Welcome to the *ON Science 10* program!

These teacher and student resources are designed to provide 100% alignment with *The Ontario Curriculum, Grade 9 and 10: Science, 2008* (SNC1D). The resources have been created to address the knowledge, skills, and attitudes needed to help your students develop scientific literacy and empower them to critically examine issues and questions from technological, societal, and environmental perspectives. *ON Science 10* has been developed to help your students achieve the three central goals of Ontario's science program, as stated in the Ontario curriculum:

1. to relate science to technology, society, and the environment
2. to develop the skills, strategies, and habits of mind required for scientific literacy
3. to understand the basic concepts of science

Through varied text features and diverse instructional approaches, *ON Science 10* enables your students to develop their scientific literacy as they learn basic concepts relating to tissues, organs and systems of living things; chemical reactions; climate change; and light and geometric optics. Students will also develop skills in the process of scientific inquiry and the analysis of issues.

As you foster the development of scientific literacy, the understanding of scientific concepts, and the skills of scientific inquiry in your classroom, you must meet many additional goals. These goals include:

- creating a safe laboratory environment
- implementing the principles of constructivism in the science classroom
- implementing differentiated instruction and recognizing multiple intelligences
- being aware of, and sensitive to, social considerations.

The *ON Science 10* textbook has been developed with these goals, as well as the curriculum, in mind. The following pages of this Teacher's Resource will provide some suggestions for using the features that will help you meet them.

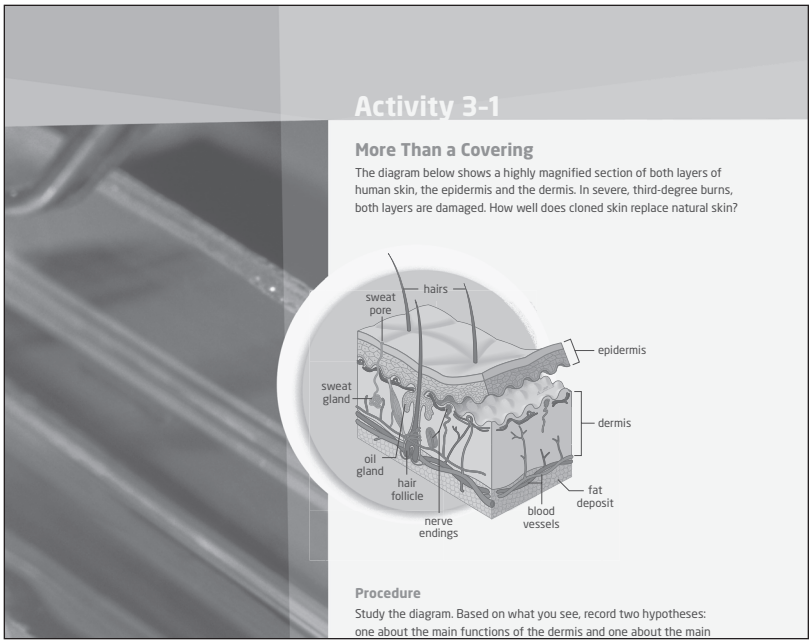
Overview of the *ON Science 10* Instructional Design

ON Science 10 has been developed to help you address the big ideas of the Ontario curriculum while meeting all of the specific expectations. Each unit of *ON Science 10* corresponds to a strand of Ontario's Grade 10 Science curriculum. Specific expectations related to Scientific Investigation Skills and Career Exploration are addressed in every unit. The student textbook and Teacher's Resource together provide the tools and strategies you and your students will need for success.

Engaging Students

To prepare students for what they will learn, each unit of the student textbook begins with an introduction to an engaging STSE issue, a preview of the three chapters in the unit, and the big ideas for the strand. Suggestions for using this material, and all other features of the student textbook, are provided in the Teacher's Resource.

Within a unit, each chapter begins with a description of the key concepts that students will learn about, an explanation of why these concepts matter, an engaging example of one of the big ideas, and an activity to get students thinking and wondering about the concepts they will learn in the chapter.



Activity 3-1

More Than a Covering

The diagram below shows a highly magnified section of both layers of human skin, the epidermis and the dermis. In severe, third-degree burns, both layers are damaged. How well does cloned skin replace natural skin?

Procedure

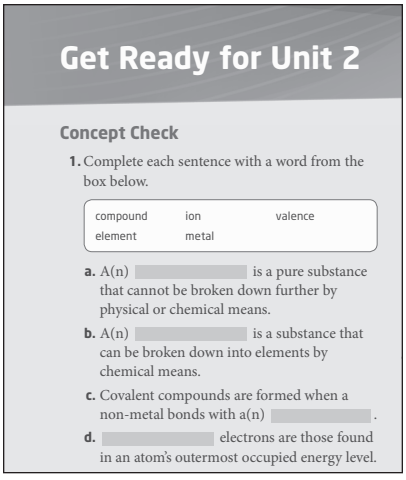
Study the diagram. Based on what you see, record two hypotheses: one about the main functions of the dermis and one about the main

Assessment FOR Learning and Assessment AS Learning

Each unit begins with Get Ready—a chance to check that students have the science understandings, and the inquiry, literacy, and numeracy skills that they will require to succeed in the unit. In the Teacher's Resource, suggestions are provided for supporting learners who do not have these understandings and skills.

Each section of *ON Science 10* includes Learning Checks—short sets of questions that students can learn to use themselves to see if they are understanding the key ideas of the section. Strategies are provided in the Teacher's Resource to help students use Learning Check questions, as well as to help support students who have not yet understood the key concepts in the text.

Each section and each chapter of *ON Science 10* ends with a summary and a review. These reviews can help you see whether students are ready to move onto the next section or chapter, and can help students see what they still need to work on. Questions are linked to Ontario's achievement chart categories. The optional blackline master CD includes alternative versions of these reviews, suitable for students who need additional support with reading and writing in English.



Get Ready for Unit 2

Concept Check

1. Complete each sentence with a word from the box below.

compound	ion	valence
element	metal	

a. A(n) _____ is a pure substance that cannot be broken down further by physical or chemical means.

b. A(n) _____ is a substance that can be broken down into elements by chemical means.

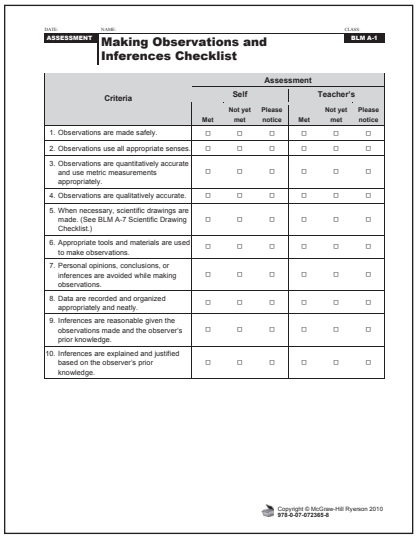
c. Covalent compounds are formed when a non-metal bonds with a(n) _____.

d. _____ electrons are those found in an atom's outermost occupied energy level.

The Teacher's Resource includes suggestions for supporting learners who are still working toward success in demonstrating understanding in these formative assessments. It also includes additional strategies to help students think about their own learning, enabling them to become self-directed learners.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Learning Check questions, page 14	Students compare plant and animal cell organelles	Have students complete **BLM 1-6 Organelle Study.** Or, have students draw each structure as you name it or describe its function.
Section 1.1 Review questions, page 15	Students understand and explain the function of different organelles	Have students compare types of cells using **BLM G-47 Venn Diagram.**

ON Science 10 includes several blackline masters to help support formative assessment and to guide students in learning to assess themselves. Please see pages TR-56.



DATE: NAME: CLASS:

ASSESSMENT **Making Observations and Inferences Checklist** BLM A-1

Criteria	Assessment					
	Self			Teacher's		
	Met	Not yet met	Please notice	Met	Not yet met	Please notice
1. Observations are made safely.	□	□	□	□	□	□
2. Observations use all appropriate senses.	□	□	□	□	□	□
3. Observations are quantitatively accurate and use metric measurements appropriately.	□	□	□	□	□	□
4. Observations are qualitatively accurate.	□	□	□	□	□	□
5. When necessary, scientific drawings are made. (See BLM A-7 Scientific Drawing Checklist.)	□	□	□	□	□	□
6. Appropriate tools and materials are used to make observations.	□	□	□	□	□	□
7. Personal opinions, conclusions, or inferences are avoided while making observations.	□	□	□	□	□	□
8. Data are recorded and organized appropriately and neatly.	□	□	□	□	□	□
9. Inferences are reasonable given the observations made and the observer's prior knowledge.	□	□	□	□	□	□
10. Inferences are explained and justified based on the observer's prior knowledge.	□	□	□	□	□	□

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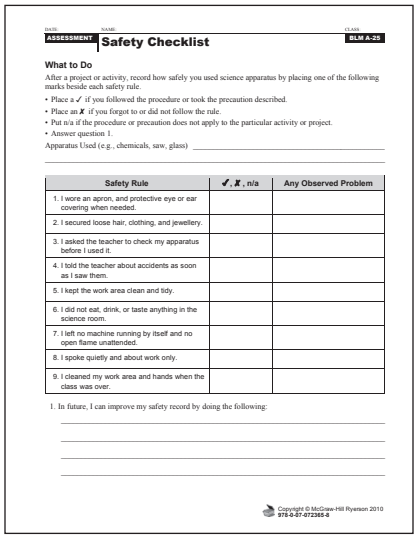

DATE: NAME: CLASS:

ASSESSMENT **Safety Checklist** BLM A-25

What to Do

After a project or activity, record how safely you used science apparatus by placing one of the following marks beside each safety rule.

- Place a ✓ if you followed the procedure or took the precaution described.
- Place an ✗ if you forgot to or did not follow the rule.
- Put n/a if the procedure or precaution does not apply to the particular activity or project.
- Answer question 1.

Apparatus Used (e.g., chemicals, saw, glass) _____

Safety Rule	✓, ✗, n/a	Any Observed Problem
1. I wore an apron, and protective eye or ear covering when needed.		
2. I secured loose hair, clothing, and jewellery.		
3. I asked the teacher to check my apparatus before I used it.		
4. I told the teacher about accidents as soon as I saw them.		
5. I kept the work area clean and tidy.		
6. I did not eat, drink, or taste anything in the science room.		
7. I left no machine running by itself and no open flame unattended.		
8. I spoke quietly and about work only.		
9. I cleaned my work area and hands when the class was over.		

1. In future, I can improve my safety record by doing the following:

_____

_____

_____

_____

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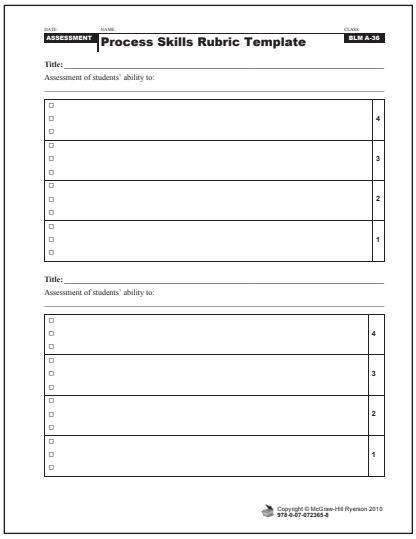

DATE: NAME: CLASS:

ASSESSMENT **Process Skills Rubric Template** BLM A-36

Title: _____

Assessment of students' ability to:

_____

□ □ □	4
□ □ □	3
□ □ □	2
□ □ □	1

Title: _____

Assessment of students' ability to:

_____

□ □ □	4
□ □ □	3
□ □ □	2
□ □ □	1

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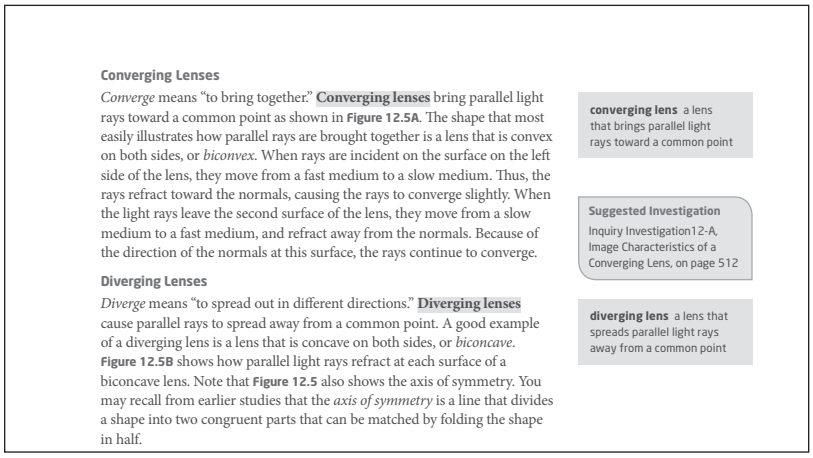
Developing Understanding

By introducing students to what they will learn at the beginning of each chapter and by engaging them in a related activity as they begin, the stage is set for learning. Within each section, the text has been organized and pages have been designed to promote understanding. Heads and subheads lead students through the section; Key Terms are introduced in context and defined; and tables, graphs, and other visuals are used whenever they would be effective. Where appropriate, students are reminded of Study Skills that will help them organize and interpret the information they are reading.



Converging Lenses

Converge means "to bring together." **Converging lenses** bring parallel light rays toward a common point as shown in **Figure 12.5A**. The shape that most easily illustrates how parallel rays are brought together is a lens that is convex on both sides, or *biconvex*. When rays are incident on the surface on the left side of the lens, they move from a fast medium to a slow medium. Thus, the rays refract toward the normals, causing the rays to converge slightly. When the light rays leave the second surface of the lens, they move from a slow medium to a fast medium, and refract away from the normals. Because of the direction of the normals at this surface, the rays continue to converge.

converging lens a lens that brings parallel light rays toward a common point

Suggested Investigation
Inquiry Investigation12-A, Image Characteristics of a Converging Lens, on page 512

Diverging Lenses

Diverge means "to spread out in different directions." **Diverging lenses** cause parallel rays to spread away from a common point. A good example of a diverging lens is a lens that is concave on both sides, or *biconcave*. **Figure 12.5B** shows how parallel light rays refract at each surface of a biconcave lens. Note that **Figure 12.5** also shows the axis of symmetry. You may recall from earlier studies that the *axis of symmetry* is a line that divides a shape into two congruent parts that can be matched by folding the shape in half.

diverging lens a lens that spreads parallel light rays away from a common point

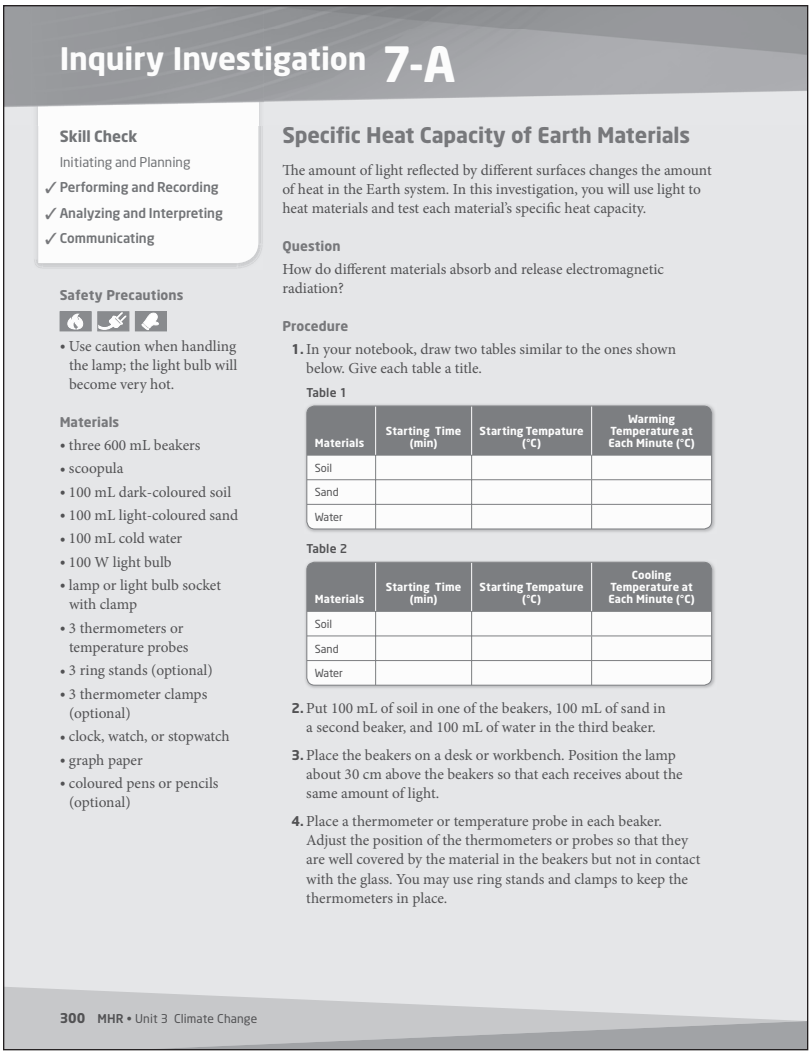
The authors of *ON Science 10* recognize that students employ a variety of learning styles to understand new content. They also recognize that it is important for students to develop comfort with using several learning styles in different contexts. The text, questions, and activities in *ON Science 10* have been developed to engage as many learning styles as possible. In the Teacher's Resource, suggestions are provided for differentiating instruction to support students with specific dominant learning styles, and to develop increased facility with learning in different ways. Many of these suggestions are highlighted for you with the icon DI. For further information on differentiated instruction, please see Teacher's Resource page TR-12.

Many students in Ontario schools are learning to communicate in the English language, at the same time as they are learning science. The many visuals in *ON Science 10* will help English language learners to make sense of the text, the Key Term definitions will help them to develop English vocabulary, and the hands-on activities will provide them with a way to learn and to demonstrate what they have learned that does not depend heavily on English skills. The Teacher's Resource provides specific suggestions for supporting English language learners as they learn in every section of the program. These suggestions are highlighted with the icon ELL. For general teaching strategies that will help English language learners (as well as others) in your classroom, please see Teacher's Resource page TR-15.

Developing Skills

At the very beginning of the student textbook, students are reminded of safe practices in a science classroom, and introduced to the WHMIS symbols and the safety symbols used in activities in *ON Science 10.* By placing safety front and centre, all other activities take place in the context of these rules. Strategies for using these pages with students are provided on Teacher's Resource page TR-10.

Activities throughout the sections of *ON Science 10* have been carefully scaffolded to build a solid foundation of science skills. Investigations at the end of each chapter provide opportunities for students to apply the skills they have been using to investigate a real-world issue. The key skills students will use in each investigation are identified right in the student textbook. Opportunities for extending these skills are also provided in each investigation. Strategies for helping students to develop and build on these skills are provided in the Teacher's Resource.



Inquiry Investigation 7-A

Skill Check

Initiating and Planning
✓ Performing and Recording
✓ Analyzing and Interpreting
✓ Communicating

Safety Precautions

- Use caution when handling the lamp; the light bulb will become very hot.

Materials

- three 600 mL beakers
- scoopula
- 100 mL dark-coloured soil
- 100 mL light-coloured sand
- 100 mL cold water
- 100 W light bulb
- lamp or light bulb socket with clamp
- 3 thermometers or temperature probes
- 3 ring stands (optional)
- 3 thermometer clamps (optional)
- clock, watch, or stopwatch
- graph paper
- coloured pens or pencils (optional)

Specific Heat Capacity of Earth Materials

The amount of light reflected by different surfaces changes the amount of heat in the Earth system. In this investigation, you will use light to heat materials and test each material's specific heat capacity.

Question

How do different materials absorb and release electromagnetic radiation?

Procedure

1. In your notebook, draw two tables similar to the ones shown below. Give each table a title.

Table 1

Materials	Starting Time (min)	Starting Tempature (°C)	Warming Temperature at Each Minute (°C)
Soil			
Sand			
Water			

Table 2

Materials	Starting Time (min)	Starting Tempature (°C)	Cooling Temperature at Each Minute (°C)
Soil			
Sand			
Water			

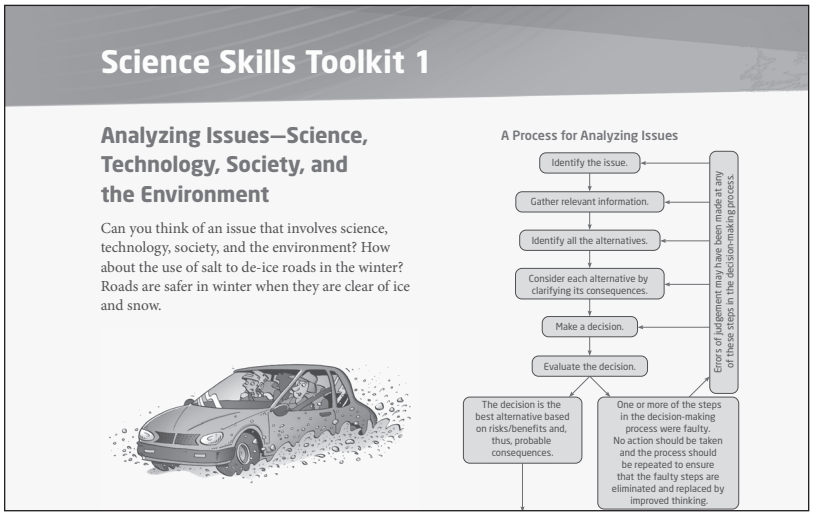
2. Put 100 mL of soil in one of the beakers, 100 mL of sand in a second beaker, and 100 mL of water in the third beaker.
3. Place the beakers on a desk or workbench. Position the lamp about 30 cm above the beakers so that each receives about the same amount of light.
4. Place a thermometer or temperature probe in each beaker. Adjust the position of the thermometers or probes so that they are well covered by the material in the beakers but not in contact with the glass. You may use ring stands and clamps to keep the thermometers in place.

300 MHR • Unit 3 Climate Change

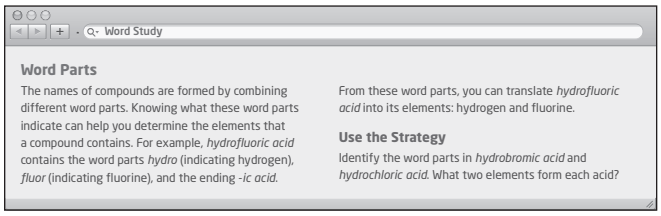
In addition to skills development in activities and investigations, students have access to three Skills Toolkits at the back of the student textbook:

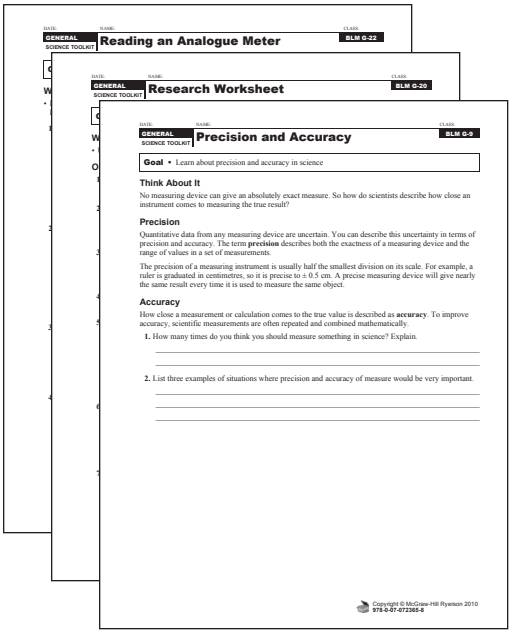
- Science Skills Toolkit
- Math Skills Toolkit
- Study Skills Toolkit

These toolkits can be used to provide students with details about the skills they will need to use, such as how to use electrical meters properly. They also can be used to review skills that students may have used in previous years. Notes right in the margins of the student textbook as well as in the Teacher's Resource suggest appropriate times to refer to one of these toolkits. The Teacher's Resource includes instructional strategies for helping students to make the most of each one of the Science Skills and Math Skills in the toolkits. See TR-Skills, page TR-71.



Literacy and Study skills are central to learning in any subject area, including science. A Study Skills Toolkit at the back of the student textbook reviews some key strategies for students to use in this program. In addition, three study skills that can be used effectively in each chapter are highlighted, with explanations and examples, at the beginning of the chapter in the student textbook. Specific suggestions for introducing students to these skills and for using them as additional support for learners who require it appear throughout the Teacher's Resource. For more information about study skills and scientific literacy in general, see page TR-71 of this Teacher's Resource.





ON Science 10 includes several blackline masters to help students develop and apply science, math, and study skills. See page TR-56.

Assessment OF Learning

Because authentic assessment is a core part of *ON Science 10,* each unit ends with two projects that students can use to show what they have learned. The activities and investigations within the unit prepare students to complete the projects. Assessment criteria are provided right in the student textbook so that students are aware of them. Rubrics for the projects are provided in the Teacher's Resource and as blackline masters. You may choose to distribute these rubrics, to help students plan their work. So that students are aware of the projects they will be completing as they work through the unit, the projects are introduced at the beginning of the unit, on the same pages as Get Ready.

Each Unit Review provides another opportunity for student assessment, and helps students show what they have learned in the unit as it relates to the big ideas of the curriculum, and the achievement chart categories: Knowledge and Understanding, Thinking and Investigation, Communication, and Application.

A table in the Teacher's Resource helps you identify the key signs that a student has achieved the overall expectations for the unit, and provides suggestions for supporting students who are working toward achieving them.

Assessment OF Learning for Unit 4

Activity	Evidence of Learning	Supporting Learners
Inquiry Project, page 522	Reflection and possibly refraction are used to direct light through a tunnel.	Students may find **BLM 12-12 Design a Light Tunnel** provides the scaffolding they need to get started. Encourage students to use their graphic organizers to identify useful properties of light. They may find that manipulating a few "template ray diagrams" helps them get started.
An Issue to Analyze, page 523	Students compare light bulbs in terms of efficiency, cost, and environmental impacts including production, use, and disposal. Students make a decision or concluding statement based on a risk-benefit-cost analysis.	Have students visit **www.scienceontario.ca** to find relevant information. Refer students to the Comparing and Contrasting strategy on page 402 of the student textbook as well as Science Skills Toolkit 1, Analyzing Issues (pages 529 to 531), and Science Skills Toolkit 10, How to Do a Research-Based Project (pages 549 and 50). Students may find that **BLM A-5 Investigating an Issue Checklist** or **BLM G-19 Scientific Research Planner** helps them get started.

Each unit also concludes with a relevant piece of text and a set of questions that students can use to practise their literacy skills in the context of a particular science strand.

Additional STSE Features

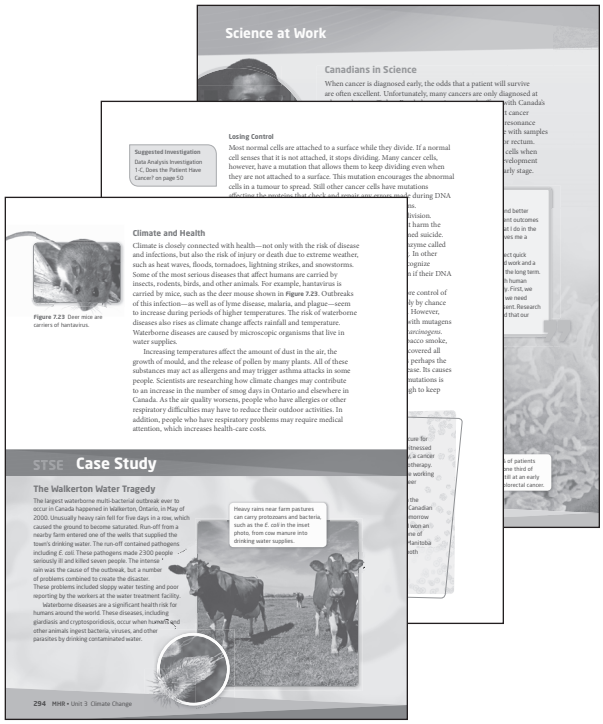
Students are growing up in a world where issues related to Science, Technology, Society, and the Environment are becoming more and more important. For this reason, STSE issues are integrated throughout the sections and activities of *ON Science 10.* In addition, *ON Science 10* includes the following features:

STSE Case Studies appear in every chapter to help students see the connections among science, technology, society, and the environment, and to allow students to apply the science skills and understandings they are learning to real, and compelling, issues.

Making a Difference, in every unit, introduces students to real people who have used science to make a difference in their world, locally and internationally.

Science at Work, near the end of every unit, features real people in careers that use science to address issues. A variety of careers that use the science students have just learned about are described, and students are encouraged to select one that interests them and learn more about it.

The following pages provide additional information about some of the key issues that inform the instructional design of *ON Science 10.*



Science Classroom Safety

Safety awareness begins with regulations and guidelines that are set by school boards and enforced by principals. Detailed safety practices should be established and supervised by the designated department head.

As the teacher, however, you have the ultimate responsibility of enforcing safety practices in your classroom. Be sure to set an example in the laboratory by observing all basic rules at all times. Always wear protective clothing and eyewear, and dispose of chemicals and other materials properly. Maintain high standards of cleanliness and organization in the science area.

Planning is essential to laboratory safety and success. That planning must include consideration for accident prevention and a review of emergency procedures. The activities in the *ON Science 10* program are designed to minimize dangers in the laboratory. Even so, there are no guarantees against accidents. Careful planning and preparation, as well as being aware of hazards, will help keep accidents to a minimum.

Information on laboratory safety is available from a variety of sources and includes detailed instructions on planning safe procedures and preventing accidents. Much of this information can be summarized in the phrase "Be prepared!" Know the rules and what common violations occur. Know your students and their abilities to follow instructions and evaluate potential hazards. Know where emergency equipment is stored and how to use it. Good laboratory housekeeping and management begin with observing your local regulations and the following guidelines.

In the Classroom/Science Laboratory

Follow your provincial science organization's recommendations as well as local board regulations. Consider the following as you set up your science supplies:

1. Store chemicals properly.
   - Separate chemicals by anion. Keep oxidizers (for example, nitrate, chlorate) separate from reducers (metals, organics, sulfur).
   - Label all chemical containers with WHMIS labels, special precautions, and the expiration date.
   - Discard outdated chemicals according to appropriate disposal methods.
   - Do not store chemicals above eye level.
   - Use wood shelving rather than metal. All shelving should be firmly attached to walls. Anti-roll lips should be placed on all shelves.
   - Store only those chemicals that you plan to use. Do not stockpile chemicals.
   - Keep flammable and toxic chemicals in special storage containers. Do not store more than 500 mL of flammable liquids in the laboratory at one time.
   - Ensure that you do not have chemicals that have been banned by your school board.
2. Store equipment properly.
   - Clean and dry all equipment before storing it.
   - Protect electronic equipment and microscopes from dust, humidity, and extreme temperatures.
   - Label and organize equipment so that it is easily accessible.
3. Provide adequate workspace for students to do investigations.
4. Provide adequate room ventilation.
5. Review safety and evacuation guidelines at the beginning of each term and from time to time throughout the term. Ensure that students with language difficulties have understood the information. Post the guidelines in a prominent place in the classroom.
6. Ensure that safety equipment is accessible and working properly. Ideally, safety equipment should include at least fire extinguishers, fire blankets, and eyewash stations.
7. Provide containers for the disposal of chemicals, waste products, and biological specimens. Disposal methods must meet local guidelines.
8. Take special care when carrying out any activities that require a heat source.
   - Use hot plates instead of laboratory burners as much as possible for activities requiring a heat source.
   - Ensure that the room has an adequate number of electrical outlets, and use only approved extension cords.
   - Use a central shut-off valve for the gas supply, accessible only to you, if laboratory burners are used.
   - Never use open flames when a flammable solvent is in the same room. Thus, alcohol burners should not be used; alcohol in the presence of fire is a potentially dangerous situation.
   - Use hot water from the tap to make a hot-water bath as an alternative to using a hotplate or laboratory burner. Warn students that water from the tap can be hot enough to cause burns.

First Day of Class/Labs

1. With students, discuss the safety rules on pages xiv–xvii of *ON Science 10.* Also discuss the *ON Science 10* Safety Symbols and WHMIS symbols shown on page xvii of the student textbook. See Science Skills Teaching Notes on page TR-71 of this Teacher's Resource for teaching strategies.
2. Review the safe use of equipment, chemicals, and biological specimens with students.
3. Review the use and location of safety equipment and evacuation guidelines with students.
4. Discuss safe disposal of materials and laboratory clean-up policy.
5. Discuss the proper attitude for working in the laboratory.
6. Document students' understanding of the above points.
   - Have students sign a safety contract (**BLM G-1 Safety Contract**) and return it to you.
   - Prepare and have students write a safety quiz. (**BLM G-2 WHMIS Symbols and Hazardous Household Product Symbols,** provides a review and quiz on WHMIS symbols.)
7. Review safety practices with students often during the school year.

Before Each Activity

1. Perform each activity yourself before assigning it to students in order to determine where students may have trouble.
2. Arrange the laboratory in such a way that apparatus and materials are easily accessible and supplies are clearly labelled. Avoid confusion in the area where materials are dispensed.
3. Prepare only the apparatus and materials needed to complete the assigned activity. This practice helps cut down or eliminate the problem of students doing unauthorized experiments.
4. Review the procedure with students. Emphasize cautions within the procedure.
5. Be sure all students know the proper procedures to follow if an accident should occur.

During Each Activity

1. Make sure the laboratory is clean and free of clutter.
2. Insist that students wear safety goggles and lab coats when indicated.
3. Never allow students to work alone.
4. Never allow students to use a cutting device with more than one edge.
5. Be sure to shield systems that are under pressure or a vacuum. Use extreme caution if you use a pressure cooker for sterilization purposes. Turn off the heat source and allow pressure to return to normal before opening the cover.
6. Students should not point the open end of a heated test tube toward themselves or other students.
7. Remove broken or chipped glassware from use immediately. Clean up any spills immediately. Dilute spilled solutions with water before cleaning them up.
8. Be sure all glassware that is to be heated is of a heat-treated type that will not shatter. Discard all other glassware.
9. Remind students that heated objects may look the same as objects at room temperature.
10. Prohibit eating and drinking in the laboratory.

After Each Activity

1. Be sure that the laboratory is clean, including all work surfaces and equipment.
2. Be certain that students have disposed of any broken glassware and chemicals properly.
3. Be sure any hot plates and burners have been turned off.
4. Insist that students wash their hands when the laboratory work is completed.

Differentiated Instruction

The Composition of Our Classrooms

Since the first schoolrooms, a student body has been composed of groups of individuals. Today, our classrooms are more cohesive in terms of age grouping, but certainly not in terms of background or learning style. In a single high school classroom, learners walk through the door with many individual characteristics that contribute to their learning profile, including ethnicity, linguistics, learning style, family environment, and socio-economic background.

Start with Reflection on Individual Potential

One of the best tools every teacher has in their repertoire is reflection. A reflective teacher is capable of adapting, changing, and improving. A reflective teacher collects a purposeful set of data from learners to reflect upon. He or she will use that data to understand the learners and inform their next set of instructional and assessment practices with the goal of student achievement by moving each student to their next level of success. Students learn best when they are challenged to learn new concepts that are developmentally appropriate for them (Flick, 2000). When teachers plan for flexible pacing of new learning and are poised to support and guide students to reach their potential, students can achieve the most. Sometimes, pacing and sufficient learning time are the most important components of instructional differentiation. Provide each student the necessary time in which to reach his or her potential and reflect on the information they are giving you as much as you possibly can.

Who They Are, What They Know, How They Investigate, How they Communicate

First, reflect on what you know about your students in the context of what will shape their learning experiences. One of the characteristics that determines the ways students' learn is learning styles. We can use Howard Gardner's Multiple Intelligences theory to help us understand the many ways in which students like to, and do, process information and experiences. In this table, each of the intelligences is described and some suggested activities that are effective for engaging each type of intelligence are delineated.

Next, to get an idea of the dominant learning styles of the students in your class, consider utilizing one or some of the learner profile assessments available on-line, through educational subscriptions, or through your school's career education programming. In addition, watch and observe

INTELLIGENCE	DEFINITION	STUDENT LIKES…	LEARNING ACTIVITIES
Verbal-Linguistic	• the ability to develop verbal skills and sensitivity to the sounds, meanings, and rhythms of words	• reading literature, playing word games, making up poetry and stories, discussions, debating, and telling jokes	• have a debate • write a news article • interview a scientist about… • create a report
Visual-Spatial	• the ability to think in images and pictures, to visualize accurately and abstractly	• to draw, paint, design, and create • tasks that require visualizing, pretending, imagining, and forming mental images	• chart, map, cluster, or graph • illustrate, paint, sketch, sculpt • create a slideshow or photo album of your trip to… (e.g., space, Earth's core) • create a poster or flyer
Logical-Mathematical	• the ability to think conceptually and sequentially and to discern logical or numerical patterns	• to conduct experiments, solve puzzles and other problems, ask cosmic questions, and analyze circumstances and people's behaviour • working with numbers and mathematical formulas and operations, and the challenge of a complex problem to solve	• design and conduct an experiment • describe the patterns or symmetry in… • create a mathematical formula • develop a code for… • measure • classify
Body-Kinesthetic	• the ability to control one's body movements and to handle objects skillfully, to learn through tactile experience	• to perform a task after seeing someone else do it first • to demonstrate to someone else how to do something	• role play • build or construct a… • create movements to explain… • conduct a hands-on experiment
Musical Rhythmic	• the ability to produce and appreciate rhythm, pitch, and timbre	• to study and work with music in the background • to play with sounds, beats, and rhythms	• create a rap or song that explains… • experiment with the effects of vibration on… • indicate the rhythmic patterns in… • use a tune to remember… • give a presentation with musical accompaniment

INTELLIGENCE	DEFINITION	STUDENT LIKES…	LEARNING ACTIVITIES
Intrapersonal	• the ability to be self-aware and in tune with inner feelings, values, beliefs, and thinking processes (reflection, meta-cognition)	• to work alone • time to be self-reflective • to be inwardly motivated rather than seek external rewards • to make connections to his/her own experiences	• describe one of your personal values about… • explain your experience with… • assess your own work/beliefs about… • reflect on…
Interpersonal	• the ability to detect and respond appropriately to the moods, motivations, and desires of others	• to learn through personal interactions • team activities • piggybacking ideas on others' thoughts • discussion	• use lab teams • write team positions on… • conduct a meeting to address… • participate in a service project • teach someone about… • write a sequel to…
Naturalist	• the ability to recognize and categorize plants, animals, and other objects in nature	• to study animals, plants, and almost any natural object • natural field experiments • to collect rocks, bugs, etc. • to be outdoors	• create observation notebooks • care for pets, plants, gardens, parks • use binoculars, telescopes, microscopes, or magnifiers to… • draw or photograph natural objects • classify natural objects
Existential	• the sensitivity and capacity to tackle deep questions about existence	• time to think • thinking about deeper messages in literature, film • community service	• design projects to answer "essential" or "big" questions • write a letter to an environmentalist group, newspaper, etc.

students in the first weeks of class to gather information and build a sound, but shapeable picture of who they are and how they learn.

Another characteristic that determines how students learn is what they have learned previously. Using Get Ready, the diagnostic tool that is presented at the beginning of each unit in the student text, you can assess much more than previous knowledge. Get Ready provides an opportunity to check understanding of concepts, as well as what inquiry skills students are capable of applying and students' level of literacy and numeracy skill. The inquiry, literacy, and numeracy skills checked at the beginning of each unit address those skills that are used often in the upcoming unit. The Concept Checks allow teachers to peer into the window of what students can remember and demonstrate from the last time a similar science topic was presented.

With your tool-belt filled with individual learning profiles and diagnostic assessment results, you are ready to plan for differentiation to increase student achievement.

Build Towards a Framework of Differentiation

Each student has a different cultural and academic background; each student has their own set of learning skills and interests. The process of differentiating instruction means to be "responsive to the diverse learning needs and preferences of individual learners. It is a comprehensive framework or organizing structure for how we understand and enact the teaching and learning in our classrooms—all the teaching and learning, not just the instruction we differentiate" (Karen Hume, page 1: *Start Where They Are*). Whenever a teacher reflects on which instruction/assessment/experience is best and most appropriate for a particular student, and enacts that decision, the teacher is engaged in differentiating to serve the individual learner. However, we can define these opportunities more clearly, as follows.

There are three kinds of differentiation:

1. Differentiating Content: When the situation requires it, we may need to differentiate the knowledge, skills or attitudes that we expect of the individual learners. This may be the case in responding to an Individual Education Plan (IEP), which may specify modification and adaptation of curriculum to meet the needs of the student.
2. Differentiating Process: Varying learning activities or instructional strategies provides appropriate methods for students to explore concepts. For example, students may be offered a choice (or be required) to use graphic organizers, a listening/video-watching centre, maps or graphical data to support or replace narrative reading and writing. They may have different skills and interest in working alone, in pairs or in small groups cooperatively. They may be instructed according to their intelligences profile, or to expand it, as teachers present material variously through song, rhyme, art, skit, and technology.

Students require opportunities "to learn in a variety of ways—individually, cooperatively, independently, with teacher direction, through hands-on experiences, and through examples followed by practice" (*The Ontario Curriculum, Grades 9 and 10: Science, 2008*).

3. Differentiating Product/Assessment: Differentiating the product means varying the complexity or type of product/assessment/response that students create to demonstrate mastery of the concepts. Allowing students to "show what they know" using a variety of modalities and media offers them the opportunity to reach their potential by communicating in ways they are able. Assessment tools like rubrics provide a handy method of assessing student achievement when students choose different products to demonstrate the same curricula learning.

Combining Instructional Acumen with Assessment Skill

At the high school level, student choice is, in a nutshell, a good thing. Open-ended inquiry, tasks, assessments and investigations allow students to design their own pathway of learning, inherently providing an assessment context for individual learning, growth, self-awareness, and reflection. The teacher's role is to provide the varied opportunities for student demonstration of learning with the professional understanding of what guidance and support may be required by each student. Then, assessment drives instruction. We begin with the idea that students may choose or need to demonstrate their learning in the variety of formats, then we design those formats, and then plan the instructional strategies that prepare students for the assessment opportunities and the curriculum to be addressed. Flexibility with respect to instructional strategies is key as students unveil new information about what they have learned and how they learn.

Benefitting from this Teacher's Resource

Teaching strategies in this program have been designed to engage a wide variety of learners. In addition, throughout this Teacher's Resource, you will be provided with tips, strategies and tools for further differentiating your instruction. As these opportunities arise, they are denoted by the icon DI, and can be found in the following support structures:

- Unit openers
- Chapter openers
- Activities
- Investigations
- Case studies
- Instructional strategies
- Using the text
- Using the images

Know the Benefits and Limitations your Instructional Approach

Whatever your preferred pedagogical styles, it is critical to know their benefits and their limitations. As a general rule for any of these approaches, the benefits and limitations are often two sides of the same coin. For example, students may gain comfort and confidence from an approach that includes a lot of structure and repetition. On the other hand, they may be challenged to grow by a more open-ended approach. Similarly, students may be able to make meaningful connections by drawing diagrams. On the other hand, they have a chance to build their vocabulary and provide support for their ideas when asked to respond in words. Be prepared to see growth from all students, in varying degrees, and move to other pedagogical techniques based on the needs that you perceive in the students.

A Final Word on Confidence

If 100 people wrote definitions of the role of the teacher, it would be difficult to find two similar definitions. Consensus eludes us as we search for clarity on what students should learn, to what depth they should learn, how quickly they should learn, and how they should learn. Yet, it is generally agreed that varying the learning experiences of students to meet their learning needs and styles makes sense, and research shows that this is a successful guiding pedagogical principle (Gregory and Chapman, 2002). Students become more engaged with science when they feel that their teacher works to understand them and considers their unique learning profile. So, get to know your students. Trust your data. Plan different learning experiences and products based on that data. Be prepared to reflect, revisit, and revise as new information about the learners' profiles becomes available. Celebrate your students' achievement as they strive to reach their potential.

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Working with English Language Learners (ELLs)

The Students:

English Language Learners (ELLs) are students who are adding English to one or more existing languages. Some ELLs come to us from other countries while some have been born in Canada but speak a language other than English in the home. Some ELLs have acquired strong "learning skills" because they have had to survive and thrive in a new culture and community. Their families may have come to Canada simply for the rich academic opportunities available here. This often provides great motivation to succeed and a strong respect for education. ELLs bring a global perspective to the classroom and they may be able to offer insights related to science topics from unique vantage points. If ELLs have strong first language skills, they often learn English very quickly. Conversational fluency often develops within the first two to three years, but their grasp of academic language takes much longer.

Most ELLs are at the same cognitive level as their English-speaking peers but they have a temporary language hurdle to overcome. They often miss the "hidden curriculum" of school language. This includes instructional language, reading and writing formats, teaching and assessment approaches, cultural knowledge, and the many unique features associated with a new learning environment. These aspects of teaching and learning may require explicit instruction for ELLs to keep pace with their first language peers. ELLs may avoid risk taking. Some students may feel self conscious about their level of English. Other students may come from cultures that discourage self advocating.

It is important to take the time to informally talk to the students about curriculum and their previous learning experiences. Understanding their circumstances enables the teacher to create an environment where students feel safe and can contribute to learning science as their knowledge and use of the English language grows.

Instructional Strategies for English Language Learners

It takes 7 to 10 years to become fully proficient in a second language. Because basic communication skills may be in place, we often forget that these students are still learning language. It appears as if ELLs have proficient English skills when they are able to converse with basic interpersonal English language; however, academic language presents considerable challenges to an ELL who has only reached this basic communication stage. Academic language takes the most time to acquire. Science teachers support ELLs when they do the following:

- **Provide Scaffolds**
  Make input comprehensible. Simplify language to make the content material more accessible. At least 80 percent of the language ELLs encounter should be understandable, while the balance can be inferred within the context of learning. Provide visual support and rich, yet simplified auditory support to minimize complex language structures. Print key instructional vocabulary on the board as it is being used. Provide synonyms, examples and non-examples.
- **Provide Wait Time**
  Allow additional time for students to process and respond. It takes time to think in a second language.
- **Value Students' First Language**
  Provide students with the opportunity to brainstorm and take notes and to write first drafts in their language. If they have peers who speak the same language, encourage them to discuss concepts and processes in that language. The use of first language allows ELLs to focus on science concepts at a deeper level rather than hold them back from learning because of their current level of English proficiency.
- **Activate Prior Knowledge**
  ELLs may not have been exposed to the Ontario curriculum, so there may be gaps in their learning. Do not assume that they have the background knowledge upon which many of the science concepts and skills are built. Find out what students know as it relates to their country of origin or prior learning experiences to effectively tap into prior knowledge.
- **"Front-End Load" Instruction**
  - Provide ELLs with a concept map from the onset of the unit. This map can be revisited throughout each chapter to connect, review and reinforce concepts as they are introduced. Add key information as the unit progresses and show ELLs how to use the map as a study guide.
  - Pre-teach critical vocabulary. Revisit it throughout the unit. Support comprehension of written instructions by highlighting key verbs and explaining them in simple language.
  - Provide many pre-reading activities. Start with hands-on activities and then visit text. Talk about print format, text features and syntactical forms.

- Teach ELLs how to read for the Big Idea, and go back to determine unknown words (i.e., using a bilingual dictionary).
- Use graphic organizers to introduce students to key concepts and relate concepts to one another before reading the text (to build background information and guide reading of dense text).
- Prepare an outline to fill in while reading—as a scaffold for note taking.
- Share reading the text: Use a jigsaw approach so ELLs only have to be experts on a small protion of text prior to using it in class.

These approaches to "front loading" instruction are scaffolds that allow ELLs to hear and use the language they will encounter in the text. Using these techniques will ensure that ELLs get more out of instruction and that they are learning the academic language of the discipline.

Assessment:

- **Check Understanding Often**
  Assessment for learning needs to happen on an ongoing basis to determine if ELLs are comprehending the content concepts and to determine if there are any language barriers that are getting in the way. It is important to do quick, continuous checks of ELLs' understanding. Consider having them draw sketches or use other visuals, such as graphic organizers, that require less language usage to check understanding.
- **Use A Variety of Grouping Strategies**
  Consider partnering ELLs with strong first language students. Triads allow ELLs to participate at a level suitable to their English language proficiency while learning concepts. Encourage first language groupings to clarify directions, discuss concepts and review materials. Talk to students to determine their preferences for the types of peer support that they need.
- **Provide Assessment Accommodations**
  It is essential to provide ELLs with accommodations that allow them to demonstrate their knowledge of science concepts while they overcome temporary English language hurdles. Assessment can take a variety of forms, including written pieces, audio-digital recordings, videotapes, podcasts, observations, creative works, discussions, and oral responses. As much as possible, assess personal progress to determine if learning has taken place.

Examples of Assessment Accommodations

1. Allow group responses. This method shows a sensitivity to ELLs (e.g., thumbs up/thumbs down, response boards, self assessment).
2. Adapt the number of items ELLs are expected to complete.
3. Simplify or rephrase instructions.
4. Provide additional time, breaking tasks into chunks.
5. Read aloud the items for assessment to ELLs (remember if you are looking for an ELL's content knowledge, not his or her ability to read directions, it is appropriate to have someone else help with the reading or clarifying the expectation of the task).
6. Allow for use of a dictionary (dual language, if suitable).
7. Adapt what "product" you expect ELLs to produce (i.e., permit drawings as a method of explaining thinking).
8. Allow for oral assessment, if writing skills lack sufficient clarity or students lack the ability to elaborate.
9. Allow ELLs to complete graphic organizers or concept maps as assessment pieces, accompanied by a student-teacher conference to clarify concepts represented in the visual product.
10. Use observation/anecdotal assessment methods as more authentic assessment strategies to "catch" ELLs demonstrating their knowledge during meaningful activities.

Building Scientific Literacy

We all want our students to be motivated readers who can effectively

- decode what is read
- feel a purpose for reading
- monitor the effectiveness of their reading
- analyze what they read to understand new concepts and processes draw conclusions by interpreting the content

Science, perhaps more than any other subject, involves complex informational and graphic texts. In addition, reading and understanding science places heavy demands on students because of the nature of scientific information. The challenges that students face include

1. lack of background knowledge related to the text
2. dense text and new vocabulary
3. abstract concepts and processes that require deep thinking
4. many kinds of graphic forms each requiring different decoding skills

ON Science 10 has been written with a combination of engaging science narrative; including margin definitions, instructional graphics, and detailed captions; and embedded literacy strategies that support students as they work through the text.

The opening paragraph of Think Literacy: Cross-Curricular Approaches, Grades 7–12, 2004, set the context for using reading strategies with great clarity.

> "As students progress through school, they are asked to read increasingly complex informational and graphical texts in their courses. The ability to understand and use the information in these texts is key to a student's success in learning. Successful students have a repertoire of strategies to draw upon, and know how to use them in different contexts. Struggling students need explicit teaching of these strategies to become better readers."

The focus here is for students to develop strategies. Students must have a repertoire of strategies to draw upon in specific situations. For this reason, the categories of Before, During, and After reading lack detail and are insufficient for communicating the purpose of the necessary skills that students need. Research on reading in the content areas, particularly in the area of science, suggests that we provide a deeper focus on content-specific reading strategies to employ with our students. The body of research touched on in Think Literacy has been synthesized in our text into a coherent literacy program. Five categories of strategies have been customized for Grade 10 science students. The categories, and their relation to before-during-after is shown below:

Category	Before	During	After
1. Preparing for reading	Y		
2. Reading effectively	Y	Y	Y
3. Reading graphic text		Y	
4. Word study		Y	
5. Organizing your learning		Y	Y

Within each category, *ON Science 10* provides students with a wide assortment of strategies that have a specific and clear purpose so that teachers can efficiently judge their applicability to their own contexts. These strategies are detailed here:

1. Preparing for Reading

- ***Previewing text*** involves flipping through the chapter to see how it is organized and how the features of the textbook support the main ideas in the chapter.
- ***Making connections to visuals*** means relating visuals, such as photographs, illustrations, and graphic text, to your own experiences and to the text that accompanies each visual.

2. Reading Effectively

- ***Asking questions*** helps students engage actively in reading the text and gives them a purpose for continuing to read.
- ***Identifying the main idea and details*** helps students figure out what is the most important information in the text they are reading. They can also use this strategy after reading, to help them organize what they have learned.
- ***Making connections to prior knowledge*** helps them relate what they already know to what they are learning.
- ***Making inferences*** helps them figure out the meaning of the text by combining information in the text with what they already know and by "reading between the lines."
- ***Monitoring comprehension*** ensures that students stop from time to time as they are reading to ask themselves whether they have understood what they have read.
- ***Skim, scan, or study*** helps them alter their reading speed based on their purpose for reading.
- ***Visualizing*** helps them transform a chunk of text into an image in their minds to help them understand and remember details and comparisons in the text.

3. Reading Graphic Text

Reading tables, graphs, and diagrams is different from reading text. The three strategies below can help students identify elements that are specific to each type of graphic text so they can interpret what the graphic text represents:

- ***Interpreting diagrams*** requires them to understand the parts of the diagram and then relate the parts to each other and to the concepts explained in the text.
- ***Interpreting graphs*** requires them to understand the organization and functions of the parts of a graph, such as axes, points, and lines. It also requires them to pay attention to the graph's title and caption.
- ***Interpreting tables*** requires them to examine data that have been organized in rows and columns with explanatory headings.
- ***Interpreting cross sections*** requires them to examine a drawing that shows the insides of an object, as though it has been sliced open either horizontally or vertically through its centre. It requires them to visualize the object in three dimensions. They also need to pay attention to the title or caption that accompanies the drawing.

4. Word Study

Science textbooks include many words that may be unfamiliar to students. Use the following strategies to help them determine the meanings of new words. Have them

- identify the ***base word,*** the main part of the word, which is distinct from a prefix, suffix, or combining part
- examine the smaller words that make up ***compound words***
- create a ***word map*** to analyze a word beyond its definition—for example, by identifying its opposites and by listing synonyms for the word
- consider the ***multiple meanings*** of a word when it appears in different contexts
- identify the ***word parts*** that combine to form multisyllabic words—for example, the names of compounds such as hydrofluoric acid, are formed by combining the word part *hydro* (indicating hydrogen) and *fluor* (indicating fluorine) and the ending *-ic acid*
- analyze ***word families*** to understand relationships among words that have common parts, such as the same base
- look up ***word origins*** in a dictionary to deepen their understanding of a word

5. Organizing Your Learning

Taking notes in class is only the first step in understanding a new concept. You may want students to organize what they have learned in a way that helps them remember key concepts and helps them study for tests.

- ***Comparing and contrasting*** involves identifying the similarities and differences between two concepts or things.
- ***Identifying cause and effect*** helps them understand why and how events occur, as well as their consequences.
- ***Making study notes*** means identifying the most important information and recording it in a way that makes sense to them.
- ***Summarizing*** involves stating the main ideas of a paragraph or a section of text in their your own words. They can summarize text using a list, a drawing, point-form notes, a table, or a graphic organizer.
- ***Using graphic organizers*** helps them organize information in a visual format.
- ***Synthesizing*** is the process of combining information from a variety of sources with prior knowledge to gain a new understanding of a topic.

At the beginning of every chapter, you will find a Study Toolkit page. Each Study Toolkit page features three of the many helpful study strategies that are described above. Instructional strategies have been organized into meaningful and relevant chunks at the beginning of every chapter for several reasons.

1. Using these strategies will help students understand and remember what they read.
2. Students need access to these literacy strategies directly. They are too important to hide from able students who can take responsibility for their learning and benefit from these skills independently.
3. We have learned how important the structure of text is. The predictability of structure benefits both teachers and students.

In this way, the literacy supports have been scaffolded throughout the text, and by the time students complete Grade 10 Science, they will have been exposed to the strategies they need for future success in reading science. The benefit of the approach also means that the student as audience has not been ignored.

As a group, students come to class with a wide variety of reading and studying skills. For this reason, a design that provides both students and teachers with maximum flexibility has been chosen. The design recognizes the needs of teachers for strong literacy supports without imposing a literacy perspective on the text. The key is to find a balance that supports the development of strong literacy skills, yet emphasizes the science as a source of inspiration for students as they discover more about their world.

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