Toolkits

Contents

Toolkit 1

Safety Symbols

Safety symbols identify potential hazards. When you see any of the following symbols, either in this book or on a product, take extra care.

Safety Symbols in This Book

Some activities in this book have symbols to help you conduct the activity safely. Look for these symbols at the beginning of activities.

When you see this symbol, wear goggles or safety glasses while doing the activity.

This symbol tells you that you will be using glassware during the activity. Take extra care when handling it.

When you see this symbol, wear an apron while doing the activity.

When you see this symbol, wear gloves while doing the activity.

WHMIS Symbols

Here are symbols you might see on the materials you use in your classroom. You will see them occasionally in the Materials and Equipment lists for activities when a substance that needs a warning is used. These symbols are called Workplace Hazardous Materials Information System (WHMIS) symbols. They are placed on hazardous materials used at job sites and in science classrooms. They may also be on other manufactured products bought for home use. A container may have one or more of the symbols shown below. Discuss with your teacher what the symbols mean.

compressed gas

biohazardous infectious material

dangerously reactive material

corrosive material

oxidizing material

flammable and combustible material

poisonous and infectious causing immediate and serious toxic effects

poisonous and infectious causing other toxic effects

Hazard Symbols for Home Products

You have probably seen some of these hazard symbols on products at home. They are a warning that the products can be harmful or dangerous if handled improperly. These hazard symbols have two shapes: a triangle (a traffic yield sign) or an octagon (a traffic stop sign). A triangle means that the container is dangerous. An octagon means that the contents of the container are dangerous. Here are four of the most common symbols.

Can you identify the symbols that are similar to the WHMIS symbols on the previous page?

Flammable Hazard: The product could ignite (catch on fire) if exposed to flames, sparks, friction, or even heat.

Toxic Hazard: The product is very poisonous and could have immediate and serious effects, including death, if eaten or drunk. Smelling or tasting some products can also cause serious harm.

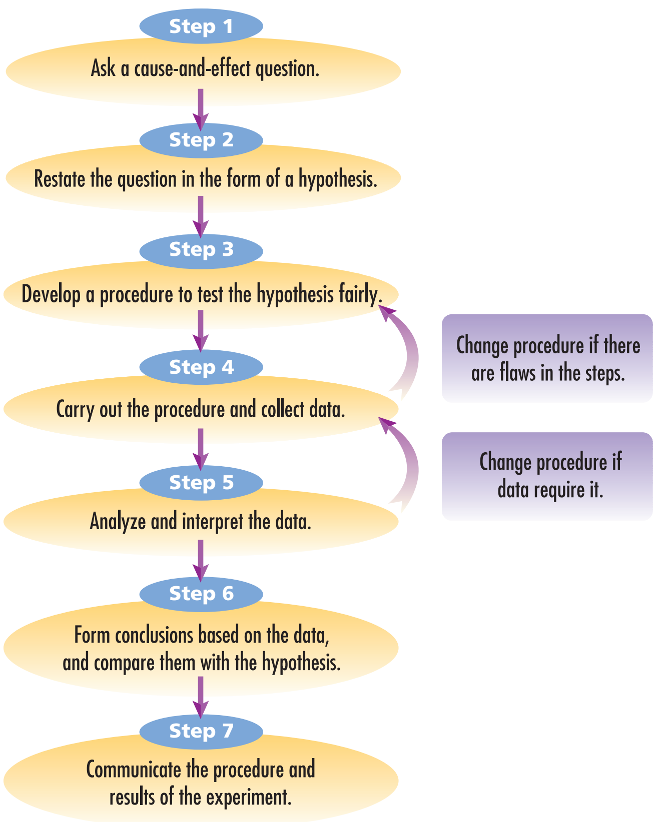
Corrosive Hazard: The product will corrode ("eat away at") clothing, skin, or other materials, and will burn eyes on contact.

Explosive Hazard: The container can explode if it is heated or punctured.

The Inquiry Process of Science

Scientists are always asking a lot of questions. They are always inquiring. They want to understand why the things they observe, and wonder about, happen. Experiments are important tools scientists use to help them answer their questions.

When scientists plan experiments, they usually follow a simple set of steps.



Hints

- Answers may lead to additional questions. New questions often lead to new hypotheses and experiments. Don't be afraid to ask questions, or to rethink the ones you've already asked.
- Science grows when scientists ask questions, answer them, and are willing to question those answers. Scientific knowledge is always growing and changing.

STEP 1 Ask a cause-and-effect question.

Asking questions is easy. Asking questions that lead to reliable answers is more challenging. That's the reason scientists usually ask cause-and-effect questions. Here are a few examples.

- How does the concentration of laundry detergent in wash water affect the cleanliness of clothing?

- How do different temperatures affect the growth of seedlings?
- How does the amount of moisture affect the growth of mould on bread?

Notice how the causes — the detergent, temperature, and moisture — are things that are changeable. For example, you can have different concentrations of detergent, different temperatures, and different amounts of moisture. Causes are manipulated or independent variables. They are factors that you change when you investigate a cause-and-effect question.

The results are changeable, too. For example, some clothes may become cleaner than others, or not clean at all. Some seedlings may grow better than others, or some might not grow at all. Some bread samples may have lots of mould, some may have less, and some might not have any. Results are responding or dependent variables. They change because of the manipulated variable.

When you ask a cause-and-effect question, you should include only one manipulated variable in your question. This allows you to see the effect of that variable on the responding variable.

STEP 2 Restate the question in the form of a hypothesis.

A hypothesis is a way of restating a cause-and-effect question so that it gives a reasonable, possible answer. Basically, a hypothesis is an intelligent guess at the solution to a problem or question. It is usually in the form of an "If ... then" statement and states the relationship between the manipulated and responding variables.

Here are hypotheses for the questions outlined in Step 1.

- If the concentration of the detergent is high, then clothing will become cleaner.
- If the temperature is decreased, then the seedlings will not grow as well.
- If the amount of moisture is increased, then the bread will get mouldier.

Hint

A hypothesis is an early step in the experiment-planning process. Your hypothesis can turn out to be "right," but it doesn't always. That's what the experiment is for — to test the hypothesis.

STEP 3 Develop a procedure to test the hypothesis fairly.

When you develop a procedure, you need to ask yourself some questions. Your answers to these questions will help you plan a fair and safe experiment. Here are some questions you should think about. These questions are answered for the seedling experiment.

- **Which manipulated variable do you want to investigate?** The manipulated variable is temperature.
- **How will you measure this variable (if it is measurable)?** You can measure temperature with a thermometer.
- **How will you keep all other variables constant (the same) so they don't affect your results?** In other words, how will you control your experiment so it is a fair test? To control the experiment, these variables should be kept constant: the amount of light the seedlings receive; the amount and temperature

of water applied to the seedlings; the kind of soil the seedlings are planted in.

- **What materials and equipment will you need for the experiment?** The materials would include seedlings, soil, growing pots or containers (same size), water and a watering can, a light source, a thermometer, and a ruler or other measuring device.
- **How will you conduct the experiment safely?** What safety factors should you consider? Some of the safety factors to consider include putting the seedling pots in a place where they would not be disturbed, washing your hands after handling the materials, and making sure you don't have any allergies to the soil or seedlings you use.
- **How will you set up the procedure to get the data you need to test your hypothesis?** You could divide your seedlings into groups (e.g., three seedlings for each temperature) and grow each group at a certain temperature. You would keep track of how much each seedling in a group grew over a specified amount of time (e.g., four weeks) and calculate the average for the group.

STEP 4 Carry out the procedure and collect data.

Depending on the kind of experiment you have planned, you may choose to record the data you collect in the form of a chart or table, a labelled sketch, notes, or a combination of these. For example, a good way to record the seedling data would be in tables like the one below (one for each week of the experiment).

Week 1: Height of Seedling Grown at Different Temperatures

Temperature seedlings grown at (°C)	Height of seedling 1 (cm)	Height of seedling 2 (cm)	Height of seedling 3 (cm)	Average height (cm)
20				
15				
10				

Hint

Analyzing the data you collect is the only way you have to assess your hypothesis. It's important that your record keeping be organized and neat.

STEP 5 Analyze and interpret the data.

Scientists look for patterns and relationships in their data. Often, making a graph can help them see patterns and relationships more easily. (Turn to Toolkit 6 for more about graphing.)

A graph of the seedling data would show you if there were a relationship between temperature and growth rate.

Hint

If you have access to a computer, find out if it has the software to help you make charts or graphs.

STEP 6 Form conclusions based on the data, and compare them with the hypothesis.

Usually, forming a conclusion is fairly straightforward. Either your data will support your hypothesis or they won't. Either way, however, you aren't finished answering your cause-and-effect question.

For example, if the seedlings did not grow as well in cooler temperatures, you can conclude that your data support your hypothesis. But you will still need to repeat your experiment several times to see if you get the same results over and over again. Doing your experiment successfully many times is the only way you and other scientists can have faith in your data and your conclusions.

If your data don't support your hypothesis, there are two possible reasons why.

- Perhaps your experimental plan was flawed and needs to be re-assessed and possibly planned again.
- Perhaps your hypothesis was incorrect and needs to be re-assessed and modified.

For example, if the seedlings grew better in the lower temperatures, you would have to re-think your hypothesis, or look at your experiment for flaws. You would need to ask questions to help you evaluate and change either your hypothesis or plan. For example, you could ask: Do certain seedlings grow better at lower temperatures than others? Do different types of soil have more of an effect on growth than temperature?

Every experiment is different and will result in its own set of questions and conclusions.

Hint

You could also enlist the help of your classmates. If others have completed the same experiment and got the same results, the conclusions are usually reliable. If not, the hypothesis must be modified. Scientists often work this way to compare results.

STEP 7 Communicate the procedure and results of the experiment.

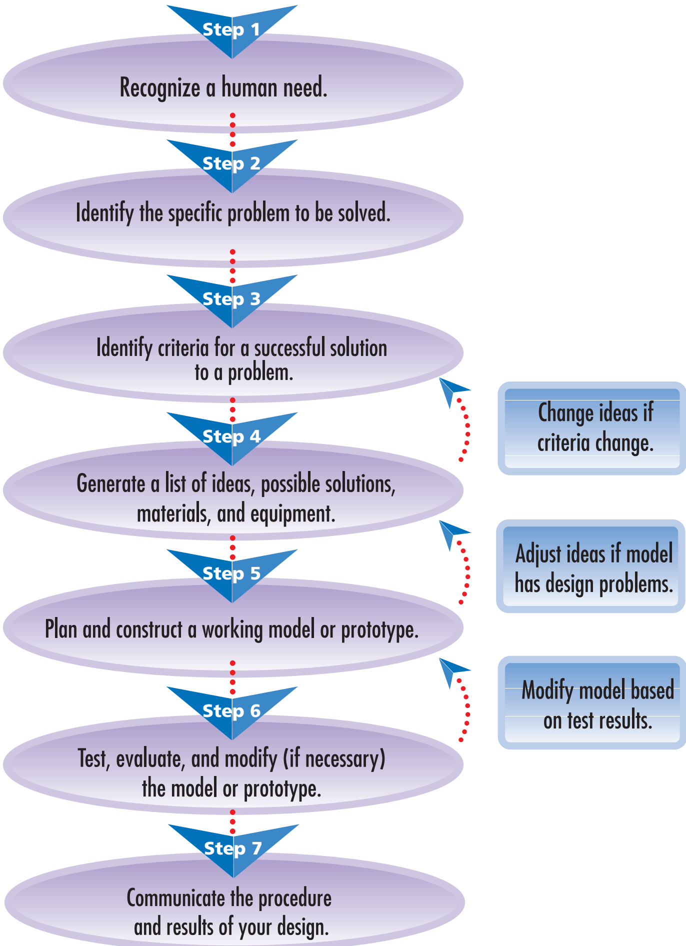
Scientists always share the results of their experiments with other people. They do this by summarizing how they performed the first six steps. Sometimes, they will write out a formal report stating their purpose, hypothesis, procedure, observations, and conclusions. Other times, they share their experimental results verbally, using drawings, charts, or graphs. (See Toolkits 6 and 8 for help on how to prepare your results.)

When you have finished your experiment, ask your teacher how he or she would like you to prepare your results so you can share them with the other students in your class.

The Problem-Solving Process for Technological Development

When you plan an experiment to answer a cause-and-effect question, you follow an orderly set of steps. The same is true for designing a model or prototype that solves a practical problem.

When people try to solve practical problems, they usually follow a simple set of steps.



STEP 1 Recognize a human need.

This involves recognizing what the problem is. For example, suppose you observe that a rope bridge across a ravine at a local park is very unstable and swings back and forth when crossed. This might be fine for people who want a thrill, but you find that most people are not comfortable crossing the bridge and don't get to enjoy one of the nicer areas of the park. You wish there were a way to make the bridge more stable so more people would use it. That is the situation or context of the problem.

STEP 2 Identify the specific problem to be solved.

When you understand a situation, you can then define the problem more exactly. This means identifying a specific task to carry out. In the situation with the bridge, the task might be to build a new bridge or add support to the existing bridge.

STEP 3 Identify criteria for a successful solution to a problem.

You have defined the problem and now you must look for solutions. But how will you know when you have found the best possible solution? Before you start looking for solutions, you need to establish your criteria for determining what a successful solution will be.

One of your criteria for success in the bridge example would be the completion of a stable bridge. The criteria you choose do not depend on which solution you select — whether to reinforce the old bridge or build a new bridge. In this case, whatever the solution, it must result in a stable bridge.

When you are setting your criteria for success, you must consider limits to your possible solutions.

For example, the bridge may have to be built within a certain time, so rebuilding completely may not be possible. Other limitations could include availability of materials, cost, number of workers needed, and safety.

If you are building a product or device for yourself, you may set the criteria for success and the limitations yourself. In class, your teacher will usually outline them.

Hint

Always consider safety. This includes safe handling and use of materials and equipment, as well as being aware of possible environmental impacts of your ideas. Discuss with your teacher and fellow students how your solution might affect the environment.

STEP 4 Generate a list of ideas, possible solutions, materials, and equipment.

Brainstorming, conducting research, or both, are key components of this step. When you brainstorm, remember to relax and let your imagination go. Brainstorming is all about generating as many ideas as possible without judging them. Record your ideas in the form of words, mind maps, sketches — whatever helps you best.

Conducting research may involve reading books and magazines, searching the Internet, interviewing people, or visiting stores. It all depends on what you are going to design.

One idea for the rope bridge would be to anchor the bridge with strong rope or thick metal wire to large rocks or to the hillside at either end of the bridge. Sketches and diagrams would help to generate different ideas for the bridge design.

Hint

Humans have been inventors for tens of thousands of years — so take advantage of what has already been developed. When you're solving a problem, you don't have to "reinvent the wheel." See how others have solved the same problem before and use their efforts as inspiration. You can also look for ways to "build upon" or improve on their ideas.

STEP 5 Plan and construct a working model or prototype.

Choose one possible solution to develop. Start by making a list of the materials and equipment you will use. Then make a working diagram, or series of diagrams, on paper. This lets you explore and troubleshoot your ideas early on. Your labels should be detailed enough so that other people could build your design. Show your plans to your teacher before you begin construction work.

A simple model of the bridge could be made to show how and where components such as stabilizing wires could be added.

Hint

If things aren't working as you planned or imagined, be prepared to modify your plans as you construct your model or prototype.

STEP 6 Test, evaluate, and modify (if necessary) the model or prototype.

Testing lets you see how well your solution works. Testing also lets you know if you need to make modifications. Does your model or prototype meet all the established criteria? Does it solve the problem you designed it for?

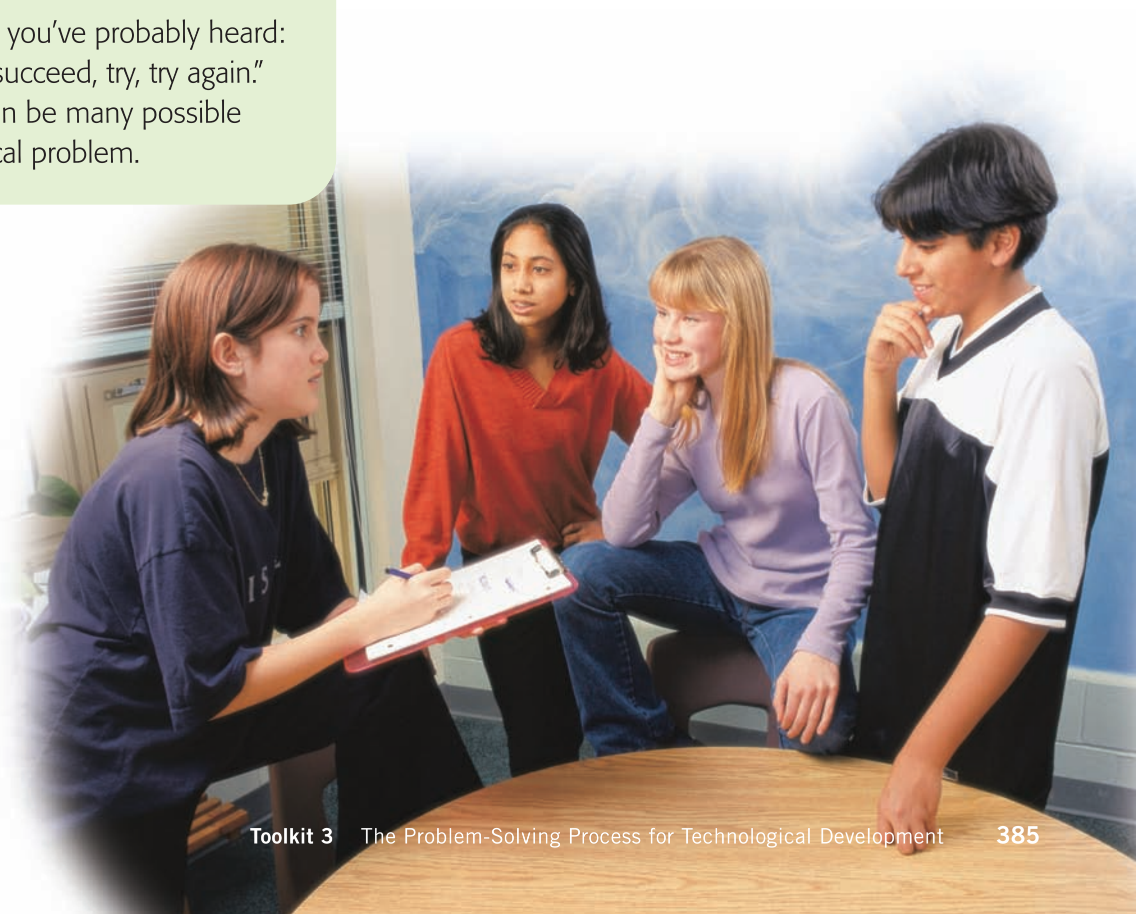
Invite your classmates to try your product. Their feedback can help you decide what is and isn't working, and how to fix anything that needs fixing. Perhaps the stabilizing wires on the bridge model could be anchored elsewhere. Maybe more wires could be added.

Hints

- For every successful invention or product, there are thousands of unsuccessful ones. Sometimes it's better to start over from scratch than to follow a design that doesn't meet its performance criteria.
- Here's an old saying you've probably heard: "If at first you don't succeed, try, try again." Remember, there can be many possible solutions to a practical problem.

STEP 7 Communicate the procedure and results of your design.

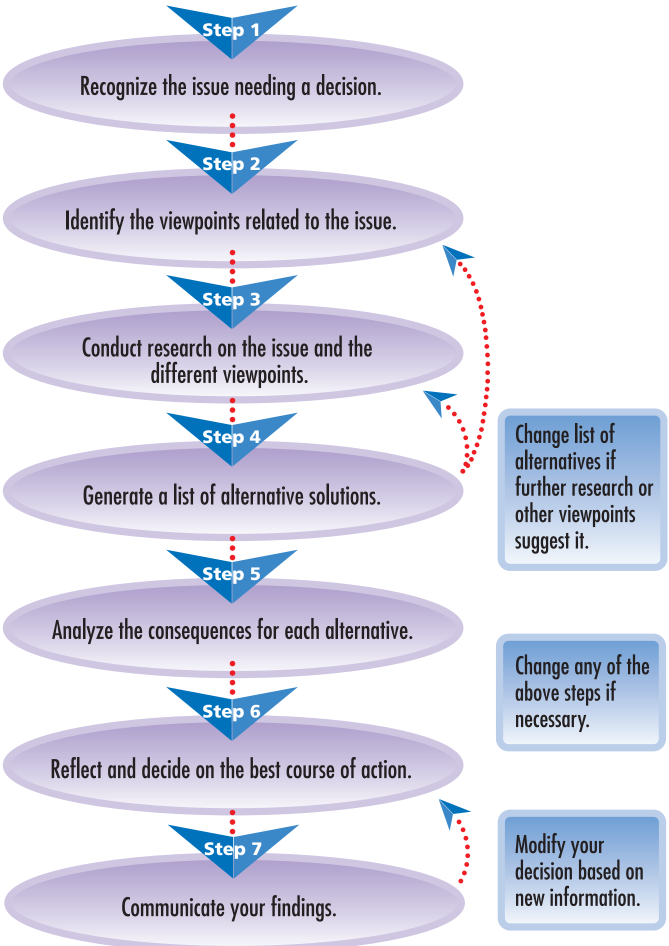
Inventors and engineers create things to meet people's needs. When they make something new, they like to show it to other people and explain to them how it works. Sometimes they will use a carefully drawn diagram of the new device and write about how they performed the first six steps. Other times, they will show the device to people and explain verbally how it works and how they built it. Your teacher will tell you how to prepare your results so you can exhibit the new device you make.



Toolkit 4

The Decision-Making Process for Social and Environmental Issues

People can have many different viewpoints or perspectives about social and environmental issues. This usually means that an issue has more than one possible solution. Scientific and technological information can be used to increase our understanding of an issue and help resolve it.



When people try to make a decision or reach a consensus about an issue, they need to use a decision-making process. Here are the steps in one possible process

STEP 1 Recognize the issue needing a decision.

This involves recognizing that an issue exists. An issue is a controversy that needs to be resolved. It may have more than one possible solution, but the chosen one is usually the one that satisfies the most people. For example, suppose you and your friends want to have some trees in a public park cut down in order to make space for a playing field. Some members of your community feel that the trees should be preserved for the birds that nest there. The local environmental specialist says that when it rains, the trees protect a nearby stream by reducing run-off, so they should be left standing. Other people say that your idea of building a playing field is too expensive.

STEP 2 Identify the viewpoints related to the issue.

The viewpoints expressed in the example in step 1 are recreational (you and your friends), ecological (people who wish to leave the trees as they are), and economic (people who think that the cost would be too high).

People often evaluate issues using one or more viewpoints. Some of these viewpoints are:

- Cultural: interest in the customs and practices of a particular group of people
- Ecological: interest in the protection of the natural environment

- Economic: interest in the financial aspects of the situation
- Educational: interest in acquiring and sharing knowledge and skills
- Esthetic: interest in the beauty in art and nature
- Ethical: interest in beliefs about what is right and wrong
- Health and safety: interest in physical and mental well-being
- Historical: interest in knowledge dealing with past events
- Political: interest in the effect of the issue on governments, politicians, and political parties
- Recreational: interest in leisure activities
- Scientific: interest in knowledge based on the inquiry process of science (Toolkit 2)
- Social: interest in human relationships, public welfare, or society
- Technological: interest in the design and use of tools and processes that solve practical problems to satisfy peoples' wants and needs (Toolkit 3)

STEP 3 Conduct research on the issue and the different viewpoints.

You will be able to suggest an appropriate solution to an issue only if you understand the issue and the different viewpoints. It's important to gather unbiased information about the issue itself and then consider the information provided by people with different viewpoints.

Develop specific questions that will help to guide your research. Questions for the playing field issue might be:

- How many people will use the playing field?
- Is there another more suitable site for the playing field?
- What kind of birds nest in these trees? Could they nest elsewhere in the area?
- What is run-off and why is it a problem?
- What would be the full cost of building the playing field (including the cost of removing the trees)?

Conducting research may involve interviewing people, reading books and magazines, searching the Internet, or making a field trip. It is important to evaluate your sources of information to determine if there is a bias and to separate fact from opinion. In this step, you are trying to gain a better understanding of the background of the issue, the viewpoints of different groups, the alternative solutions, and the consequences of each alternative. You will find tips on how to conduct research in the following section on researching topics.

STEP 4 Generate a list of alternative solutions.

Examine the background of the issue and the viewpoints in order to generate a list of alternative solutions. Brainstorming can be a useful component of this step. Use your research to help guide your thinking.

Examples of possible alternatives for the issue in step 1 might be as follows:

- Cut the trees and build the playing field.
- Leave the park as it is.
- Find another more suitable location.
- Modify the plan in the existing park.

STEP 5 Analyze the consequences for each alternative.

Decide how you will measure the risks and benefits for the consequences of each alternative solution. You may decide to examine the importance, likelihood, and duration of each possible consequence. The importance of the consequence and the likelihood of its occurrence can be ranked high (3), moderate (2), low (1), or none (0). Duration is considered short term (S) if it is less than 50 years or long term (L) if it is longer than 50 years. Ask how many people will benefit from the alternative and how many will be affected negatively. Make sure to consider health and safety.

For the playing field example, you could analyze the consequences of each alternative solution in a table like the one shown below.

Analysis of Consequences: Alternative 1 – Build the playing field in the park.

Consequence	Importance (3, 2, 1, 0)	Likelihood of occurrence (3, 2, 1, 0)	Duration (S, L)
Trees cut	2	3	L
Run-off	3	3	S
Birds move	2 to 1	3	L
Playing field well used	2	2	possibly L
Development and maintenance cost	2 to 1	3	L

STEP 6 Reflect and decide on the best course of action.

Evaluate your decision-making process to ensure that each step is completed as fully as possible. Consider the consequences of the alternative solutions and how people will respond to each one. Then decide on what you think is the best course of action.

STEP 7 Communicate your findings.

Communicate your findings in an appropriate way. For example, you may prepare a written report, a verbal presentation, or a position for a debate or a public hearing role-play. Defend your position by clearly stating your case and presenting supporting evidence from a variety of sources.

Researching Topics

Research involves finding out something about a topic or subject. That means going to certain resources that will give you accurate information. Information can be found just about anywhere: from your home bookshelves to the public library, from asking experts to looking on the Internet. Here is the process you should follow when you do your research.

Choosing a Topic

In some situations, your teacher may give you the topic to research. Other times, you will select one of your own, such as the issue described above. If you have trouble coming up with a topic, try brainstorming ideas either by yourself or with a group. Remember, when you brainstorm, there are no right or wrong answers, just "ideas." Here are some brainstorming suggestions to get you started:

- List two or three general topics about science that interest you.
- For each topic, spend a few minutes writing down as many words or ideas that relate to that topic. They don't have to be directly connected to science.
- Share your list with others and ask them to suggest other possibilities.
- Now you have to "filter" your idea list to find a topic to research. In other words, go through your ideas until you find two or three that interest you. To help you narrow your idea list, try grouping similar words or ideas, modifying what you've written, or even writing down a new idea. Sometimes, too, working with other people will help to focus your thoughts.
- When you settle on an idea for your topic, write it down. Try to explain it in a couple of sentences or a short paragraph. Do that for each of your two or three topic ideas.
- Have your teacher approve your topics. Now you're ready to go!

Which Topic Should I Choose?

How does product design help sell a product?

How do gears improve the performance of a bicycle?

The next thing you have to do is settle on one topic. (Remember, you should start your research with two or three topic ideas.) One way to help you decide is to determine how easy it will be to find information on your topic.

- Use some of the resources listed under "Finding Information" to do your preliminary research.
- If you can't easily find at least four good references for a topic, consider dropping it and going on to the next idea.

Hint

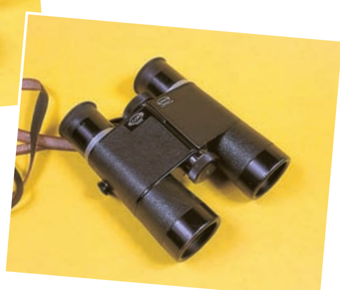
Sometimes topics are too broad in scope or too general to make good research reports (for example, "transportation" instead of just "bicycles"). Try rewriting your topic to narrow its focus.

If all the topics are easy to research, then you'll need some other criteria to help you decide. Think about

- which topic interests you the most
- which topic is not being researched by many students in your class
- which topic interests you the least

How Hard Will It Be to Find Information?

How Camera Lenses Are Manufactured



How Mirrors Are Used in Some Optical Devices

Once you've finally chosen your topic, you might want to work with other students and your teacher to:

- finalize its wording
- make sure it matches the project or assignment you are doing

Finding Information

There are many resources that you can use to look up information. You'll find some of these resources:

- in your school
- in your community (such as your public library)
- on the Internet
- in CD-ROM encyclopedias and databases

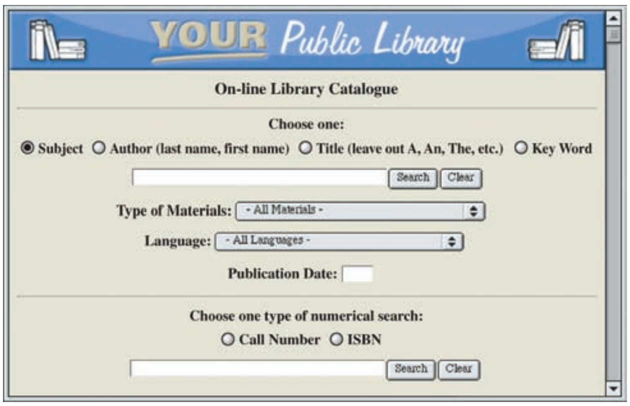
Here is a suggested list of resources.

Resource	✓	Details
Books		
CD-ROMs		
Community Professionals or Experts		
Encyclopedias		
Films		
Government Agencies (local, provincial, and federal)		
Internet Sites		
Journals		
Library Catalogue		
Newspapers		
Non-profit Organizations		
Posters		
DVDs and Videos		

Searching Tips

Finding Information at Your Library

Library computer catalogues are a fast way to find books on the subjects you are researching. Most of these electronic catalogues have four ways to search: *subject*, *author*, *title*, and *key words*. If you know the *author* or *title* of a book, just type it in. Otherwise, use the *subject* and *key words* searches to find books on your topic.



- If you're doing a *subject* search, type in the main topic you are researching. For example, if you're searching for information on solar energy, type in "solar energy." If there are no books on that topic, try again using a more general category, like "renewable resources," or just "energy."
- If you're doing a *key words* search, type in any combination of words that have to do with your topic. For the solar energy example, you could type in words such as: "renewable energy sun solar panels." Using several key words will give you a more specific search. Using only one or two key words, like "sun" and "energy," will give you a more general search.

Hints

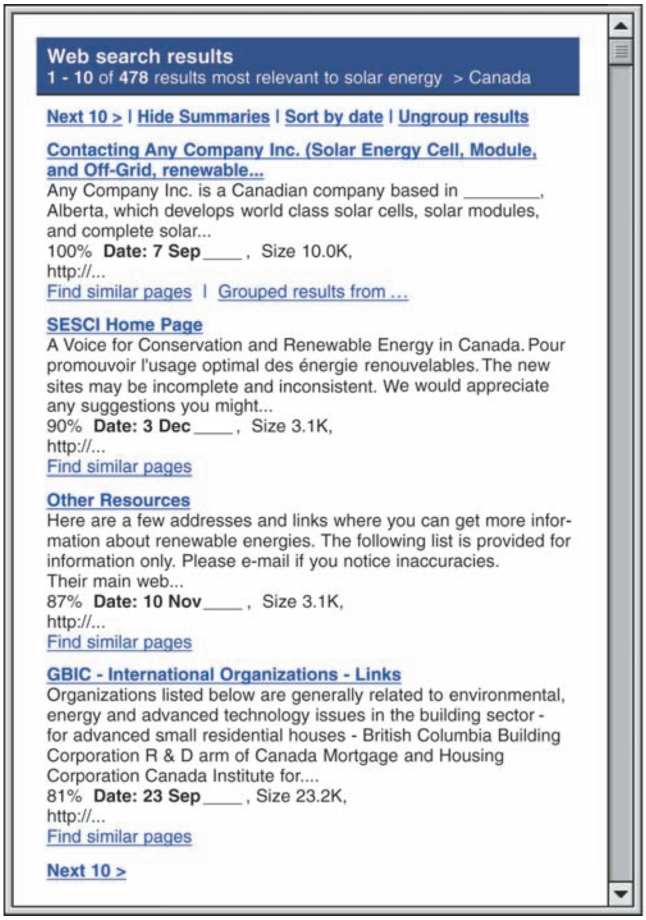
- The library may also have a way to search for magazine articles. This is called a *periodical search*. It's especially useful for searching for information on events and/or discoveries that have taken place recently. Ask your librarian how to do a periodical search.
- Your library will probably have a reference section where all the encyclopedias are kept. There you may find science and technology, environmental, or even animal encyclopedias, as well as other reference books.

Finding Information on the Internet

On the Internet, you can use searching programs, called *search engines*, to search the Internet on just about any subject. To find a search engine, ask your teacher or click on the search icon found at the top of your Internet browser. Here are some suggestions on how to search the Internet:

- Once you reach a search engine Web page, type in key words or phrases that have to do with your topic. For solar energy, you could type in "solar energy," "solar panels," "renewable resources," or any combination of these and other similar words.

- The search engine will display a list of Web pages it has found that have these words or phrases somewhere in them. Click on any Web page on the list that looks interesting.
- Quite often you will get a long list of possible Web pages to look at. You may need to make your search more specific. This can be done by adding other key words to your search. For example, if you were looking for solar energy examples in Canada and used the key word "solar energy," you may want to do a second search of these results with the key word "Canada" added.
- Don't forget to record the addresses of any interesting Web pages you find. Why not work with a friend? One person can record the addresses of Web pages while the other person searches on the computer. Or you can save any Web page as a *bookmark* for easy future access. Check with your teacher or librarian to find out how to save and organize your bookmarks.



BEFORE YOU START!

Check with your teacher to find out what your school's policy is about acceptable use of the Internet. Remember to follow this policy whenever you use the Internet at school. Be aware as you use the Internet that some websites may be strongly biased toward a specific point of view. If you are looking for scientific or technical information, educational or government websites are generally reliable.

Recording Your Information Sources

An important part of researching a topic is keeping track of where you obtain information. As you do your research, you are reading through or viewing a variety of different sources. Some may be in print, such as magazines and books. Others may be electronic, such as websites and CD-ROMs. And others may be visual, such as videos and photos. No matter what sources you use, you should keep track of them.

With this information, you can easily go back and check details. You can also use it to help you respond to any questions about the accuracy or completeness of your information. Your record of sources should include at least the following basic information:

- title or name of the source (e.g., if you read a chapter of a book, you would write down the book's title; for a website, you would include the address)
- author's name, if known
- publisher (e.g., for a website, this would be the name of the person or the organization that has put up the site)
- date of publication
- pages consulted

Your teacher may want you to list your information sources in a specific format. Check what this format will be before you begin your research so that you can collect the details you need to complete your reference list later. You may want to do your own research on formats for such reference lists or bibliographies.

Reading in Science

You use different skills and strategies when reading different materials such as a novel or a textbook. In a novel, you are mainly reading to enjoy the story. In a science textbook you are reading for information. A science textbook has terms and concepts that you need to understand.

Investigating Science and Technology 7 helps you with your non-fiction reading by giving you opportunities to use different reading strategies. You will find these reading strategies in the following literacy activities:

- Getting Ready to Read at the beginning of each unit
- Before Reading at the beginning of each chapter
- During Reading or Writing Checkpoints in each section
- After Reading at the end of each chapter

Using Reading Strategies

You can use the following strategies to help better understand the information presented in this book.

Before Reading

- Skim the section you are going to read. Look at the headings, subheadings, visuals, and boldfaced words to determine the topic.
- Look at how the information is organized. Ask yourself: Is it a cause-and-effect passage? Is it a contrast and compare passagte? Think about how the organization can help you access the information.
- Think about what you already know about the topic.
- Predict what you will learn.
- List questions that you have about the topic. This will help you to set a purpose for reading.

As You Read

- Rewrite the section headings and subheadings as questions. Look for the answers to the questions as you read.
- Use your answers to the questions to decide on the main idea in each section or subsection.
- Look carefully at any visuals — photographs, illustrations, charts, or graphs. Read the captions and labels that go with the illustrations and photographs, and the titles of any charts or graphs. Think about the information the visuals give you and how this information helps you understand the ideas presented in the text.
- Notice the terms that are boldfaced (dark and heavy type). These are important words that will help you

understand and write about the information in the section. Make sure you understand the terms and how they are used. Check the terms in the Glossary to confirm their meanings.

- Use different strategies to help remember what you read. For example, you can make mental pictures, make connections to what you know, or draw a sketch.

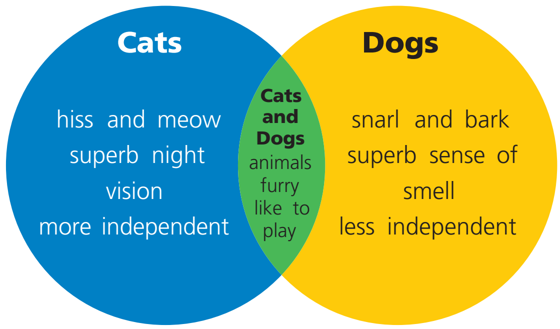
After Reading

- Find the information to answer any review questions. Use the headings and boldfaced terms to locate the information needed. Even if you are sure of the answer, reread to confirm that your answer is correct.
- Write brief notes to synthesize what you have learned, or organize the information in a graphic organizer. You will find information about graphic organizers in the following section.
- Personalize the information. Think about opinions you have on what you've read. Consider if the new information you have learned has changed any previous ideas. List questions you still have about the topic.

Using Graphic Organizers

Graphic organizers can be used to organize information that you read, and to display ideas visually. You have probably learned and used several of the techniques shown here. Try out the ones that are less familiar to you. You may find that some help you open up your thinking in new and creative ways.

Venn Diagram



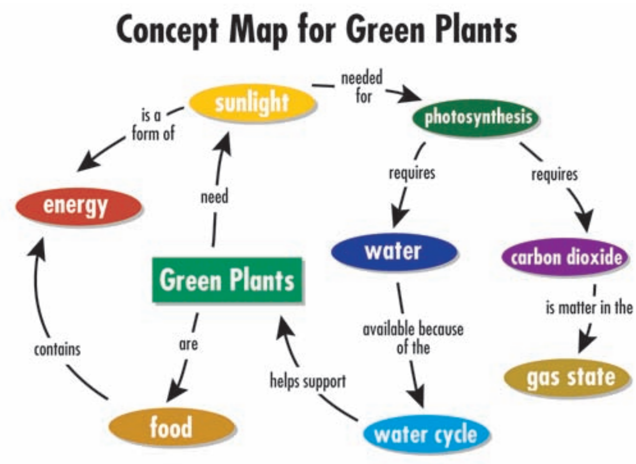
Venn diagrams are usually used to compare two things by showing their similarities and differences. To use a Venn diagram, ask yourself questions such as:

- What things do I want to compare?
- What do they have in common?
- In what ways are they different?

Hint

You can use Venn diagrams to compare more than two things. Try it and see!

Concept Map



A concept map, or a mind map, is a web diagram with many uses. For example, you can use it to:

- review something you already know
- gather information about something you don't know
- explore new ways of thinking about something
- outline plans for an essay, a song, an experiment, a design challenge, a science project, and multimedia presentations

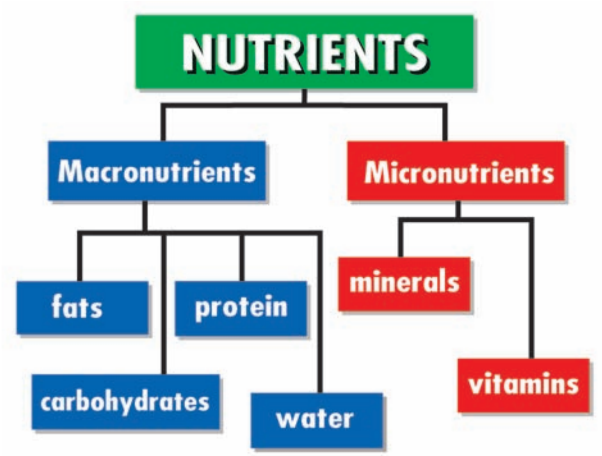
To use a concept map, ask yourself questions such as:

- What is the key idea, word, question, problem, or issue to build the map around?
- What words, ideas, objects, or questions come to mind when I think about the item at the centre of my map?
- How are the ideas, objects and concepts on my map linked or connected to each other?

Hint

If you have access to a computer, find out if it has the software to help you make your graphic organizers.

Tree Diagram



Tree diagrams allow you to see how things originate or how larger things can be broken down into their smaller components. Tree diagrams also allow you to organize or group concepts and things. Knowing about the parts of something helps you to better understand the concept or thing you are studying.

Comparison Matrix

Things to compare	Characteristics			
	walk	use food	talk	swim
goat	X	X	X	
tree		X		
rock				
person	X	X	X	X

This is often used to compare the characteristics or properties of a number of things. To use a comparison matrix, ask yourself questions such as:

- What things do I want to compare?
- What characteristics will I choose to compare?
- How are the things I'm comparing similar and how are they different?

Hint

A comparison matrix can be useful for brainstorming.

Note-Taking Chart

A note-taking chart helps you understand how the material you are reading is organized. It also helps you keep track of information as you read.

Your teacher will assign several pages for you to read. Before you begin reading, look at each heading and turn it into a question. Try to use "how," "what," or "why" to begin each question. Write your questions in the left column of your chart. Leave enough space between each question so that you can record information from your reading that answers your question.

For example, you may be assigned several pages about the scientific meaning of work. These pages contain the following headings:

- The Meaning of Work
- Calculating Work
- Energy and Work

You can see an example of a note-taking chart below.

Questions from Headings	Answers from Reading
What is the meaning of the word "work"?	– work is done when a force acts on an object to make the object move – If there's no movement, no work is done – just trying to push something isn't work—it's only work if the object moves
How do you calculate work?	
How are energy and work related?	

Communicating in Science

In science, you use your communication skills to clearly show your knowledge, ideas, and understanding. You can use words and visuals, such as diagrams, charts, and tables, to communicate what you know. Some communication may be short, as in answering questions, or long, as in reports.

Writing Reports

Toolkit 2 shows you how to plan a science experiment. Toolkit 3 shows you how to do technological design, and Toolkit 4 shows you how to use a decision-making process for social and environmental issues. Here you will learn how to write a report so you can communicate the procedure and results of your work.

Here is a list of things you should try to do when writing your science reports.

- Give your report or project a title.
- Tell readers why you did the work.
- State your hypothesis or describe the design challenge.
- List the materials and equipment you used.
- Describe the steps you took when you did your experiment, designed and made your product, or considered an issue.
- Show your experimental data, the results of testing your product, or the background information on the issue.
- Interpret and analyze the results of your experiment.
- Make conclusions based on the outcome of the experiment, the success of the product you designed, or the research you did on an issue.

Give your report or project a title.
Write a brief title on the top of the first page of your report. Your title can be one or two words that describe a product you designed and made, or it can be a short sentence that summarizes an experiment you performed, or it can state the topic of an issue you explored.

Tell readers why you did the work.
Use a heading such as “Introduction” or “Purpose” for this section. Here, you give your reasons for doing a particular experiment, designing and making a particular product, or considering a specific issue. If you are writing about an experiment, tell readers what your cause-and-effect question is. If you designed a product, explain why this product is needed, what it will do, who might use it, and who might benefit from its use. If you were considering an issue, state what the issue is and why you have prepared this report about it.

State your hypothesis or describe the design challenge.
If you are writing about an experiment, use a heading such as “Hypothesis.” Under this heading you will state your hypothesis.

Your hypothesis is your guess at the solution to a problem or question. It makes a prediction that your experiment will test. Your hypothesis must indicate the relationship between the manipulated and responding variable.

If you are writing about a product you designed, use a heading such as “Design Challenge.” Under this heading, you will describe why you decided to design your product the way you did. Explain how and why you chose your design over other possible designs.

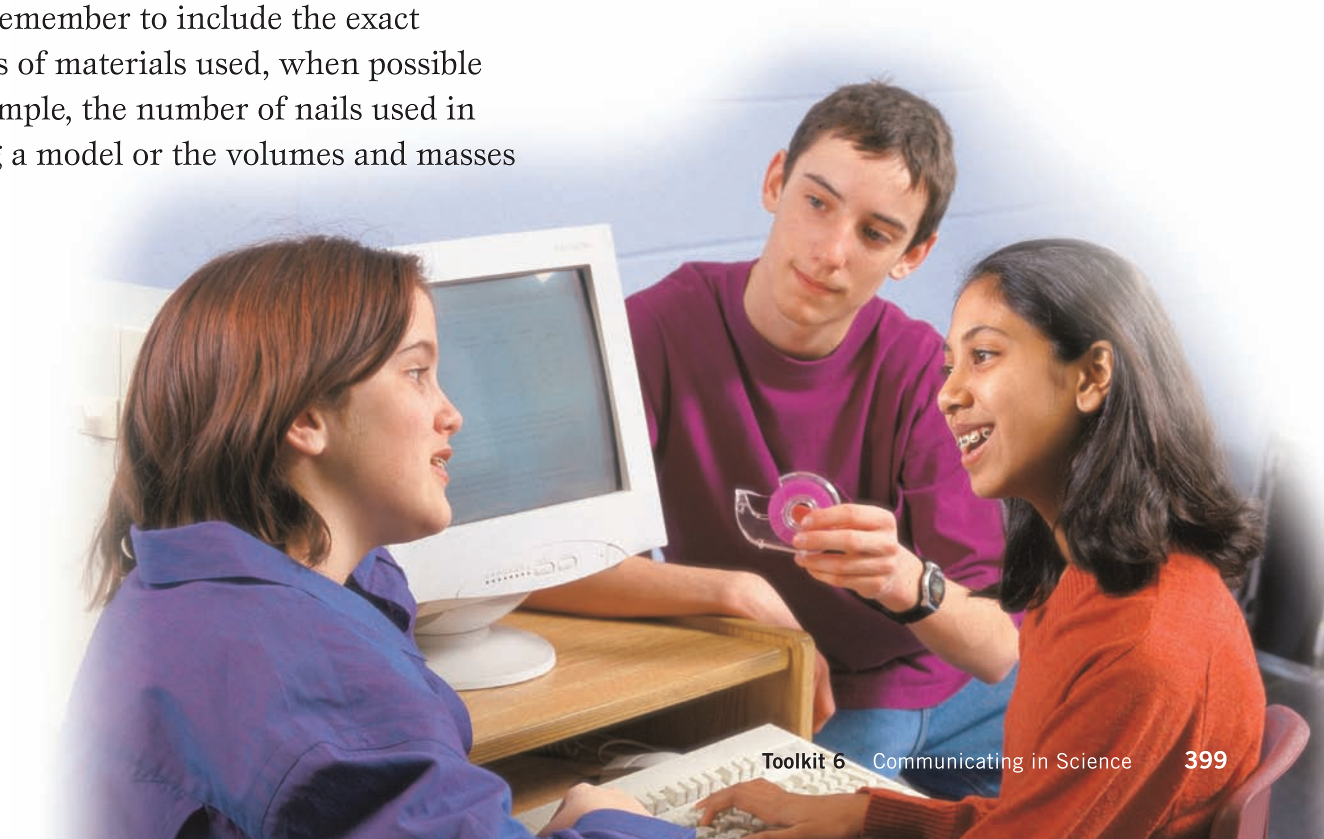
List the materials and equipment you used.

This section can come under a heading called “Materials and Equipment.” List all the materials and equipment you used for your experiment or design project. Your list can be in point form or set up as a table or chart. Remember to include the exact amounts of materials used, when possible (for example, the number of nails used in building a model or the volumes and masses of substances tested in an experiment). Include the exact measurements and proper units for all materials used.

Also include diagrams to show how you set up your equipment or how you prepared your materials. Remember to label the important features on your diagrams. (See the following section on diagrams for drawing tips.)

Describe the steps you took when you did your experiment, designed and made your product, or researched the issue.

Under a heading called “Procedure” or “Method,” describe, in detail, the steps you followed when doing your experiment, designing and making your product, or considering an issue. If you made a product, describe how you tested it. If you had to alter your design, describe in detail how you did this.



Show your experimental data, the results of testing your product, or the background information on the issue.

Give this section a heading such as "Data," "Observations," or "Background Information." In this section, you should show the data or information you collected while performing the experiment, testing your product, or researching an issue. In reporting about an issue, use only a summary of the essential information needed for a reader to understand the issue and different viewpoints about it.

Use tables, diagrams, and any other visual aids that show the results of your tests. If you performed your experiment a few times, give results for each trial. If you tested different designs of your product, give results for each design.

Interpret and analyze the results of your experiment.

Interpret and analyze the data you collected in your experiment. Calculations, graphs, diagrams, charts, or other visual aids may be needed. (See Toolkit 8 for graphing tips.) Explain any calculations or graphs that you used to help explain your results.

Make conclusions based on the outcome of the experiment, the success of the product you designed, or the research you did on an issue.

This last section of your report can be called "Conclusions." In one or two paragraphs, explain what your tests and experiments showed, or what decision you made as a result of your research.

If you did an experiment, explain if your results were predicted by the hypothesis. Describe how you might adjust the hypothesis because of what you learned from doing the experiment, and how you might test this new hypothesis.

If you made a product, explain if your design did what it was supposed to do, or worked the way it was supposed to work. If you changed the design of your product, explain why one design is better than another.

Describe the practical applications your product or experiment might have for the world outside the classroom.

If you considered an issue, explain why you made your decision. Briefly summarize your supporting evidence. If necessary, explain how you have responded to different viewpoints on the issue.

Diagrams

Have you heard the saying "a picture is worth a thousand words"? In science, a picture can be worth even more. A carefully done diagram can help you express your ideas, record important information, and experiment with designs. Diagrams are an important tool in communicating what you know and your ideas.

Four types of diagrams you can use are a Simple Sketch, an Isometric Diagram, an Orthographic (Perspective) Diagram, and a Computer-Assisted Diagram. Examples of these types of diagrams are shown on the next two pages.

The photo on this page shows the set-up of an experiment. Practise drawing it using one or several of the diagram types presented on the next pages. What labels would you include? Would your labelling choices change depending on the style of diagram you make?

Tools of the Trade

You will need the following equipment for each type of diagram.

Hand-drawing tools

- a sharp pencil or mechanical pencil
- a pencil sharpener or extra leads
- an eraser
- a ruler

For simple and isometric diagrams

- blank white paper

For orthographic drawings

- blank orthographic graph paper

For computer-assisted diagrams

- access to computer and software

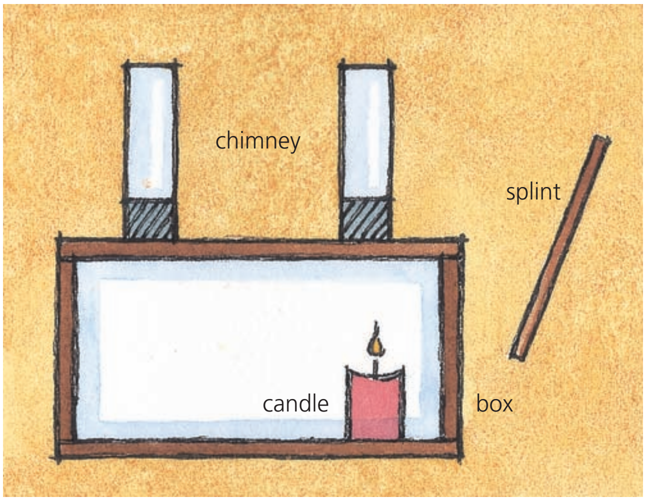
Remember!

- Give your diagram a title at the top of the page.
- Use the whole page for your diagram.
- Include only those details that are necessary, keep them simple, and identify them by name.
- If you need labels, use lines, not arrows. Place your labels in line with the feature being labelled, and use a ruler to keep your lines straight.
- Don't use colour or shading unless your teacher asks you to.
- Include notes and ideas if the sketch is a design for a structure or an invention.

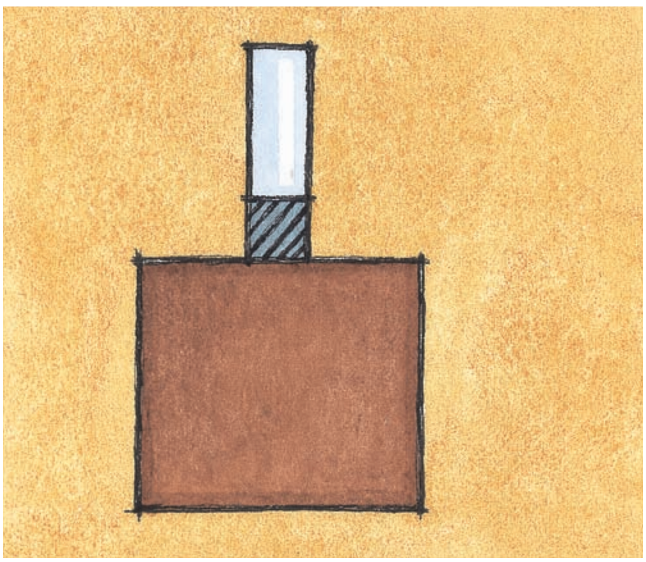
Hint

If you're going to use your diagram to help you design a structure, include a top, side, and front view.

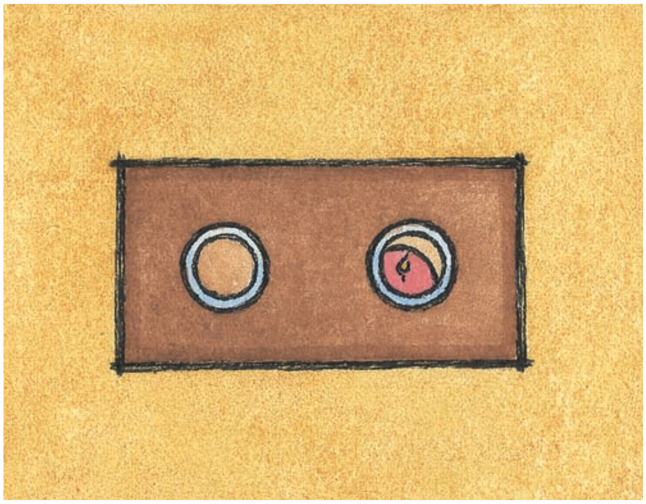
A Simple Sketch (Front View)



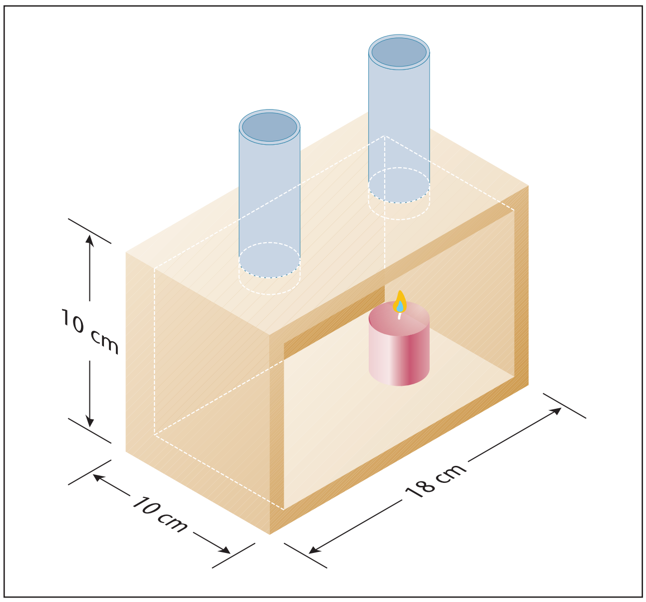
A Simple Sketch (Side View)



A Simple Sketch (Top View)



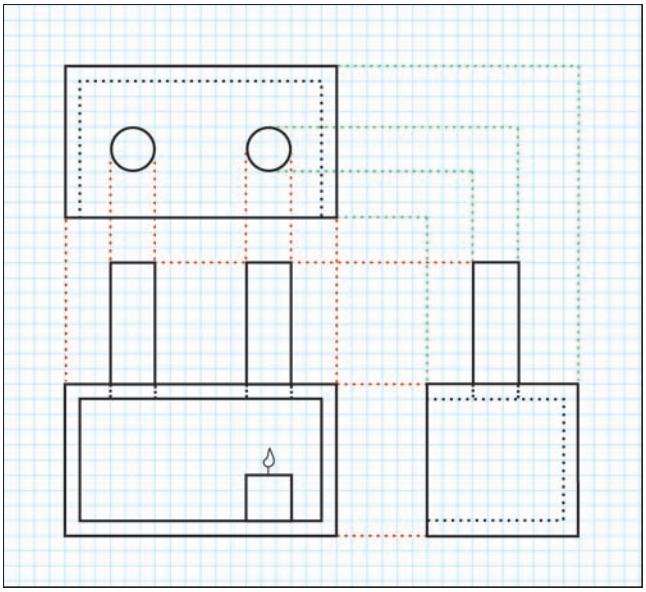
An Isometric Diagram



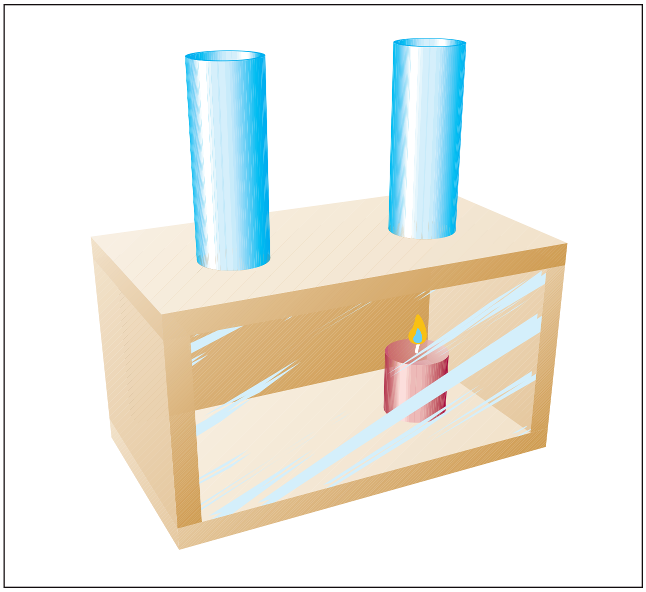
Hint

You can use the squares of your graph paper to make the scale of your orthographic diagram accurate. For example, suppose that each square stood for 1 cm. If what you're drawing is 14 cm long, you would use 14 squares to represent its length.

An Orthographic (Perspective) Drawing



A Computer-Assisted Diagram



Hint

Use graph paper to help you with the details of your diagram if you don't have a ruler handy.

Hint

One advantage of using a computer is that you can easily change your work. After saving your original, practise making changes and moving the image around.

Toolkit 7

Measurement

Observations from an experiment may be qualitative (descriptive) or quantitative (physical measurements). Quantitative observations help us to describe such things as how far away something is, how massive it is, and how much space it takes up. Here are some types of measurements you might come across every day.

Length

Length tells you

- how long or short something is
- how far or near something is
- how high or low something is
- how large or small something is

Common units used to measure length include millimetres (mm), centimetres (cm), metres (m), and kilometres (km). All these units are based on a single standard: the metre.

INSTANT PRACTICE

For each of the following, choose the unit of measurement that you think would be used. Explain why you chose that unit of measurement in each case.

1. the height of a desk
2. the depth of an ocean
3. the thickness of a penny
4. the length of a soccer field
5. the distance to drive from Thunder Bay to Ottawa
6. the distance from Earth's surface to the Moon

Hint

When you use a ruler, tape measure, or metre-stick, always start from the 0 measurement point, not the edge of the measuring tool.

When you use a measuring tool such as a ruler, look directly in line with the measurement point, not from an angle.

Volume

The volume of something tells you the amount of space that it takes up (occupies). Common units used to measure volume include litres (L) and millilitres (mL). Remember, 1 mL equals 1 cm^3.

At home, you often use a measuring cup to determine the volume of something. At school, you usually use a graduated cylinder. Here, "graduated" means a container that has been marked with regular intervals for measuring. For example, a measuring cup, a beaker, and a thermometer are all graduated.

When you add a liquid to a graduated cylinder, the top of the liquid is curved near the sides of the cylinder. This curve is called a meniscus. To measure the liquid's volume

properly, you need to observe the liquid's surface from eye level so you can see the flat, bottom portion of the curve. Ignore the sides.

INSTANT PRACTICE

1. Each of the following objects takes up space. Estimate the volume of each, using appropriate units.
   (a) a cereal bowl
   (b) a test tube
   (c) a bathtub
2. Certain ancient volume measures, such as the teaspoon, are still in use today. Write a fictional paragraph describing where the ancient Japanese volume measure "koku" originated. One koku is approximately 278 L.

Mass and Weight

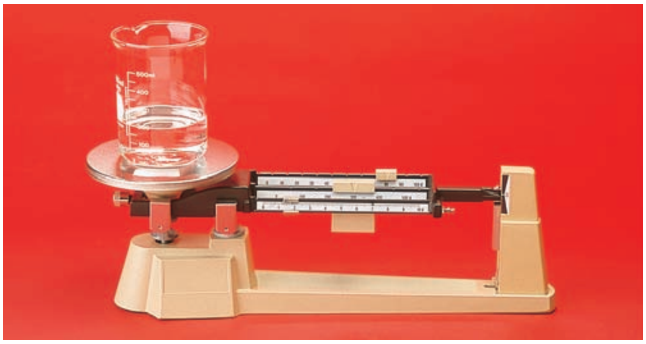
In science, the mass of an object and its weight mean different things. The mass of something tells you the amount of matter it has. The weight of an object is the measure of the force of gravity acting on it. We use mass more often in science. Common units used to measure mass include grams (g) and kilograms (kg).

You usually measure mass with a balance. Your classroom probably has an equal arm balance or a triple beam balance like the ones shown here.

The equal arm balance and triple beam balance basically work in the same way. You compare the mass of the object you are measuring with standard or known masses (or their mass equivalent values on the triple beam).

equal arm balance

An equal arm balance has two pans. You place the object whose mass you want to know on one pan. On the other pan, you place standard (known) masses until the two pans are balanced (level). Then, you just add up the values of the standard masses. The total is the mass of the object you are measuring.


triple beam balance


spring scale

A triple beam balance has a single pan. You place the object you are measuring on the pan. You adjust the masses on the beams until the beam assembly is level. Then, you add up the mass equivalent values of the beam masses from the scales on the beam.

You can use a spring scale to measure weight, which is the force of gravity acting on an object. A spring scale is sometimes called a force meter. A spring scale measures force in newtons.

A spring scale has three main parts: a hook, a spring, and a measuring scale. The hook at the end is used to attach the object to the scale. The spring pulls on the object. As the spring pulls, the pointer moves along the measuring scale.

To measure the weight of an object, first hang the spring scale from a clamp on a retort stand. Then hang the object from the hook of the spring scale. Once the pointer stops moving, record the measurement.

INSTANT PRACTICE

1. Describe how you would determine the mass of the amount of sand you can hold in your hands. All you can use is a small bucket and a triple-beam balance, and you cannot make a mess!
2. Explain why the following statement is false: "If I flew to Mars, my mass would be less than it is on Earth." Rewrite this sentence so it is true.

Estimating

When you estimate, you use your mind to guess the length, volume, or mass of an object. Sometimes, you can estimate by comparing one object with another object that has known measurements. For example, if you are asked to estimate the volume of your drink, you could estimate by comparing it with a large jar of mayonnaise that has its volume marked on the label.

For a large object or distance, you might divide it up into portions in your mind and guess the length, volume, or mass of one portion. You then multiply that guess by the number of imaginary portions to estimate the measurement of the whole.

Sometimes, it's useful to estimate the measurement of an object before you actually measure it. You might do this to help you decide which units of measurement and which measuring tool to use. In other cases, you might not be able to measure an object at all. In this case, an estimate of its length, volume, or mass might be the best you can do.

Try to estimate the measurements of the items listed below. Include the measurement units that you think should go with your estimates. Then, measure them to see how close your estimates were to the real values. Did you choose the correct measurement units? If you don't have some of these items in your classroom, check at home.

Object	Length	
	estimate (cm)	actual value (cm)
pencil		
height of your teacher's desk		
length of your classroom		

Object	Mass	
	estimate (g)	actual value (g)
this textbook		
banana from someone's lunch		
piece of chalk		

Object	Volume	
	estimate (mL)	actual value (mL)
amount of water poured into an empty jar		
marker cap		
drink thermos		

Graphing

Science and technology often involve collecting a lot of numerical data. This data may be recorded in tables or charts. Sometimes, however, it's difficult to see if there are any patterns in the numbers. That's when it's useful to reorganize the data into graphs. Graphs help to interpret data collected during an experiment by showing how numbers are related to one another. You have probably drawn a lot of graphs over the years in your studies of mathematics, geography, and, of course, science and technology.

Creating Line Graphs

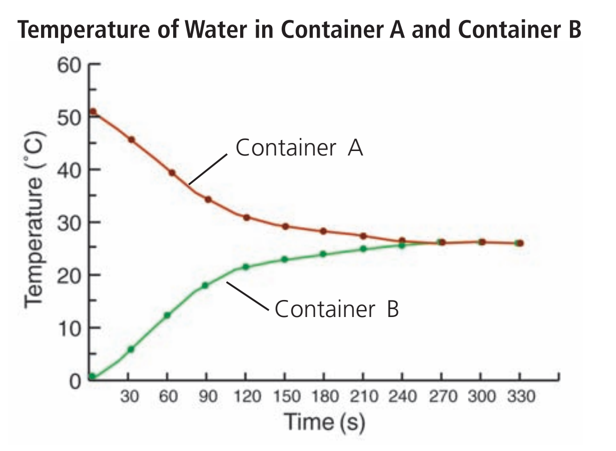
Line graphs are good for exploring data collected for many types of experiments. Using line graphs is a good way to analyze the data of an experiment that are continually changing. For example, here are some data collected by a group of students investigating temperature changes. They poured hot water into a large container (Container A) and cold water into a smaller container (Container B). After recording the starting temperatures of the water in each container, they placed Container B inside Container A and took measurements every 30 s until there were no more temperature changes.

Here are the data they collected shown as a chart and as a line graph. On the graph, they put the manipulated variable — time — on the *x*-axis, and the responding variable — temperature — on the *y*-axis.

Evidence

Temperature of Water in Container A and Container B		
Time (s)	Temperature (°C) of water in Container A	Temperature (°C) of water in Container B
0	51	0
30	45	7
60	38	14
90	33	20
120	30	22
150	29	23
180	28	24
210	27	25
240	26	26
270	26	26
300	26	26

Analysis



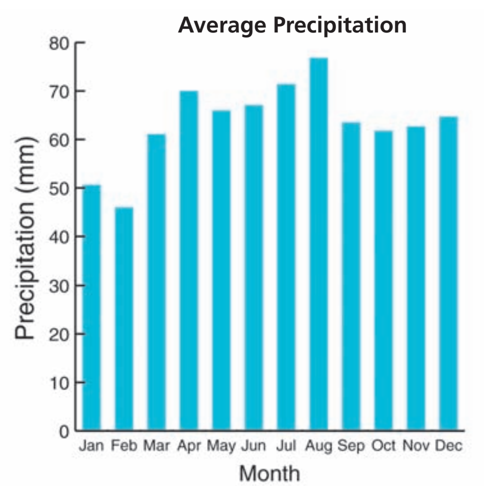
INSTANT PRACTICE

1. When drawing graphs, a sharp pencil is always used, and every straight line is drawn with a ruler. Why are both of these rules important when drawing graphs?
2. The scale of an axis refers to the method of adding numbers along regular intervals. If you had a piece of graph paper that had 22 squares to represent five minutes of time, suggest the scale you would use.
3. Examine the graph of the experiment above. Write a sentence that describes what you see happening on the graph.
4. Every 30 seconds, the temperature was taken. What happens every 30 seconds on the graph? What connects each instance the temperature was taken?
5. What was the temperature after 2 minutes and 15 seconds? Explain.

Creating Bar Graphs

Bar graphs are useful for showing relationships between separate sets of data. For example, the chart below shows the monthly average precipitation (both snow and rain) for a city in Canada. Compare the data in this chart with how they "look" when they are reorganized in the form of a bar graph. On the graph, they put the manipulated variable — month — on the *x*-axis, and the responding variable — precipitation — on the *y*-axis.

Month	Average Precipitation (mm)
January	50.4
February	46.0
March	61.1
April	70.0
May	66.0
June	67.1
July	71.4
August	76.8
September	63.5
October	61.8
November	62.7
December	64.7



Hint

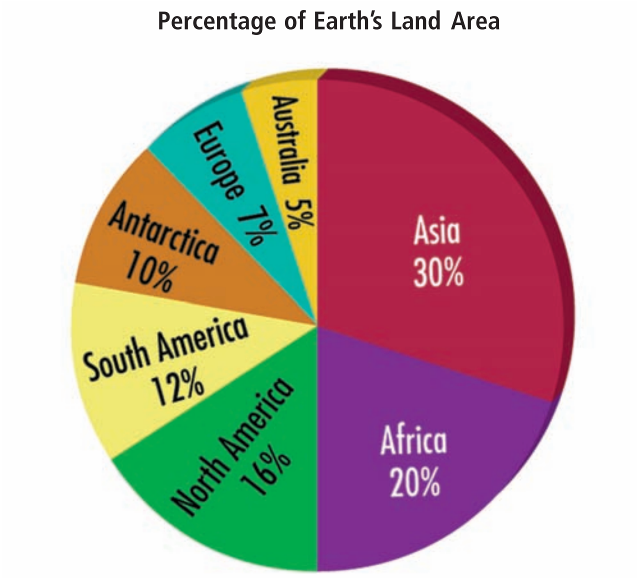
Scales for bar graphs are often rounded off to the nearest whole number.

INSTANT PRACTICE

1. Why is each bar on a bar graph the same width?
2. Which axis is used for the manipulated variable? Which is used for the responding variable?Your graph paper is 22 squares by 34 squares. December has the most precipitation of any month, with 90 mm. Describe how you would create the scales to show twelve months of precipitation.
3. How was the scale for each axis chosen?
4. The yearly average precipitation for this city is 761.5 mm. How would you modify the bar graph to include this additional information? How would you need to change your graph if the yearly total of precipitation, 497 mm, needed to be added as well.

Creating Circle (Pie) Graphs

A circle graph is useful when you want to display data that are part of a whole. For example, in this circle graph, the "whole" is Earth's total land area. The "parts" are the approximate percentages of land made up by each continent.



Hint

You might consider using a computer to draw your circle graphs. Some computer drawing programs allow you to use different colours for the different sections of your graph, making it easier to read.

Compare the data in this chart with how they "looked" when they were organized in the form of a circle graph on the previous page. Which can you interpret more easily and more quickly?

Continent	Percentage of Earth's Land Area
Asia	30%
Africa	20%
North America	16%
South America	12%
Antarctica	10%
Europe	7%
Australia	5%

INSTANT PRACTICE

1. Which continents, when added together, make up about half of all the land mass on Earth? Why is it easier to determine this from the circle graph than from the chart of data?

2. A survey of students in your class of 24 students showed the following:
   - 12 students usually eat cereal for breakfast
   - 6 students usually eat toast, waffles, or bread for breakfast
   - 3 students usually eat a snack bar or packaged food for breakfast
   - 2 students usually only drink juice for breakfast
   - 1 student usually does not eat or drink anything for breakfast

   Sketch what this circle graph would look like.