Using the Science and Numeracy Skills Toolkit

Skills Toolkit Teaching Notes

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The Value of the Science Skills Toolkit and the Numeracy Skills Toolkit

The strategies described on the following pages complement the Science Skills Toolkit and the Numeracy Skills Toolkit on pages 366–398 of the student textbook. They also provide strategies for using Safety in your Science Classroom, on pages xii–xv of the student textbook.

The skills component of the *Science Links 10* program will be critical to you as you successfully deliver the curriculum. Therefore, you will find the Science Skills Toolkit and the Numeracy Skills Toolkit at the end of the student textbook useful in providing students with the tools they need for further skills development (and remediation). They can refer to these tools throughout the program because they are built into the textbook as an integral part of instruction.

Each unit of the *Teacher's Resource* includes many useful ideas to help students build science skills. The skills development that your students will gain from using the Science Skills Toolkit and Numeracy Skills Toolkit at the end of the textbook will provide students with further background and practice for the skills they are using. They will also 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. This Toolkit will help you to integrate skills throughout your course that your students will find invaluable.

Safety in your Science Classroom, pages xii–xv

This opening section presents 13 rules for safe conduct in and out of the science classroom. They are:

1. Working with your teacher
2. Starting an activity or investigation
3. Wearing protective clothing
4. Acting responsibly
5. Handling edible substances
6. Working in a science classroom
7. Working with sharp objects
8. Working with electrical equipment
9. Working with heat
10. Working with various chemicals
11. Working with living things
12. Cleaning up the science classroom
13. Designing and building

Page xv presents the safety labels and symbols. Encourage students to become familiar with the safety symbols used in *Science Links 10*. Students also review all Workplace Hazardous Materials Information System (WHMIS) symbols.

BACKGROUND INFORMATION

- Safety symbols are a necessary common feature of science resources 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 skillsunderstand the risks associated with doing certain activities and using certainmaterials. 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 WHMIS. They will encounter WHMIS symbols in this book and on containers of substances they use in the science lab and at work if they have jobs.

INSTRUCTIONAL STRATEGIES

- Provide time in class for students to read the safety rules on pages xii–xiv of the student textbook. Encourage students to ask about any rule that they do not understand. Have students write the rules in their notebooks to reinforce the rules. Provide a demonstration of the rules prior to starting the first laboratory activity. Demonstrate any relevant rules that pertain to an activity before the start of the activity. Provide a summary chart of the rules and post it in the science classroom as a reminder. Incorporate these rules into your classroom rules and routines. Provide **BLM G-1 Safety Contract** on the first day of class. Students should sign it and keep a copy for their records.
- Have students bring in a variety of empty, clean containers that have the various symbols. Use these and other examples found in the science classroom and around the school to test students' knowledge. Provide **BLM G-2 WHMIS Symbols** to further test their knowledge.
- Provide examples of laboratory experiments or sets up using photographs or descriptions or have students act out an experiment. Have students point out the safety hazards in each situation and recommend the correct safety procedure when handling the chemicals or equipment.

ADDITIONAL SUPPORT

- DI The laboratory examples activity described above will provide enhanced understanding and recall of the symbols for many students, including bodily-kinesthetic learners (if acting out the scenario), linguistic learners (if using descriptions), and visual learners (if using photographs).
- DI Some students, especially visual learners, may wish to draw cartoon characters who warn about various hazardous situations.

Instant Practice–Safety Symbols Answers, p. xv

Answers will vary. For example:
Clothing Protection Safety, Electrical Safety, and Sharp Object Safety are all found in Investigation 1A. The glass microscope slides can break and cause injury. Aprons should be worn, in case tissue stains leak from the broken slide. Students are cautioned to make sure the microscope is unplugged, and with dry hands, the plug is pulled, not the cord. Eye Safety is found in Investigation 2A. Students are cautioned not to get any of the chemicals in their eyes. Chemicals can irritate or damage the eyes.

Instant Practice–WHMIS Symbols Answers, p. xv

1. "Flammable and combustible material" and "Compressed Gas"
2. Answers will vary but may include:
   - **a)** Hydrogen will ignite if it comes into contact with a spark. Hydrogen is under pressure and the container may explode if heated.
   - **b)** Anyone working with hydrogen should take precautions to keep the container cool and not drop or bang it. They must also not allow any flames or sparks close to where they are working.
   - **c)** Store in a cool place away from any possible sources of sparks.
   - **d)** If the gas leaks, everyone should evacuate the area. If the container explodes, treatment for cuts and burns may be necessary.
3. More detailed information may be found in the Material Safety Data Sheet for hydrogen.

Further Practice

- You may wish to refer to **BLM G-1 Safety Contract** and **BLM G-2 WHMIS Symbols** periodically with your students, depending on the needs you observe and the level of awareness and responsibility they demonstrate.

Science Skills Toolkit 1: Analyzing Issues–Science, Technology, Society, and the Environment, p. 367

This Science Skills Toolkit encourages students to think about how science and technology relate to the issues affecting society. Students learn to use science and the processes they are learning as they work through a decision-making model.

BACKGROUND INFORMATION

- Decisions about science and technology are oft en far reaching but are sometimes made without a clear understanding of what their effects (both positive and negative)might be. As members of society, students need to accept responsibilities for science technology-society decisions. They need to learn to evaluate possible impacts of decisions on the world outside of the classroom. Examples of issues that may require society's decision-making skills include: deforestation, organ transplants from one species to another, responsible and safe use of plastics, and the increasing use of fossil fuels.

INSTRUCTIONAL STRATEGIES

- Discuss the Science Skill scenario with the students. Have them compare the process that was followed with the steps in the model on page 367. What was the issue that was identified? How did the students go about finding their information? What alternatives did they consider?
- Suggest that students use the decision-making model to make a decision about any issue that affects their own lives by asking small groups of students to research and present the process they might take to make a decision about a societal or environmental issue. Have the students write a sentence to describe the issue and to indicate the nature of the decision. Have them write the questions they will need to answer in order to obtain the knowledge and background that will help them to suggest and evaluate alternatives. Ask them to give examples of each stage as shown in the diagram on page 367.

- Investigating an issue in their own community allows students to internalize science-technology-society-environment connections. Personal experience with such issues heightens awareness of the complexity of societal issues. Local issues enable students to appreciate the challenges that are encountered on a global scale. Whenever possible, draw in local examples with which students may have some first-hand experience.
- You may wish to distribute **BLM G-24 Making Decisions Flowchart** to help students develop decision-making skills.

Instant Practice–Analyzing Issues, p. 370

Answers will vary but may include:

2.-3. *Advantages of Alberta Oilsands development*

- Directly provides lots of jobs for people in Alberta and from elsewhere
- Improves the local economies
- Benefits spin-off sectors, such as business services, retail, manufacturing, finance and insurance
- Provincials and Federal coffers enriched when oil prices are high

Disadvantages of Alberta Oilsands development

- Responsible for global warming
- Can result in pollution of land, water, and air (oil spills)
- Gases produced are thought to be responsible for increased respiratory illnesses
- Oil is a non-renewable resource
- More energy used to produce one barrel of oil than what oil provides in energy
- Destruction of animal habitats, disrupts ecosystems

4.-5. Presentations and discussions will vary and discussions can get spirited!

6. Some examples of alternatives are wind power, fuel cells, solar cells, solar power, nuclear power, biomass power, and tidal power. Advantages and disadvantages will vary for each. For example:

Advantages of nuclear power

- Technology is fairly advanced, with many built-in safeguards
- Produces large amounts of clean electrical power
- Fuel is relatively plentiful and long lasting

Disadvantages of nuclear power

- High cost of building a reactor
- Spent fuel rods take thousands of years to become less radioactive (few places to store)
- Possibility of reaction resulting in radioactive material release
- Plants may poise a danger to national security if terrorists try to take advantage of resource

Science Skills Toolkit 2: Scientific Inquiry, p. 371

Science Skills Toolkit 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.

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 oft en more cyclical than linear and conclusive. For example, an experiment or investigation oft en stimulates new questions to explore.
- The Science *Links 10* 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. A *hypothesis* usually adds a possible reason for this relationship. For example, "If heat causes particles to vibrate more vigorously, then increased temperature will cause the rate of the reaction to increase."
- 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 theories are just as important as, or more important than, data that support current thinking.

INSTRUCTIONAL 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)

- 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).
- As the diameter of the balloons increases, the drop speed will [class predicts a result], because [class suggests a hypothesis].

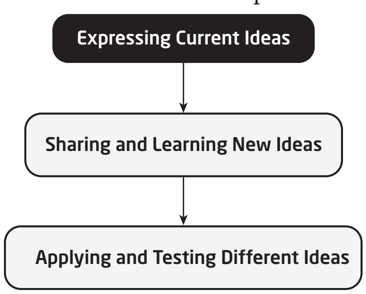
Seeking Empirical Support (i.e., conducting experiments and studies)

- **BLM G-7 Variables in Science** can help students understand manipulated, responding, and control variables.
- 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. Ask a few students to demonstrate the test with balloons of different diameters for the class, having others record data.

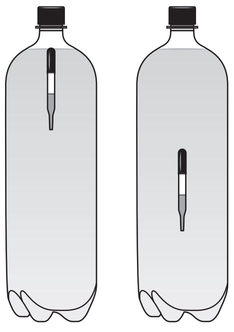
Communicating (i.e., publishing articles, giving lectures, presenting findings at conferences and scientific publications)

- Help students create a graph to show their results dropping balloons, such as a point-and-line graph. Students can use **BLM G-34 Constructing a Line Graph** for support constructing a line graph, or refer to Numeracy Skills Toolkit 2: Organizing and Communicating Scientific Results with Graphs.

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 oft en 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 sequence: observe, question, hypothesize, predict, test, communicate.



- 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 discussion 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.

Instant Practice–Making Qualitative and Quantitative Observations Answers, p. 372

1. **a)** Qualitative
   b) Quantitative
2. **a)** Qualitative
   b) Quanlitative
3. **a)** Quantitative
   b) Quantitative
4. **a)** Quanlitative
   b) Quantitative
5. **a)** Qualitative
   b) Quantitative
6. **a)** Quantitative
   b) Qualitative

Instant Practice–Stating an Hypothesis Answers, p. 373

Answers will vary but may include:

1. If pollution causes respiratory problems and diseases, then someone constantly exposed to pollution may get asthma.
2. If antacids reduce the acidity of foods, then antacids will increase the pH of acidic stomach acids and almost neutralize the acids in the stomach.
3. If the average global temperature is increased due to global warming then the polar ice caps will melt more rapidly than before.
4. If different types of glass have different light bending properties, then light will be bent at different angles depending on the type of glass light is passing through.

Instant Practice–Identifying Variables Answers, p. 374

1. Control: lung tissue that has not been exposed to cigarette smoke
   Manipulated variable: the amount of cigarette smoke lung is exposed too
   Responding variable: amount of damage to lung tissue
2. Control: a spot of dirt on a square of fabric
   Manipulated variable: different types of cleaner, including water
   Responding variable: how clean each cleaner, including water, cleans the same size spot of dirt by how much of the dirt is removed
3. Control: algae in room temperature water for a specific time interval
   Manipulated variable: temperature of water for a specific time interval
   Responding variable: mass of algae at each temperature
4. Control: cathode ray image
   Manipulated variable: type of TV—LCD or plasma rendering of same image
   Responding variable: clarity of the picture relative to cathode ray image

Science Skills Toolkit 3: Measuring, p. 346

This Science Skills Toolkit provides information about the purpose of measuring (volume, mass, and angles) and provides opportunities for students to practise these skills.

BACKGROUND INFORMATION

- Measuring is the act of finding the magnitude of a quantity—what size or how much, relative to some unit of measurement. Often an instrument is used to take a reading. Measuring is is not be confused with an estimation which is simple sampling.

INSTRUCTIONAL STRATEGIES

- Encourage students to express their understanding of how to measure. If time allows, having the students demonstrate their own methods would set up a comparison to the methods described here. Let the students draw their own conclusions as to the efficiency and accuracy of any method.
- When students measure the size of angles in situations involving light rays, it is preferable that the apparatus be set up on a sheet of paper. While the light is still on, the students should mark the position of the incident ray and reflected (or refracted) ray(s) using a pencil directly on the paper. Two marks should be drawn for each ray and the position of all apparatus noted as well. After the apparatus is removed, the students should be able to use the marks to complete the drawing (using a ruler) and measure the needed angles from the drawing.
- While it is tempting to set up a number of stations for students to rotate through while practising the methods described here, it is more appropriate to refer to them when each technique is needed for the particular investigation that is to be carried out. In this way, the relevance of the methodology is immediately apparent. Whether you decide to provide work stations or refer to measuring techniques only when students actually need them, provide opportunities for students to attempt the various measurements a number of times using different samples and materials.

ADDITIONAL SUPPORT

- Most students will have little difficulty with the skills outlined here. Break up the skill set for those who cannot acquire the skills easily, and supplement it with additional opportunities to practise the acquired skills when appropriate to the investigations planned.
- Enrichment—Provide challenges for students who have no difficulties with the concepts and skills taught in this section. Ask them to devise methods to measure in increasingly difficult situations, such as gas production of water plants or yeast cells, moose populations in aerial photographs of central Ontario or fish populations in fast-flowing streams that have been sampled by nets strung in certain places. In these cases, estimation or simple sampling, is required.

INSTRUCTIONAL STRATEGIES (Measuring Volume)

- Go over the material presented on pages 376–377 of *Science Links 10,* making sure that students understand the terms and that they understand the importance of measuring from the lowest level of the meniscus.
- Through discussion, elicit from students the reason for using the liquid displacement method for finding the volume of an irregularly shaped object. Have them complete the Instant Practice on page 348. In small groups, have students measure several irregularly shaped objects. Each student should have an opportunity to measure the object and then share his or her findings.

Instant Practice–Measuring Volume Answers, p. 376

A. 73 mL

B. 18.0 mL

C. 650 mL

INSTRUCTIONAL STRATEGIES (Measuring Mass)

- Students are probably familiar with using balances to measure mass, so it is simply a matter of ensuring that they are familiar with the type of balance used in your school and that they learn how to handle it carefully. It should be pointed out that weight and mass are two different concepts. Weight is the force exerted on an object by gravity. Mass is the amount of matter in an object. Gravity does not have an effect on the mass of an object. Use an example of the mass and weight of two different objects as measured on Earth and on the moon. The masses of two different objects can be different on Earth and so too will their weights. However, on the moon, the masses remain constant, while the weight changes, that is, both objects will have a weight almost equal to zero on the moon. By pointing out the difference between mass and weight, you can explain the next point.
- Ask students if they are familiar with the question "Which is heavier, a kilogram of lead or a kilogram of feathers?" Although it is tempting for students to say that the lead is heavier, if the measure is the same the mass of the two substances is the same. Have students complete the Instant Practice on page 377.

Instant Practice–Measuring Mass Answers, p. 377

The mass of the table salt is 70 g.

INSTRUCTIONAL STRATEGIES (Measuring Angles)

- Students may have little or no experience with protractors but will probably enjoy using them. If any students have difficulty using their protractors, a few extra practice examples should solve the problem. If you see students who seem unsure of what they are doing, provide more examples of angles to give them more practice in identifying existing angles before they go on to draw angles of their own. Make sure the additional examples are angles in different orientations.
- Provide an opportunity for students to do the Instant Practice on page 378.

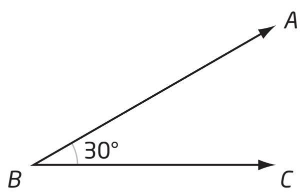
ADDITIONAL SUPPORT

- Pair a student who is competent in using a protractor with one who requires support.

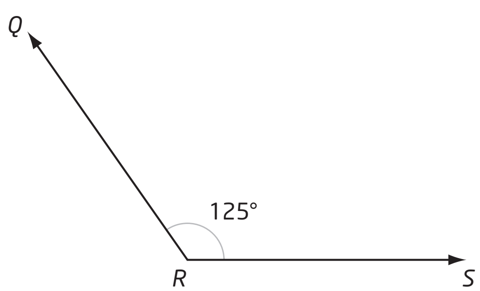
Instant Practice–Measuring Angles Answers, p. 378

1. **a.** 55°
b. 140°
c. 84°
d. 85°
e. 96°
f. 180°
g. 80°
h. 164°

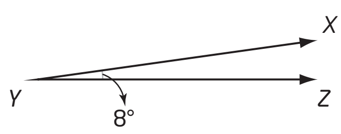
2. **a.**



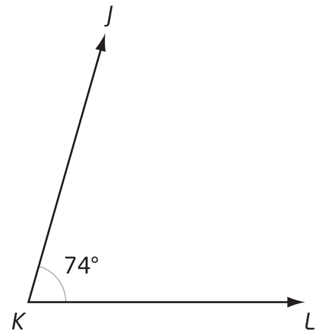
b.



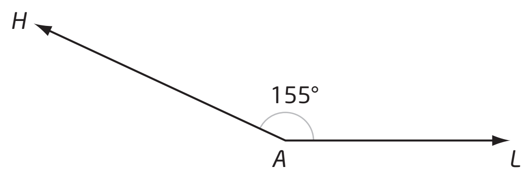
c.



d.



e.



INSTRUCTIONAL STRATEGIES (Measuring Temperature)

- Go over the material on page 379 of the textbook, ensuring that students understand how to properly use and read a thermometer.
- Draw students' attention to the tips on page 379, and provide time to discuss the reasons for tips second and third (the thermometer is too delicate to use as a stirring rod; a false reading could be obtained if the thermometer bulb touches the walls of a container).
- Provide a folded towel so students can place their thermometer on and to prevent it from rolling off the table.

Instant Practice–Measuring Temperature, Answers p. 379

1. −12°C
2. 94°C

ASSESSMENT

- Performance tasks involving the measuring of similar materials can be used to assess how well students have learned these skills. The performance tasks should parallel the type of work done by the students during the formative learning of this material.

Science Skills Toolkit 4: Using a Microscope, p. 380-381

Science Skills Toolkit 4 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.

INSTRUCTIONAL 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.
- You may wish to use an overhead transparency of a light microscope (for example, **BLM G-10 Parts of a Microscope**) and have students point out the various parts and describe what they do. 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, and so on. Encourage students to use any strategy that helps them become more familiar with this instrument.
- Have students complete the Instant Practice—Viewing a Slide on page 381 of *Science Links 10*. Observe students as they view a slide using the microscope. Be available, if students have trouble working with the microscope or have trouble seeing the slide image. Ask students which problem under Troubleshooting on page 381 are they experiencing.

TROUBLESHOOTING

- The following are additional common microscope problems encountered by students and how to deal with them. Post these on the board.
  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).

ASSESSMENT

Use the Instant Practice—Viewing a Slide activity on page 381 as a performance task. Ask students to assess how well they think they know the parts of a microscope and how well can they use it.

Science Skills Toolkit 5: Scientific Drawing, p. 382–383

Science Skills Toolkit 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 diff ers 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, formatted, and labelled as described in the checklist shown on page 383.

INSTRUCTIONAL 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 the requirements for a science diagram for students by presenting a checklist similar to the one provided below.

Checklist for Science Diagrams

On unlined white paper. 1 Title is underlined. 1	/2
Diagram fills page. 0 1 2 Diagram is neat. 0 1 2 Diagram is in pencil. 1	/5
Labels are on right side of diagram. 1 Labels are neat. 1 Labels are in ink. 1 Labels have horizontal (vertical where applicable) lines. 1	/4
Diagram summary present and good quality 0 1 2	/2
Magnification stated correctly 1 Magnification positioned correctly in lower right-hand corner 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 that are poorly represented (for example, 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 above for students to use in evaluating the diagrams you have provided or for 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?"
- You may wish to distribute **BLM A-7 Scientific Drawing Checklist** or **BLM A-27 Scientific Drawing Rubric** to help students assess their own drawings.

ADDITIONAL SUPPORT

- Students who require support with written or oral language 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.

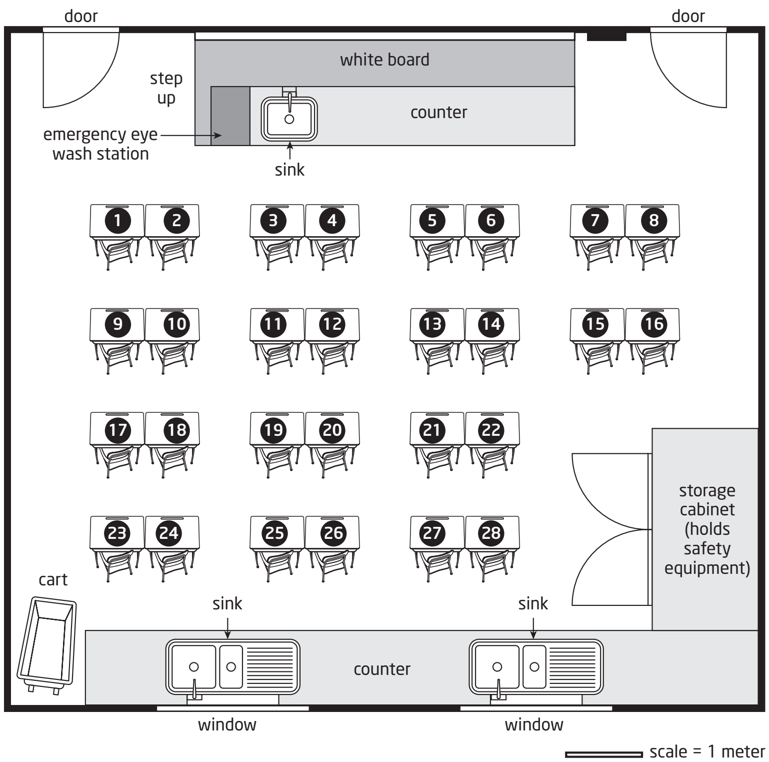
- Students who are having particular difficulties could work with a classmate. Each could evaluate the other's diagrams, so that appropriate adjustments, based on peer evaluation, could be made prior to final submission.
- Using the checklist, students could evaluate their own work, comparing it to a drawing that you provide. Students could then defend their grade. The "defense" 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.

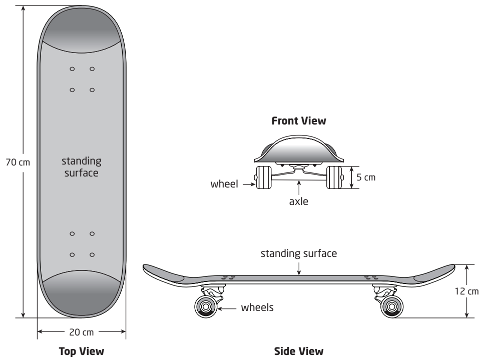
Instant Practice–Scientific Drawings Answers, page 383

1.



Desk	Student	Desk	Student	Desk	Student
1	Name A	11	Me	21	Name T
2	Name B	12	Name K	22	Name U
3	Name C	13	Name L	23	Empty
4	Name D	14	Name M	24	Empty
5	Name E	15	Name N	25	Name V
6	Name F	16	Name O	26	Name W
7	Name G	17	Name P	27	Name X
8	Name H	18	Name Q	28	Name Y
9	Name I	19	Name R		
10	Name J	20	Name S		

2.



Science Skills Toolkit 6: Using Models and Analogies in Science, page 384

This Science Skills Toolkit helps students understand the value of models and analogies to scientific communication.

BACKGROUND INFORMATION

- A *model* is "a picture, a mental image, a structure, or even a mathematical formula." An *analogy* is "a comparison between two things that have some characteristics in common." Each attempts to explain a concept or hypothesis. Models and analogies are usually simplificationsof the concept they represent so that the concept can be studied or more easily
- Scientific models can take many different forms, but they fall into two major categories, physical and mental. Some of the more common forms can include the following physical models: equations, symbols, formulas, drawings, diagrams, scale models, quantitative modelling (statistics), simulations (computer and otherwise), and mental models such as the particle theory of matter and atomic theory. Even the processes of science (scientific methodologies) used in the *Science Links 10* program are expressed in model form. The flowcharts found on pages 367 and 371 are models of these scientific processes.
- Although the concept of two types of models (physical and mental) is implicit in the definition provided, at this level the focus is on physical models, and students are not expected to differentiate between physical and mental models.
- Much recent scientific work entails the use of statistical modelling. This type of model includes as much quantitative and qualitative data as possible and then generates equations that are viewed as lines on graphs (or other graphical conceptions). Scientists can change certain values of data and play "what if?" in an attempt to gain a deeper understanding of the system under study.
- Early scientists assumed that the planets orbited the Sun in circular patterns. Further study and observation, however, showed that the circles (and their describing equations) did not adequately account for the positions of the planets. In the early 17th century, Johannes Kepler tried fitting a number of other curve patterns to the data and eventually determined that the ellipse best fit the data. Since then, the general shape of the planetary orbits is understood to be elliptical, but the actual equations have been adjusted to account for a number of other pieces of data. A similar procedure was used in the "discovery" of Pluto when mass was unaccounted for in the outer reaches of the solar system. The data suggested where the mass might be, and then astronomers searched for it using telescopes and blink comparators.

INSTRUCTIONAL STRATEGIES

- At the simplest level, the graphing of data and the analysis of those graphs in some of the investigations in *Science Links 10* involve models. Graphing skills are very important to students who are attempting to understand relationships between variables. As a result, students should be given as many opportunities as possible to develop their graphing skills. Although students will not be determining equations from these models, they should be assisted in determining trends and patterns (lines of best fit) that are particularly apparent in line graphs. This type of modelling work is significant in the development of student-designed investigations for many of the same reasons.
- In some activities, building or drawing a physical or working model, or stating an analogy, may be helpful in understanding the relationships (in terms of physical association) between the pieces of the model.
- If working on scientific questions, students should be encouraged to make predictions—if a variable (or a number of variables) changes in some way, then (an) other variable(s) changes in some way—and to suggest possible theoretical reasons for the predictions (that is, the variables change in this way because …). These rationales canbe supported by the data produced in the investigation as well as the models that aredeveloped based on them.

ADDITIONAL SUPPORT

- ELL Analogies, especially, can be very helpful to English language learners, helping them to understand a new term by relating it to one they already know.
- DI Encourage students who have difficulty with manual graphing to use dedicated-purpose computer graphing packages or general-purpose spreadsheet programs. The dedicated-purpose programs are generally easier to use since they have fewer options. Encourage the students to analyze the patterns in the graphed data and draw in their own line of best fit, rather than having the computer determine the trend line. If computer soft ware is not available, prepare blackline masters with grids for those students needing motor skills remediation.
- DI Many materials are appropriate for use by bodily-kinesthetic learners in making models. These include plaster of Paris, paper, papier-mâché, modelling clay, wood, sticks and balls, chemistry sets, and so on. Whenever appropriate, provide such materials for the students' use.

Ideas for Communicating

- Students should be given the opportunity to present and explain their models and analogies to small groups, to the teacher, or the entire class. The explanations should focus on how the model conforms to the data.
- When several groups have designed investigations that are closely related (in that they have several variables in common or they are attempting to explain similar phenomena), each group should share data and models with peers while attempting to arrive at a consensual understanding. This would model scientific conventions.

Instant Practice–Using Models Answers, p. 384

Answers will vary. Sample answers:

a. Gina has five dollars. She loans Carlos 2 dollars. Gina has 3 dollars left.

b. A cell can be modelled by a manufacturing plant. The boss is the nucleus who tells workers what to do. Mitochondrion are the engines that run the plant, supplying energy. The workers are the various organelles that make products, mostly proteins.

c. The human body can be modelled by a car. The engine is heart. The dashboard is the brain. The fluid lines are the circulatory systems. The other car parts are the other internal organs.

Instant Practice–Using Analogies Answers, p. 385

1. Answers may vary. For example:
   The levels of organization in a large company are like the organization levels in an organism. A business has corporate or head administration. An organism has a brain. The different departments that help the company function are like the internal organs. The administrative staff are like the circulatory systems, helping to aid the departments or organs in their roles. All systems function to serve the purpose of the corporate office or brain.
2. One analogy is shown on page 148 in Figure 2.20. Masses are used to represent atoms on a scale. The balanced scale is an analogy for balancing chemical equations. Another analogy is shown on page 218 in Figures 312A and 3.12B. The heat transfer, absorption, and radiation in a greenhouse are an analogy for the greenhouse gas effect on Earth's atmospheric temperatures.

Science Skills Toolkit 7: How to Do a Research-Based Project, p. 358

Science Skills Toolkit 7 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 diff erent methods of
- presentation and choose one to suit their data and their audience.

INSTRUCTIONAL 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 Skills Toolkit 7 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 Grade10 students and parents?

ADDITIONAL SUPPORT

- For those students who are unfamiliar with the proper method of conducting research for a project, provide **BLM G-13 How to Do a Research-Based Project.** Additional help may be provided with **BLM G-18 Internet Research Tips** and **BLM G-19 Internet Research Worksheet.**

Instant Practice Answers, p. 389

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 some characteristics of global warming?
3. Answers will vary. For example,
   Students might suggest including visuals or multimedia to keep the younger students interested, as well as using simple vocabulary. Perhaps showing some sample experiments that model climatic behaviour, such as a water current movement, would provide a greater understanding of the concept.

Science Skills Toolkit 8: Creating Data Tables, p. 365

Science Skills Toolkit 8 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, subdivide the rows or columns to include subcategories of data.
- Word processing soft ware or spreadsheet soft ware 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 school yard. 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 226 of the student textbook: an investigation of solar radiation and Earth's surface. Students should proceed with question 4. At each distance and angle, the number of lit squares will be recorded.
- 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 soft ware.
- **BLM G-9 Data Tables** provides templates for some simple tables for students working by hand who require support.

Instant Practice–Creating Data Tables Answers, p. 390

1. Answers may vary, but could be a three column table. Headings would be: "Week", "Type of Weed", and "Number of Weeds".

2.

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

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

Numeracy Skills Toolkit 1: Significant Digits and Rounding, p. 391

Numeracy Skills Toolkit 1 provides students with strategies to deal with uncertainty and level of precision in measuring, rounding, and calculating.

BACKGROUND INFORMATION

- No measurement is exact. On a metre stick, for example, you can measure to the nearest millimetre, for example, 1.724 m. With a more precise tool, you can measure to the nearest micrometre, for example, 1.724 530 m. The number of decimal places in the measurement tell the reader how precise the measurement is. It is important that students not add zeros to a measure, as that would convey a false degree of precision.

- In calculating with measurements, we use their precision to determine the precision of the final result. For example, if a rectangle is measured as 2 m × 3 m, we can say that its area is 6 m^2. This tells the reader that the area is between 5.5 m^2 and 6.4 m^2. If the area is measured with a more precise tool and found to be 2.12 m × 3.24 m, we can write its area as 6.74 m^2—a much more precise value. Note that the number of digits in the area is the same as the number of digits in the least precise measurement. This is one of the rules of calculating with significant digits.

INSTRUCTIONAL STRATEGIES

- Show students a small box and ask a student to measure the length, width, and height to the nearest millimetre. Record these measurements on the chalkboard in metres. Have students calculate the volume of the box, for example:
  0.314 m × 0.226 m × 0.187 m = 0.013 270 268 m^3
- Discuss with students whether this number is realistic. First, is it reasonable, and second, does it make sense that we can calculate the volume of this box so precisely (to the nearest billionth of a cubic metre)? Explain that this is an example of why scientists developed rules to help us decide how many digits it is reasonable to include in a number you calculate from measurements.
- Consider having students write a number and challenge a classmate to decide how many significant digits it contains.
- Read Rules for Rounding together. This is a relatively simple rule, but consistent interpretation of scientific results depends on everyone agreeing on it.
- Read Adding or Subtracting Measurements and Multiplying and Dividing Measurements together. These are also simple rules, but important ones, as they ensure that scientific results will not be misinterpreted. Give students a few examplesof measurements to calculate, and have them compare their answers with those of a classmate, to ensure they have included the correct number of significant digits.

Numeracy Skills Toolkit 2: Organizing and Communicating Scientific Results with Graphs, p. 392

This Numeracy Skills Toolkit introduces students to the principles and procedures used in the tabulation and representation of data. Students learn which graph is appropriate for various types of data and have opportunities to practise their graphing skills.

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 contain data 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 variable while the y-axis represents the responding variable.

INSTRUCTIONAL 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.
- You may want to distribute **BLM G-35 Reading and Interpreting Line Graphs** to provide practice and reinforcement.
- When students have mastered the ability to read graphs and understand the relationship between data points, 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. Hand out **BLM A-16 Data Table Checklist** and **BLM A-17 Graph from Data Checklist** for students who need reminders.

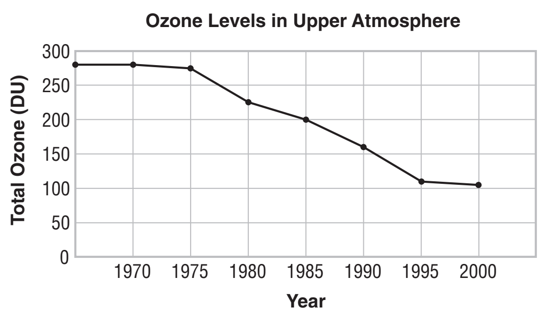
Format for Tables	Format for Graphs
All tables must have the following: • Title • Labelled columns or rows • Units of measurement included with data • Description or summary of the table's data • Appropriate size • Neat prsentation	All tables must have the following: • Title • Labelled *x*-axis • Labelled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

- Line of best fit is another traditional area of difficulty for students. Explain that the line of best fit represents an average of a potential trend in the data, where, if possible, approximately the same number of data points should be on the line and at an equal distance both above and below the line. Place some scatter graphs on the chalkboard or use an overhead, and work with the students to develop a line of best fit for each. Then provide students with scatter graphs to add their own smooth lines of best fit. Remind students that the line does not have to be straight. A clear plastic ruler is a useful tool that allows students to see where all the data points are arrayed as they try to place the line in the best position. A piece of string can serve a similar purpose, especially with graphs with curving lines of best fit.
- Once students have conceptually mastered the skill of graphing, you can introduce them to spreadsheet programs that allow them to input data into fields, manipulate data with sort functions, and graph data. The ease and speed in which data are input and graphs produced will take away from the "procedural noise" of tabulating and plotting data that hampers students' understanding of the skill. If time is spent up front with the students becoming soft ware literate, they can then copy tables or graphs from the database into a word-processing document. This will allow them to produce high-quality reports that are easily modified if oversights or mistakes are made. **Note:** If your students are using a spreadsheet, make sure they input only one type of data into each cell. (For example, in a column used to record individuals' height, height is the only data that would be entered in any cell in that column. Units, which in this example would be "cm," are not used in the cell entry, as they will already appear in the column heading.)

INSTRUCTIONAL STRATEGIES (Drawing a Line Graph)

- Have the students examine Table 1 on page 392 of *Science Links 10* and compare it with the graph on page 393 in step 7. Ask them what information the two visuals contain. Ask which visual more efficiently and effectively communicates the information it contains. Alternatively, you could have half of the class examine the table while half examine the graph. Have a race to see which half of the class understands the information first. The students using the graph will probably understand the information more quickly.
- With the students, go over the steps in drawing a line graph to ensure that they understand how to perform each of the steps. For steps 3 and 4, you might want to provide several different types of examples so that the students develop a clear understanding of scale and its importance to a graph.
- Have the students do the Instant Practice on page 393. You may wish to distribute **BLM G-34 Constructing Line Graphs** to provide practice and reinforcement.

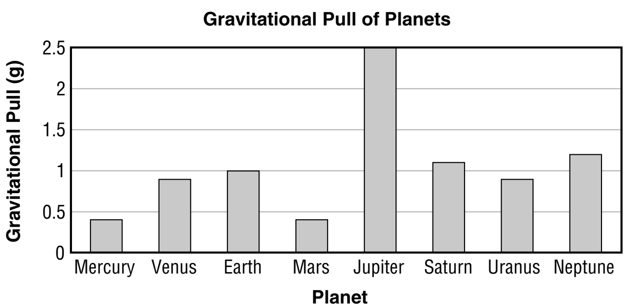
Instant Practice–Line Graph Answer, p. 393



INSTRUCTIONAL STRATEGIES (Constructing a Bar Graph)

- Discuss with the students the information presented in Table 3 on page 394. Have them examine the bar graph on page 394 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.
- Have students do the Instant Practice on page 372.

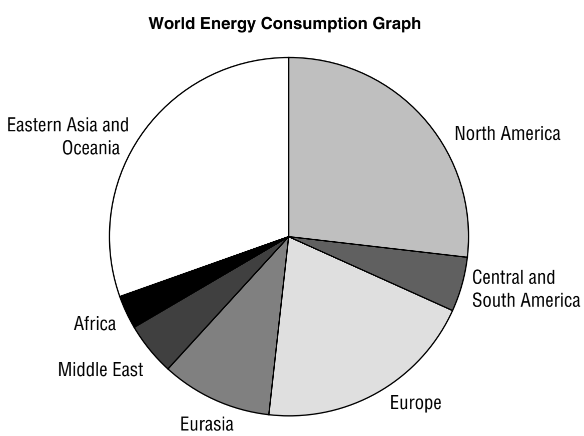
Instant Practice–Bar Graph Answer, p. 394



INSTRUCTIONAL STRATEGIES (Constructing a Pie Graph)

- 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.
- Go over the steps in constructing a pie graph with the students and then have them do the Instant Practice on page 395.

Instant Practice–Pie Graph Answers, p. 395



ADDITIONAL SUPPORT

- For students who have motor coordination difficulties, the use of a spreadsheet to generate a pie graph will be helpful. Students can input the data into the table and convert the data by entering the appropriate formulas into the spreadsheet.

Further Practice

- You may wish to use **BLM G-35 Reading and Interpreting Line Graphs** and **BLM G-34 Constructing Line Graphs** for students who require more support or review.
- Provide several data sets and ask students which graph would be the most appropriate to display the data and why. Reinforce the concepts of continuous versus noncontinuous of discrete data. Discrete data are measurements that cannot be broken into smaller parts. For example, the number of cars in a parking lot, the number of cows in a herd, and the number of students in the a grade 10 science class. Examples of continuous data are money, time, and length.

Instant Practice–Choosing Graph Types Answers, p. 397

1. line graph
2. bar graph
3. line graph
4. pie graph
5. scatter plot

Numeracy Skills Toolkit 3: The GRASP Problem Solving Method, p. 398

This Numeracy Skills Toolkit introduces students to a procedure that can be used to solve numerical problems. G-given, R-required, A-analysis, S-solution, P-paraphrase–GRASP.

BACKGROUND INFORMATION

- The method for solving numerical problems will be familiar to students from their studies in mathematics. Remind students of the stages of the GRASP method by posting them in the classroom.

INSTRUCTIONAL STRATEGIES

- Provide a more detailed approach to the GRASP method.

Remind students of the following:

Given: • Read the problem three times.
- On the first read, get a general sense of what the question is asking.
- On the second read, determine the information given then write it down.
- On the third read, determine if there is any unnecessary information.
  Is there hidden or missing information? Do you need to make any assumptions?
  Do you need clarification before proceeding?

Required: • Determine what you need to find.

Analysis: • Plan out your solution. Does the problem look like one you have solved before?
- Choose a strategy that you might use:

- brainstorm or make an idea web
- estimate
- draw a diagram, graph, or model
- act it out
- solve a simpler problem
- break the problem into simpler parts
- make a table, chart, or organized list
- look for a pattern
- express a pattern using algebra
- set up and solve an equation or inequality
- work backward
- use systematic trial
- make an assumption
- use logical reasoning
- use technology such a calculator, graphing calculator, or spreadsheet

Solution:
- Solve the problem by carrying out your plan.
- Estimate your answer, if possible first, so you can check the reasonableness of your calculated answer.
- Calculate your answer. Be sure to show all steps so you can check your work. Make sure your work is neat and orderly.

Paraphrase:
- Check your work. State your solution and check for the reasonableness of your answer. Ask yourself:
  - Have you answered the question?
  - Check your answer by solving the problem a different way.
  - Check your answer with a classmate.
  - Present your solution to a classmate. Does it make sense?

- Give a problem to pairs of students. Have each pair solve the problem in a different way and compare their solutions in class.
- Have students work in pairs to solve a problem. One student works on several stages and the other completes the remaining.
- When students are familiar with GRASP and have carefully reviewed the solution to the example, complete the Instant Practice on page 398.

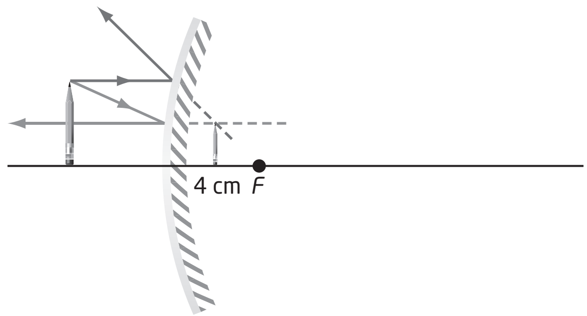
ADDITIONAL SUPPORT

- DI For visual learners or students who have trouble reading or poor problem solving strategies, have them write the problem in their notebooks. Highlight the given information in one colour and the information that they need to find in another colour. This will help consolidate what is given and what is needed, G and R.
- Pair a strong student with a student who needs support to solve a problem. The stronger student could guide the other student through the different stages. For difficult problems, a blackline master of the question with scaffolding could be provided. Parts of the question and/or diagrams could be partially completed for students.
- You may wish to provide simpler problems from grade 9 for some students to complete for extra practice.
- For students who are not able to solve problems independently, model solving a problem by each of the strategies listed in Instructional Strategies. Then, provide

problems that can be solved by the various strategies and have students follow your examples to solve them.

- Provide **BLM G-20 Problem Solving Using GRASP** for students who need a template for writing a solution.

Instant Practice–Using GRASP Answers, p. 398



The image of an object in a convex mirror will have the following characteristics.

- The image is closer to the mirror than the object is.
- The image is upright.
- The size of the image is smaller than the size of the object.
- The image is virtual.