DISCOVERING SCIENCE 9
TEACHER'S RESOURCE

SCIENCE SKILLS GUIDE

Table of Contents

McGraw-Hill Ryerson

THE VALUE OF THE SCIENCE SKILLS SECTION

In these pages, you will find teaching strategies to use as you introduce your course, using the introductory sections of *Discovering Science*, beginning with Safety in Your Science Classroom, pages 9–15. From this introductory skill development section, we then take you to the end of the student textbook, to the Science Skills Guide, pages 478–501.

The skills component of the *Discovering Science* program will be critical to you as you successfully deliver the curriculum. Thus, you will find the introductory safety section and the Science Skills Guide at the end of the book useful in providing students with the tools they need for further skills development (and remediation). They may refer to these tools throughout the program because they are built into the textbook as an integral part.

Each unit of the *Teacher's Resource* includes many useful ideas for your implementation. The skills development that your students will gain from using the Science Skills Guide at the end of the textbook will remind students of the importance of the processes of science, and its effect on their lives, whether they venture on into a science and/or technology career focus, or in a totally different direction. All career paths and daily lives involve science and technology in some ways, thus this handbook will help you to integrate skills throughout your course that your students will find invaluable.

SCIENCE SKILL 1 SAFETY, p. 480

Science Skill 1 presents safety labels and symbols, and encourages students to become familiar with the safety symbols used in *Discovering Science 9*.

BACKGROUND INFORMATION

- Safety symbols are a necessary common feature of science references and appear on containers of materials used in the science lab, the workplace, and the home. These symbols help people of differing experience, knowledge, and language skills understand the risks associated with doing certain activities and using certain materials. As students learn about scientific inquiry and methods, they should become familiar with the symbols used in this book and with the labelling system of the Workplace Hazardous Materials Information System (WHMIS). They will encounter WHMIS symbols on containers of substances they use in the science lab and at work if they have jobs.

TEACHING STRATEGIES

- Students can play a safety symbols card game (duration about 30 min) in small co-operative learning groups. During this grouping, you will act as a facilitator, encouraging students to understand the group task and functional criteria, and emphasizing the group's social roles and skills.

  Prepare cards by making copies of the safety symbols and the descriptions. Cut them into similar sizes and stack them in piles, one pile each for symbols and descriptions. You may prefer making more copies of the cards to lengthen playing time and provide opportunities for the players to see each card more frequently. There should be equal numbers of symbols and descriptions.

  To play the game:

  1. Have students establish a working, co-operative learning group of four students.
  2. The dealer places all cards facing down on the table in four rows of four cards.
  3. Each player is allowed to turn over any two cards.
  4. Each player must match as many symbols as he or she can to each description.
  5. If a player is unable to match the two cards that are face up, they are turned over, and someone else attempts to make a match.
  6. If a player chooses cards on which the symbol and description match, that individual keeps the cards and then proceeds to turn face-down again two more cards.
  7. The game continues until all cards are picked up.

Supporting Different Needs

- The card game should be involving and rewarding for kinesthetic, non-verbal, verbal, and visual learners.
- Some students may wish to draw cartoon characters who warn about various hazardous situations.

Instant Practice–Safety Symbols Answers, p. 480

Answers will vary but may include the following.

Technical arts room—thermal safety to warn students around the welding equipment or soldering irons; sharp object safety to warn students about the many sharp tools; eye safety to warn students around the drills or saws; electrical safety as there would be electrical tools in use

Home economics room—thermal safety when working around the ovens; sharp object safety as the students will be working with knives; clothing protection safety as the students will be working with many materials that may damage or stain clothing

Cafeteria—thermal safety as the student helpers may be working around ovens or deep fryers; sharp object safety as knives and other sharp utensils used;

electrical safety as there are many electrical appliances being used in the cafeteria; clothing protection safety as the students would need to protect their clothing from splatters
Home kitchen—thermal safety, especially if the student is responsible for cooking the dinner; skin protection safety if the student needs to clean up spills using some of the cleaning supplies found there; electrical safety as the student may be using electrical appliances while cooking
Garage or storage shed—disposal alert if there are leftover paints or garden chemicals; skin protection safety when working with those same chemicals; fire safety when working with some of the flammable materials in the shed like spray paint

Further Practice

- You may wish to use BLM G-2, Safety Contract, and BLM G-3, WHMIS Symbols, with your students, depending on the needs you observe and the level of awareness and responsibility they demonstrate.

SCIENCE SKILL 2 SCIENTIFIC INQUIRY, PROBLEM SOLVING, AND DECISION MAKING, pp. 481–483

Science Skill 2 provides students with insight into the nature of science and, in particular, the methods of inquiry by which scientific knowledge is developed and validated. It also presents models for scientific inquiry, technological problem solving, and decision making.

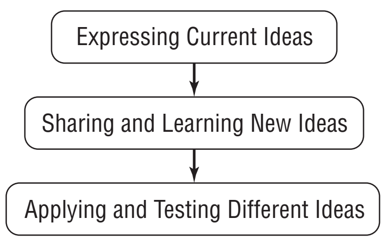
BACKGROUND INFORMATION

- All scientific disciplines and specializations share one characteristic: they are based on an orderly, systematic process for asking questions and developing explanations for natural phenomena. The process is not a recipe, but it has several important features. The process is often more cyclical than linear and conclusive. For example, an experiment or investigation often stimulates new questions to explore.
- The *Discovering Science 9* program develops the process of science inquiry as an inherent part of the flow, sequence, and emphasis of the text and activities. Questions are stressed as the starting point for all science.
- Hands-on activities provide students with opportunities to develop inquiry skills with concrete problems and materials. Students reinforce and build upon the basic concepts covered by the text through investigation, observation, experimentation, and critical thinking about, and application of, results. Students are encouraged to evaluate not only their experimental results but also their experimental process.
- **Prediction vs. hypothesis:** A prediction is a statement of likely changes to a responding variable as a result of changes (forced or natural) in a manipulated variable. For a prediction you can use the statement "If…, then…." An hypothesis usually adds a possible reason for this relationship. An hypothesis can use the statement "… because…." For example, "If temperature increases, then the rate of dissolving should increase (prediction), because particles of matter vibrate more vigorously when heated (hypothesis)."
- Scientists gain empirical support for their predictions and hypotheses through *experiments*.
  - An experiment is a test in which a manipulated variable is forced to change in order to detect a predicted result.
  - Although data-collection is important for establishing relationships and laws, the usefulness of particular models and theories for explanations is always debated by scientists. Constant evaluation and re-evaluation in terms of new data is important. Data that disprove theory are just as important as, or more important than, data that support current thinking.

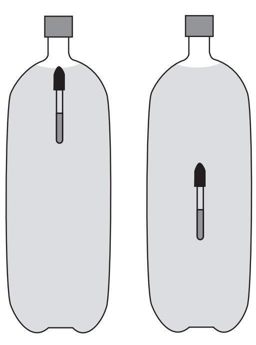
TEACHING STRATEGIES

- You may wish to reinforce students' understanding of the stages in the science inquiry process with further elaboration and discussion. Summarize the process by breaking it into three stages:
  - Developing Ideas (i.e., devising predictions and hypotheses from observations and by learning from others),
  - Seeking Empirical Support (i.e., conducting experiments and studies),
  - Communicating (i.e., publishing articles, giving lectures, presenting findings at conferences and scientific publications).
- **Hypothesis**: BLM G-4, Developing an Hypothesis, gives students practice making "If…, then…" statements.
- Help students distinguish between a prediction and its hypothesis by having them consider what might happen to the drop speed of three balloons, each inflated to a different diameter (and knotted).
  - Work with students to develop a prediction and hypothesis using the model sentence: As the diameter of the balloons increases, the drop speed will [class predicts a result], because [class suggests a hypothesis].
  - Ask a few students to demonstrate the test for the class, having others record data.
  - Help students create a graph to show their results, such as a point-and-line graph.
- **Variables:** BLM G-5, Variables in Science, can help students understand manipulated, responding, and control variables and understand why all variables except one must be controlled in a fair test.

- **Observations:** Point out to students that observing —and every other stage in science inquiry—is based on or limited by some kind of theory. For example, observations cannot be made without some ideas in mind about how to interpret stimuli (i.e., sights, sounds, and so on). When we see a burner glowing red, we understand that it is hot. When we see leaves on a plant that are dry and brown, we understand that they are dead.
- **Practice with Science Inquiry:** A three-phase approach will help teachers and students explore the nature of science throughout this program. Generally, students will already have some preconceived notions about the nature of science, along with preconceived notions about laws and theories. These preconceived ideas should be expressed by students before they share and learn new ideas about the nature of science. Then, once they have a number of ideas available to them, they should have an opportunity to apply and test them in authentic problem-solving contexts.



- The "Cartesian Diver" demonstration will help you illustrate the science inquiry approach to questions and problems:
  - Almost fill a 2 L plastic pop bottle with water.
  - Drop in an eye dropper that is about half-filled with water, and tighten the cap on the bottle. The eye dropper should float at the top and drop down as the bottle is squeezed.



  - With one hand, hold the bottle up in front of your face and pretend to "force" the eye dropper to move down by moving a plastic pen (that you have rubbed on your clothing) along the edge of the bottle as you gently (and secretly) squeeze the bottle.
  - Ask students what they observe. Students often move directly to hypothesizing. They may say, "The pen is magnetized and is forcing the eye dropper to move." Work with the class, getting them to direct you to try different tests until they determine that pressure is the cause.
  - Point out how it is common to go through this logic: observe, question, hypothesize, predict, test.
- Encourage students to conduct their own tests. Start by showing them an inflated balloon flying around the room when you release the untied end.
  - Ask students what they could do to get the balloon to go farther or to do more loops. Get them to brainstorm some manipulated and responding variables. Ask students to predict what might happen to the balloon if a variable is changed. Ask them to give a reason for their prediction.
  - Then, ask students to form small groups and design a test that may give them evidence to support their ideas. Ask them to record their ideas and give reasons for their decisions.
  - Once student groups have completed their tests, invite them to share their inquiry ideas and test results with the class. Encourage a consensus about the different inquiry approaches. Have students note (if appropriate) that each group had its own way of doing things and wanted to defend its methods and conclusions. This will help you stress the creative, very human aspect of science that may include "more than one right answer" when it comes to designing an approach to a problem.
- To help students understand the three flow charts, describe a situation in which each process might be used, and have students work in pairs or small groups to develop a plan, using the appropriate flow chart as a guide. For example,
  - *Scientific Inquiry:* You notice that the trees on one side of a road are dying, but similar trees on the other side of the road are healthy.
  - *Technological Problem Solving:* Present students with a personal entertainment or communications item and tell them that it does not work.
  - *Decision Making:* Should students be required to bring their lunches to school in reusable containers, to reduce garbage?

SCIENCE SKILL 3 HOW TO DO A RESEARCH-BASED Project, p. 484

Science Skills 8 outlines the steps of a research project, as well as some things to keep in mind at each step.

BACKGROUND INFORMATION

- Students have been asked to research in school, but some parts of the process may be new to them:

- They may not have experience formulating their own topic or question.
- They may not have experience evaluating sources of information.
- They may not have been expected to uphold rigorous standards of copyright, and taught how to avoid plagiarism.
- They may not have had the opportunity to consider different methods of presentation and choose one to suit their data and their audience.

TEACHING STRATEGIES

- Ask a student to relate the process they used to research for a recent school project. (You may need to reassure them that they are not being set up to be criticized.) As the student describes what he or she did, write key steps on the chalkboard. Key steps might include:
  1. Ask some general questions about the topic.
  2. Find sources of information.
  3. Use the sources to look for information that help to answer the questions
  4. Ask more questions to help completely cover the original topic.
  5. Repeat steps 2 and 3.
  6. Choose a method to present your results, and create a presentation.
- Use the steps you record as discussion points as you talk about the material in Science Skill 8 with students.
- For each of the steps above, give an example of a project, and ask students what they might do for that particular project. For example, for a project about possible careers related to chemistry, what sources might you consult? For a project about the formation of the solar system, how might you communicate your results to other Grade 9 students and parents?

Instant Practice Answers, p. 495

1. Steps might include:
  1. Ask some general questions about the topic.
  2. Find information from reliable sources to help answer your questions. Record the sources, too.
  3. Ask more questions to help you revise and complete your research.
  4. Find information to answer these questions, and record the answers.
  5. Repeat steps 1–4 as necessary to answer your original question.
  6. Consider your audience and choose a method of communicating your results. Develop your presentation.

2. Answers will vary. For example, What are the characteristics of the moons of Jupiter?

SCIENCE SKILL 4 USING GRAPHS IN SCIENCE, pp. 486–487

This Science Skill introduces students to the principles and procedures used in the tabulation and representation of data. Students learn the advantages and limitations of each type of graph and which graph is appropriate for various types of data.

BACKGROUND INFORMATION

- Acceptance of new ideas is more likely if the individual who "discovers" something is credible. Credibility is enhanced if that individual displays or presents material in a format that is socially agreed upon to represent that area of knowledge. Professionally produced tables and graphs that present data in an effective format present a convincing argument. They are then available for further reference. Finally, they indicate the worth of a scientific investigation, given that this lies in the reliability and validity of the data produced.
- Data collected in science investigations need to be recorded into tables that organize the data into fields (rows and columns) of a variable (i.e., data on one variable are collected and recorded together). The table or data base will have several fields of related data organized either vertically or horizontally. The data should be in ascending (increasing) value of the manipulated variable or in rows of related data. Tabulated data can then be graphed to show potential relationships between data. Depending on the variables' relationships, different graphs are used. The table below shows the graph and variable relationship.

Variable Relationship	Type of Graph
• Non-continuous words (or categories) and numbers	• Bar graph
• Continuous words and numbers	• Histogram
• Categories or divisions of one variable	• Circle graph
• Non-continuous comparison of numerical variables	• Line graph, scatter graph
• Continuous comparison of numerical variables	• Line graph

- In graphs, the x-axis generally represents the manipulated, or controlled, variable while the y-axis represents the responding variable.

TEACHING STRATEGIES

- Students frequently find graphing and interpretation of graphs difficult. To overcome this obstacle, students need repeated exposure to practise this skill. They will also benefit from a variety of jigsaw activities.

- Give a group of students different graphs that are labelled but not titled. Give another group of students a title for a graph. Have each group seek out the group that has the match to its title or graph.
- Play *Jeopardy!*, a game in which an untitled graph is presented and the students formulate a (causal) question to describe the graph.
- Present students with a number of titled graphs and ask them to interpret the relationship demonstrated in the graphs. To promote student understanding of the relationship between the variables of a graph:
  - supply students with a number of partial tables of data and a corresponding graph. They should then try to determine the missing field of data.
  - supply students with split tables of data (e.g., all one variable) and a number of graphs. Have students match the data and tables.
- When students have mastered the ability to read graphs and understand the relationship between data points and the best types of graph to use to represent different sets of data, they are ready to attempt to graph. Provide them with a checklist such as the following to ensure they include all components of a graph or table.

Format for Tables	Format for Graphs
All tables must have the following: • Title of table • Labelled columns or rows • Units of measurement included with data • Description or summary of the table's data • Appropriate size • Neat presentation	All graphs must have the following: • Title of graph • Labelled *x*-axis • Labelled *y*-axis • Units of measurement included with data • Description or summary of the graph's data • Appropriate size • Neat presentation

TEACHING STRATEGIES

Line graphs: Have the students examine the line graph on page 486 of the student textbook. Ask them:

- What information does this graph convey?
- What can you tell by looking at this graph that you would not be able to tell easily by looking at a table?
- What would you be able to tell by looking at a table that you cannot tell by looking at this graph?

Alternatively, create a data table on the chalkboard that corresponds to the graph. Have half of the class analyze the data table and the other half analyze the graph, then compare what they learned.

Bar Graphs: Have students examine the bar graph on page 486 and think how they might present that information in a line graph. They should quickly be able to see that the information would be difficult to present as a line graph and such a representation would be less effective and less useful. Remind students that each type of graph has a specific purpose and that when they are preparing presentations for which graphing would be useful, they need to take into account the type of information that will be graphed and choose the appropriate graph.

Circle Graphs: Students will probably be familiar with circle graphs from earlier grades. Remind them that such graphs are also called pie graphs, pointing out that when a piece of pie is cut from a whole pie, it is easy to see how much has been cut and how much is left. If the pie is cut into several slices, it is easy to tell whether one slice is much bigger than the others, so a circle graph is a good way of displaying data when it is necessary to see how much of the whole (what percent) a portion of the data represents.

SCIENCE SKILL 5 SCIENTIFIC DRAWING, pp. 488–489

Science Skill 5 leads students through the important points they need to know about producing clear, accurate scientific drawings.

BACKGROUND INFORMATION

- Conventional Western European science initially recorded knowledge about the human body, celestial movements, and mechanical devices exclusively with diagrams. As time and technology progressed, the quality and detail of these diagrams steadily improved. Today's high-technology image-capturing tools enable us to construct diagrams of vastly improved quality and to record images and share knowledge quickly and easily.
- Diagrams and other non-verbal forms of communication are used between cultures to express meaning. When we meet another person whose native language differs from ours, we adopt diagrammatic forms of communication. We may "talk with our hands" to give added meaning to our words. We may draw pictures.
- Diagrams in science are inferences of what researchers believe they observe. As much as possible, the investigator should avoid adding misleading information such as colour, or other artistic interpretations or representations. While these details have meaning for the researcher, they may be unclear to others. However, some latitude can be allowed on such additions as stippling if the teacher, class, or research group concur that it helps to clarify the diagram. Finally, diagrams are the researcher's scientific evidence. As such, they should be neat and formatted as described in the checklist shown here.

TEACHING STRATEGIES

- Initiate a discussion or have students brainstorm reasons why a scientific drawing requires a prescribed format. This could be modified with other groups playing "devil's advocate," brainstorming arguments against formatting. The groups of protagonists could then pair up and debate their group's view.
- As a group, develop potential parameters for science diagrams prior to exposing the students to the "official" view.
- Outline for students the requirements for a science diagram by presenting a checklist similar to the one provided here.

Checklist for Science Diagrams

On unlined white paper. Title is underlined.	1 1	/2
Diagram fills page. Diagram is neat. Diagram is in pencil.	0 1 2 0 1 2 1	/5
Labels are on right side of diagram. Labels are neat. Labels are in ink. Labels have horizontal (vertical where applicable) lines.	1 1 1 1	/4
Diagram summary present and good quality	0 1 2	/2
Magnification stated correctly Magnification positioned correctly in lower right-hand corner	1 1	/2
	Total	**/15**

- You could present students with a series of diagrams that have certain components missing (titles, labels, description or summary, magnification) or poorly represented (e.g., coloured diagrams; labels on left; diagrams or labels using ink, lead, or coloured pencil inappropriately; poor descriptions or summaries). To assist students in their critical analysis, you might provide a checklist similar to the one shown here for students to use in evaluating the diagrams you have provided or any that they produce.
- Go over the steps in Making a Scientific Drawing with students and check that they understand by asking simple questions such as "Why is it a good idea to use unlined paper?" "Why should you use a pencil?" "Why is it not a good idea to make a very small scientific drawing?"
- Go over the steps in Drawing to Scale with the students, and have them examine the illustration in the right-hand column on page 489 of *Discovering Science 9.*
- You may wish to distribute BLM G-9, Scientific Drawing Rubric, to help students assess their own drawings.

Supporting Different Needs

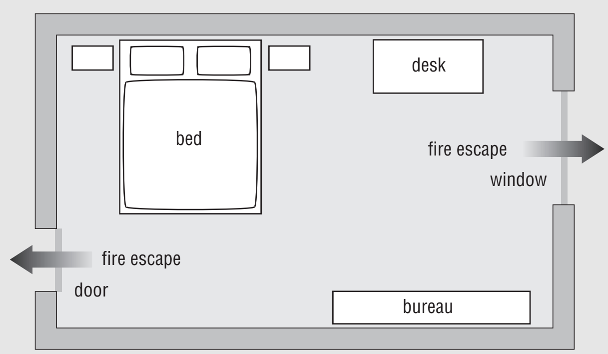
- Students with written or oral language difficulties might be more successful in learning from diagrams so they should be encouraged to develop skill in this area.
- The checklist could be used to indicate areas of concern about students' diagrams without generating a grade. The assessed work could then be returned to students for further attempts until students have overcome their difficulties.
- Students who are having particular difficulties could work as partners. Each could evaluate the other's diagrams, so that appropriate adjustments, based on the evaluation, could be made prior to final submission.
- Using the checklist, students could evaluate their own work, comparing it to a drawing that you provide. Students could then defend their grade. The "defence" may provide insight into any difficulty students might be experiencing.

Ideas for Communicating

- Students could generate a booklet of diagrams from a series of observations of various events. One of the diagrams could be turned into a poster, either by the student or teacher (on an enlarging photocopier), to display and share with the class as exceptional work or to illustrate a course theme.
- Students could attempt to record all work in their science logs as a series of pictograms for a certain period of time.

Instant Practice—Scale Drawings Answer, p. 489

Answers will vary but may include:



Example scale: 1:50 (cm)

SCIENCE SKILL 6 USING A MICROSCOPE, pp. 490–491

Science Skill 6 acquaints students with the various parts of the light microscope and with its use and care.

BACKGROUND INFORMATION

- There are many types of microscopes used to study micro-organisms. The microscopes used in classrooms are usually compound light microscopes. These microscopes usually have better illumination than microscopes used with mirrors, although their power of resolution can be inadequate. Resolution of a microscope is the ability of the instrument to separate and distinguish details between two objects. The light microscope used in class frequently cannot resolve detail finer than the size of a small bacterium (0.20 μm). Increasing the magnification to a maximum of 1500 times will only increase the blurriness.

  Modern light microscopes have improved the quality of the image but not the resolution. The ability to study cellular organelles is still limited by the wavelengths of light. Vast improvements in cytology (study of cell biology) were aided by the arrival of the electron microscope. Modern electron microscopes can achieve a resolution about a thousand times better than light microscopes.

TEACHING STRATEGIES

- To help students to appreciate how delicate and precise a microscope is, engage them in a discussion about cameras and their photographic capabilities. It should quickly become clear that the better and more capable a camera, the more care and cost go into constructing it and the more delicate the interior mechanism. Students can reflect on how much more is involved in building an instrument that can view objects as clearly and precisely as the microscope can.
- Students may create a table, titled "The Compound Light Microscope," with two columns, headed "Part" and "Function," and then enter the following subtitles: tube, eyepiece or ocular lens, objective lens, revolving nosepiece, arm, coarse- and fine-focus knobs, light source, stage, diaphragm, etc. Encourage them to use any strategy that helps them become more familiar with this instrument.
- Have students complete the Instant Practice on page 491 of *Discovering Science 9*. While students are explaining the parts of the microscope, observe the interaction between students and examine their drawings to see how well they have absorbed the information.

TROUBLESHOOTING

- Following are common microscope skill problems encountered by students and how to deal with them.

  Problem: The field of view is small and dark.
  Solution: Check the diaphragm. Ensure that the correct aperture is open.

  Problem: The image seen in the microscope is too large (i.e., it is outside the field of view).
  Solution: Change to the lower objective lens to bring the desired section into the field of view.

  Problem: The image cannot be seen well.
  Solution: Start with the low-power objective lens. Once the image is obtained and focussed in the low-power lens, students can move to a higher power without damaging the specimen or the lens.

- Additional troubleshooting tips:
  - When moving to the next higher objective lens, make sure students do not adjust the coarse-adjustment knob once the microscope is focussed at low power. There is a chance that the objective lens will crash into the specimen slide. The image should be adjusted with the fine-adjustment knob.
  - Ensure that students use the stage clips to hold the specimen slides.
  - When changing the objective lens, have students pay attention to the lens as it moves into the lens groove and clicks into position. Remind them to listen for or feel the click.
  - If there is any malfunction (e.g., poor focussing, loose knobs), remind the students that they must inform you; they should never try to repair any part of the microscope themselves.
  - Remind students to report all damages and injuries to you (or to the teacher in charge).

SCIENCE SKILL 7
USING ELECTRIC CIRCUIT SYMBOLS AND METERS pp. 492–494

Science Skill 7 provides information about circuit symbols and the correct use of electrical meters. Students are provided with the opportunity to draw circuit diagrams, identify the correct placement of meters, and practise reading an analogue meter.

BACKGROUND INFORMATION

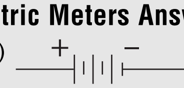
- Circuit diagram symbols are a common method of simplifying a complex electrical circuit. Circuit symbols provide an international language when conveying information about circuits. Most of the symbols resemble the actual electrical component they represent. The long (+) and short (-) posts on the cell symbol represents the two dissimilar metals in the cell. The battery, which contains more than one cell, is therefore symbolized by several cells connected together. Traditionally, chemical cells had a maximum potential difference of around 1.5 V so a 6.0 V battery would be symbolized as four cells connected together. Modern technology has produced chemical cells that can produce more than two volts. Because of this, it is difficult to predict how many cells are in a modern battery. It is now acceptable to draw the battery symbol as a single cell and simply write the total battery voltage beside the symbol.

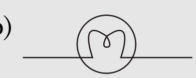
- There are many types of electric meters used today to analyze electric circuits. Analogue meters usually measure only either voltage or current. The advantage of this is that students differentiate between a voltmeter and an ammeter. The disadvantage of analogue meters is that grade 9 students may have difficulty determining the correct value displayed on the scale. As well, analogue meters must be connected correctly in order to avoid damaging the meter. Care must be taken to make sure that the positive terminal (red) is always connected to the positive side of the circuit. On some meters, the negative terminal (black) is sometimes called "common." If the meter is connected backwards, the needle will try to deflect in the wrong direction and damage could occur.
- Digital meters tend to combine several meters into one. A meter that can measure current, voltage, and other electric concepts is called a multimeter. Even though students may find a digital multimeter easier to read, care must be taken to make sure the meter has been connected and set to the appropriate scale. That is, if the digital multimeter is to be used as a voltmeter, the connection terminals and settings are different than if it is to be used as an ammeter. Unlike an analogue meter, if a digital meter is connected backwards (positive side of the meter to the negative side of the circuit), the display will place a negative sign in front of the displayed value. This will not damage the meter, but students should reverse their connections so that the meter is connected correctly.
- Regardless of whether the meter is digital or analogue, an ammeter should always be placed in series with the circuit. That is, the circuit must be disconnected and the ammeter inserted so that all the current flows through the meter. Ammeters are designed to have a very low resistance so that they do not significantly change the resistance of the circuit when they are inserted. Because of an ammeter's low resistance, it should never be connected directly across a battery. The large current drawn by the low resistance ammeter will damage it.
- A voltmeter is always connected in parallel to the load or source of potential difference. Voltmeters are designed to have a very large resistance so that they do not significantly change the resistance of the circuit when placed in parallel with a component.

TEACHING STRATEGIES

- Students can make flashcards with the symbol on one side and the name on the other. Then the actual electrical components could be randomly placed on a table and the students have asked to match the symbol with the component.
- If the students will be using analogue meters, give students: an ammeter, a voltmeter, a red connecting wire, and a black connecting wire. Call out a certain meter and scale setting, and check to see if students have the correct connections and/or settings. For example, you might say "A voltmeter on the 25 V scale."
- If the students will be using multimeters, give students: a multimeter, a red connecting wire, and a black connecting wire. Call out a certain meter and scale setting, and check to see if students have the correct connections and/or settings. For example, you might say "An ammeter on the 200 mA scale."
- Go over the information on pages 492–493 regarding connecting a voltmeter and connecting an ammeter. Use the diagrams on page 493 to emphasize the following points:
  1. The positive side of the meter is always connected to the positive side of the circuit.
  2. When using an ammeter, the circuit must be disconnected so that the ammeter can be placed into the circuit.
  3. When using a voltmeter, the circuit does not have to be manipulated. The voltmeter is placed directly across either a load or a source of potential difference.
- Have students complete the Instant Practice on page 494 of *Discovering Science 9*.

Instant Practice – Using Circuit Symbols and Electric Meters Answers, p. 494

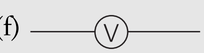
1. (a) 

(b) 

(c) 

(d) 

(e) 

(f) 

2. (a) Red
(b) Black

3. The positive terminal of the meter should be connected to the positive side of the power source.

4. The circuit must be disconnected before inserting an ammeter.

5. Set the meter on the largest scale to obtain an approximate value. Then, lower the scale until you have the highest possible reading without going off scale.

6. (a) Use the 2.5 scale and multiply your value by 10. Answer = 6.5 V.
(b) Use the 5 scale and multiply your value by 100. Answer = 285 V.
(c) Use the 1 scale and multiply your value by 10. Answer = 8.8 V.
(d) Use the 1 scale and multiply your value by 100. Answer = 44 mA

SCIENCE SKILL 8 USING YOUR TEXTBOOK AS A STUDY TOOL, pp. 495–496

USING GRAPHIC ORGANIZERS

This Science Skill includes a summary of several useful graphic organizers, and provides opportunities for students to practise selecting and using them.

BACKGROUND INFORMATION

- Graphic organizers are used to organize learning. Diagrams allow students to organize terms and ideas into concept groups.

TEACHING STRATEGIES

- In order to prepare a graphic organizer, students must have some familiarity with the general topic to be mapped.
- Ensure that students are supplied with notebooks, pen or different-coloured pens or pencils, and self-adhesive notes.
- Begin by explaining that a graphic organizer is a written representation of the relationships among major concepts, ideas, objects, events, or processes.
- To demonstrate the usefulness of a **main idea web** ask students to select a topic that they are studying now. They might use the title of a section or a major heading from the textbook. Have them write the topic in the centre of the web and write supporting details around it, connecting each one to the centre. You might have each group summarize a different section this way, then display all main idea webs and have a "walk-around," in which students tour the room, reading each web.
- To demonstrate the development of a **concept map**, have students make a list of major concepts or processes to include on the map. Using a flowering plant, have students state the main organs, such as leaves, stems, flowers, fruit, roots.
  Under each major concept, they should then list more specific concepts to form a cluster of related ideas. For example, with leaves, include colour, type of veins, leaf stalk, number of leaves on the stalk, shapes of leaves, and thickness of leaves. They should join or draw lines vertically to connect the major concepts and ideas to one another.

  Have the students include a description or phrase or word(s) to link ideas.
  Encourage them to draw horizontal links that relate ideas and concepts in one part of the map to another part of the map.
- For a **spider map**, have students think of a subject about which they have plenty of information. Sports, books, or movies would make good subjects. These will provide fairly easy entries into spider map construction. Have students brainstorm the subject of their choice and then develop some categories for the brainstormed items. For example, they might begin categorizing movies as comedy, drama, mystery, horror, etc., and place each movie into the appropriate category.

  Have them share their spider maps to see if they can improve on each other's work.
- For a **flowchart**, have students make a list of major concepts or processes to include on the map. They can use "immune system" as the key concept to state the main terms associated with how the body fights pathogens.

  Under this major idea, encourage them to list more specific sequences of events or processes.
  With related ideas, processes, or steps, have them continue the sequence.
- For a **cycle chart**, have students begin by brainstorming cyclical events, such as the water cycle. They may also recall that science inquiry is cyclical in nature.

  Have them select one of the events they have brainstormed and, in groups, make notes of the various steps in the event. Encourage them to be as detailed as they can. Have them organize the steps into a cyclical pattern.
- There are two types of cause and effect maps. Consider having some students draw one to illustrate an event that has several effects, such as not brushing your teeth, or walking more often instead of using a vehicle. Have others use a cause and effect map to illustrate an event that is caused by several things, for example, global warming, or being good at sports. Then students can meet in groups to compare their maps.
- A **Venn diagram** is most useful when comparing and contrasting ideas or objects for a better understanding of the material that is being studied. Encourage students to come up with some topics for comparison and contrast. If they have trouble, you could suggest such topics as winter and summer activities (e.g., swimming and skating could be contrasted in that both involve water, one warm and one frozen; one involves few clothes while the other involves many clothes; one involves special equipment, while the other requires

no equipment; both can be done outdoors or indoors). You could work on this example with the class as a whole before assigning the Instant Practice questions.

SCIENCE SKILL 9 UNITS OF MEASUREMENT AND SCIENTIFIC NOTATION, pp. 497–499

Science Skill 9 presents a review of the metric system and unit conversion.

BACKGROUND INFORMATION

- Some may question why British Imperial units such as miles, pounds, and ounces are not used in science. The answer to this question is twofold. First, scientists have agreed upon the metric system *(Système international d'unités)* as being the system of measurement for science. Second, the metric system has fixed standards of measurement for easy comparison. The Imperial system was based upon measurements such as the length of a certain king's foot, while the inch was the width of a thumb.

  Obviously these things could and would change from one individual to another. Further, British Imperial units of measurement did not always match those of American units. For example, a British gallon is larger than an American gallon. To avoid confusion, the metric system has been universally adopted. Imperial measurement is still used in some cases. Wood is still sold and purchased in Imperial units, and students might be interested to learn that horses are still measured in hands, the unit used to indicate the height of a horse from its front hoof to its shoulder. As well, the fathom is still used to measure the depth of water. A fathom is the measure of a length of rope that is stretched between two extended hands, traditionally considered to be six feet. This measure was used to detect the depth of water under the hull of a boat as a weighted rope was slowly lowered over the side and the number of arm's lengths of rope was counted.

TEACHING STRATEGIES

- To introduce the students to the relationship of prefixes in measurement, provide each student with a metre stick. Inform the students that the stick represents a metre. Point out to them how it can be divided into units of 10 (decimetres):
  1 metre = 10 decimetres

  Within a decimetre (starting on the left), have the students count the number of major divisions. Tell the students that these major divisions represent centimetres. Help them to make the inference that 1 dm = 10 cm.

  Finally, have students count the number of markings between centimetres. Help them to make the inference that 1 cm = 10 mm. Get students to then correlate between the minor units of measurement in the metric system:

  10 cm = 1 dm
  10 dm = 1 m
  100 mm = 1 dm

  To reinforce these ideas, play *Jeopardy!* with teams of contestants and conversion problems.
- To help students develop some facility with conversions, use a stair format or unit number line. In the stair format, the larger units are written at the top left of the stairs. Descending units are written on lower rungs. The number is written on the stair with a decimal place. Moving up or down is done by moving the decimal, and zeros are added on the vacant stairs between the original number and the new unit. For example:

  30 cm = 0.3 m

  kilometre
  hectometre
  decametre
  metre 0.3
  decimetre 3.0
  centimetre 30
  millimetre

  Using a unit line applies the same principle in a linear fashion. For example,

  3 m = 300 cm

kilo	hecto	deca	root unit	deci	centi	milli
			3.0			

kilo	hecto	deca	root unit	deci	centi	milli
			3	0	0.	

  Do one or two examples on the chalkboard with students, then provide an example to pairs of students. Students should try to complete the stair or unit number line and then exchange with their partner to see if they have inserted the same numbers.

  Discuss the examples on page 498 of *Discovering Science 9*, copying them onto the chalkboard, if necessary. Ensure that all students appreciate which way the conversion is going (from a larger to a smaller unit or vice versa). Using the examples, demonstrate to students how this can help them to assess whether their answers are right or wrong. When students are comfortable with conversions, have them complete the Instant Practice on the bottom left of page 499.

Instant Practice—Using Metric Measurements Answers, p. 498

1. 3500 mg
2. 0.350 L of acetic acid
3. 230 cm wingspan
4. 190 000 000 g
5. 2.5 mL

SI UNITS

TEACHING STRATEGIES

- Ask students if they would know what you meant if you described something as being about the length of a metre stick. This is something they are all familiar with and can picture, even if it is not directly in front of them. Ask them to indicate with their hands the length of something that is about half or a third of a metre in length. They should readily be able to do this. Point out that such standard measures as metres are useful as a base to which other units can be related. Using these units makes it easier to understand exactly what is being discussed. Work through the examples on text page 499 with the students, and then have them complete the Instant Practice on the bottom right.
- Have the students measure some common objects such as the length of the class, width of a car, number of students in the school, or size of the lottery jackpot; represent these numbers in larger and smaller units; and convert from standard to scientific notation where appropriate.
- You may wish to distribute BLM G-13, Metric Conversions, to provide practice and reinforcement.

Supporting Different Needs

- If students are having difficulty, it may be worthwhile to find material from appropriate mathematics textbooks for additional problems.

Ideas for Communicating

- Have the students develop a poem or song to illustrate their understanding of the relationship between various increments of the metric system.
- Have them write a short story about a student who wanted to use only pennies for monetary transactions.

Instant Practice—Converting to SI Units Answers, p. 498

1. 52 000 m
2. 2580 s
3. 0.008 63 kg
4. 45.973 m
5. 5378.91 m
6. 6300 s
7. 16 000 kg
8. 100 000 m/3600 s or 27.7 m/s

EXPONENTS OF SCIENTIFIC NOTATION

TEACHING STRATEGIES

- To help students appreciate the usefulness of exponents, ask them to write one trillion in numbers. Ask them to imagine what it would be like to have to write or type this number each time they wanted to refer to it. Point out that a trillion in Europe has six more zeroes than a trillion in North America. Writing 10^{12} makes it very clear to the reader what number is being referred to.
- To help students to understand exponents, review the relationship between bases and powers. Have students work with examples you provide, such as:

  $10^2 = 10 \times 10$

  $10^3 = 10 \times 10 \times 10$

  $10^{-1} = \frac{1}{10}$

  $10^{-2} = \frac{1}{10} \times 10$

  When students are working from larger exponents to smaller, or smaller exponents to larger, it may help if they draw a negative symbol on their right hand and a positive symbol on the their left hand.
- When students seem comfortable working with exponents, have them complete the Instant Practice on page 500.

Supporting Different Needs

- If students are having difficulty, you might wish to find material from appropriate mathematics textbooks for additional problems.

Other Problem-Solving ideas

- Have students take some common measures such as the length of the class, diameter of a car, number of students in the school, and size of the lottery jackpot, and represent these numbers in larger and smaller units, converting from standard to scientific notation where appropriate.

Instant Practice—Scientific Notation Answers, p. 499

1. (a) 4×10^{11} stars
   (b) 2.3×10^{19} km
   (c) 8×10^{23} km
   (d) 1.7×10^{-24} g
2. (a) 980 000 m
   (b) 2 300 000 000 kg
   (c) 0.000 055 L
   (d) 0.000 000 000 65 s

SCIENCE SKILL 10 USING CHEMICAL SKILLS, p. 500

This Science Skill summarizes for students how to fold a filter paper.

BACKGROUND INFORMATION

- Folded filter paper in a funnel is a widely used tool to separate a mixture into its solid, or particulate, and liquid components. Conduct an Investigation 3-3C, Observing Changes in Matter, on page 92 of the student textbook makes use of folded filter paper.
- The note at the bottom of page 500 about turning the filter paper inside out helps to keep dirt from the folder's hands from contaminating the part of the mixture being collected.

TEACHING STRATEGIES

- If you are teaching this skill to the whole class, place students in groups of four. Each student should have his or her own piece of filter paper. Demonstrate each step, one at a time. Circulate around the room to show everyone the results of your folding in each step. Give each group time to ensure that all of their members have performed that step correctly. In the end, everyone should have a correctly folded piece of filter paper.
- If students are conducting an activity in groups, and each group needs one piece of folded filter paper, designate one of the group members the folder. Have each folder follow your steps using his or her own piece of filter paper as other group members set up other parts of the apparatus.

SCIENCE SKILL 11 CREATING DATA TABLES, p. 501

Science Skill 11 will help students to organize data into tables for effective communication of scientific results.

BACKGROUND INFORMATION

- Organized data make it easier for others to understand the results of an investigation and also give the researcher credibility.
- Simple tables have columns with heads that show what is being recorded and rows with heads that show data items. It is acceptable to reverse the function so that columns are used for data items and rows are used for what is being recorded, in order to make the table fit a horizontal or vertical format.
- More complex tables, like the one on page 501 of the student textbook, subdivide the rows or columns to include subcategories of data.
- Word processing software or spreadsheet software provide good templates for data tables, allowing students to add or subdivide rows or columns, and to revise data, without having to recreate the table.

INSTRUCTIONAL STRATEGIES

- Show examples of tables from newspapers or magazines. Discuss them with students, asking students to interpret the data in each one, and to comment on the effectiveness of the presentation.
- Divide students into small groups, and have each group design a table that they could use to record the number of dandelions growing in 6 different sections of the schoolyard. Invite groups to share their results, and comment on why they set up their table as they did.
- Then ask each small group to design a table that they could use to record data from the investigation described on page 501 of the student textbook: an investigation of the water quality of a stream. Samples will be taken at three different locations. At each one, the numbers and types of organisms will be recorded, as well as the pH. Invite groups to share the table they created and explain why they set it up as they did. Have students compare their tables with the one on page 501 and discuss similarities and differences. What makes the table on page 501 effective for this data? What makes their table effective?
- For students who are not familiar with creating tables on the computer, use a projector to demonstrate how to create and customize tables using word processing or spreadsheet software.

Instant Practice—Creating Data Tables Answers, p. 501

1. Answers may vary, but could resemble the table shown on page 501. Headings would be: "Week", "Type of Weed", and "Number of Weeds".
2.

Day	Plant	Amount of Fertilizer	Height of Plant
1	Plant 1	5 mL	**5 cm**
2	Plant 2	10 mL	10 cm
3	Plant 3	15 mL	**15 cm**
4	Plant 4	20 mL	**20 cm**

Students may report that they heights of the plants cannot be recorded without seeing the actual data.