Welcome to the *ON Science 9* program!

These teacher and student resources are designed to provide 100% alignment with The Ontario Curriculum, Grade 9: 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 9* 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 9* enables your students to develop their scientific literacy as they learn basic concepts relating to sustainable ecosystems; atoms, elements, and compounds; the study of the universe; and the characteristics of electricity. 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 work to 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 9* 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.

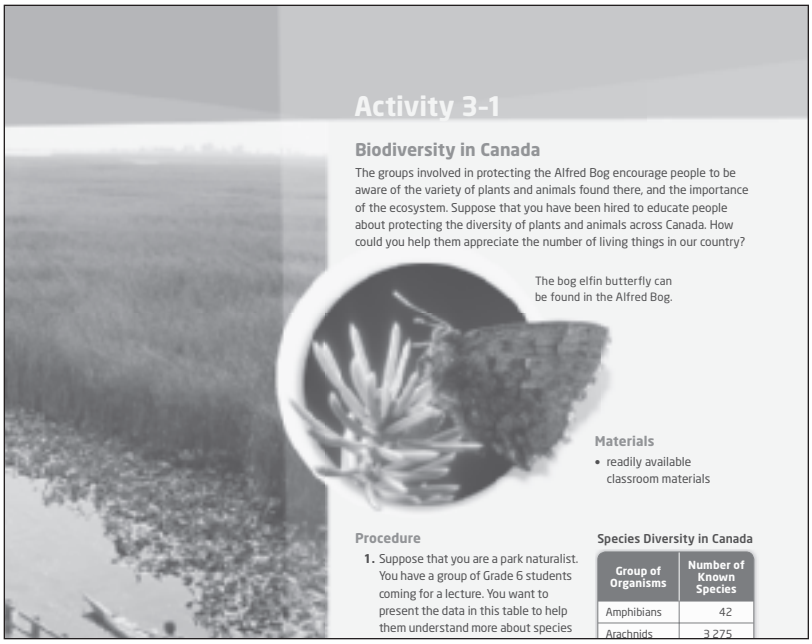
Overview of the *ON Science 9* Instructional Design

ON Science 9 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 9* corresponds to a strand of Ontario's Grade 9 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 of 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

Biodiversity in Canada

The groups involved in protecting the Alfred Bog encourage people to be aware of the variety of plants and animals found there, and the importance of the ecosystem. Suppose that you have been hired to educate people about protecting the diversity of plants and animals across Canada. How could you help them appreciate the number of living things in our country?

The bog elfin butterfly can be found in the Alfred Bog.

Materials

- readily available classroom materials

Procedure

1. Suppose that you are a park naturalist. You have a group of Grade 6 students coming for a lecture. You want to present the data in this table to help them understand more about species

Species Diversity in Canada

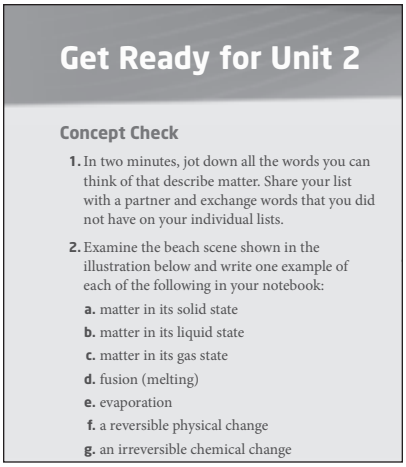
Group of Organisms	Number of Known Species
Amphibians	42
Arachnids	3 275

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 9* 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 9* 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

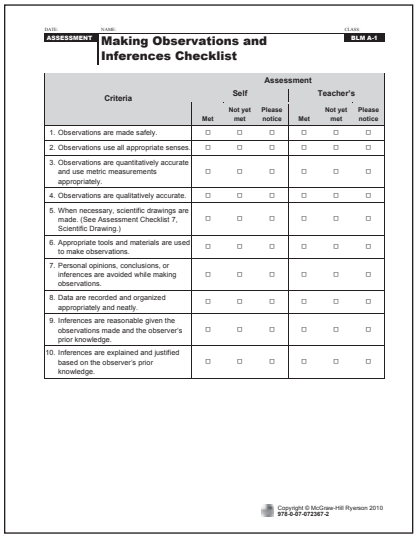
Concept Check

1. In two minutes, jot down all the words you can think of that describe matter. Share your list with a partner and exchange words that you did not have on your individual lists.
2. Examine the beach scene shown in the illustration below and write one example of each of the following in your notebook:
   - **a.** matter in its solid state
   - **b.** matter in its liquid state
   - **c.** matter in its gas state
   - **d.** fusion (melting)
   - **e.** evaporation
   - **f.** a reversible physical change
   - **g.** an irreversible chemical change

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, pages 9, 19	Students • explain how the elements of an ecosystem interact • describe the process of eutrophication.	To help students identify the cause-and-effect relationships involved in eutrophication, have them complete BLM 1-10, Cause and Effect.
Section 1.1 Review questions, page 20	Students describe the role nutrient cycles play in a balanced ecosystem, and what can cause ecosystems to become unbalanced.	**Play a game** Divide the class into teams with members of diverse strengths and abilities. Each team must submit five questions similar to those in the review, with answers. Teams take turns choosing questions from other groups and answering them. Students can use notes for the Section Review to help them. Set a time limit for students to come up with an answer. Allow opportunities to "phone a friend."
Activity 1-2, What Symbol Would You Choose?, page 11 Create a Poster	Symbol meets the criteria listed, clearly represents one or more of today's issues, and increases awareness for the future.	Students may feel uncomfortable with their own artistic skills. Show them exemplars of varying artistic ability that all meet the criteria for the assignment and that would achieve the same level (3+ or 4). Allow students to use alternative media, such as computer drawing applications, or use mini whiteboards. The lack of permanence of mini whiteboards makes them less intimidating for students.

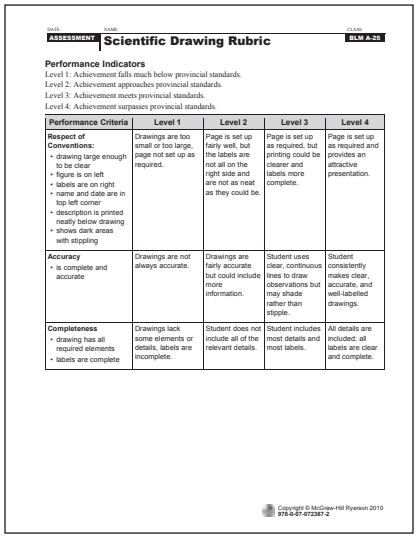
ON Science 9 includes several blackline masters to help support formative assessment and to guide students in learning to assess themselves. Please see the accompanying CD.



DATE NAME CLASS

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

Criteria	Assessment: Self			Assessment: 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 Assessment Checklist 7, Scientific Drawing.)	□	□	□	□	□	□
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.	□	□	□	□	□	□

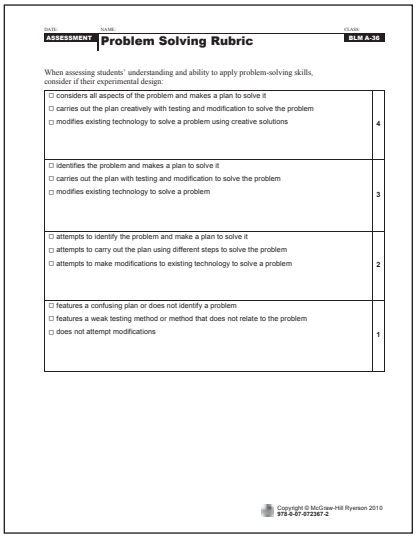


DATE NAME CLASS

ASSESSMENT **Scientific Drawing Rubric** BLM A-25

Performance Indicators
Level 1: Achievement falls much below provincial standards.
Level 2: Achievement approaches provincial standards.
Level 3: Achievement meets provincial standards.
Level 4: Achievement surpasses provincial standards.

Performance Criteria	Level 1	Level 2	Level 3	Level 4
Respect of Conventions: • drawing large enough to be clear • figure is on left • labels are on right • name and date are in top left corner • description is printed neatly below drawing • shows dark areas with stippling	Drawings are too small or too large, page not set up as required.	Page is set up fairly well, but the labels are not all on the right side and are not as neat as they could be.	Page is set up as required, but printing could be clearer and labels more complete.	Page is set up as required and provides an attractive presentation.
Accuracy • is complete and accurate	Drawings are not always accurate.	Drawings are fairly accurate but could include more information.	Student uses clear, continuous lines to draw observations but may shade rather than stipple.	Student consistently makes clear, accurate, and well-labelled drawings.
Completeness • drawing has all required elements • labels are complete	Drawings lack some elements or details, labels are incomplete.	Student does not include all of the relevant details.	Student includes most details and most labels.	All details are included; all labels are clear and complete.



DATE NAME CLASS

ASSESSMENT **Problem Solving Rubric** BLM A-36

When assessing students' understanding and ability to apply problem-solving skills, consider if their experimental design:

□ considers all aspects of the problem and makes a plan to solve it □ carries out the plan creatively with testing and modification to solve the problem □ modifies existing technology to solve a problem using creative solutions	4
□ identifies the problem and makes a plan to solve it □ carries out the plan with testing and modification to solve the problem □ modifies existing technology to solve a problem	3
□ attempts to identify the problem and make a plan to solve it □ attempts to carry out the plan using different steps to solve the problem □ attempts to make modifications to existing technology to solve a problem	2
□ features a confusing plan or does not identify a problem □ features a weak testing method or method that does not relate to the problem □ does not attempt modifications	1

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, 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.

circuit diagram a diagram that uses standard symbols to represent the components in an electric circuit and their connections

Circuit Diagrams

A practical way to describe a circuit is to draw a circuit diagram. A **circuit diagram** uses standard symbols to represent the components of an electric circuit and their connections. **Figure 11.19** shows the components in a flashlight and the corresponding circuit diagram.

Figure 11.19 The symbol for a cell is two parallel lines of different lengths. The shorter line represents the negative terminal of the cell. The switch is usually shown in the open position so that it is not mistaken for a connecting wire. Note that straight lines are always used to represent the connecting wires.

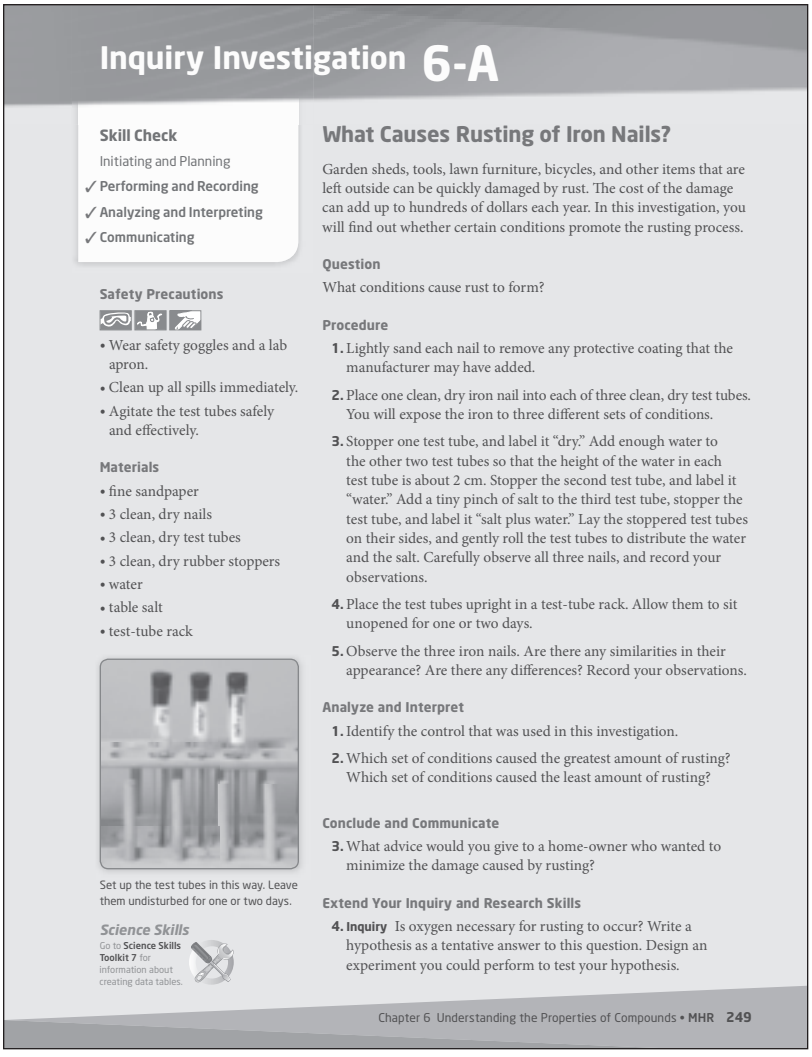
The authors of *ON Science 9* recognize that students employ multiple learning styles to understand new content. They also recognize that it is important for students to develop comfort with using several learning styles in different contexts. The text, questions, and activities in *ON Science 9* have 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 differentiating 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 9* 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 9.* 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 beginning on page TR-67.

Activities throughout the sections of *ON Science 9* 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 6-A

Skill Check

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

Safety Precautions

- Wear safety goggles and a lab apron.
- Clean up all spills immediately.
- Agitate the test tubes safely and effectively.

Materials

- fine sandpaper
- 3 clean, dry nails
- 3 clean, dry test tubes
- 3 clean, dry rubber stoppers
- water
- table salt
- test-tube rack

Set up the test tubes in this way. Leave them undisturbed for one or two days.

Science Skills
Go to **Science Skills Toolkit 7** for information about creating data tables.

What Causes Rusting of Iron Nails?

Garden sheds, tools, lawn furniture, bicycles, and other items that are left outside can be quickly damaged by rust. The cost of the damage can add up to hundreds of dollars each year. In this investigation, you will find out whether certain conditions promote the rusting process.

Question

What conditions cause rust to form?

Procedure

1. Lightly sand each nail to remove any protective coating that the manufacturer may have added.
2. Place one clean, dry iron nail into each of three clean, dry test tubes. You will expose the iron to three different sets of conditions.
3. Stopper one test tube, and label it "dry." Add enough water to the other two test tubes so that the height of the water in each test tube is about 2 cm. Stopper the second test tube, and label it "water." Add a tiny pinch of salt to the third test tube, stopper the test tube, and label it "salt plus water." Lay the stoppered test tubes on their sides, and gently roll the test tubes to distribute the water and the salt. Carefully observe all three nails, and record your observations.
4. Place the test tubes upright in a test-tube rack. Allow them to sit unopened for one or two days.
5. Observe the three iron nails. Are there any similarities in their appearance? Are there any differences? Record your observations.

Analyze and Interpret

1. Identify the control that was used in this investigation.
2. Which set of conditions caused the greatest amount of rusting? Which set of conditions caused the least amount of rusting?

Conclude and Communicate

3. What advice would you give to a home-owner who wanted to minimize the damage caused by rusting?

Extend Your Inquiry and Research Skills

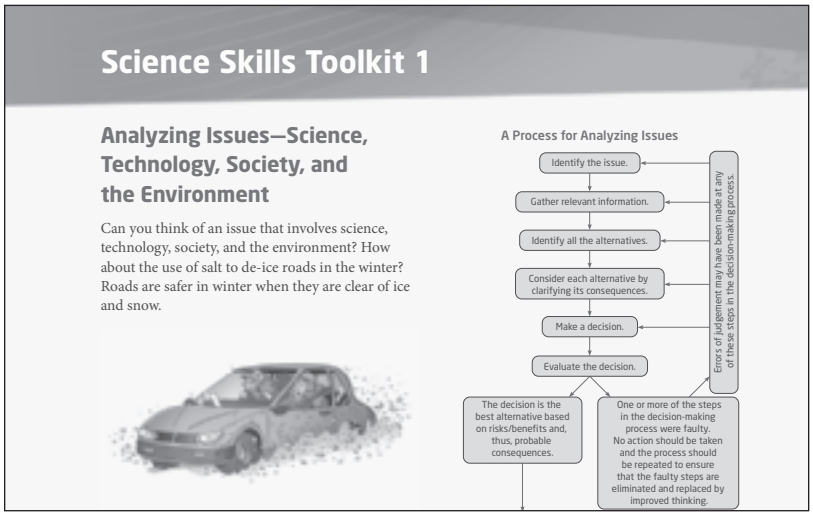
4. **Inquiry** Is oxygen necessary for rusting to occur? Write a hypothesis as a tentative answer to this question. Design an experiment you could perform to test your hypothesis.

Chapter 6 Understanding the Properties of Compounds • MHR 249

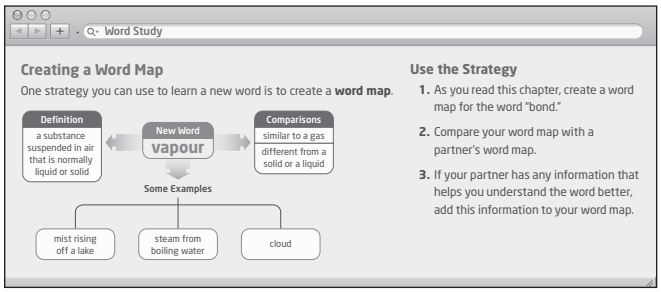
In addition to skills development in activities and investigations, Students have access to three Skills Toolkits at the back of the student textbook:

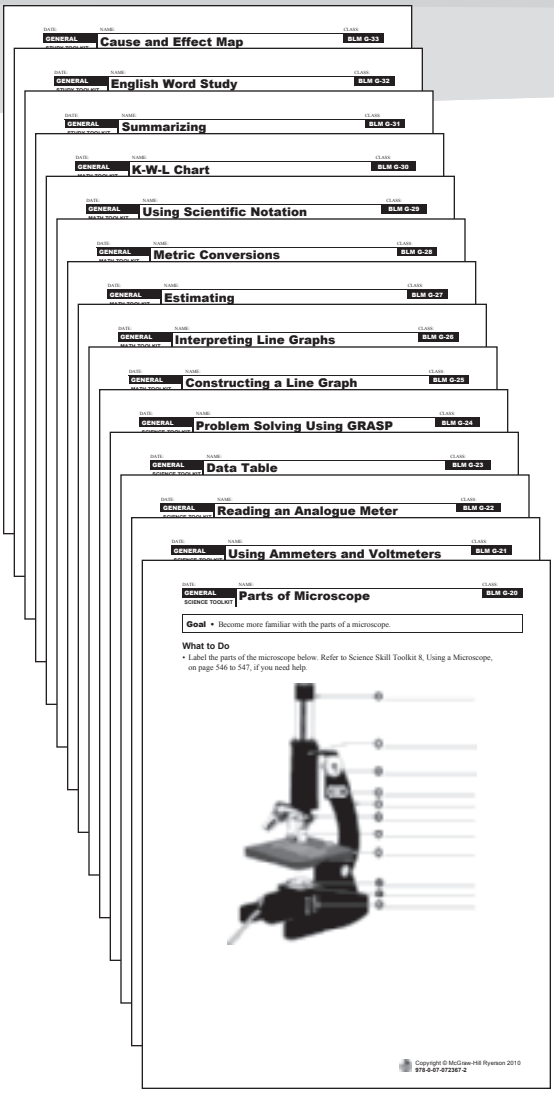
- Science Skills Toolkit
- Math Skills Toolkit
- Study Skills Toolkit

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 page TR-67.



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-17 of this Teacher's Resource.





ON Science 9 includes several blackline masters to help students develop and apply science, math, and study skills. See the accompanying CD.

Assessment OF Learning

Because authentic assessment is a core part of *ON Science 9*, 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.

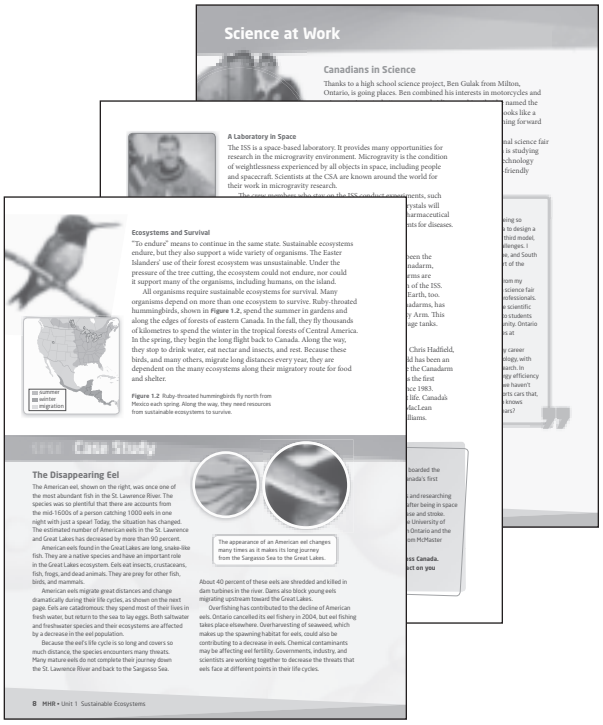
Assessment OF Learning for Unit 4

Activity	Evidence of Learning	Supporting Learners
Unit Inquiry Project	Students describe components in an electrical circuit and draw schematic diagrams. Students design and construct a circuit board that represents the actual wiring in a room. Students redesign a room so it becomes "greener."	Review series, parallel, and household circuits in Sections 11.3 and 11.5, and on BLM 10-2, Designing Circuits. As a class, brainstorm ideas on how to make any room in a home greener. As an alternative, have students conduct Internet research to discover tips on making their homes green. Start at **www.scienceontario.ca.**
Unit Issue Analysis Project	Students define the issue, describe multiple perspectives, and take a position with supporting evidence. Students conduct research, and communicate information to the intended audience.	Refer students to Science Skills Toolkit 1, Analyzing Issues–Science, Technology, Society, and the Environment, on pages 529 to 531, and Science Skills Toolkit 11, How to Do a Research-Based Project, on pages 552 and 553. See BLM A-5 Investigating an Issue Checklist. See BLM G-12 Scientific Research Planner.

Because students in Grade 9 are preparing for the Grade 10 Literacy Test, 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 9.* In addition, *ON Science 9* 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 9.*

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 9* 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 9*. Also discuss the *ON Science 9* Safety Symbols and WHMIS symbols shown on page xvii of the student textbook. See Science Skills Teaching Notes on page TR-67 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 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). 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. 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 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.

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.

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 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, 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 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 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.

References Cited:

Gardner, H. (1993). *Frames of Mind.* Basic Books.

Hume, K. (2008) *Start Where They Are.* Pearson Education Canada.

Flick, L.B. (2000). "Cognitive Scaffolding That Fosters Scientific Inquiry in Middle Level Science." *Journal of Science Teacher Education,* 11(2), 109–129.

The Ontario Curriculum, Grades 9 and 10 (2008). Queen's Printer for Ontario.

Gregory, G. and Chapman, C. (2002) *Differentiated Instructional Strategies.* Corwin Press Inc.

Working with English Language Learners

The Students

English language learners

- are adding English to one or more existing languages.
- may come from other countries, or may have been born in Canada but speak a language other than English at home.
- may have acquired strong learning skills because they have had to survive and thrive in a new culture and community.
- may have come to Canada for the rich academic opportunities available, which often provides great motivation to succeed and a strong respect for education.
- bring a global perspective to the classroom and may be able to offer insights related to science topics from unique vantage points.

Learning English

If English language learners have strong first-language skills, they often learn English very quickly. Conversational fluency often develops within the first two or three years, but their grasp of academic language takes much longer. Most English language learners 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, which includes instructional language, reading and writing formats, teaching and assessment approaches, cultural knowledge, and the many unique features associated with the new learning environment. These aspects of teaching and learning may require explicit instruction to help English language learners keep pace with their English-speaking peers.

English language learners may avoid risk taking. Some students may feel self conscious about their level of English. Other students may come from a culture that discourages self advocating. It is important to take the time to informally talk to the students about the curriculum and their previous learning experiences. Understanding their circumstances enables the teacher to create an environment where students feel safe and where they can learn science as their knowledge and use of the English language grows.

Instructional Strategies for English Language Learners

It takes seven to ten years to become fully proficient in a second language. It can appear as if English language learners have proficient English skills when they are able to converse with basic interpersonal English skills; however, academic language presents considerable challenges to an English language learner who has only reached this basic communication stage.

Science teachers support English language learners when they do the following:

- **Provide Scaffolds**
  - Simplify language to make the content material more accessible. At least 80 percent of the language that English language learners 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 information and respond. It takes time to think in a second language.
- **Value Students' First Language**
  - Provide students with the opportunity to brainstorm, take notes, and write first drafts in their first language.
  - If English language learners have peers who speak the same language, encourage them to discuss concepts and processes in that language. Using their first language allows English language learners to focus on science concepts at a deeper level rather than being held back from learning because of their current level of English proficiency.
- **Activate Prior Knowledge**
  - English language learners 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 on 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 English language learners with a concept map at the beginning 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 English language learners how to use the map as a study guide.

- Pre-teach critical vocabulary, and 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 examine the text. Talk about print format, text features, and syntactical forms.
- Teach English language learners how to find references to the Big Ideas as they read, and to determine unknown words (for example, by using a bilingual dictionary).
- Use graphic organizers to introduce students to key concepts and to relate concepts to one another before reading the text (to build background information and guide reading of dense text).
- Prepare an outline for students to fill in while reading, as a scaffold for note taking.
- Share reading the text: Use a jigsaw approach so the English language learner only has to be an expert on a small portion of text prior to using it in class.

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

Assessment for English Language Learners

- **Check Understanding Often**
  Assessment for learning needs to happen on an ongoing basis to determine if English language learners are comprehending the 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 English language learners' understanding. Consider having them draw sketches or use other visuals, such as graphic organizers, which require less language usage to check understanding.
- **Use A Variety of Grouping Strategies**
  Consider partnering English language learners with strong English-speaking students. Triads allow English language learners to participate at a level suitable for their English Language proficiency while learning concepts. Encourage English-speaking students 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 English language learners 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: written pieces, audio-digital recordings, pod casts, observations, creative work, discussion, oral response. As much as possible, assess students' progress to determine if learning has taken place.

Examples of Assessment Accommodations

1. Group responses show a sensitivity to the English language learners (for example, thumbs up/thumbs down, response boards, self assessment).
2. Adapt the number of items that the English language learner is expected to complete.
3. Simplify or rephrase instructions.
4. Provide additional time, and break tasks into chunks.
5. Read aloud the items for assessment to the English language learner. (If you are looking for an English language learner's content knowledge, not his or her ability to read directions, it is appropriate to have someone else help with the reading, or with clarifying the expectation, of the task.)
6. Allow English language learners to use a dictionary (dual language, if suitable).
7. Adapt what "product" you expect the English language learner to produce (for example, permit drawings as a method of explaining one's thinking).
8. Allow for oral assessment if writing skills lack sufficient clarity or if student lacks the language skills to elaborate.
9. Allow an English language learner's completed graphic organizer or concept map to be an assessment piece, accompanied by a student-teacher conference to clarify concepts represented in the visual product.
10. Use observation/anecdotal assessment methods as a more authentic assessment strategy to observe English language learners demonstrating their knowledge during meaningful activities.

Building Scientific Literacy

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 the following:

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 that each require different decoding skills

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

- decode what they 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.

ON Science 9 has been written with a combination of an engaging science narrative; 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 on in specific situations. For this reason, the headings "before reading," "during reading," and "after reading," used alone, lack detail and are insufficient for communicating the purpose of the necessary skills that students need. Research on reading in the content areas, particularly the area of science, suggests that we need to provide a deeper focus on science-specific reading strategies to employ with students. The body of research touched on in *Think Literacy* has been synthesized in our text into a coherent scientific literacy program. Five categories of strategies, customized for Grade 9 science students, have been embedded in *ON Science 9*. These strategies, and their relation to before, during, and after reading, are 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 9 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 involves relating visuals—such as photographs, illustrations, and graphic text—to personal 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 that 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 students relate what they already know to what they are learning.
- ***Making inferences*** helps students 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 students alter their reading speed based on their purpose for reading.

- ***Visualizing*** helps students 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 that they can interpret what the graphic text represents:

- ***Interpreting diagrams*** requires students to read and understand the parts of the diagram and then relate the parts to one another and to the concepts explained in the text.
- ***Interpreting graphs*** requires students 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 students to examine data that have been organized in rows and columns with explanatory headings.

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:

- Identify the ***base word.*** The base word is 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 its synonyms.
- Consider the ***multiple meanings*** of a word when it appears in different contexts.
- Identify the ***suffixes*** that change the meaning of a word. A suffix is a small word part at the end of a word.
- 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 your 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 or more concepts or things.
- ***Identifying cause and effect*** helps students 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 students.
- ***Summarizing*** involves stating the main ideas of a paragraph or a section of text in your own words. Students can summarize text using a list, a drawing, point-form notes, a table, or a graphic organizer.
- ***Using graphic organizers*** helps students organize information in a visual format.

Using the Study Toolkit

At the beginning of every chapter of the student textbook, you will find a Study Toolkit page. Each Study Toolkit page features three of the many helpful study strategies that were described above. Instructional strategies have been organized into meaningful and relevant chunks at the beginning of every student textbook 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 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 9 science, they will have been exposed to the strategies that they need for future success in reading science textbooks. The benefit of the approach also means that the student as the 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 teacher's needs 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, and still allows the science to be a source of inspiration for students as they discover more about their world.