so you might want to use intervals of 5 for the $y$-axis. That means that every space on your $y$-axis represents 5 students. Use a tick mark at major intervals on your scale, as shown in the graph on the next page.
4. You want to make sure you will be able to read your graph when it is complete, so make sure your intervals on the $x$-axis are large enough.
5. To plot your graph, gently move a pencil up the $y$-axis until you reach a point just below 30 (you are representing 28 students). Now move along the line on the graph paper until you reach the vertical line that represents the first recycling bin. Place a dot at this point (1 bin, 28 students). Repeat this process for all of the data.

6. If it is appropriate, draw a line that connects all of the points on your graph. A graph showing yearly data that rises and falls without a predictable pattern might have a jagged line connecting all of the points. However, this is not always appropriate. Scientific investigations often involve quantities that change smoothly. In addition, experimental data points usually have some error. On a graph, this means that you should draw a smooth curve (or straight line) that has the general shape outlined by the points. This is called a **line of best fit**. If the points are almost in a straight line, draw a straight line as close to most of the points as possible. There should be about as many points above the line as there are below the line. If the data points do not appear to follow a straight line, then draw a smooth curve that comes as close to the points as possible. Think of the dots on your graph as clues about where the perfect smooth curve (or straight line) should go. A line of best fit shows the trend of the data. It can be extended beyond the first and last points to indicate what might happen.

7. Give your graph a title. Based on these data, what is the relationship between the number of students using recycling bins and the number of recycling bins?

**Number of Students Using Recycling Bins vs. Number of Bins Available**




### Line Graphs of Potential Difference, Current, and Resistance

While most line graphs have the independent variable on the $x$-axis and the dependent variable on the $y$-axis, this is usually not the case for graphs showing the relationship between potential difference and current, potential difference and resistance, or current and resistance.

- In a graph of potential difference and current, the potential difference is shown on the $y$-axis and current is shown on the $x$-axis, even when potential difference is the independent variable. This is because there is a special relationship between potential difference and current that can be shown by graphing them this way.
- In a graph of potential difference and resistance, potential difference is usually shown on the $y$-axis and resistance is shown on the $x$-axis.
- In a graph of current and resistance, current is usually shown on the $y$-axis and resistance is shown on the $x$-axis.

### Instant Practice—Line Graph

The level of ozone in Earth's upper atmosphere is measured in Dobson units (DU). Using the information in the table below, create a line graph showing what happened to the amount of ozone over Antarctica during a period of 35 years.

**Table 2 Ozone Levels in Earth's Upper Atmosphere**

| Year | Total Ozone (DU) |
|---|---|
| 1965 | 280 |
| 1970 | 280 |
| 1975 | 275 |
| 1980 | 225 |
| 1985 | 200 |
| 1990 | 160 |
| 1995 | 110 |
| 2000 | 105 |

## Constructing a Bar Graph

Bar graphs help you to compare a numerical quantity with some other category at a glance. The second category may or may not be a numerical quantity. It could be places, items, organisms, or groups, for example.

**Example**

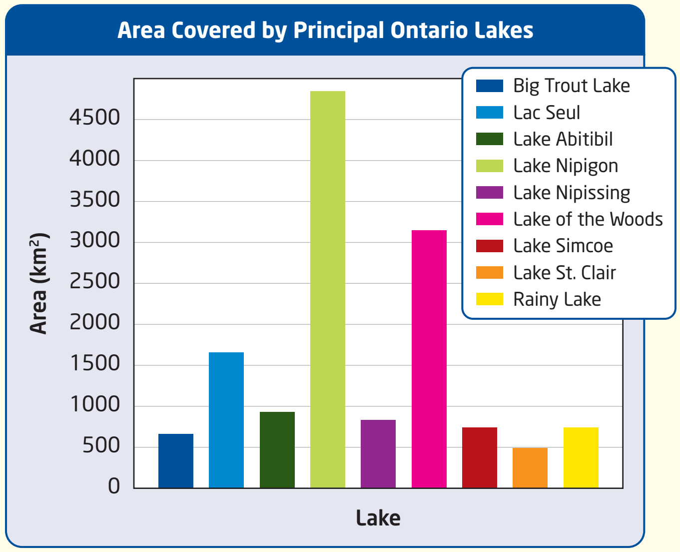
To learn how to make a bar graph to display the data in **Table 3** below, examine the graph in the column as you read the steps that follow.

**Table 3 Area Covered by Principal Ontario Lakes**

| Lake | Area ($km^2$) |
|---|---|
| Big Trout Lake | 661 |
| Lac Seul | 1657 |
| Lake Abitibi | 931 |
| Lake Nipigon | 4848 |
| Lake Nipissing | 832 |
| Lake of the Woods | 3150 |
| Lake Simcoe | 744 |
| Lake St. Clair | 490 |
| Rainy Lake | 741 |

**Procedure**

1. Draw your $x$-axis and $y$-axis on a sheet of graph paper. Label the $x$-axis "Ontario Lakes" and the $y$-axis "Area ($km^2$)."
2. Look at the data carefully in order to select an appropriate scale. Write the scale of your $y$-axis.
3. Using Big Trout Lake and 661 as the first pair of data, move along the $x$-axis the width of your first bar, then go up the $y$-axis to 661. Use a pencil and ruler to draw in the first bar lightly. Repeat this process for the other pairs of data.
4. When you have drawn all of the bars, add labels on the $x$-axis to identify the bars. Alternatively, use colour to distinguish among them.
5. If you are using colour to distinguish among the bars, you will need to make a legend or key to explain the meaning of the colours. Write a title for your graph.




### Instant Practice—Bar Graph

Make a vertical bar graph using **Table 5**, which shows each planet's gravitational force in relation to Earth's gravity.

**Table 4 Gravitational Pull of Planets**

| Planet | Gravitational Pull ($g$) |
|---|---|
| Mercury | 0.40 |
| Venus | 0.90 |
| Earth | 1.00 |
| Mars | 0.40 |
| Jupiter | 2.50 |
| Saturn | 1.10 |
| Uranus | 0.90 |
| Neptune | 1.10 |

### Constructing a Pie Graph

A pie graph (sometimes called a pie chart) uses a circle divided into sections (like pieces of pie) to show the data. Each section represents a percentage of the whole. All sections together represent all (100 percent) of the data.

#### Example

To learn how to make a pie graph from the data in **Table 5**, study the corresponding pie graph on the right as you read the following steps.

**Table 5** Birds Breeding in Canada

| Type of Bird | Number of Species | Percent of Total | Degrees in Section |
|---|---|---|---|
| Ducks | 36 | 9.0 | 32 |
| Birds of prey | 19 | 4.8 | 17 |
| Shorebirds | 71 | 17.7 | 64 |
| Owls | 14 | 3.5 | 13 |
| Perching birds | 180 | 45.0 | 162 |
| Other | 80 | 20.0 | 72 |

#### Procedure

1. Use a mathematical compass to make a large circle on a piece of paper. Make a dot in the centre of the circle.
2. Determine the percent of the total number of species that each type of bird represents by using the following formula.

$$\text{Percent of total} = \frac{\text{Number of species within the type}}{\text{Total number of species}} \times 100\%$$

For example, the percent of all species of birds that are ducks is

$$\text{Percent that are ducks} = \frac{\text{36 species of ducks}}{\text{400 species}} \times 100\% = 9.0\%$$

3. To determine the number of degrees in the section that represents each type of bird, use the following formula.

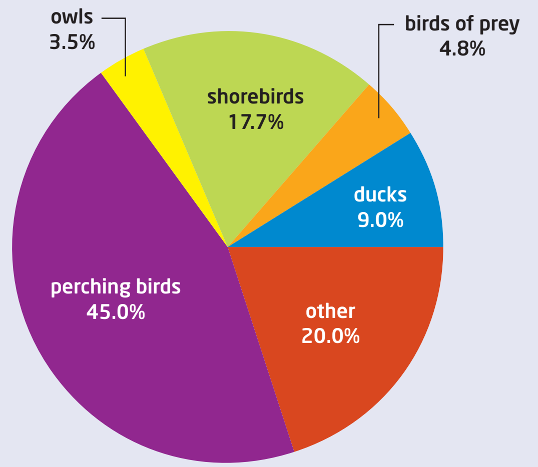
$$\text{Degrees in "piece of pie"} = \frac{\text{Percent for a type of bird}}{100\%} \times 360°$$

Round your answer to the nearest whole number. For example, the section for ducks is

$$\text{Degrees for ducks} = \frac{9.0\%}{100\%} \times 360° = 32.4° \text{ or } 32°$$

4. Draw a straight line from the centre to the edge of the circle. Use your protractor to measure 32° from this line. Make a mark, then use your mark to draw a second line 32° from the first line.
5. Repeat steps 2 to 4 for the remaining types of birds.

**Species of Birds Breeding in Canada**




### Instant Practice—Pie Graph

Use the following data on total energy (oil, gas, electricity, etc.) consumption for 2004 to develop a pie graph to visualize energy consumption in the world.

**Table 6** World Energy Consumption in 2004

| Area in the World | Consumption (quadrillion btu) |
|---|---|
| North America | 120.62 |
| Central and South America | 22.54 |
| Europe | 85.65 |
| Eurasia | 45.18 |
| Middle East | 21.14 |
| Africa | 13.71 |
| Eastern Asia and Oceania | 137.61 |

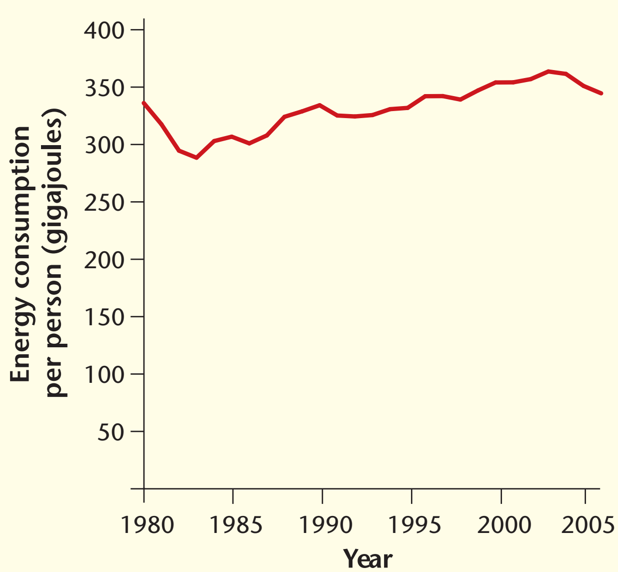
## Choosing the Right Graph for the Job

It is important to choose the appropriate type of graph to organize and communicate your data. Some guidelines are given below.

### Line Graphs

Line graphs are useful for

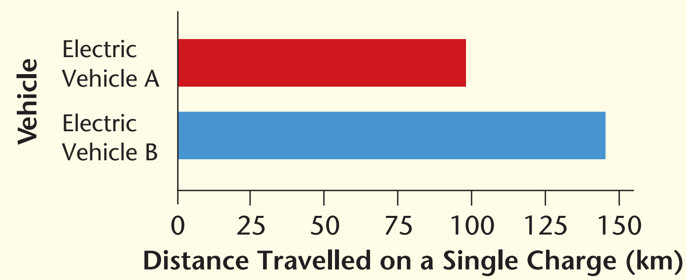
- making comparisons between a large number of categories or across a range of values for the variable that is being tested. For example, the graph below shows the annual energy usage per person from 1980 to 2006. Time is the variable being tested or considered.
- showing general trends in the relationship between variables. Does an increase in the manipulated (independent) variable cause an increase or a decrease in the responding (dependent) variable?
- finding the mathematical relationship between two variables. Rates and ratios can be calculated from a line showing how a variable changes over time.



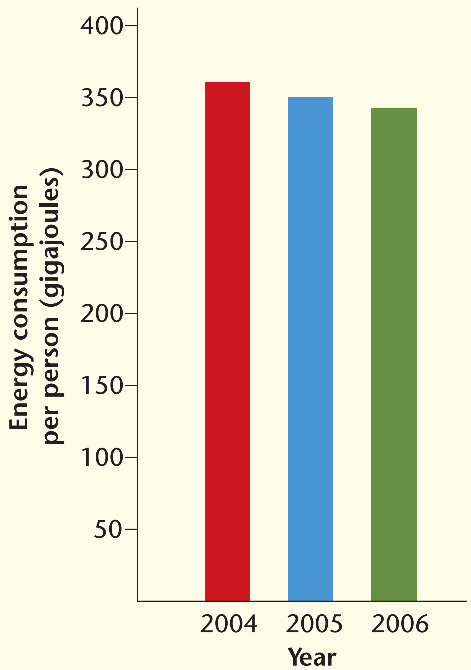

### Bar Graphs

Bar graphs are useful for

- comparing a responding (dependent) variable between two distinct types of things, such as plant cells and animal cells, or between competing things, such as brands of a product. For example, this graph compares the distance travelled on a single charge by two different electric cars.




- comparing a responding (dependent) variable among categories within a group, such as provinces in Canada, months in a year, or phases of mitosis.
- reporting the results of surveys. For example, you might want to show how many people said "Yes" and how many said "No" to each question on a survey.
- showing annual changes. For example, you might use a bar graph to show how energy usage had changed from 2004 to 2006. (However, if you were comparing a large number of categories, such as annual energy use from 1980 to 2006, it would be better to use a line graph.)



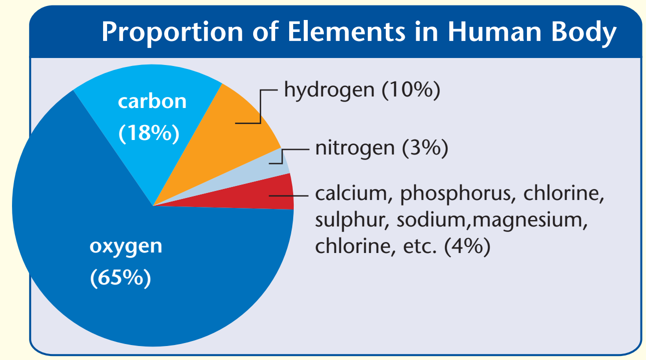

**Pie Graphs**

Pie graphs are useful for

- quick visual comparisons of proportions between segments of a whole.
- showing, at a glance, the most common category within a fixed set of categories. For example the pie graph on page 373 shows that perching birds are the most common category of the breeding birds sampled.

Limitations of pie graphs include the following:

- They cannot be used to show change over time. They are a snapshot of data collected at one specific time.
- They cannot be used to show complex relationships between variables.
- They must represent categories as percentages of a whole.
- It is difficult to compare similar categories unless the percentages represented by each slice of the pie are clearly labelled, as they are in this example from Unit 2.




**Instant Practice—Choosing Graph Types**

What would be the best type(s) of graph to use for each purpose?

1. calculating the rate at which a chemical reaction takes place
2. comparing the number of cells in each stage of the cell cycle
3. showing how average annual global temperature changed from 1960 to today
4. comparing the amount of each chemical element present in a product
5. showing the relationship between world population and degree of global warming

# Numeracy Skills Toolkit 3

## The GRASP Problem Solving Method

Solving any problem is easier when you establish a logical, step-by-step procedure. One useful method for solving numerical problems includes five basic steps: **Given**, **Required**, **Analysis**, **Solution**, and **Paraphrase**. You can easily remember these steps because the first letter of each word spells the word **GRASP**.

### Example of the GRASP Problem Solving Method [Different example]

Draw a ray diagram for an object that is exactly halfway between *F* and 2*F* for a concave mirror that has a focal length of 5 cm. Predict the image characteristics.

**Given—Organize the given data.**

type of mirror: concave
object distance: 1.5 focal lengths from mirror (1.5*f*)
focal length: 5 cm

**Required—Identify what information the problem requires you to find.**

image characteristics:
- image distance
- orientation of image
- size of image
- type of image

**Analysis—Decide how to solve the problem.**

1. Determine how far the object is from the mirror.
2. Draw a ray diagram to predict the object's image.

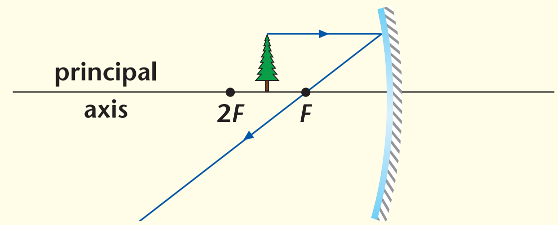
**Solution—Solve the problem.**

**1.** If the focal length of the mirror is 5 cm and the object is exactly halfway between F and 2F, calculate the object distance:

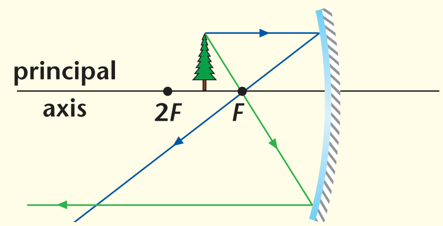
$$1.5f = 1.5 \times 5 \text{ cm}$$
$$= 7.5 \text{ cm}$$

**2.** Draw a ray diagram for a concave mirror with a focal point, *F*, at 5 cm, and draw an object 7.5 cm from the mirror.

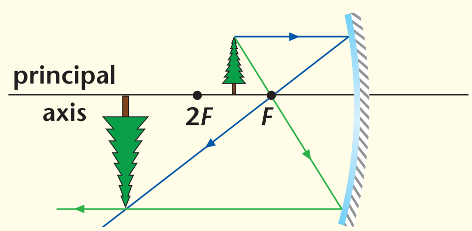
**i)** Draw a ray parallel to the principal axis, with the reflected ray passing through the focal point.




**ii)** Draw a ray through the focal point, with the reflected ray parallel to the principal axis.




**iii)** Draw the image where the two rays meet.




**Paraphrase—Restate the solution and check your answer.**

**Restate** The image distance is larger than the object distance. The image is inverted. The image is larger than the object. The image is real.

**Check** If you look back at Topic 4.4, you will see that these image characteristics match those for an object that lies between *F* and *C*. *C* and 2*F* are the same point, since the focal point is exactly halfway from the centre of curvature to the mirror.

**Instant Practice—Using GRASP**

Draw a ray diagram for an object that is at *F* for a convex mirror with a focal length of 4 cm. Predict the image characteristics.

# Literacy Skills Toolkit 1

## Preparing for Reading

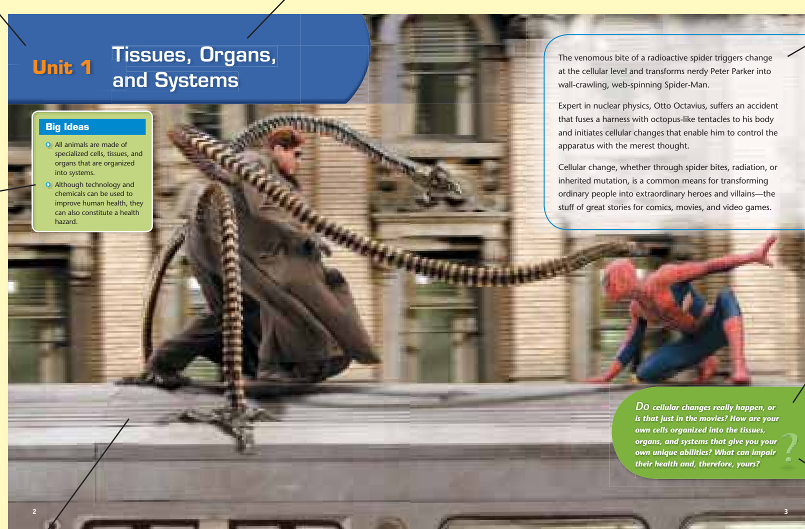
### Previewing Text Features

Before you begin reading a textbook, become familiar with the book's overall structure and features. This will help you understand where information can be found and how it will be presented. If you look at the Table of Contents on page v, you will see that this textbook is divided into four *units*. Each unit is divided into *topics*.

#### The Unit Opener

Each unit begins with a unit opener. It includes several features that will help to get you thinking about the unit. Examine the sample unit opener that is reproduced below.

- The unit number appears at the top left corner of the unit opener in large orange type.
- The unit title appears beside the unit number in large white type.




- The big ideas of the unit are summarized within a light green box. These are the main points that you should keep in mind as you proceed through the unit.
- Text describing the image and its context appear in a white box. This text relates to one or more ideas you will explore in the unit.
- A statement relates the image or the text, or both, to the content of the unit.
- A question gets you thinking about some of the ideas you will explore in the unit.
- The image relates to the content of the unit. It will get you thinking about ideas you will explore further within the unit.

### Instant Practice

1. From what unit is the above sample taken? What does this unit opener tell you about the unit?
2. What is the purpose of each of the features in the unit opener?
3. Find the unit opener for Unit 2. What are the big ideas in that unit?

# Preparing for Reading

## Previewing Text Features

### The Topic Opener

Each unit is broken into *topics*. Each topic explores a question related to the unit. The topic opener contains information about what concepts you will explore, what skills you will develop, and what vocabulary you will learn throughout the topic. It also includes a general introduction to the topic and an activity to get you started. A sample topic opener is shown below.

- The topic number includes the unit number (1) followed by the topic number (1). It appears in the top left corner of the topic opener.
- The topic question forms the title for the topic. It appears in large blue print beside the topic number.
- A brief section of text introduces the topic and prepares you to read further.
- Each topic is broken into key concepts, or important points, that answer the topic question. These are listed as bullet points.
- Key skills are developed through activities within the topic. They are listed below the Key Concepts.
- Key terms are important words that are defined within the topic. They are listed below the Key Skills.


- A starting point activity lets you explore what you already know about the topic before reading any further.
- One or more images show examples that relate to the topic question.
- A curved green panel on the left side of the left page signals the beginning of a new topic.
- The topic number and title appear again at the bottom right corner of the topic opener. This is called a footer. It also includes the page number and information about the publisher (MHR stands for McGraw-Hill Ryerson).

**Instant Practice**

1. Describe two pieces of information that you can find in a topic opener.
2. Find the topic question for another topic in Unit 1. How does the image(s) in the topic opener relate to the question?

# Preparing for Reading

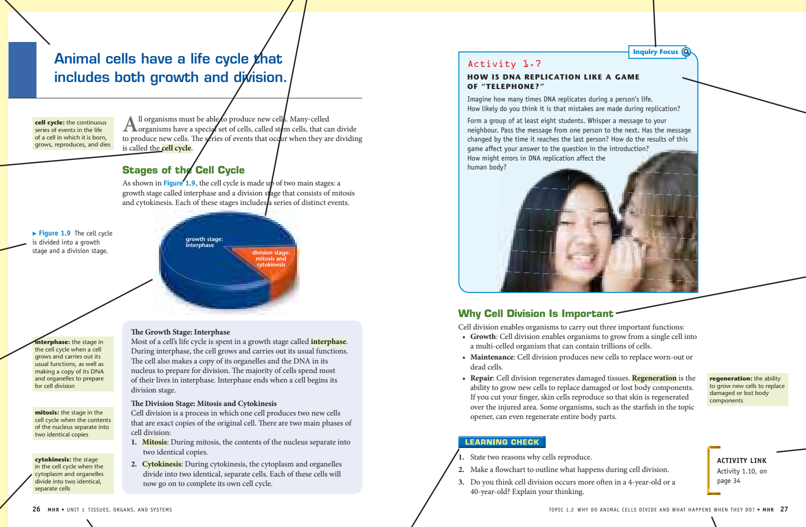
## Previewing Text Features

### The Main Text

Most of the information related to the key concepts of a unit appears in the main text pages of each topic. This is where you will explore the topic questions in detail, find definitions for important vocabulary, and develop skills through activities related to the topic. Each key concept within a topic takes up one or two pages. These pages contain many features designed to help you find your way while reading.

Examine the pages below. They include several features that will help you understand the content.

- The key concept appears in large blue print at the top of the page.
- Important visuals and their references within the text are identified by a blue figure number.
- Activities are labelled with a key skill focus, such as literacy, numeracy, inquiry, or research.
- Key terms are highlighted in pale green. They also appear in **bold** (dark) print.
- Captions describe or give extra information about images.
- Figures help to explain the text in a visual way.




- Activities appear in a pale blue box.
- Headings in green print break the text into chunks. These headings give you a clue to what you are about to read.
- Activity Links give the page numbers of related activities that appear later in the textbook.
- Key terms are defined in the margin, close to where they appear in the text. Definitions are also highlighted in pale green.
- The unit number and title appears in the footer on the left page.
- Learning Check questions help you review what you have just read. If you cannot answer these questions, reread the text on these two pages.
- The topic number and title appears in the footer on the right page.

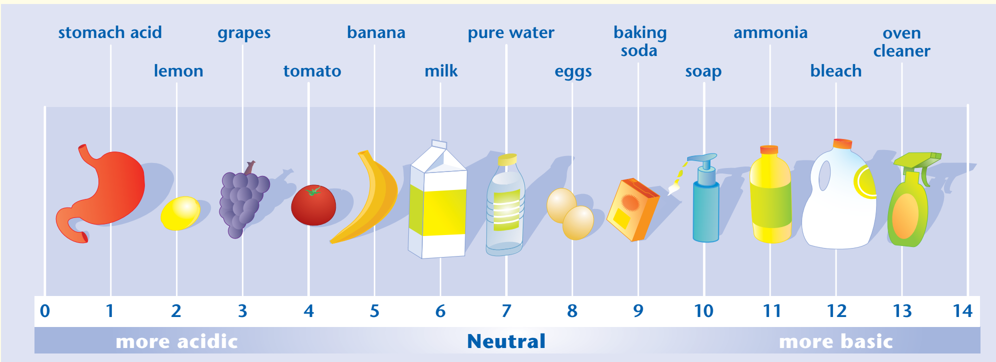
### Instant Practice

1. Describe two ways to identify the key terms in a section.
2. Describe two ways to learn more about a visual in this textbook.

# Preparing for Reading

## Making Connections to Images

Images help to explain or expand on information in the text. Making connections to images help you understand their purpose and meaning. When you look at an image such as the one below (from page 162), start by reading the caption. The caption tells you what is in the image. It may also provide some interesting details.




◄ **Figure 2.25** Acids have a pH less than 7. Bases have a pH greater than 7. Substances with a pH of 7 are neutral, which means that they are neither an acid nor a base.

Some people read a textbook by reading the text first and then looking at the images. Other people "read" the images first. If you start by looking at the image, use the figure number to find more information. The figure number in the caption has a matching reference in the text, and both are in bright blue print. The text will tell you more about the figure and how it relates to a key concept.

As you examine an image, think about the answers to these questions:

1. What personal connections can I make to the image, based on what I already know?
2. What do the text and the caption tell me about the image?
3. What questions do I have about the image that the text and caption do not answer?

In some places in the textbook, an image may appear without a figure number or a caption. Sometimes the caption is left out because the image is part of an activity. In other places, such as the topic opener, the main text tells you more about the image. Sometimes, the caption is left out on purpose, so that you will ask yourself questions about the image:

1. What does the image show?
2. Why did the author include it?
3. How does it relate to the text?

# Reading Effectively

## Identifying the Main Idea and Details

The *main* idea of a text is the *most important* idea. Here are some strategies for identifying the main idea of a topic or paragraph.

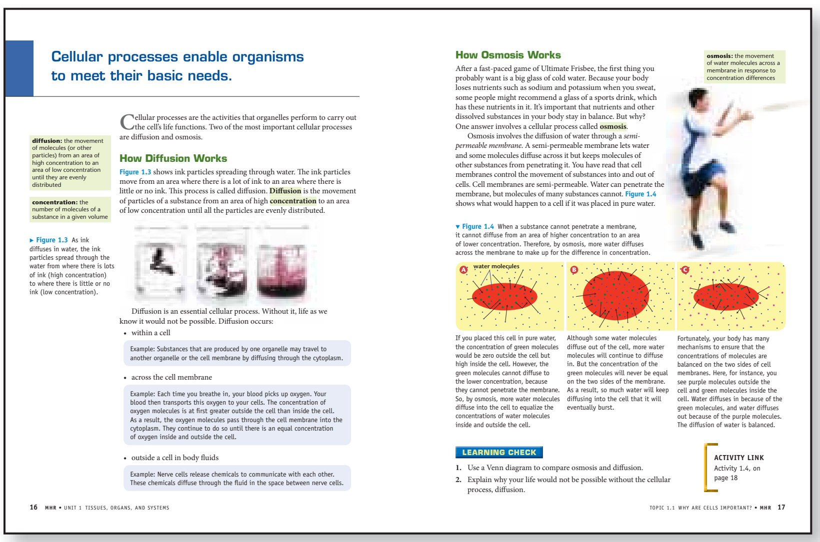
- Pay attention to titles, headings, and subheadings. Note how print size and colour help you identify each of these.
- Look at the images on the page to get a general idea of the content.
- Note any terms that appear in **bold** or *italic* print. Bold print is used to identify key terms. Italics are used to add emphasis to other important words.

*Details* in the text *support and explain* the main idea. Details might be facts or examples. These phrases are clues that details will follow:

- For instance
- For example
- ...such as

### Instant Practice

**1.** Examine the pages below and identify clues that hint at the main idea.



Cellular processes enable organisms to meet their basic needs.

Cellular processes are the activities that organelles perform to carry out the cell's life functions. Two of the most important cellular processes are diffusion and osmosis.

**diffusion:** the movement of molecules (or other particles) from an area of high concentration to an area of low concentration until they are evenly distributed

**concentration:** the number of molecules of a substance in a given volume

How Diffusion Works

Figure 1.3 shows ink particles spreading through water. The ink particles move from an area where there is a lot of ink to an area where there is little or no ink. This process is called diffusion. **Diffusion** is the movement of particles of a substance from an area of high **concentration** to an area of low concentration until all the particles are evenly distributed.

▸ Figure 1.3 As ink diffuses in water, the ink particles spread through the water from where there is lots of ink (high concentration) to where there is little or no ink (low concentration).

Diffusion is an essential cellular process. Without it, life as we know it would not be possible. Diffusion occurs:

- within a cell

Example: Substances that are produced by one organelle may travel to another organelle or the cell membrane by diffusing through the cytoplasm.

- across the cell membrane

Example: Each time you breathe in, your blood picks up oxygen. Your blood then transports this oxygen to your cells. The concentration of oxygen molecules is at first greater outside the cell than inside the cell. As a result, the oxygen molecules pass through the cell membrane into the cytoplasm. They continue to do so until there is an equal concentration of oxygen inside and outside the cell.

- outside a cell in body fluids

Example: Nerve cells release chemicals to communicate with each other. These chemicals diffuse through the fluid in the space between nerve cells.

16 MHR • UNIT 1 TISSUES, ORGANS, AND SYSTEMS

How Osmosis Works

After a fast-paced game of Ultimate Frisbee, the first thing you probably want is a big glass of cold water. Because your body loses nutrients such as sodium and potassium when you sweat, some people might recommend a glass of a sports drink, which has these nutrients in it. It's important that nutrients and other dissolved substances in your body stay in balance. But why? One answer involves a cellular process called **osmosis**.

Osmosis involves the diffusion of water through a *semi-permeable membrane*. A semi-permeable membrane lets water and some molecules diffuse across it but keeps molecules of other substances from penetrating it. You have read that cell membranes control the movement of substances into and out of cells. Cell membranes are semi-permeable. Water can penetrate the membrane, but molecules of many substances cannot. Figure 1.4 shows what would happen to a cell if it was placed in pure water.

**osmosis:** the movement of water molecules across a membrane in response to concentration differences

▾ Figure 1.4 When a substance cannot penetrate a membrane, it cannot diffuse from an area of higher concentration to an area of lower concentration. Therefore, by osmosis, more water diffuses across the membrane to make up for the difference in concentration.



If you placed this cell in pure water, the concentration of green molecules would be zero outside the cell but high inside the cell. However, the green molecules cannot diffuse to the lower concentration, because they cannot penetrate the membrane. So, by osmosis, more water molecules diffuse into the cell to equalize the concentrations of water molecules inside and outside the cell.

Although some water molecules diffuse out of the cell, more water molecules will continue to diffuse in. But the concentration of the green molecules will never be equal on the two sides of the membrane. As a result, so much water will keep diffusing into the cell that it will eventually burst.

Fortunately, your body has many mechanisms to ensure that the concentrations of molecules are balanced on the two sides of cell membranes. Here, for instance, you see purple molecules outside the cell and green molecules inside the cell. Water diffuses in because of the green molecules, and water diffuses out because of the purple molecules. The diffusion of water is balanced.

LEARNING CHECK

1. Use a Venn diagram to compare osmosis and diffusion.
2. Explain why your life would not be possible without the cellular process, diffusion.

ACTIVITY LINK
Activity 1.4, on page 18

TOPIC 1.1 WHY ARE CELLS IMPORTANT? • MHR 17

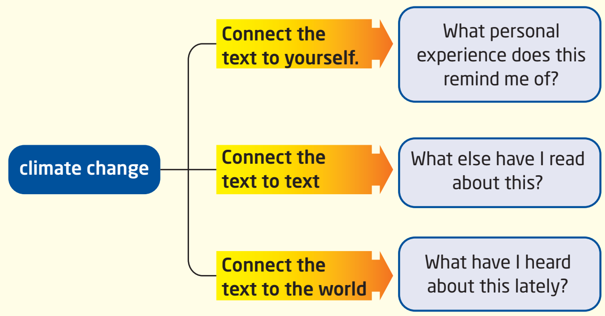
**2.** Here is a section of text from the pages shown above. Can you identify any details in this text that might support the main idea?

> Osmosis involves the diffusion of water through a *semi-permeable membrane*. A semi-permeable membrane lets water and some molecules diffuse across it but keeps molecules of other substances from penetrating it. You have read that cell membranes control the movement of substances into and out of cells. Cell membranes are semi-permeable. Water can penetrate the membrane, but molecules of many substances cannot. Figure 1.4 shows what would happen to a cell if it was placed in pure water.

# Reading Effectively

## Making Connections to What You Already Know

You may already know some facts about the concept you are studying. You may have gathered knowledge from reading other texts, from the news, or from your own experiences. This knowledge can help you understand new information.




In Unit 3, you will learn about climate change. You can use a **concept map** like the one above to organize what you already know about climate change.

## Making Inferences (Reading Between the Lines)

Often, a text does not contain *all* the details related to a particular topic. Some details or connections between ideas may be hinted at rather than stated clearly. The writer relies on you to make inferences, or "read between the lines." This involves combining information in the text with what you already know. It also involves thinking about how two pieces of information are related.

Read the following text:

By cutting down a forest near a stream, tree roots that once trapped soil wither and die. Soil and nutrients wash into the stream, and this can harm or kill fish and other living things.

Ask yourself questions about the text and organize your thoughts in a graphic organizer like the one below.

| | |
|---|---|
| **What information does the text provide? The text says...** | → Cutting down a forest near a stream can kill or harm fish. |
| **What does this tell you about forests and nearby streams? The text says.../I think...** | → Forests and nearby streams are connected. |
| **What do you already know about forests? I say...** | → People sometimes cut down trees in forests. |
| **What connection can you make between what you already know and what you just read? And so...** | → Cutting down trees could harm or kill fish in nearby streams. |

# Reading Effectively

### Skim, Scan, or Study

Not all parts of a textbook should be read at the same speed. In general, how fast you should read a chunk of text depends on your purpose for reading. **Table 1** shows three reading speeds, each suiting a different purpose for reading.

Sometimes the features of the text can help you decide how fast you should read. For example, if you see a page that contains several bold, highlighted key terms, you should read the text slowly and carefully. Text in a topic opener can be read more quickly, since it is only an introduction to the topic.

**Table 1**
**Purposes of Reading Speeds**

| Purpose | Reading Approach (Skim, Scan, or Study) |
|---|---|
| Preview text to get a general sense of what it contains. | Read quickly (skim). |
| Locate specific information. | Read somewhat quickly (scan). |
| Learn a new concept. | Read slowly (study). |

**Instant Practice**

1. Look through Topic 2.4 with a partner. Identify two sections of text that should be read slowly. Then identify two sections that could be skimmed.
2. Can you think of a reason why you would need to scan a section of text?

### Asking Questions

As you are reading, stop every now and then to ask yourself questions starting with *who, what, where, why, when,* and *how*.

Read the following paragraph from page 56:

> In 2009, Canadian astronaut Robert Thirsk began a six-month stay on the International Space Station (ISS) orbiting around Earth. For the astronauts to survive in space, the temperature and pressure within the ISS must be maintained. An adequate supply of oxygen must be provided, and waste gases, such as carbon dioxide, must be removed. Solid waste must also be removed, but urine is recycled to provide the crew with clean water. All of these functions are achieved with the help of advanced technology systems.

**Who** stayed on the ISS?
**When** was he there?
**Where** is the ISS?
**What** is recycled?
**Why** is recycling necessary?
**How** is recycling done?

If you can't answer these questions about the text you've just read, you might need to go back and read more carefully.

You can also use these questions to predict what you will read next. Then continue reading to see if your questions are answered by the text. If they are not, write them down. You can discuss them with a partner, ask your teacher, or do some research to find out more.

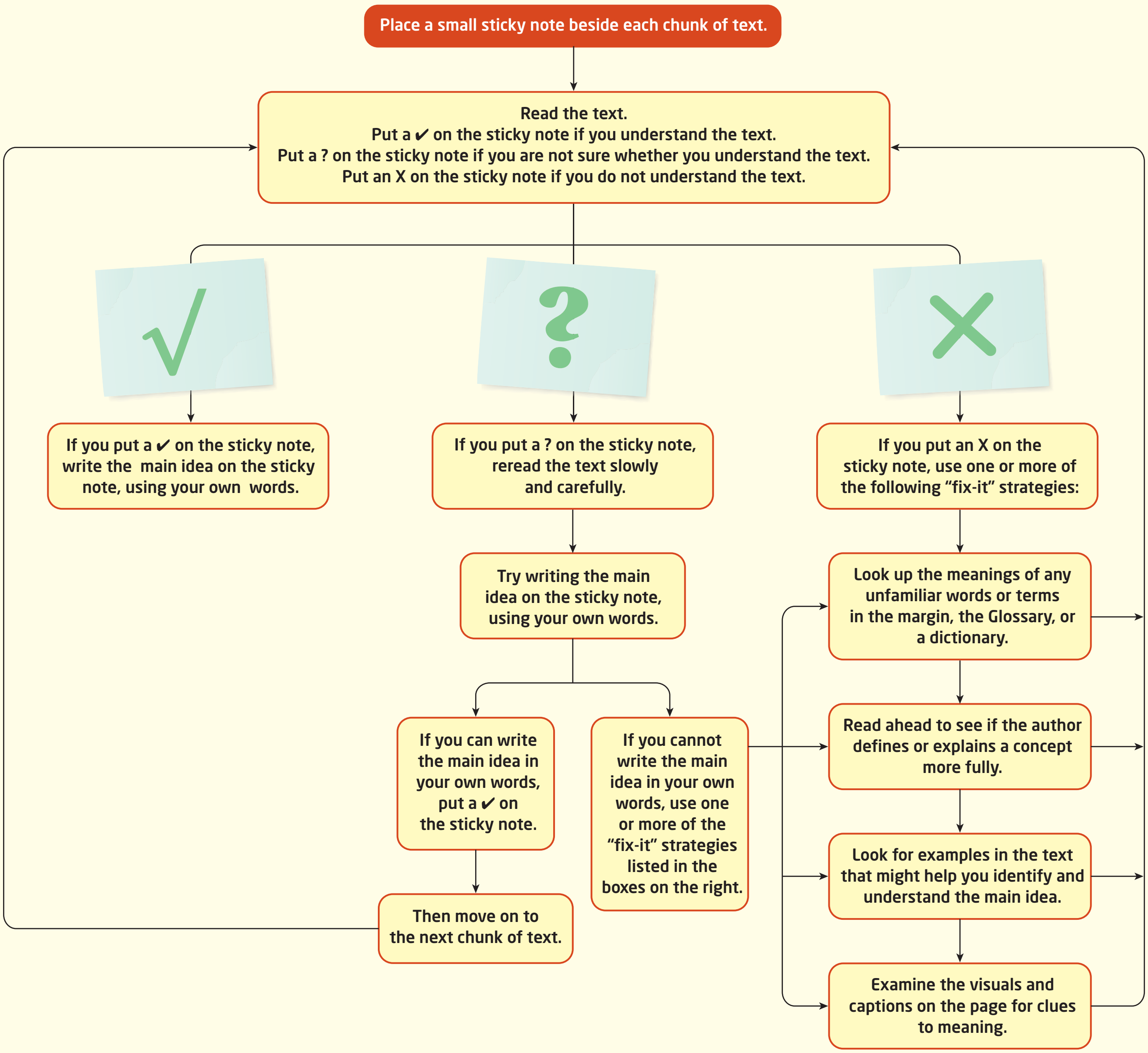
**Instant Practice**

Use the coloured question words to ask questions that are not answered in the paragraph on the left. Then go to page 56 to see if your questions are answered in the next paragraph.

# Reading Effectively

## Checking Your Understanding

When you are reading text that contains new ideas and new key terms, stop after each chunk of text to make sure that you understand what you have just read. You can use the steps in the following flowchart to do this.




### Instant Practice

1. Make a list of steps you could follow if you were not sure that you had understood a section of text. Number your steps.
2. Make a bulleted list of the four "fix-it" strategies, using your own words.

## Reading Graphic Text

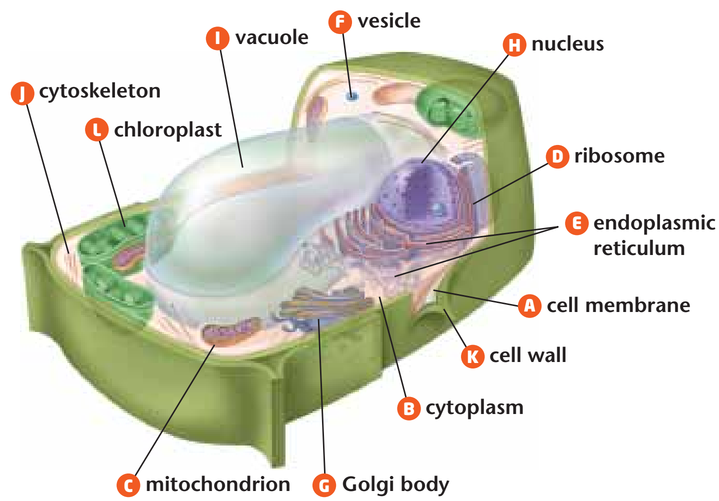
### Reading Diagrams

A diagram is a simplified drawing that uses symbols to represent objects, directions, and relationships. Reading the labels of a diagram can help you understand these symbols.

*To read a diagram*

1. **Read the title or caption to understand the main idea of the diagram.**
   For example, the caption of **Figure 1.2** tells you that you are looking at a diagram of a typical plant cell. (You will learn about this in Topic 1.1.)
2. **Consider how each part illustrates the main idea.**
   The diagram shows all of the parts of a plant cell.
3. **Look closely at the labels and reread the caption, if you need to, to understand the details of the diagram.**
   The labels and the illustration list the names and functions of organelles in a plant cell.
4. **Find the reference to the diagram in the text to find out additional information, and to understand how the diagram relates to the main idea in the text.**

In the main text, near the figure reference, you find the following information: "Each organelle and cell part has a specific role within a cell. This role is important to the proper functioning of both the cell and the organism."




▲ **Figure 1.2** This diagram shows a typical plant cell. Like animal cells, plant cells vary according to their role.

**Instant Practice**

Examine **Figure 1.20** on page 59. Follow the steps above to read the diagram.

1. Explain the main idea of the diagram.
2. How did the caption, labels, and information in the main text help you to understand the diagram?

# Reading Graphic Text

## Reading Tables

A table contains cells that are organized in rows and columns. Each cell contains data. Each column and row has a heading to help you understand the information in each cell.

*To read a table or to find patterns in a table*

1. **Read the title of the table.**
   Based on the title, you should be able to predict what kind of information you will see in the cells.
2. **Read the column and row headings carefully.**
3. **Move your eyes left and right across the rows, and up and down along the columns.**
4. **When you look at a cell, look again at the headings.**
   What is the heading of the column containing this cell? What is the heading of this row?
5. **Look for units.** If measurements are included in the table, the column headings should tell you what units are being used to report the measurements.
6. **Look for patterns as you move left to right across a row, or top to bottom down a column.**
   If the column contains numbers, do the numbers increase steadily as you move down the column? Do they decrease steadily?
7. **Look for breaks in patterns.**
   Is there one cell that doesn't fit the pattern in the rest of its column? Think about why this might be the case.
8. **Look for relationships between columns or rows.**
   Do the numbers in one column increase as the numbers in another column decrease? Do numbers increase from top to bottom in every column? What does this tell you?

In **Table 1** below, the number 500 is found in the column labelled "Number of Zebra Mussels (per $m^2$)" and in the row labelled "1992." This number tells you that 500 zebra mussels per $m^2$ were found in Lake Ontario in 1992.

The year increases as you look down the first column. The number of zebra mussels per $m^2$ also increases as you look down the second column. This tells you that the number of zebra mussels in Lake Ontario increased over time.

**Table 1**
**Zebra Mussels in Lake Ontario**

| Year | Number of Zebra Mussels (per $m^2$) |
|---|---|
| 1990 | 0 |
| 1991 | 230 |
| 1992 | 500 |

# Reading Graphic Text

## Reading Graphs

**1. First read the graph's title.**
Predict what relationship, the graph will display, based on the title.

**2. Read the labels on each of the sections (pieces of pie) in a pie graph.**
What is being compared? In a pie graph, each section represents a percentage of the whole circle. Think about what the whole circle represents.

**3. Look for the percentages on each section of a pie graph.**
If two sections are similar in size, it can be difficult to compare the size of the sections visually. It helps to compare the percentage of the whole that each section takes up.

**4. Compare the sections of a pie graph.**
Which section takes up most of the circle? Which section takes up the least? Is the circle evenly divided into sections?

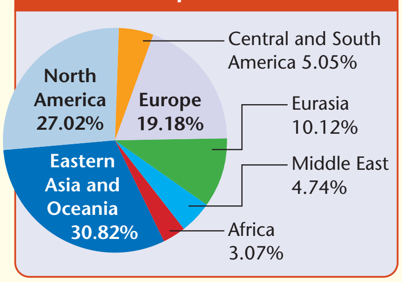
**2.) Read the labels on the x-axis and the y-axis of line graphs and bar graphs.**
What relationship will the graph display, based on the axis labels?

**3.) Note the units on the axes and the numbering on the scales of line graphs and bar graphs.**
Does the graph use very large units or very small ones?

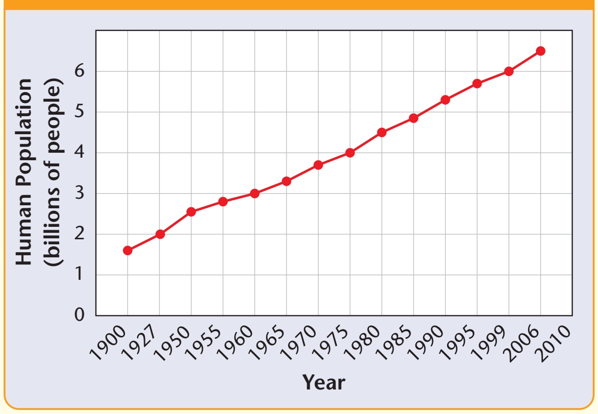
**4.) Look for and describe patterns in the shape of a line graph.**
Line graphs show relationships between two sets of numbers. How does an increase in the numbers on the *x*-axis affect the numbers on the *y*-axis? Is the graph a straight line or a curved one? Does it increase or decrease as you look at it from left to right? Does the line zigzag up and down regularly? (This shows that you have graphed a cycle.)

**4. Compare the size of the bars in a bar graph.**
Describe any pattern you see in how the height of the bar changes between categories.

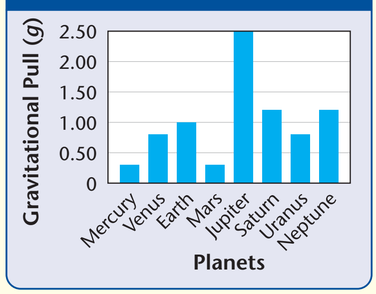
**World Energy Consumption in 2004**




**Changes in Global Population from 1900–2010**




**Gravitational Pull of Planets**



# Literacy Skills Toolkit 4

## Word Study

### Common Base Words, Prefixes, and Suffixes in Science

Understanding how words are put together can help you figure out their meanings. The list below includes some common *base words* that are used in science. Also listed are some common *prefixes* and *suffixes*, which change the meaning of a base word when they are combined with the base word.

| Base Word | Definition | Example |
|---|---|---|
| conduct | To lead or act as a channel for | A **conductor** allows electrons to move easily between atoms. |
| electr(o) | Having to do with electricity | An **electroscope** is a device for detecting an electric charge. |
| phot(o) | Having to do with light | A **photometer** measures the amount of light that is emitted from a source. |
| resist | To hold off; to prevent or oppose | A **resistor** decreases the electric current that is flowing through a component. |
| sustain | To keep going; to maintain | **Unsustainable** means not able to keep going. |
| **Prefix** | **Definition** | **Example** |
| dis- | Not; the opposite of; having an absence of | A **disinfectant** helps to remove and prevent infection. |
| infra- | Below; beneath | **Infrared** light has a a lower frequency than red light. |
| semi- | Half or partial | A **semiconductor** allows electrons to move fairly well between atoms. |
| non- | Not; having an absence of | A **non-metal** is an element that does *not* have the properties of a metal. |
| trans- | Across, over, beyond | **Transmit** send over, pass through |
| **Suffix** | **Definition** | **Example** |
| -al | Relating to | **Environmental** means relating to the environment. |
| -ic | Relating to; characterized by | **Atomic** means relating to an atom. |
| -ity | The state or quality of | **Reactivity** is the quality of being reactive. |
| -ion | The action or process of | **Pollution** is the process of polluting. |

#### Instant Practice

1. Use the table to predict the meaning of transmission.
2. Think of a word that ends in one of the suffixes listed above. (You can browse through this textbook or a dictionary to find a word, if you wish.) Explain the meaning of your word. Compare your word and definition with words and definitions that your classmates suggest.

# Word Study

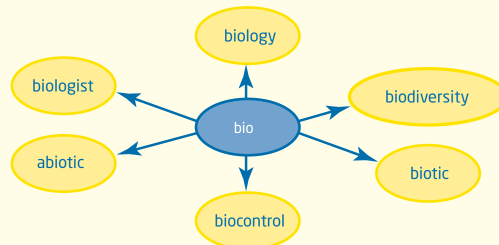
## Word Family Webs and Word Maps

Science textbooks include many words that you may not have seen before. On the last page, you learned that looking at base words, prefixes, and suffixes can help you to understand the meanings of unfamiliar words.

### Word Family Webs

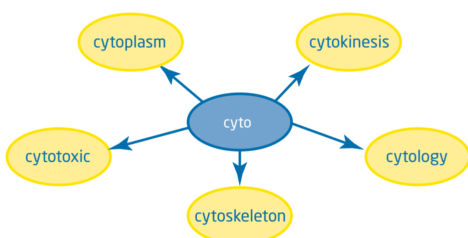
Words that share the same base, prefix, or suffix are related. They make up a word family. A *word family web* can help you see the connections between words in a word family. Then you can figure out unfamiliar words in the family.

The web to the right shows words that all have the prefix *bio*, from the Greek word meaning life. *Biology*, for example, means the study of life. If *ogist* means someone who studies, what does *biologist* mean?



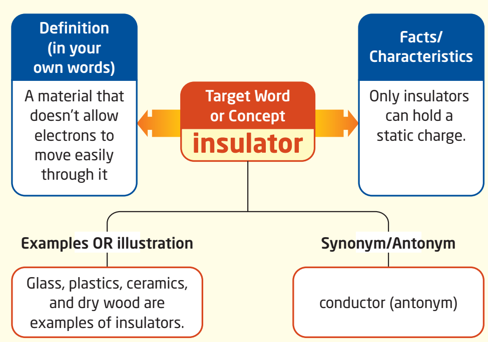

#### Instant Practice

The prefix *cyto* means cell. Use this knowledge of the prefix to predict the meanings of unfamiliar words in the web shown. Check your predictions by locating these words in a dictionary or in this text.




### Word Maps

*A word map* helps you organize your thoughts about a word. Look at the word map for the word *insulator*. The map contains the definition of insulator, but it also includes other information that explains the *concept* of an insulator. You might want to add a section to your word map—*non-examples*. What materials are NOT insulators? If you are able to think of non-examples, you know you have a good understanding of the concept.




#### Instant Practice

1. Create a word map for the word *reflection.*
2. Exchange word maps with a partner. Are your maps the same?

# Literacy Skills Toolkit 5

## Organizing Your Learning: Using Graphic Organizers

When deciding which type of graphic organizer to use, consider your purpose: to brainstorm, to show relationships among ideas, to summarize a section of text, to record research notes, or to review what you have learned before writing a test. Twelve different graphic organizers are shown here. A chart at the end of this toolkit summarizes the function of each organizer to help you decide on the best one for the information you are working with.

### T-Chart

A *t-chart* is a simple two-column chart that can be used to compare or show a relationship between two things.

| Acid | Base |
|---|---|
| • compound | • compound |
| • tastes sour | • tastes bitter |
| • corrodes metals and tissue | • corrodes tissue |
| • turns blue litmus paper red | • turns red litmus paper blue |

### PMI Chart

A *PMI chart* has three columns. PMI stands for "Plus," "Minus," and "Interesting." A PMI chart can be used to state the good and bad points about an issue. The third column in the PMI chart is used to list interesting information related to the issue. PMI charts help you to organize your thinking after reading about a topic that is up for debate or that can have positive or negative effects.

| Grocery stores now charge 5¢ for a plastic grocery bag. | | |
|---|---|---|
| **P** | **M** | **I** |
| • This may make people want to use fewer plastic bags.<br>• There will be fewer plastic bags heading to landfills.<br>• People may be more likely to bring reusable cloth bags to the store.<br>• Cloth bags are strong and can carry many groceries.<br>• Cloth bags can easily be washed before being re-used. | • The charge may not be high enough to stop people from using plastic bags.<br>• It is easy to forget your reusable bags at home.<br>• Over time, cloth bags can collect bacteria if they are used to carry meat, fish, dairy, and produce.<br>• It is inconvenient to have to pay for bags or bring bags from home. | • Some stores have plastic bag recycling centres.<br>• If you have a certain spot where you always keep your bags, you'll be more likely to remember them.<br>• Plastic bags were introduced to replace paper bags. At the time, people thought plastic bags were better for the environment than paper ones. |

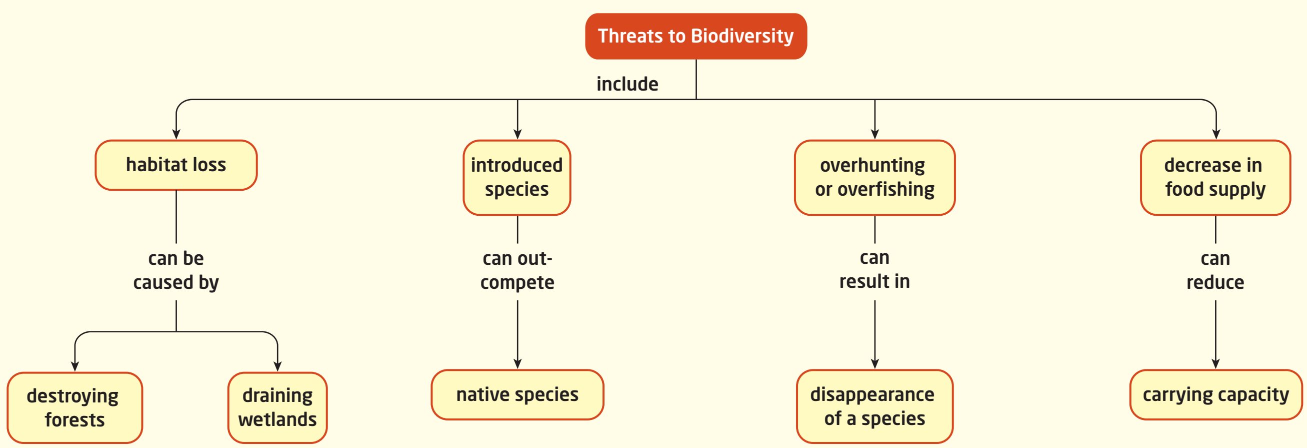
## K-W-L Chart

A *K-W-L chart* is used to record what you already know about a topic, what you want to learn about the topic, and what you know after you have read about the topic. It can help you to plan your research about a subject or check your learning after reading about a subject.

| What You Know | What You Want to Know | What You Learned |
|---|---|---|
| • There are many stars in the sky.<br>• The Sun is a star.<br>• The Sun is the centre of our solar system. | • How many stars are there?<br>• How far away is the nearest star other than our Sun?<br>• Is it part of a solar system too? | • There are so many stars that scientists find it difficult to even estimate how many there are. They estimate that there are 100 000 000 000 ($10^{11}$) stars just in our galaxy, and possibly $10^{22}$ to $10^{24}$ in the whole universe.<br>• The nearest star, Proxima Centauri, is more than four light years away.<br>• Proxima Centauri is part of the Alpha Centauri solar system. |

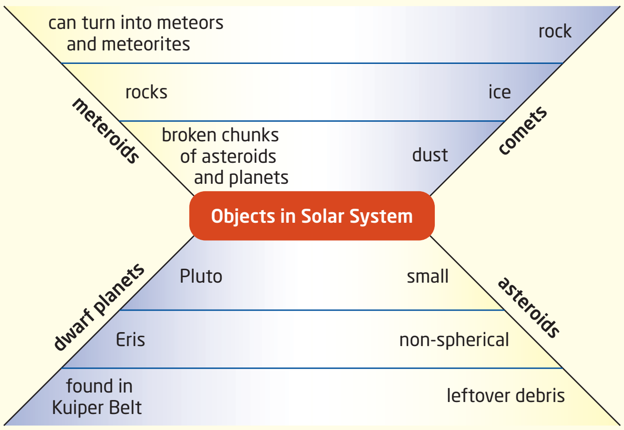
## Concept Map

A *concept map* uses shapes and lines to show how ideas are related. Each idea, or concept, is written inside a circle, a square, a rectangle, or another shape. Words that explain how the concepts are related are written on the lines that connect the shapes.



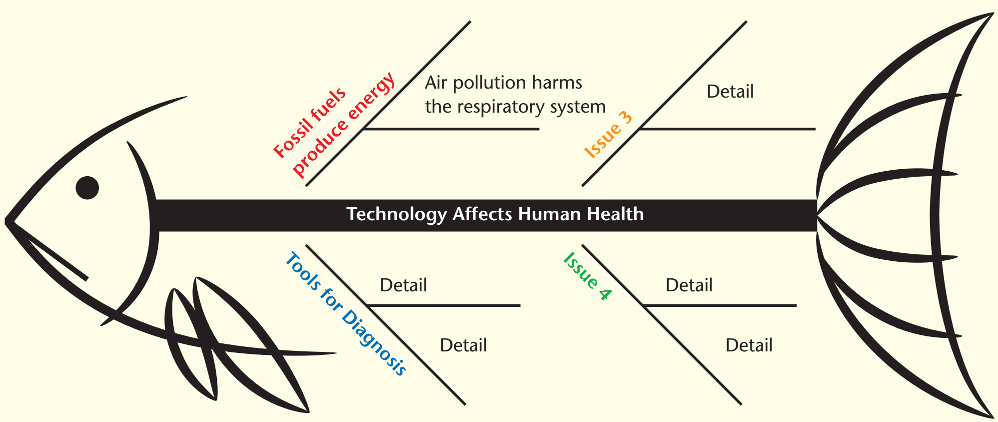
## Spider Map

A *spider map* shows a main idea and several ideas related to the main idea. It does not show the relationships among the ideas. A spider map is useful when you are brainstorming or taking notes.



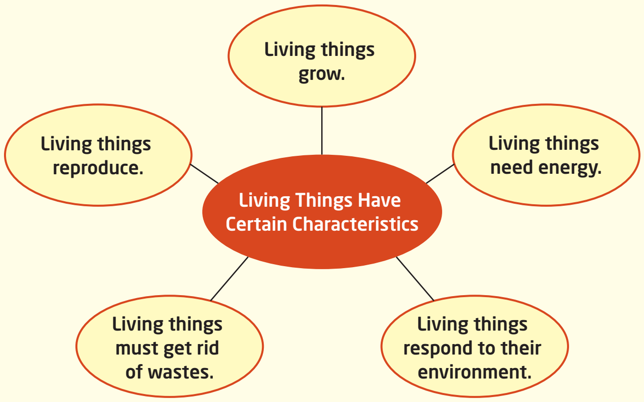

## Fishbone Diagram

A *fishbone diagram* looks similar to a spider map, but it organizes information differently. A main topic, situation, or idea is placed in the middle of the diagram. This is the "backbone" of the "fish". The "bones" (lines) that shoot out from the backbone might be used to list reasons that the main situation exists, issues that affect the main idea, or arguments that support the main idea. Finally, supporting details shoot outward from these issues. Fishbone diagrams are useful for planning and organizing a research project. You can clearly see when you don't have enough details to support an issue. Then you can do more research.



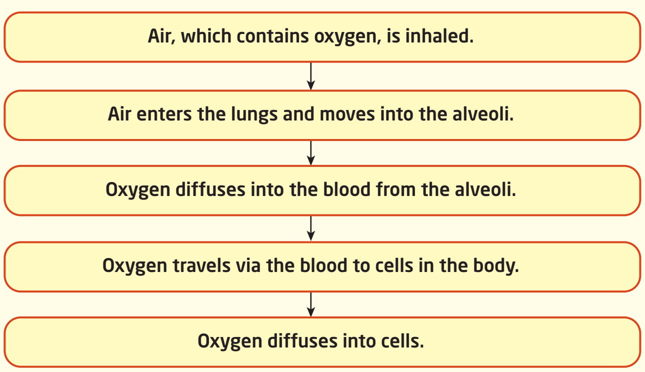
### Main Idea Web

A *main idea web* shows a main idea and several supporting details. The main idea is written in the centre of the web, and each detail is written at the end of a line going from the centre.



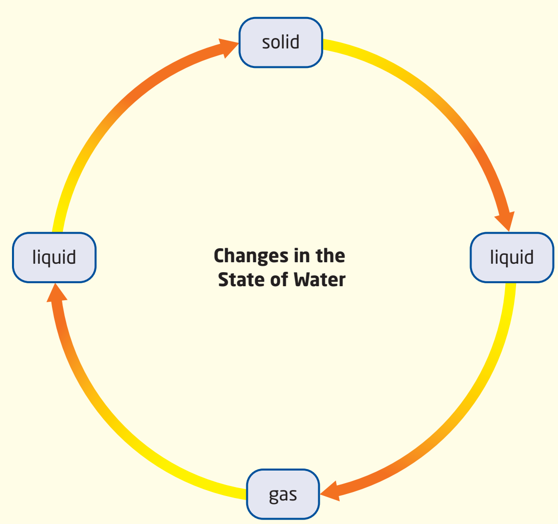

### Flowchart

A *flowchart* shows a sequence of events or the steps in a process. A flowchart starts with the first event or step. An arrow leads to the next event or step, and so on, until the final outcome. All the events or steps are shown in the order in which they occur.



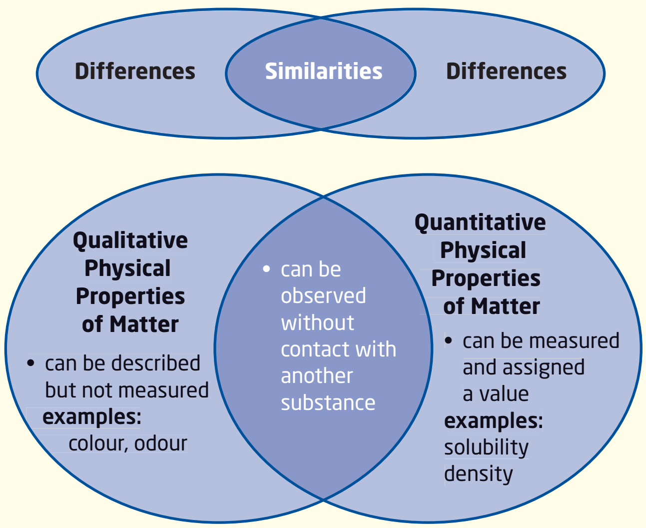

### Cycle Chart

A *cycle chart* is a flowchart that has no clear beginning or end. All the events are shown in the order in which they occur, as indicated by arrows, but there is no first or last event. Instead, the events occur again and again in a continuous cycle.



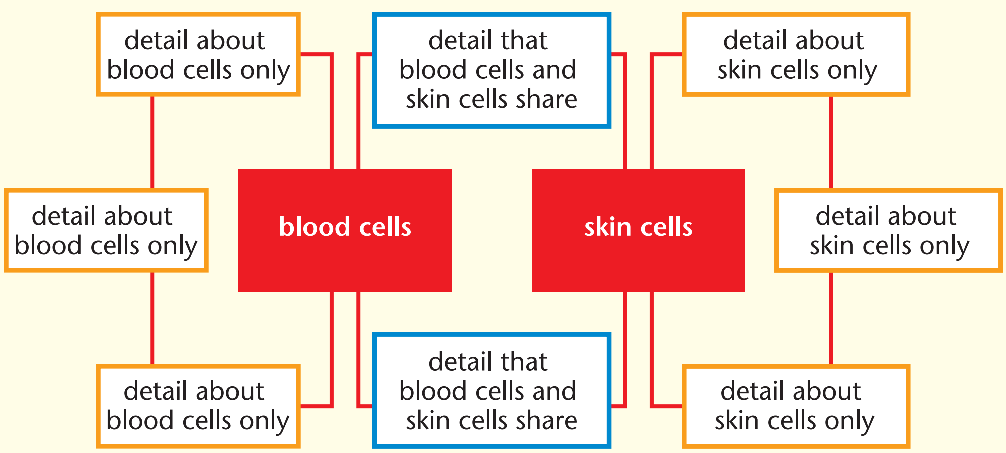
## Venn Diagram

A *Venn diagram* uses overlapping shapes to compare concepts (show similarities and differences).



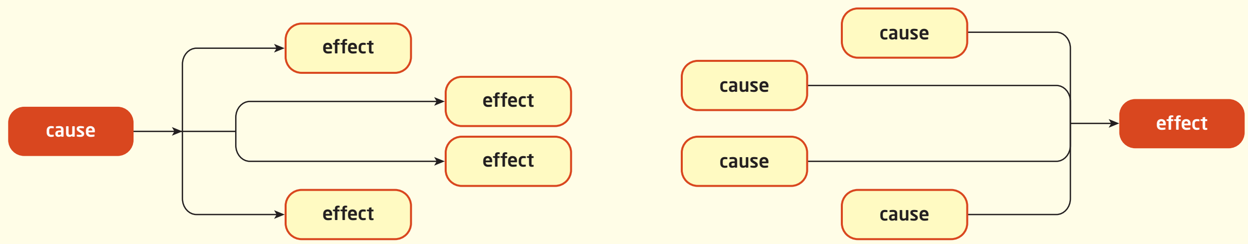

## Double Bubble Organizer

Like a Venn diagram, a *double bubble organizer* is used to concepts (show similarities and differences). It separates the details that two concepts share and the details that they do not share.



### Cause-and-Effect Map

The first *cause-and-effect map* below shows one cause that results in several effects. The second map shows one effect that has several causes.




### Which Organizer Should I Choose?

When you are trying to decide how to organize information, you can use the following chart to help you.

| What are you trying to do with your graphic organizer? | t-Chart | PMI-Chart | K-W-L Chart | Concept Map | Spider Map | Fishbone Diagram | Main Idea Web | Flowchart | Cycle Chart | Venn Diagram | Double Bubble Organizer | Cause-and-Effect Map | Word Map (see page 389) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brainstorm | | | | X | X | | X | | | | | | |
| Show relationships among ideas or words | | | | X | | X | X | | | | | | X |
| Check your understanding | | | X | | | X | | X | X | X | X | X | X |
| Compare (show similarities and differences) | X | | | | | | | | | X | X | | |
| Examine the pros and cons of an issue | X | X | | | | | | | | | | | |
| Examine the causes and/or effects of an action or issue | | | | X | | X | | X | | | | X | |
| Take notes | | X | X | X | X | X | X | | | | | | |
| Plan your research | | | X | | | X | | X | | | | | |
| Show a process or series of events | | | | | | | | X | X | | | | |
| Show a continuous series of events | | | | | | | | | X | | | | |

**Instant Practice**

1. Create a Venn diagram that compares X rays and CT scans.
2. Draw a spider map that reflects what you know about climate change.