McGraw-Hill Ryerson

DISCOVERING SCIENCE 9

TEACHER'S RESOURCE

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DISCOVERING SCIENCE 9
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INTRODUCTION AND IMPLEMENTATION HANDBOOK

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Introducing the *Discovering Science 9* Program

Welcome to the *Discovering Science 9* program! These teacher and student resources are designed to provide 100 percent alignment with Newfoundland and Labrador's science curriculum. The resources have been created to address the knowledge, skills, and attitudes needed to help students develop scientific literacy and empower them to critically examine issues and questions from technological, societal, and environmental perspectives.

The *Discovering Science 9* program is consistent with the vision expressed in the *Common Framework of Science Learning Outcomes, K–12: Pan-Canadian Protocol for Collaboration on Student Curriculum* (Council of Ministers of Education, Canada, 1997).

> Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to: develop inquiry, problem-solving, and decision-making abilities; become lifelong learners; and maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their lives, their careers, and their futures.

Through varied text features, *Discovering Science 9* enables students to develop their scientific literacy as they learn basic concepts relating to interactions within ecosystems; heat; characteristics of mixtures and solutions; and Earth's crust. Students will also develop skills in the processes of scientific inquiry. In *Discovering Science 9*, students learn scientific theories and conduct investigations that are related to the concepts and skills explored in each unit.

Meeting Your Goals in the Science Classroom with *Discovering Science 9*

In your science classroom, you must meet many goals as you present science skills and concepts and foster scientific literacy. 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 *Discovering Science 9* student textbook has been developed with these goals, as well as the curriculum, in mind. To help support the goal of creating a safe laboratory environment, the textbook includes an introductory section on Safety in the Science Classroom (pages 8–15). In addition, each investigation and activity in the textbook contains specific, detailed information on the safety issues and safety precautions involved.

Discovering Science 9 Supporting Resources

- In addition to the textbook, the *Discovering Science 9* program includes valuable resources for you and your students in print and electronic format. Like the textbook, these resources were developed with the curriculum, the principles of scientific literacy, and the goals of you and your students in mind. This *Teacher's Resource* provides science background, planning, and implementation strategies, as well as tips for meeting your classroom goals.
- Our *Blackline Masters* (BLMs) provide you with additional materials you can use for vocabulary building, skill building, concept clarification, alternative activities for differentiated instruction, support for visual learners, assessment, and more. The BLMs are contained on the CD-ROM portion of this package and are modifiable using Microsoft Word™ software.

- Our *Computerized Assessment Bank* will assist you in the implementation of the *Discovering Science 9* program. The authors and consultants are confident that we have provided you with the best possible program to help ensure students achieve excellence and a high degree of scientific literacy in their course of study. The variety of question styles will support differentiated instruction in your classroom. The assessment bank is also found on the CD-ROM.
- Our *website*, located at www.discoveringscience.ca, provides links to sites that will help students see the connection between the real world and the new concepts and skills that they are learning. In addition, the site has links to materials that will assist you in delivering the course material. The first time you enter this site, use the following username and password:

  Username: Discovering9
  Password: teacher_9

  Once you log in, you will be prompted to create your own unique username and password.

Meeting the challenge of developing excellent learning resources for today's broad range of needs has been done through a team effort by experienced teaching professionals. We believe our *Discovering Science 9* program will serve you and your students well.

Components of the *Discovering Science 9* Program

Student Resources

Discovering Science 9 student textbook
Website (www.discoveringscience.ca)
- links to sites that support Internet Connect, Explore More features, and Integrated Research Investigations in the textbook
- links to interesting educational and entertaining sites that support the curriculum

Teacher Support Materials

Teacher's Resource (print)
Teacher's Resource (CD-ROM)
- complete text of print Teacher's Resource in PDF format
- modifiable Blackline Masters in both English and French
- assessment checklists and rubrics

Computerized Assessment Bank (CD-ROM) in both English and French
- 1000 questions
- coded by topic and key word to the Newfoundland and Labrador learning outcomes
- variety of question types
- all answers provided
- user-friendly ExamView™ software

Website (www.discoveringscience.ca)
- additional interactive on-line resources for teachers and parents
- links for teachers

Note: All web links are monitored and maintained by McGraw-Hill Ryerson to help ensure relevance and security.

Using *Discovering Science 9* in Your Classroom

SCIENCE CLASSROOM SAFETY

Safety awareness begins with regulations and guidelines outlined within the Newfoundland and Labrador Provincial Laboratory Safety Manual. Detailed safety practices can be found within this document and teachers are strongly encouraged to read and become familiar with this manual.

As the teacher, however, you have the ultimate responsibility for 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 review of emergency procedures. The activities in the *Discovering 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 the Newfoundland and Labrador Department of Education safety manual 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 the following guidelines and your local regulations.

In the Classroom/Science Laboratory

Follow your Newfoundland and Labrador Provincial Laboratory Safety Manual recommendations as well as local board regulations. Consider the following as you set up your science supplies:

1. Store chemicals properly.
   - Separate chemicals by reaction type.
   - Label all chemical containers, including purchase date, special precautions, and 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 or province.
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, a safety blanket, 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 hot plate 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 8–15 of *Discovering Science 9*. Also discuss the *Discovering Science 9* symbols and WHMIS symbols shown on page 12 of the student textbook.
   - Have students sign a safety contract and return it to you.
   - Prepare and have students write a safety quiz.
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 proper attitude for working in the laboratory.
6. Document students' understanding of the above points.
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 the Activity

1. Make sure the laboratory is clean and free of clutter.
2. Insist that students wear safety glasses 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.
9. Remind students that heated objects may look the same as objects at room temperature.
10. Prohibit eating and drinking in the laboratory.

After the 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 each student wash his or her hands when the laboratory work is completed.

OVERVIEW OF THE INSTRUCTIONAL DESIGN

There are a number of definitions of constructivism in science education. The instructional design and strategies suggested in *Discovering Science 9* support an approach in which constructivism is "a social process of making sense of experience in terms of what is known." That guiding definition has three important points:

- Constructivism is a *social process*, meaning that students articulate their ideas and discuss them with one another.
- Students are *making sense of* experience through "hands-on" and "minds-on" activities in the classroom, and each student is given opportunities to make sense of events and phenomena.
- Finally, *what is known* refers to both what students already know (their pre-existing knowledge) and the accepted scientific concepts they are expected to learn through the curriculum.

The Role of Students in a Constructivist Classroom

In a constructivist classroom, students are active participants in their learning. They constantly modify their knowledge and skills as they are exposed to new concepts and experiences. Students are encouraged to assume responsibility for their own learning by actively making sense of their experiences. They are not simply passive recipients of scientific knowledge.

Students also develop an understanding that their learning requires modification of their pre-existing knowledge on the basis of valid reasoning. Their "meta-cognitive" awareness of this learning process is as important as their grasp of scientific concepts.

The Role of Teachers in a Constructivist Classroom

Just as students in a constructivist classroom are not passive recipients of information, you are not simply a transmitter of information. Neither, however, do you stand back passively and let students take charge. *Discovering Science 9* supports a balanced approach in which you set up most investigations and conduct discussions that enable students to construct meaning based on experiences arising from their investigations.

You help students express their pre-existing understanding of the topic at hand, engage students in a discussion of the adequacy of their explanations, and introduce accepted scientific concepts and ideas for consideration and assessment. Students can then compare the effectiveness of their ideas to accepted scientific ideas, in a search for deeper understanding and growth. To develop the understanding that science investigations are not made up of closed questions with known answers, stress the idea that both students and scientists are involved in developing explanations.

The following chart details emphases of teaching strategies, based on research about how students best learn.

Constructivism as a Model for Learning

CHANGING EMPHASES[1]	
LESS EMPHASIS ON...	**MORE EMPHASIS ON...**
treating all students alike and responding to the group as a whole	understanding and responding to individual students' interests, strengths, experiences, and needs
rigidly following curriculum	selecting and adapting curriculum
focussing on student acquisition of information	focussing on student understanding and use of scientific knowledge, ideas, and inquiry processes
presenting scientific knowledge through lecture, text, and demonstration	guiding students in active and extended scientific inquiry
asking for recitation of acquired knowledge	providing opportunities for scientific discussion and debate among students
testing students for factual information at the end of the unit or topic cluster	continuously assessing student understanding
maintaining responsibility and authority	sharing responsibility for learning with students
supporting competition	supporting a classroom community with co-operation, shared responsibility, and respect
working alone as a teacher	working with other teachers to enhance the science program

Reference Cited

1. Texley, Juliana, and Ann Wild, eds. (1996) *Pathways to The Science Standards High School Edition.* National Science Teachers Association, Arlington, VA, p. 24.

In a constructivist classroom, you have an important role in ensuring that students understand reasons why their pre-existing knowledge may sometimes be inadequate to explain the events and phenomena under examination. Educational research has demonstrated that it is ineffective simply to tell students that their ideas are wrong. There needs to be a negotiation in which the new scientific concepts and ideas are shown to be more meaningful, valid, and effective.

An Instructional Model to Support the Constructivist Classroom

A three-phase approach can be used to implement constructivism in the classroom. The three phases are explore, develop, and apply. By using this approach, you can help students build new knowledge into a comprehensive framework of facts, concepts, skills, and theories.

1. **Explore**
   The explore phase of the instructional model has three purposes: focus the students, activate prior knowledge, and determine preconceptions. To focus, motivate, and determine preconceptions, *Discovering Science 9* provides the following:
   - *Unit Opener:* The opening spread in each unit provides a colour picture that can be used for a class discussion. Teaching notes in this *Teacher's Resource* provide suggested questions to assist in starting the discussion. On the next two pages, the Getting Started provides two choices for introducing the unit to your class. The first choice is a short reading related to one or more concepts covered in the unit. The second choice is a short, informal Find Out activity. You may choose to do either, both, or neither to introduce the unit and to focus and motivate students.
   - *Chapter Opener:* This spread listing what students will learn, why it is important, and skills they will develop provides a context for the learning in the chapter. The Foldables™ activity at the beginning of each chapter can help students prepare for the lessons or sections in the chapter. Each Foldable activity provides an opportunity for students to prepare a unique study tool that can be used during one of the sections. Encourage students to create their own Foldable for different sections in the chapter.

- *Section Opener:* Key vocabulary terms (Key Terms) are listed at the start of each section or lesson next to the section summary. Both of these text features can be used to help focus students and prepare them for the section. A Find Out activity is usually located within the first few pages of each section. These activities can be used to engage students at the start of a lesson.

2. **Develop**
The develop phase provides students with a variety of learning opportunities in which they can begin to develop their own understanding of the concepts under study. In *Discovering Science 9*, these opportunities include reading, hands-on activities, and features.
    - *Reading:* Developing literacy skills is key to understanding concepts in science. *Discovering Science 9* provides highly visual and age-appropriate text to help students learn the concepts in the Grade 9 curriculum. A formative assessment tool, called Reading Check, occurs every few pages. Each Reading Check contains questions directly related to the material just covered. Students who have difficulty answering these questions require additional support.
    - *Activities: Discovering Science 9* provides more activities than can be done in a Science 9 class in a year. The intent is to provide you with choices from which you can select the activities that best meet students' needs. Engaging students in hands-on activities not only motivates students but also assists them in restructuring their knowledge to explain scientific concepts.
    - *Features:* There are five different types of features: Science Watch, www Science, Career Connect, Science Math Connect, and National Geographic. Each feature can be used to extend various concepts covered in the section.
3. **Apply**
The apply phase provides opportunities for students to demonstrate their understanding of the ideas covered in *Discovering Science 9*. Assessment opportunities are woven through each section, chapter, and unit. It is not intended that students answer every question in the text but rather that you select a series of questions that are appropriate for your students. End-of-unit assessment includes a performance-based assessment task in the Project and a research-based project in the Integrated Research Investigation.

Limits of Constructivism

When using the constructivist approach to teaching, keep in mind that learning science is not a purely individual process for explaining the world. Scientific knowledge, in other words, is more than personal belief reinforced by observation. That is why you need to be prepared to introduce valid scientific concepts to students as they develop their frameworks of understanding.

For example, it is not generally effective for you to simply provide students with experiences of phenomena and expect them to arrive at accepted conclusions about science and technology. Students invariably "discover" what is apparent to them, not necessarily what would be an acceptable scientific idea. For a student to learn, therefore, experience alone is not enough. Students need access to different lenses—laws, models, and theories—through which to view phenomena, design tests, and interpret data. Teaching is often about getting students to see things in new ways, through new lenses.

Students' existing ideas about phenomena can affect all activities and processes associated with science and technology. How a student classifies objects or phenomena, for instance, depends on what categories for classification the student already has in mind. The emphasis on prompting students to activate and express their prior knowledge is therefore a critical classroom strategy.

DIFFERENTIATED INSTRUCTION

Today's classrooms reflect the diversity of a global world. In a single classroom, students vary in their racial, ethnic, linguistic, socio-economic, familial, and learning profiles. Each student brings his or her own unique set of abilities, perceptions, and needs into the classroom. Research and anecdotal observation confirm that students of the same age have differing levels of academic readiness, background knowledge, and experience.

These differences mean that students vary in what they already know, what they are ready to learn, the pace at which they are able to proceed through the curriculum, and the level of adult support they require for success. Students learn best when they are challenged to learn new concepts that are developmentally appropriate for them that is; concepts that are neither too easy nor too difficult (Flick, 2000). Given the diversity of students in modern inclusive classrooms, therefore, you are challenged to present materials at a variety of complexity levels, provide for flexible pacing, and be open to receive responses from students that reflect their abilities and their potential (Hertzog, 1998).

Definition

Differentiated instruction means offering several different learning experiences simultaneously within a classroom in response to students' varied needs, rather than a single task for all students regardless of appropriateness (Tomlinson, 1995). It is your response to the diverse make-up of your classroom. Learning activities and materials may be varied by difficulty and pace to challenge students at different readiness levels, by topic in response to students' interests, and by students' preferred ways of learning or expressing themselves. When you offer learning stations or centres, use math games of varying levels, or allow students to choose independent projects, you are diversifying instruction.

The key to a differentiated classroom is that all students are regularly offered *choices* and students are matched with tasks compatible with their individual learner profiles.

The curriculum should be differentiated in three areas:

1. Content: Multiple options for taking in information
2. Process: Multiple options for making sense of the ideas
3. Product: Multiple options for expressing what they know

Philosophy Behind Differentiated Instruction

Essentially, the aim of differentiated instruction is to maximize each student's growth by creating developmentally appropriate learning opportunities. This means meeting each student where he or she is, and helping the student to progress. However, it does not mean individualizing each and every student's program. Rather, a continuum of choices within open-ended activities allows small groups of students to work at their level.

Differentiated instruction, therefore, is based on the following beliefs.

- Students differ in their learning profiles.
- The curriculum needs to be varied in content, process, and product.
- Classrooms in which students are active learners, decision makers, and problem solvers are more natural and effective than those in which students are served a "one-size-fits-all" curriculum and treated as passive recipients of information.

Implementing Differentiated Instruction in Your Classroom

- **Differentiating Content:** Content can be described as the knowledge, skills, and attitudes we want students to learn. Differentiating content requires that students are given choices in topics of interest or are pre-tested so you can identify the appropriate curriculum for groups of students.
- **Differentiating Process:** Varying learning activities or strategies provides appropriate methods for students to explore concepts. This is the most common way to differentiate process. It is important to give students alternative ways to approach concepts. For example, students may use graphic organizers, a listening centre, maps, diagrams, or charts to augment text. They may work in co-operative or flexible groupings. Teaching through songs, art, drama, and film in addition to text-based research allows for multiple ways of learning. Varying the complexity of a graphic organizer, diagram, film, etc., can very effectively facilitate differing levels of cognitive processing for students of differing ability.
- **Differentiating Product:** Differentiating the product means varying the complexity or type of product/response that students create to demonstrate mastery of the concepts. Allowing students to "show what they know" through multiple modalities allows students who struggle with written work to demonstrate mastery. Role-plays, demonstration experiments, posters, and computerized slide shows are alternatives to written reports that allow students with differing learning profiles to be successful.

The chart on the following page summarizes the more common student needs and gives additional tips that may help you structure the learning environment to meet those individual needs.

	Description	Tips for Instruction
Learning Disabled	All learning disabled students have an academic problem in one or more areas, such as academic learning, language, perception, social-emotional adjustment, memory, or attention.	• Provide support and structure with clearly specified rules, assignments, and duties. • Establish learning situations that lead to success. • Practise skills frequently. • Use games and drills to help maintain student interest. • Allow students to record answers on tape, and allow extra time to complete tests and assignments. • Provide outlines or tape lecture material. • Pair students with peer helpers, and provide class time for pair interaction.
Behaviourally Disordered	Students with behaviour disorders deviate from standards or expectations of behaviour and impair the functioning of others and themselves. These students may also be gifted or learning disabled.	• Provide a clearly structured environment with regard to scheduling, rules, room arrangement, and safety. • Clearly outline objectives and how you will help students obtain objectives. • Seek input from students about their strengths, weaknesses, and goals. • Reinforce appropriate behaviour, and model it for students. • Do not expect immediate success. Work for long-term improvement. • Balance individual needs with group requirements.
Physically Challenged	Students who are physically challenged fall into two main categories—those with orthopedic impairments and those with other health impairments. Orthopedically impaired students have the use of one or more limbs severely restricted, so the use of wheelchairs, crutches, or braces may be necessary. Students with other health problems may require the use of respirators or other medical equipment.	• Openly discuss with the student any uncertainties you have about when to offer aid. • Ask parents or therapists and the student what special devices or procedures are needed and if any special safety precautions need to be taken. • Allow physically disabled students to do everything their peers do, including participating in field trips, special events, and projects. • Help non-disabled students and adults understand physically disabled students.
Visually Impaired	Students who are visually impaired have partial or total loss of sight. Individuals with visual impairments are not significantly different from their sighted peers in ability range or personality. However, blindness may affect cognitive, motor, and social development, especially if early intervention is lacking.	• As with all students, help the student become independent. Some assignments may need to be modified. • Teach classmates how to serve as guides. • Limit unnecessary noise in the classroom. • Encourage students to use their sense of touch. Provide tactile models whenever possible. • Describe people and events as they occur in the classroom. • Provide taped lectures and reading assignments. • Team the student with a sighted peer for laboratory work.

	Description	Tips for Instruction
Hearing Impaired	Students who are hearing impaired have partial or total loss of hearing. Individuals with hearing impairments are not significantly different from their hearing peers in ability range or personality. However, the chronic condition of deafness may affect cognitive, motor, and social development if early intervention is lacking. Speech development may also be affected.	• Seat students where they can see your lip movement easily, and avoid visual distractions. • Avoid standing with your back to the window or light source. • Use an overhead projector so you can maintain eye contact while writing. • Seat students where they can see speakers. • Write all assignments on the chalkboard, or hand out written instructions. • If the student has an interpreter, allow both the student and interpreter to select the most favourable seating arrangements.
English as a Second Language	Recent immigrants may speak English as a second language or not at all. The customs and behaviour of people in the majority culture may be confusing for some of these students. Cultural values may inhibit some of these students from full participation in class activities.	• Remember that students' ability to speak English does not reflect their academic ability. • Try to incorporate students' cultural experience into your instruction. • Include information about different cultures in your curriculum to help build students' self-image. Avoid cultural stereotypes. • Encourage students to share their cultures in the classroom.
Gifted	Although no formal definition exists, these students can be described as having above-average ability, task commitment, and creativity. Gifted students rank in the top 5 percent of their class. They usually finish work more quickly than other students and are capable of divergent thinking.	• Make arrangements for students to finish selected subjects early and to work on independent projects. • Encourage students to express themselves in art forms such as drawing, creative writing, or acting. • Ask "what if" questions to develop high-level thinking skills. Establish an environment that is safe for risk taking and creative thinking. • Emphasize concepts, theories, ideas, relationships, and generalizations.

Johnson David, Roger Johnson, and Edythe Holubec, (1995) *Cooperative Learning in the Science Classroom.* Glencoe McGraw-Hill, New York, NY.

The Supporting Diverse Student Needs notes in the sections of this *Teacher's Resource* will give you further suggestions regarding differentiating instruction for specific groups of learners. Even so, the teaching strategies outlined here and throughout this *Teacher's Resource* are consistent with Pathways 1 and 2 as outlined in the brochure *Pathway to Programming and Graduation*, from the provincial Department of Education. Students who need more extensive adjustment of curriculum or teaching methods due to identified exceptionalities would benefit from an Individual Support Services Plan (ISSP) as per Department of Education policy.

MULTIPLE INTELLIGENCES

One educational framework that supports differentiated instruction is Multiple Intelligences (MI) theory (Gardner, 1993). MI recognizes that students have differing learning profiles, and that all are equally valuable and legitimate. For example, it may help students to put the times tables into a song or rap if they are musical-rhythmic learners. As long as in the end the students master the skill/information, singing is considered to be as equally valid a way to learn as writing the facts with pencil and paper. Thus, MI provides a framework for differentiating process and product *in ways that match a student's learning potentials.*

Another reason for considering MI pedagogy is that MI allows for teaching to diversity in an inclusive classroom in ways that traditional teaching methods cannot. "Traditional schools are designed for organized, left-brain learners who are book lovers. This type of learner, however, represents only one quarter of the population" (Rasmussen, 2000). In an MI classroom, students are given opportunities to learn and represent their knowledge in a variety of ways, which allows many more students to be a part of the learning community and be valued equally for their contributions. For instance, if learning takes place only through reading of non-fiction texts and written responses, students who are acquiring English as a second language or who have learning difficulties cannot participate fully in the learning. Instead, they have to be given adult support, or a different task/text, which stigmatizes them as unable. However, if students' intelligences are equally valued, then the student who is visual-spatial can be paired with the student who is verbal-linguistic to complete an activity as equal partners. One partner reads the text aloud, while the other creates a poster demonstrating the concept. MI also develops students' ability to self-direct their learning by encouraging them to develop their sense of self, know their strengths and weaknesses, see value in those strengths and weaknesses, and make choices about career directions more successfully.

All students have varying degrees of each intelligence. Relative strengths and challenges can help guide appropriate differentiation. Students can complete "challenge activities" in their non-preferred intelligences as part of a goal-setting process to develop these areas. Teachers must then be aware that during these activities students will require more support. At other times, students can be allowed to use their strengths to learn new material and "show what they know."

Multiple Intelligences: Definitions and Activities

In the table on the previous page, definitions for each of the intelligences and some suggested activities are delineated. When planning science units, ask yourself whether you have included opportunities for students to process information and demonstrate their learning in a variety of ways. Consult the Multiple Intelligences chart in the front matter of each unit of this Teacher's Resource for the MI coding of all activities.

For further information or details, see Lazear, 1998.

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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.

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CO-OPERATIVE LEARNING

Learning science is a social activity. Many students learn best working in co-operative learning groups that encourage communication on a variety of levels. Language and communication are important in developing and consolidating ideas.

This context of learning and doing science reflects the world outside the classroom. The effective use of co-operative skills is becoming increasingly necessary

Co-operative Learning Groups	Traditional Groups
• Shared leadership	• One leader
• Positive interdependence	• No interdependence
• Heterogeneous membership	• Homogeneous membership
• Instruction in co-operative skills	• Assumption of effective social skills
• Responsibility for all group members' achievement	• Responsibility for individual achievement
• Emphasis on task and co-operative relationships	• Emphasis only on task
• Support by teacher	• Direction by teacher
• One group product	• Individual products
• Group evaluation	• Individual evaluations

to cope successfully in the workplace. Because of the increasing importance of co-operative interaction, it is essential that educational strategies include these skills. Students need to learn how to listen, respond, agree, disagree, clarify, encourage, and evaluate. All these skills help teams work together productively.

Basic Elements of Co-operative Learning

The basic elements of a co-operative learning strategy are:

1. Students must perceive that they "sink or swim together."
2. Students are responsible for seeing that everyone in the group (as well as themselves) learns the assigned material.
3. Students must see that they all have the same goals.
4. Students must divide up tasks and share responsibilities equally among group members.
5. Ideally, students should be given one evaluation or reward applicable to all members of the group. This strategy can be modified for specific group or individual problems as described in the Troubleshooting section of this document.
6. Students share leadership while they acquire skills for collaborating during learning.
7. Students are held individually accountable for material worked on in co-operative groups.

Forming Groups

Groups should contain from two to five students. Heterogeneous groups that represent a mixture of abilities, genders, and ethnicity expose students to peers with ideas different from their own and help them learn to work with a variety of people.

At first, co-operative learning groups should work together for only a day or two or for short assignments. Once students gain more experience, assign longer assignments. Assessment Rubric 3, Co-operative Group Work Rubric, can also assist you in promoting co-operative group work.

Co-operative Learning in Your Classroom

Help students see for themselves the benefits of co-operative learning. Ask students to work for five or ten minutes on something a bit too difficult for them to do alone. It could be identification of animal tracks, a list of health-related myths and facts that they must identify as true or false, or a complex crime that must be solved. Then ask them to work in a group of four to solve the same problem. Ask them to compare individual problem solving with co-operative problem solving.

Beginning Co-operative Learning Strategies

- **Study Buddies:** In groups of two, have each student question the other about the material being studied. Tell pairs they will receive bonus points if they score above a certain percentage.
- **Checkmates:** Have groups compare homework answers or class worksheet answers. Students should discuss answers that differ and come to an agreement on the best answers. Collect one paper per group. Do not tell the class in advance which paper you are planning to collect.
- **Turn to Your Neighbour:** After a teacher-led discussion of a topic, an explanation of directions, or assignment, ask students to turn to their neighbour and summarize the key points of what was said.
- **Jigsaw:** On a reading assignment of one or two pages that does not have sequential importance, divide up the reading among the members of a group of three or four. Each person reads his or her part of the assignment and then teaches it to the other group members. Quiz other group members to make sure that they understand the material. Do not divide up whole chapters or units until students have considerable experience in co-operative learning. This strategy can become an advanced co-operative learning task with larger blocks of material.
- **Brainstorming:** Use this strategy to generate a large number of ideas for discussion of a question. Ask students to make a group list. They should not evaluate the ideas until the list is complete. Encourage them to build on each other's ideas, go on sidetracks, and gather the silliest and weirdest ideas they can think up. Stress that all ideas are acceptable on a brainstorming list. Evaluation begins when students have no more ideas or the time is up.
- **Chalkboard Share:** Ask one member from each group to put the group's best idea or answer on the chalkboard. This strategy allows the groups still at work to consider the ideas on the board as well as their own and perhaps come to an even higher level of thinking.
- **Write a Note:** All members of a team of four write a note that begins, "What I understand about this lesson is… I am still having trouble with…" Ask students to trade notes with someone who is not having the same trouble and reply to the note. They should write the note as if they were writing a real note to friend.

Advanced Co-operative Learning Strategies

- **Group Interdependence:** For each group, prepare a set of four to five "clue cards" for one concept, including a distractor clue. For example, you could make a set of clues for the properties of gases, another for solids, and another for liquids. The sets are traded from one group to another as they figure them out. Instruct students: (a) not to allow anyone to see their clue; (b) to verbally communicate their clues to their group; (c) to decide which of the clues are distractors; and (d) to decide what concept the clues represent.

- **Peer Feedback:** Distribute one of the Assessment Checklists from the *Assessment* section. Students should evaluate another person's or group's performance task using the checklist. Encourage students to comment on what is good before saying anything negative. To avoid arguments, tell students to paraphrase comments so the person knows he or she has been understood.
- **Talking Chips:** Give each group member seven small pieces of paper. Each time someone speaks, he or she must give up a piece of paper. When a group member is out of paper, he or she can no longer speak until everyone has used all their pieces of paper. This strategy ensures that one group member does not dominate discussions.
- **Snowballing:** A pair of students answers worksheet questions or compares lab report conclusions or other written work. Two pairs come together to review and compare answers. Two groups of four come together and compare. One person from a group of eight writes answers or conclusions on the board.
- **Roundtable:** One group member has a pencil and paper. He or she reads a question out loud. Group members consult and refer to the textbook in order to agree on the answer. The group member who has the pencil and paper writes the answer. The answer sheet is passed to the next group member. Repeat the process until all questions are answered. One person in each group should check the answers using a key provided by the teacher. This strategy is especially useful for review questions.
- **Teammate Consulting:** Each student should have a worksheet. All pencils should remain in the middle of the table while group members read and discuss a question. When the group reaches agreement, everyone should pick up a pencil and write the answer to the question. Collect only one worksheet per group. This strategy is an excellent method of reviewing or answering questions for activities and investigations.
- **Group Visits:** Three students from each group take their completed work and visit another group. One student in each group remains and presents his or her group's work to the visitors. The visitors compare their work and note any differences. Students return to their original groups. A different group member then remains while the other three visit different groups. Visits continue until every student has visited three times and explained once. This strategy is useful for checking work.
- **Paraphrase First:** Each time a group member has contributed an idea, another group member must correctly restate the idea before another idea can be contributed.
- **Making Analogies:** Ask students to brainstorm ways a concept is like something in everyday life. For example, students may compare performing an experiment to producing a play. Analogy ideas should be brainstormed by the group. These ideas might be sequential processes such as production of a newspaper, baking a cake, or taking a vacation. If appropriate for the concept, give each group a large sheet of paper on which to make a labelled diagram of its analogy. The diagram should illustrate the everyday process with vocabulary labels from the scientific process. This strategy works well to help students understand a difficult scientific concept.
- **Group Contract:** Ask each group to make a list of specific behaviours that can be changed to improve their group. "We need to work together better" is not specific. Examples of specific behaviours include "Eric should come to class on time" or "Rachel should stop reading magazines." Beside each item, have students write how the change will be accomplished. The teacher then reads the contract and writes on it the number of points or rewards the group will gain by meeting their contract. At the end of the time period, each group should write a justification for the number of points they think they should receive.

Troubleshooting

- **A Student Resists Working in a Group:** In the rare case of determined opposition to working in a group, you may want to allow a student to work individually. The student may eventually reconsider. Alternatively, suggest that the student commit to a group for a limited time, perhaps three weeks. Monitor the group closely during this time. Encourage group members to offer possible solutions to the problem.
- **A Student Behaves Inappropriately:** Whenever possible, allow the group to deal with the problem. By intervening you give up your most powerful tool: peer influence. You also risk sending the message that the students are not capable of solving their own problems. When necessary, offer assistance in the form of specially designed group analysis questions.
- **Students Do Not Effectively Use Co-operative Skills:** Structure lessons so groups can identify their weak skills and practise them. Allow ample time for groups to evaluate their work using Assessment Checklist 21, Project Self-Assessment, and Assessment Checklist 22, Project Group Assessment. Encourage individuals or groups to commit to improving specific skills by forming a group contract as described in the preceding Advanced Co-operative Learning Strategies. Recognize and reward improvement. Keep in mind that giving or receiving praise or encouragement may be very difficult for students who have a reputation for being tough.

- **Group Members Do Not Share Equally in the Work:** Divide up materials so that each group member has information others need. Give the group only one worksheet. Assign each group member an essential role.

  Give each group member five slips of paper. For each contribution to the group task, a student must reliniquish a slip of paper. When a student has no more slips of paper, he or she may no longer contribute.

  If one group member consistently does not participate despite efforts by others to include him or her, take this into consideration when assigning the group mark so other group members are not penalized.
- **A Student's Ability Is Considerably Lower than That of Other Group Members:** Tailor the weaker student's task. Provide appropriate reference materials for him or her to use. You may want to adapt tests and quizzes or the scoring method you use, or automatically add points to the student's individual grade when using it to figure out the group mark.
- **A Student Is Absent:** Have the group suggest appropriate make-up work. Approve the assignment. Consider combining groups if two or more students are absent from a group. Another option is to have floaters who are academically successful and skilled in using co-operative strategies fill in empty places.
- **A Student Is Chronically Absent:** Assign the student as an extra member to a group with a core that is usually present, or have the student fill in for absent students when he or she does come to class. Offer a permanent assignment when attendance improves.
- **Students Use "Put-downs," Ridicule, and Demeaning Remarks:** Ask the group to make a list of all the positive qualities they can think of for each group member. Ask them to make a written plan of action for dealing with their negative communication. Ask them what would be a good reward if they were able to improve in one week.
- **A Student Is Extremely Shy:** Use team-building, trust-building, and active listening activities that create an atmosphere of acceptance and respect for each other. Make complimenting, encouraging participation, and appreciating individual differences the co-operative skills that groups must practise. Assign shy students to a smaller group. Ask the group to take on task roles and assign the shy student the role of reader, recorder, or spokesperson.
- **A Student Is a High Achiever:** Reward the student for helping others. Ask him or her to work with a difficult partner and give the group a bonus for the difficult partner's success. Assign challenging roles that the student does not usually take. This student may do observations of the co-operative efforts of the entire class. Group the high achievers together occasionally to work on an especially fast-paced, challenging project. If necessary, reassure the student (and parents if necessary) that research shows that mastery and retention of academic material by high-ability students is found to be higher in co-operative than in competitive or individualistic learning situations.
- **A Student Actively Attempts to Sabotage Group Work or Products:** Reinforce daily any behaviour that is near the co-operative goal. Assign a co-operative skill tied to the disruptive behaviour. Write the skill on an overhead transparency beside the student's name. Tally the number of times the co-operative skill is used by the student, rewarding positive behaviour at the end of class. Choose a reward this student would like. Tell the group that they will receive this reward when they earn a certain number of points for taking positive steps to correct the behaviour. Use a student contract. Role-play the problem with the other students in the class and have a class discussion about how to solve the problem. As a last resort, ask the disruptive student to work alone until he or she is willing to practise co-operative skills.
- **The Noise Level Rises Too High:** Develop a signal that means "quiet." You may simply raise your hand, with students following your example as soon as they see you raise your hand. It may be a quick flick of the light switch or a bell. Have students practise the co-operative skill of working as a group to establish their own technique for keeping noise down early in the year, and again if noise is a problem. Assign the role of "noise monitor" to one member of each group. Educate your colleagues and principal about the difference between "noise" and "beehive of activity" in co-operative learning. Reward groups for keeping the noise level down.
- **Group Consistently Refuses to Work with a Particular Student:** Give the outcast student roles with leadership responsibility. Use careful strategies for grouping. Be sure one student in the group has some positive feelings about the outcast student. Each day, ask the group to start by saying one positive comment to each person in the group. Use strategies for conflict resolution, and structure the activities so the student is needed by the group for them to be successful. Strategies such as jigsaw and limiting materials and information may be included. Ask the group to practise skills such as honouring individual differences and showing appreciation and empathy.

READING INFORMATIONAL TEXT

If students can read narrative fiction with good comprehension, why do they so often need special instruction and support when reading informational text? Does reading a story require different skills than reading informational text? The answer to this question is, most definitely, yes.

The structure of a story is not the same as the structure of informational text. Therefore, the method of reading fiction is not the same as reading nonfiction. To begin, the former tends to be read quickly, with the reader filling in or guessing at unknown or hard-to-pronounce words. Reading nonfiction requires slow, deliberate pacing, as the student must carefully decode all new words and stringently process new ideas.

Why Students Need Assistance in Reading Informational Text

In stories, authors typically use such techniques as allowing different characters to present their responses to the same event. Through this form of repetition, readers gain a clearer understanding of the characters, settings, main ideas, and events.

Informational text, on the other hand, introduces new vocabulary connected to new concepts. The reader is expected to become familiar with all the new words and learn new concepts and new ways of thinking. To do this, most students need the help of a teacher to learn how to:

- slow their pace during the reading of informational text
- make connections between new ideas and previously learned ones
- extract main ideas from the density of ideas introduced and explained
- interpret visuals and graphic organizers
- apply the newly learned concepts to the world around them

Teaching students how to read instructions, scientific explanations, nonfiction narrative, and persuasive material, as well as to identify the text structures, should be a critical part of the curriculum lesson. Once the reader understands that each form has different expectations and objectives, reader comprehension soars.

Helping Students Comprehend Informational Text

Comprehension of informational nonfiction comes from solid grounding in:

- knowing the purpose for reading a passage or chapter
- learning the key vocabulary associated with the new concepts
- activating prior knowledge so the new information can fit into an existing personal framework
- understanding that the text has its own unique organization, and using that particular organization to facilitate learning

These are not separate or distinct factors. They work together and reinforce each other. For example, new vocabulary must reflect the concepts to be learned. These concepts are determined by the teacher when the purpose for reading is set. Once the purpose is set, prior knowledge must be accessed so that the student can make connections between old and new information.

Literacy and the Organization of Informational Text

In this Information Age, more than 70 percent of the material we encounter is expository. "Students who learn to use the organization and structure of informational texts are better able to comprehend and retain the information found in them" (Goldman and Rakestraw, 2000; Pearson and Duke, 2002).

Giving students the reading tools to comprehend informational text is no longer a skill that can be offered only to some students in some classes. All students must be provided with these critical skills and strategies as part of a literacy program that prepares students for active participation in their communities and in their futures.

Understanding how informational text such as student textbooks are organized will give students the strategies needed to make sense of what, at first glance, might appear to be dense and overwhelming material. Students need instruction and practice to help them to:

- use a table of contents and an index
- recognize main ideas
- understand how details elaborate on a concept
- understand cause-and-effect structures
- explore the relationship of phenomena to other information
- demonstrate broader understanding of new ideas through graphic organizers

Comprehension occurs when students learn new vocabulary, understand the main concepts, and are able to demonstrate in a variety of ways that they have learned and internalized the content of the lesson.

Familiarizing Students with Their *Discovering Science 9* Textbook

Here are some features of the *Discovering Science 9* textbook that students can use to sharpen their comprehension skills as they encounter informational text passages.

- **Table of Contents:** The table of contents, on pages iv–ix of the student textbook, lists units, chapters, and sections. It also includes activities and chapter reviews.

- **Tour of the Textbook:** Located on pages x–xvi of the student textbook, the tour explains in detail the key structural features of the textbook. Take the tour with students to familiarize them with the organizational components of their textbook.
- **Section Summary:** The shaded beige box below the section title contains a summary of the science concepts that students will study in the section. This summary is essentially a précis or abstract of the lesson, so new terms may be used here but are not bolded or defined. Have students read the summary before they start the section, even though they may not know all the words. Then, when they finish the section, they can go back and reread the summary to make sure that they understand what they have studied in the section. Students can use the summaries as reviews for studying.
- **Reading Checks:** These features ask recall questions about the material that students have just read. They are designed to help students slow down and think about what they are reading. Encourage students to use Reading Checks to confirm their understanding of new terms and concepts before proceeding.
- **Visuals:** Encourage students to pay attention to the visuals in their textbook, including tables and other graphic organizers. The visuals in a textbook, along with their captions, offer important clues to the main points that are discussed in the running text.
- **Headings and Subheadings:** Point out the headings and subheadings in a chapter section. These text elements also offer clues to the main points to be discussed in the text that follows.
- **Section and Chapter Reviews:** Each section and each chapter ends with a series of questions that you and your students can use to assess students' understanding of the material. Encourage students to draw a network tree or a spider map to demonstrate their understanding of the new vocabulary they have encountered in the previous text passages. (Refer students to Science Skill 8 on page 495 of the *Discovering Science 9* textbook.)
- **Key Terms:** At the beginning of each section and in the unit review are lists of the boldfaced Key Terms found in that section or unit.
- **Glossary:** The Glossary at the back of the student textbook lists and defines Key Terms that are arranged alphabetically. Pronunciation guides are included where appropriate. The definition includes a reference to the text section in which each Key Term first appears.
- **Index:** Ensure that students know how to use the index, located at the back of their textbook.

In addition to the features in the student textbook, each section of this *Teacher's Resource* includes a Using Reading feature that suggests specific Pre-reading, During Reading, and After Reading techniques that students can use to enhance their comprehension of the material in the student textbook.

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References and Resources

CORRELATION TO THE NEWFOUNDLAND AND LABRADOR GRADE 9 SCIENCE CURRICULUM	
OUTCOMES	**MCGRAW-HILL RYERSON DISCOVERING SCIENCE 9** **NOTE: THE CURRICULUM OUTCOMES ARE FUNDAMENTAL TO THE MCGRAW-HILL RYERSON DISCOVERING SCIENCE PROGRAM. FOLLOWING ARE SOME POINTS IN THE TEXTBOOK WHERE THE CURRICULUM OUTCOMES ARE ADDRESSED. THIS IS NOT AN EXHAUSTIVE LIST.**
ATOMS, ELEMENTS, AND COMPOUNDS	
Theory of Matter	
Compare earlier conceptions of the structure of matter with current conceptions. (110-1)	
Describe Empedocles' and Aristotle's belief that all matter was composed of 4 "elements": earth, air, water, fire.	Section 1.3, Atomic Theory, pp. 24–33
Define matter	Section 1.2, Investigating Matter, pp. 16–23
Investigate materials and describe them in terms of their physical properties and chemical properties. (307-12)	Activity 1-2C, Physical and Chemical Properties, p. 20
Distinguish between physical and chemical properties.	Section 1.2, Investigating Matter, pp. 16–23 Activity 1-2B, A Chemical Family, p. 19 Activity 1-2C, Physical and Chemical Properties, p. 20
List examples of physical and chemical properties. Include: – Physical i) color ii) density iii) melting/boiling points iv) texture – Chemical i) combustibility ii) reactivity	Activity 1-2C, Physical and Chemical Properties, p. 20
State a prediction and a hypothesis based on background information and observed patterns of events. (208-5)	Activity 1-2C, Physical and Chemical Properties, p. 20
Compile and display data collected during an investigation of the physical and chemical properties of materials.	Activity 1-2C, Physical and Chemical Properties, p. 20
Demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials. (209-7)	Section 1.1, Safety in the Science Classroom, pp. 8–15 Activity 1-1A, Science Lab Safety, p. 9 Activity 1-1B, Safety Guidelines for Your Lab, p. 13
Organize data using a format that is appropriate to the task or experiment. (209-4)	Activity 1-1A, Science Lab Safety, p. 9
State a conclusion based on experimental data and explain how evidence supports or refutes an initial idea. (210-11)	Activity 1-2B, A Chemical Family, p. 19
Atomic Theory	
Explain the importance of using the terms law and theory in science. (109-14)	Section 1.3, Atomic Theory, pp. 24–33
Distinguish between a theory and a law.	Section 1.3, Atomic Theory, pp. 24–33
Identify major changes in atomic theory up to and including the Bohr model. (110-3)	Section 1.3, Atomic Theory, pp. 24–33
Define atom.	Section 1.3, Atomic Theory, pp. 24–33
Describe the contribution of various individuals (scientists) to the development of current atomic theory. Include: i) Democritus ii) Aristotle iii) Dalton iv) Thomson v) Rutherford vi) Bohr	Section 1.3, Atomic Theory, pp. 24–33 Activity 1-3B, The People Behind the Atom, p. 31

CORRELATION TO THE NEWFOUNDLAND AND LABRADOR GRADE 9 SCIENCE CURRICULUM	
Recognize that atomic theory continues to be refined.	Section 1.3, Atomic Theory, pp. 24–33
Provide examples of technologies that have enhanced, promoted, or made possible scientific research in chemistry.	Section 1.3, Atomic Theory pp. 24–33
Describe Rutherford's experiment to "test" Thomson's atomic model as an example of how technologies have enhanced, promoted, or made possible scientific research in chemistry. (111-4)	Section 1.3, Atomic Theory, pp. 24–33
Provide examples to illustrate that scientific and technological activities related to atomic structure take place in a variety of individual and group settings. (112-8)	Section 1.3, Atomic Theory, pp. 24–33
Use models in describing the structure and components of atoms. (307-14)	Activity 1-2C, Physical and Chemical Properties, p. 20
Distinguish among protons, neutrons and electrons in terms of their: i) charge ii) relative mass iii) location in the atom	Section 1.3, Atomic Theory, pp. 24–33
Periodic Table	
Identify and write the chemical symbol for common elements. Include: i) hydrogen ii) sodium iii) potassium iv) magnesium v) calcium vi) iron vii) nickel viii) copper ix) zinc x) carbon xi) nitrogen xii) oxygen xiii) neon xiv) helium xv) chlorine xvi) sulfur xvii) silver xviii) gold xix) mercury xx) lead (307-16)	Activity 2-1A, Meet the Elements, p. 17
Define element.	Section 2.1, Elements, pp. 38–47
Recognize that elements are represented by an internationally agreed upon system of symbols.	Section 2.1, Elements, pp. 38–47
Identify each element symbol as either an upper-case symbol or an upper-case letter followed by a lower case letter.	Section 2.1, Elements, pp. 38–47
Describe and explain the role of collecting evidence, finding relationships and proposing explanations in the development of the periodic table. (109-2)	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59
Identify the periodic table as a listing of all known elements.	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59 Activity 2-2A, Understanding the Periodic Table, p. 49
Describe Mendeleev's contribution to the development of the modern periodic table.	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59
Define period.	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59
Define family.	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59

CORRELATION TO THE NEWFOUNDLAND AND LABRADOR GRADE 9 SCIENCE CURRICULUM

Using the Periodic Table, develop an understanding that the elements are grouped on the basis of similar characteristics. Include: i) alkali metals ii) alkaline earths iii) halogens iv) noble gases v) metals vi) non-metals vii) metalloids viii) transition metals (210-1, 307-15)	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59
Explain the importance of using words that are scientifically or technologically appropriate. (109-13)	
Distinguish between atomic number and atomic mass.	Activity 2-2A, Understanding the Periodic Table, p. 49
Using atomic mass and atomic number for an element, determine its number of protons, electrons and neutrons.	Activity 2-2A, Understanding the Periodic Table, p. 49
Use the periodic table to identify new questions and problems that arise from what was learned.	Activity 2-2A, Understanding the Periodic Table, p. 54
Provide examples of common properties which a family of elements share. Include: i) noble gases: extremely unreactive ii) alkali metals: combine readily with nonmetal elements, therefore are found in nature as only compounds iii) halogens: the most reactive nonmetals	Section 2.2, The Periodic Table and Chemical Properties, pp. 48–59
List properties of metal elements. Include: i) shiny ii) ductile and malleable iii) conduct electricity iv) conduct heat	Section 2.1, Elements, pp. 38–47
List properties of nonmetal elements. Include: i) dull ii) non-ductile and non-malleable iii) do not conduct electricity iv) do not conduct heat well	Section 2.1, Elements, pp. 38–47
Identify examples of common elements, and compare their characteristics and atomic structure. (307-15)	Section 2.1, Elements, pp. 38–47
Define energy level.	Section 2.3, The Periodic Table and Atomic Theory, pp. 60–67
Identify the maximum number of electrons which exist in the first 3 energy levels.	Activity 2-3A, Looking for Patterns in Atoms, p. 61
Draw Bohr-Rutherford diagrams for elements 1-18.	Section 2.3, The Periodic Table and Atomic Theory, pp. 60–67
Interpret patterns and trends, and explain relationships among variables. (210-6)	Activity 2-3A, Looking for Patterns in Atoms, p. 61
Make comparisons of energy level diagrams for elements from the same column.	Activity 2-3A, Looking for Patterns in Atoms, p. 61
Indicate that elements' electronic structure dictates how elements react with one another.	Activity 2-3B, Flaming Metal Ions, p. 64
Identify, and suggest explanations for, hydrogen's unique position on the periodic table.	Section 2.3, The Periodic Table and Atomic Theory, pp. 60–67
Describe hydrogen as a unique element since it sometimes behaves as a metal, and sometimes as a nonmetal.	Section 2.3, The Periodic Table and Atomic Theory, pp. 60-67
Chemical and Physical Changes	
Describe changes in the properties of materials that result from some common chemical reactions. (307-13)	Activity 3-3A, Magnesium in Dilute Acid, p. 87
Distinguish between physical and chemical changes.	Section 3.3, Physical and Chemical Changes, pp. 86–95
Recognize that chemical changes produce new substances (elements or compounds) but physical changes do not.	Activity 3-3C, Observing Changes in Matter, p. 92

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Recognize that during a chemical change, elements are conserved but compounds are not.	Section 3.3, Physical and Chemical Changes, pp. 86–95
List examples of physical and chemical changes. Include: – Physical i) melting ii) dissolving iii) evaporation – Chemical i) corrosion ii) fruit ripening iii) fuel combusting	Chapter 3 Review, pp. 96–97
List evidence that a chemical change may have occurred. Include: i) Heat is produced or absorbed. ii) A new color appears. iii) A precipitate is formed. iv) A gas is produced. v) Process is difficult to reverse.	Chapter 3 Review, pp. 96–97 Activity 3-3A, Magnesium in Dilute Acid, p. 87
Identify and write chemical formula of common compounds. (307-16)	Activity 3-2A, What's In a Name? p. 80 Section 3.2, Names and Formulas of Simple Compounds, pp. 80–85
Define compound.	Section 3.1, Compounds, p. 72–79
Identify that a compound is represented by a combination of element symbols known as a chemical formula which indicates the proportion in which the elements are present.	Section 3.2, Names and Formulas of Simple Compounds, pp. 80–85
List chemical formulas for some common chemical compounds. Include: i) table salt ii) sugar (sucrose) iii) carbon dioxide iv) propane v) water vi) calcium carbonate	Chapter 3 Review, pp. 96–97
Determine, where possible, if the change in a material or object is physical or chemical based on experimental data. (210-11)	Activity 3-3C, Observing Changes in Matter, p. 92
Demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials. (209-7)	Activity 3-3C, Observing Changes in Matter, p. 92
Organize data using a format that is appropriate to the task or experiment. (209-4)	Activity 3-3C, Observing Changes in Matter, p. 92
Use tools and apparatus safely. (209-6)	Activity 3-3C, Observing Changes in Matter, p. 92
State a conclusion based on experimental data and explain how evidence supports or refutes the idea. (210-11)	Activity 3-3C, Observing Changes in Matter, p. 92
Identify new questions about physical and chemical changes that arise from investigations. (210-16)	Activity 3-3B, Detecting Vitamin C in Fruit Drinks, p. 91 Activity 3-3C, Observing Changes in Matter, p. 92
Provide examples where knowledge of chemistry has resulted in the development of commercial materials. Include: i) medicines ii) clothing iii) fiberglass (111-11)	Unit 1 Integrated Research Investigation, p. 101
Make informed decisions about applications of science and technology, taking into account environmental and social advantages and disadvantages. (113-9)	Unit 1 Integrated Research Investigation, p. 101
Explain how society's needs can lead to developments in chemistry. (112-3)	Activity 3-3B, Detecting Vitamin C in Fruit Drinks, p. 91 Section 3.3, Physical and Chemical Changes, pp. 86–85
Provide examples illustrating how limited resources have forced scientists (and technologists) to develop more efficient ways to extract elements and compounds from nature. Include: i) crude oil ii) aluminum iii) iron	www.science, p.46

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Provide examples illustrating how limited resources have forced scientists (and technologists) to find or develop appropriate substitutes. Include: i) plastics ii) synthetic rubber iii) coinage metals	Science Watch, p. 7 www.science, p. 94
REPRODUCTION	
Cellular Processes	
Recognize that the nucleus of a cell contains genetic information and determines cellular processes. (305-1)	Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Explain the role of the nucleus and its contents in determining traits and controlling cell division.	Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Define traits.	Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Define genes.	Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Describe chromosomes as being composed of numerous genes.	Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Explain the importance of using the terms gene and chromosome properly. (109-14)	Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Illustrate and describe the basic processes of cell division, including what happens to the cell membrane and the contents of the nucleus. (304-11)	Section 5.1, The Cell Cycle and Mitosis, pp. 136–151 Activity 5-1B, The Cell Cycle: A Play in Six Scenes, p. 144
Define mitosis.	Section 5.1, The Cell Cycle and Mitosis, pp. 136–151
State and briefly describe the four phases of mitosis.	Section 5.1, The Cell Cycle and Mitosis, pp. 136–151
Select and integrate information from various print and electronic sources to examine chromosomes. (209-5)	
Observe, identify and describe a cell nucleus undergoing division.	Activity 5-1C, Observing the Cell Cycle in Plant Cells, p. 148
Observe, identify and describe chromosomes.	Activity 5-1C, Observing the Cell Cycle in Plant Cells, p. 148 Section 6.1, Meiosis, pp. 170–179 Activity 6-1B, Comparing Mitosis and Meiosis, p. 176 Activity 6-4A, Examining a Karyotype, p. 207
Determine and graph the theoretical population growth rate of cells and interpolate and extrapolate the cell population from the graph. (210-2, 210-4, 210-9)	Activity 5-1C, Observing the Cell Cycle in Plant Cells, p. 148
Illustrate and describe the basic processes of cell division, including what happens to the cell membrane and the content of the nucleus. (304-11)	Activity 5-1B, The Cell Cycle: A Play in Six Scenes, p. 144 Section 5.1, The Cell Cycle and Mitosis, p. 136–151 Activity 6-1B, Comparing Mitosis and Meiosis, p. 176
Organize data using a format that is appropriate to the task or experiment. (209-4)	Activity 6-1B, comparing Mitosis and Meiosis, p. 176
Compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots. (210-2)	Activity 6-1B, comparing Mitosis and Meiosis, p. 176
Receive, understand, and act on the ideas of others. (211-1)	Activity 6-1B, comparing Mitosis and Meiosis, p. 176
State and briefly describe the eight phases of meiosis.	Activity 6-1B, Comparing Mitosis and Meiosis, p. 176
Compare and contrast mitosis and meiosis. Include: i) types of cells that undergo each ii) number of daughter cells produced iii) amount of genetic material in each daughter cell iv) their respective roles in asexual and sexual reproduction	Activity 6-1B, Comparing Mitosis and Meiosis, p. 176
Asexual and Sexual Reproduction	
Distinguish between sexual and asexual reproduction in representative organisms. (305-2)	Section 6.2, Sexual Reproduction, pp. 180–195 Activity 6-2B, Comparing Sexual and Asexual Reproduction, p. 194

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Explain how the following organisms reproduce asexually. i) protists ii) molds iii) yeast iv) plants	Activity 5-2A, Asexual Reproduction in Duckweed, p. 153 Activity 5-2B, Determining the Best Conditions for Yeast Reproduction, p. 162 Section 5.2, Asexual Reproduction, pp. 152–165
Rephrase questions in a testable form and clearly define practical problems.	
State a hypothesis based on background information or an observed pattern of events.	Activity 5-1A, From One Cell to Many Cells, p. 138
Use tools and apparatus safely to investigate the growth of yeast cells under positive and negative environmental conditions. (209-3, 209-6)	Activity 5-2B, Determining the Best Conditions for Yeast Reproduction, p. 162
Use instruments effectively and accurately for collecting data.	Activity 5-2A, Asexual Reproduction in Duckweed, p. 153 Activity 5-2B, Determining the Best Conditions for Yeast Reproduction, p. 162
Interpret trends in data, and infer and explain relationships among the variables. (210-6)	Activity 5-2A, Asexual Reproduction in Duckweed, p. 153 Activity 5-2B, Determining the Best Conditions for Yeast Reproduction, p. 162
Communicate the results of an investigation into yeast population growth. (211-2)	Activity 5-2B, Determining the Best Conditions for Yeast Reproduction, p. 162
Distinguish between sexual and asexual reproduction in representative organisms. (305-2)	Section 6.2, Sexual Reproduction, pp. 180–195 Activity 6-2B, Comparing Sexual and Asexual Reproduction, p. 194
Explain how various organisms reproduce sexually. i) moss ii) flowering plant iii) insect a) incomplete metamorphosis b) complete metamorphosis	Section 6.2, Sexual Reproduction, pp. 180–195 Activity 6-2A, Predict a Pollinator, p. 194
Compare and contrast complete and incomplete metamorphosis.	Section 6.2, Sexual Reproduction, pp. 180–195
Compare sexual and asexual reproduction in terms of their advantages and disadvantages. (305-3)	Section 6.2, Sexual Reproduction, pp. 180–195 Activity 6-2B, Comparing Sexual and Asexual Reproduction, p. 194
Compare and contrast asexual and sexual reproduction.	Section 6.2, Sexual Reproduction, pp. 180–195 Activity 6-2B, Comparing Sexual and Asexual Reproduction, p. 194
Compare the advantages and disadvantages of sexual and asexual reproduction. Include: – amount of energy required – parental care – genetic variety in offspring	Activity 6-2B, Comparing Sexual and Asexual Reproduction, p. 194
Human Reproduction	
Compare the structure and function of the human reproductive systems. (305-4)	Section 6.3, Human Reproductive Systems, pp. 196–203
Identify the major parts of the male reproductive system. i) testes ii) scrotum iii) penis iv) vas deferens v) urethra	Section 6.3, Human Reproductive Systems, pp. 196–203
Identify the major parts of the female reproductive system. i) vagina ii) cervix iii) uterus iv) oviduct v) ovary	Section 6.3, Human Reproductive Systems, pp. 196–203
Identify visible signs of pregnancy. Include: i) cessation of menstrual flow ii) widening of the hips iii) enlargement of the breasts iv) morning sickness v) weight gain vi) cravings (305-12A)	Section 6.3, Human Reproductive Systems, pp. 196–203

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Describe the major stages of human development from conception to early infancy. Include: i) fertilization ii) first trimester iii) second trimester iv) third trimester (305-12B)	Section 6.3, Human Reproductive Systems, pp. 196-203
Identify major shifts in scientific understanding of genetics. Include: i) Mendel's experiments ii) Watson & Crick's double helix model of DNA iii) Human Genome Project iv) genetic engineering (111-3)	Section 6.4, Studying Genetic Changes, pp. 204–211 Find Out Activity, Unit 2, Designing Your Supper, p. 109 Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Provide examples of genetic conditions that cannot be cured using scientific and technological knowledge at the present time. Include: i) Down syndrome ii) Cystic Fibrosis iii) Allderdice Syndrome (113-10)	Section 6.4, Studying Genetic Changes, pp. 204–211 Section 4.2, Mutation, pp. 122–131
Discuss factors that may lead to changes in a cell's genetic information. (305-5)	Section 4.2, Mutation, pp. 122–131 Activity 4-2A, Identify the Mutation, p. 123
Define mutation.	Section 4.2, Mutation, pp. 122–131
Define mutagen.	Section 4.2, Mutation, pp. 122–131
Give examples of mutations caused by: i) nature ii) human activity	Section 4.2, Mutation, pp. 122–131
Evaluate information and evidence gathered on the topic of genetics and genetic engineering. (209-5, 210-8)	Find Out Activity, Unit 2, Designing Your Supper, p. 109 Section 4.1, The Function of the Nucleus within the Cell, pp. 112–121
Provide examples of how the knowledge of cellular functions has resulted in the development of technologies. (111-1)	Section 5.2, Asexual Reproduction, pp. 152–165
Provide examples of Canadian contributions to science and technology related to heredity and genetic engineering. (112-12)	Unit 2 Integrated Research Investigation, p. 217
ELECTRICITY	
Static Electricity	
Explain the production of static electrical charges in some common materials. (308-13)	Section 7.1, Static Charge, pp. 228–237 Activity 7-1A, Detecting Static Charge, p. 229
Define static electricity.	Section 7.1, Static Charge, pp. 228–237
Describe the types of charges on objects. Include: i) positive charge ii) negative charge iii) neutral	Section 7.1, Static Charge, pp. 228–237
Describe how the charges on objects can change. Include: i) neutral objects can develop a positive charge ii) neutral object can develop a negative charge iii) positively charged object can become neutral iv) negatively charged object can become neutral	Section 7.1, Static Charge, pp. 228–237 Activity 7-1B, Visualizing Charge Transfer, p. 231 Activity 7-1C, Charging Insulators and Conductors, p. 235
Identify properties of static electrical charges. (308-14)	Section 7.1, Static Charge, pp. 228–237
Define the Laws of Electric Charges. Include: i) like charges repel ii) unlike charges attract iii) charged objects attract some neutral ones	Section 7.2, Electric Force, pp. 238–245
Provide examples of how knowledge of static electricity has resulted in the development of technologies. Include: i) lightning rods ii) photocopiers iii) electrostatic air cleaners (111-1, 112-7)	Section 7.1, Static Charge, pp. 228–237 Section 7.2, Electric Force, pp. 238–245
Current Electricity and Electric Circuits	
Explain the importance of using precise language while studying the characteristics of electricity. (109-14)	Section 8.1, Electric Potential Energy and Voltage, pp. 250–259 Section 8.2, Electric Current, pp. 260–269

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Define electric current.	Section 8.2, Electric Current, pp. 260–269
Identify the ampere (symbol A) as the SI unit for current.	Section 8.2, Electric Current, pp. 260–269
Compare (qualitatively) static electricity and electric current. (308-15)	Section 8.2, Electric Current, pp. 260–269
Describe the flow of charge in an electric circuit. (308-16)	Section 8.2, Electric Current, pp. 260–269
Define electric circuit.	Section 8.2, Electric Current, pp. 260–269
Describe the parts of an electric circuit. Include: i) source of electrical energy ii) electrical load iii) control/switch iv) conductor	Section 8.2, Electric Current, pp. 260–269
Organize information using a format appropriate to studying and describing current electricity. (209-4)	Activity 8-2D, Measuring Current, p. 266
Create circuit diagrams using appropriate circuit symbols. Include symbols for: i) lamp ii) cell iii) battery iv) wires v) resistors vi) ammeter vii) voltmeter	Activity 8-2C, Drawing Circuit Diagrams, p. 265
Define electrical resistance.	Section 8.3, Resistance and Ohm's Law, pp. 270–281
Identify the ohm (symbol Ω) as the SI unit for electrical resistance.	Section 8.3, Resistance and Ohm's Law, pp. 270–281
List the factors which affect the amount of resistance in a wire. Include: i) length ii) diameter iii) type iv) temperature	Section 8.3, Resistance and Ohm's Law, pp. 270–281
OHM's Law	
Use an ammeter and a voltmeter to measure current and voltage in a circuit. (209-3)	Activity 8-2D, Measuring Current, p. 266 Activity 8-1B, Using the Voltmeter, p. 255
Define electric potential (voltage).	Section 8.1, Electric Potential Energy and Voltage, pp. 250–259
Identify the volt (symbol V) as the SI unit for electric potential.	Section 8.1, Electric Potential Energy and Voltage, pp. 250–259
Identify that electric potential is provided at the source and "used" by the circuit elements (a potential or voltage drop occurs).	Section 8.2, Electric Current, pp. 260–269
Identify potential sources of error in ammeter and voltmeter readings. (210-10)	Activity 8-3D, Resistors and Ohm's Law, p. 278
Identify and suggest explanations for discrepancies in data collected using an ammeter and a voltmeter. (210-7)	Activity 8-3B, Calculating Resistance, p. 275
Present graphically, using a line of best fit, the data from investigation of voltage, current and resistance. (210-5, 211-2)	Section 8.3, Resistance and Ohm's Law, pp. 270–281
Identify new questions and problems that arise from what was learned concerning voltage, current and resistance. (210-16)	Activity 8-2D, Measuring Current, p. 266 Activity 9-1D, A Series of Lights and Cells, p. 298
Recognize that as the voltage drop (potential difference across a resistor) increases, so does the current in the circuit, and vice-versa.	Activity 8-3D, Resistors and Ohm's Law, p. 278
State Ohm's Law.	Section 8.3, Resistance and Ohm's Law, pp. 270–281
Given voltage drop and current through a resistor, calculate its resistance.	Activity 8-3D, Resistors and Ohm's Law, p. 278
Given voltage drop and resistance, calculate current through a resistor.	Activity 8-3D, Resistors and Ohm's Law, p. 278

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Given current through a resistor and its resistance, calculate the voltage drop.	Activity 8-3D, Resistors and Ohm's Law, p. 278
Parallel and Series Connections	
State a prediction and a hypothesis based on background information or an observed pattern of events. (208-5)	Activity 9-1B, Is the World Series a Series Circuit? p. 288 Activity 9-1C, More Things are Parallel Than Lines, p. 291 Activity 9-1E, Parallel Lights and Cells, p. 299
Interpret patterns and trends in data, and infer and explain relationships among the variables. (210-6)	Activity 9-1A, Turn Out the Lights, p. 287 Activity 9-1D, A Series of Lights and Cells, p. 298
Identify and evaluate potential applications of findings.	Activity 9-1D, A Series of Lights and Cells, p. 298
Rephrase questions in a testable form related to series and parallel connections of cells.	
Distinguish between series and parallel connections of cells.	Section 9.1, Series and Parallel Circuits, pp. 286–303
Determine the effective voltage for cells connected in series and parallel.	Section 9.1, Series and Parallel Circuits, pp. 286–303 Activity 9-1D, A Series of Lights and Cells, p. 298
Describe pros and cons of parallel and series connections of cells. (113-2A)	Section 9.1, Series and Parallel Circuits, pp. 286–303
Indicate that series connections increase the effective voltage, but the resulting battery life is shortened.	Section 9.1, Series and Parallel Circuits, pp. 286–303
Indicate that parallel connections maintain the effective voltage, but the resulting battery life is lengthened.	Section 9.1, Series and Parallel Circuits, pp. 286–303
Give examples of situations where parallel and series connections of cells are used. Include: i) flashlights availing of series connections ii) powering a remote or hard to access device (e.g., lighthouse) might avail of parallel connections	Section 9.1, Series and Parallel Circuits, pp. 286–303
Describe series and parallel circuits, with a maximum of three resistors, involving varying resistance, voltage and current. (308-17)	Activity 9-1F, Resistors in Series and Parallel, p. 300
Carry out procedures controlling the major variables. (209-1)	Activity 3-1F, Resistors in Series and Parallel
Use instruments effectively and accurately for collecting data. (209-3)	Activity 3-1F, Resistors in Series and Parallel
Use tools and apparatus safely. (209-6)	Activity 3-1F, Resistors in Series and Parallel
Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise. (211-3)	Activity 3-1F, Resistors in Series and Parallel
Rephrase questions in a testable form related to series and parallel connections of cells. (208-1)	Activity 3-1F, Resistors in Series and Parallel
Distinguish between series and parallel connections of resistors (or lamps).	Activity 9-1F, Resistors in Series and Parallel, p. 300
Describe the effect on the total resistance of the circuit as resistors are added: i) in series ii) in parallel	Activity 9-1F, Resistors in Series and Parallel, p. 300
Describe positive and negative effects of parallel and series connections of resistors (or lamps). Include: (113-2A) i) If lights are connected in series, when one light extinguishes so must all others. ii) If lights are connected in parallel, when one light extinguishes, the remaining can continue to function.	Section 9.1, Series and Parallel Circuits, pp. 286–303
Give examples of situations where parallel and series connections of resistors are used. Include: (113-2B) i) Christmas lights connected in series vs. parallel ii) Household lights connected in parallel	Section 9.1, Series and Parallel Circuits, pp. 286–303
Uses of Electrical Energy	
Analyse the design of a technology and the way it functions on the basis of identified criteria such as cost and impact on daily life and the community. (113-5)	Section 9.1, Series and Parallel Circuits, pp. 286–303

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Relate electrical energy to domestic power consumption costs. (308-18)	Activity 9-2B, The Cost of Electricity, p. 310
Define electrical energy.	Section 9.2, The Power of Electricity, pp. 304–313
Identify the Joule (symbol J) as the unit to measure energy.	Section 9.2, The Power of Electricity, pp. 304–313
Recognize that electrical energy cost depends on three factors. These are: i) voltage drop ii) electrical current iii) time	Section 9.2, The Power of Electricity, pp. 304–313
Explain the importance of using precise language in evaluating electrical energy costs. (109-14)	Section 9.3, Electrical Energy in the Home, pp. 334–323
Define electrical power.	Section 9.2, The Power of Electricity, pp. 304–313
Identify the Watt (symbol W) as the unit to measure electrical power.	Section 9.2, The Power of Electricity, pp. 304–313
Identify the kWh as a more convenient unit to express electrical energy consumption.	Section 9.2, The Power of Electricity, pp. 304–313
Given power rating and time, determine electrical energy used.	Activity 9-2B, The Cost of Electricity, p. 310
Given electrical energy used and cost of electrical energy, determine cost to consumer.	Activity 9-2B, The Cost of Electricity, p. 310
Propose a course of action that reduces the consumption of electrical energy. Include: i) For homes heated by electricity, improve insulating factors. ii) Turn off lights when not required. iii) Use energy-efficient light bulbs iv) Air dry clothes when possible. (113-13)	Activity 9-3B, Conserving Electricity, p. 322
Make informed decisions about applications of science and technology, taking into account environmental and social advantages and disadvantages. (113-9)	Activity 9-3A, Putting Energy Conversions to Good Use, p. 315 Activity 9-3B, Conserving Electricity, p. 322
Determine quantitatively the efficiency of an electrical appliance that converts electrical energy to heat energy.	Section 9.3, Electrical Energy in the Home, pp. 314–323
Identify different approaches taken to answer questions, solve problems, and make decisions. (109-7)	Section 9.3, Electrical Energy in the Home, pp. 314–323.
Recognize that electrical energy is converted to many other forms. Include: i) light ii) heat iii) sound	Section 9.3, Electrical Energy in the Home, pp. 314–323
Given useful output energy and input energy, calculate efficiency of an electrical device.	Section 9.3, Electrical Energy in the Home, pp. 314–323
Evaluate the design of electrical devices in terms of their efficiency. Include: (113-6)	Section 9.3, Electrical Energy in the Home, pp. 314–323 Activity 9-3A, Putting Energy Conversions to Good Use, p. 315
Compare examples of past and current technologies that used current electricity to meet similar needs. (110-9)	
Recognize that Energuide labels are used to aid consumers.	Section 9.3, Electrical Energy in the Home, pp. 314–323
Describe the transfer and conversion of energy from a generating station to the home. (308-20)	Section 9.4, Electricity and the Environment, pp. 324–335
Identify the components of an electrical generator. Include: i) coil of wire ii) magnets	Section 9.4, Electricity and the Environment, pp. 324–335
Describe different types of electrical generating stations. Include: i) hydroelectric ii) thermal iii) nuclear	Section 9.4, Electricity and the Environment, pp. 324–335
Explain that electrical energy is transmitted over large distances at high voltage and low current.	Section 9.4, Electricity and the Environment, pp. 324–335

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Define transformer.	Section 9.4, Electricity and the Environment, pp. 324–335
Recognize that voltage is provided at 120 V and 240 V for domestic use.	Section 9.4, Electricity and the Environment, pp. 324–335
Apply criteria for evaluating environmental problems associated with electrical energy production. Include: i) safety ii) cost of production iii) degree of environmental impact (210-8)	Section 9.4, Electricity and the Environment, pp. 324–335
Give examples of alternative sources of electrical energy. Include: i) wind generator ii) solar energy iii) fuel cell (109-6A)	Section 9.4, Electricity and the Environment, pp. 324–335
Explain the development of alternative sources of energy as constrained by several factors. Include: i) cost ii) availability of materials iii) properties of materials (109-6B)	Section 9.4, Electricity and the Environment, pp. 324–335
Provide examples of careers related to electricity in their community and province. Include: i) electrician ii) photocopier repairman (112-10)	Section 9.2, The Power of Electricity, pp. 304–313
SPACE EXPLORATION	
The Solar System	
Describe and explain the apparent motion of celestial bodies: – moon – sun – planets – comets – asteroids (312-4)	Section 10.1, Observing the Stars, pp. 352–365 Activity 10-1B, Observing the Sky, p. 362
Define celestial body.	Section 10.1, Observing the Stars, pp. 352–365
Identify that celestial bodies move in cyclic paths called orbits and that these orbits result from gravitational forces.	Section 10.1, Observing the Stars, pp. 352–365
Identify that planets, suns, and moons revolve on a central axis.	Section 10.2, Early Models of the Universe, pp. 366–375
List examples of constellations and recognize them on a sky chart. Include: – Ursa Major, the Great Bear — including the Big Dipper – Ursa Minor, the Little Bear — including the Little Dipper – Orion – Cassiopeia – Leo	Section 10.1, Observing the Stars, pp. 352–365 Activity 10-1B, Observing the Sky, p. 362 Activity 10-1C, Building a 3-D Constellation, p. 363
Organize data using a format that is appropriate to the task or experiment. (209-4)	Activity 10-3A, The Length of the School Year on Different Planets, p. 381
Identify strengths and weaknesses of different methods of collecting and displaying data.	Activity 10-2B, Pointing in the Right Direction, p. 374
Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise. (211-3)	Activity 10-2A, Build Your Own Telescope, p. 373 Activity 11-3B, Designing a Space Station, p. 422
Describe theories on the formation of the solar system. (312-1)	Chapter 12
Explain the contributions made by the following to our knowledge and understanding of celestial bodies and their motions: – Aristotle – Ptolemy – Copernicus – Galileo – Kepler – Newton	Section 10.2 Early Models of the Universe, pp. 366–375 Section 10.3, Standing on the Shoulders of Giants, pp. 376–385

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Identify early technologies that advanced scientific observations about the solar system. Include: – stone circles – astrolabe – telescope	Section 10.2 Early Models of the Universe, pp. 366–375 Section 11.1 The Sun and Its Effect on Earth, pp. 390–397
Contrast the geocentric model of the solar system with the heliocentric model.	Section 10.2 Early Models of the Universe, pp. 366–375
Describe past and present theories related to the formation of our solar system. Include: – Creationism – Catastrophism (stellar collision theory) – nebular hypothesis	Section 12.1 Explaining the Early Universe, pp. 428–443
Select appropriate methods and tools for collecting data and information and for solving problems. (208-8)	Activity 10-3B, Strolling Through the Solar System, p. 382
Evaluate designs and prototypes in terms of function, reliability, and use of materials. (210-15)	Activity 10-3B, Strolling Through the Solar System, p. 382.
Work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise. (211-3)	Activity 10-3B, Strolling Through the Solar System, p. 382.
Use instruments effectively and accurately for collecting data. (209-3)	Activity 10-2B, Pointing in the Right Direction, p. 374 Activity 11-1A, Observing Sunspots, p. 395
Identify potential sources and determine the amount of error in measurement.	
Describe the composition and characteristics of the following components of the solar system. Include: i) terrestrial and gas planets ii) Pluto iii) periodicity of comets iv) asteroids/meteors. (312-5)	Section 11.2 Characteristics of the Celestial Bodies of the Solar System, pp. 398–411
Compare and contrast the composition of the four inner rocky (terrestrial) planets with the four outer gaseous (Jovian) planets.	Activity 11-2A, Terrestrial and Jovian Planets, p. 402
Explain how Pluto differs from the other eight planets.	Section 11.2 Characteristics of the Celestial Bodies of the Solar System, pp. 398–411
Describe the composition of comets.	Section 11.2 Characteristics of the Celestial Bodies of the Solar System, pp. 398–411
Define periodicity as it relates to comets.	
Compare and contrast asteroid, meteor and meteor.	Section 11.2 Characteristics of the Celestial Bodies of the Solar System, pp. 398–411
Define impact sites.	Section 11.2 Characteristics of the Celestial Bodies of the Solar System, pp. 398–411 Activity 11-2B, Making Craters in the Classroom, p. 409
Define the following terms and describe the effects these solar phenomena have on Earth. Include: i) sun-spots ii) solar flares iii) solar radiation (312-6)	Activity 11-1B, Observing Sunspots, p. 395 Section 11.1, The Sun and Its Effect on Earth, pp. 390–397 Chapter 11 Review, pp. 424–425
Propose alternative solutions to a given practical problem, select one, and develop a plan. (208-4)	Activity 11-3B, Designing a Space Station, p. 422
Test the design of a constructed device or system. (210-13)	Activity 11-3B, Designing a Space Station, p. 422
Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task. (211-4)	Activity 11-3B, Designing a Space Station, p. 422
In small groups, design and describe a model space station based on what they have learned about the sun's influences on Earth.	Activity 11-3B, Designing a Space Station, p. 422
Explain the need for new evidence in order to continually test existing theories about the composition and origin of our solar system and galaxies. (110-6, 210-3)	Section 11.3, The Exploration of Space, pp. 412–423 Section 12.3, Our Future in Space, pp. 456–467

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Recognize that astronomical theories are based on data collected remotely. New evidence forces rethinking of old theories.	Section 11.3, The Exploration of Space, pp. 412–423
The Universe	
Describe theories on the origin and evolution of the universe: – Big Bang Theory – Oscillating Theory (312-3)	Section 12.1, Explaining the Early Universe, pp. 428–443
Describe and classify the major components of the universe: – nebula – galaxies – giant stars – dwarf stars – quasars – black holes (312-2)	Section 12.1, Explaining the Early Universe, pp. 428–443 Section 12.2, Galaxies and Stars, pp. 444–455
Define the terms: – nebula – galaxies – giant stars – dwarf stars – quasars – black holes	Section 12.1, Explaining the Early Universe, pp. 428–443 Section 12.2, Galaxies and Stars, pp. 444–455
Explain how data provided by technologies contribute to our knowledge of the universe. (109-3)	Section 11.3, The Exploration of Space, pp. 413–423
Describe current technologies used to explore space. Include: – spectroscopy – reflecting telescopes – adaptive optics – radio telescopes – Hubble Space Telescope – space probes	Section 11.3, The Exploration of Space, pp. 413–423 Section 12.3, Our Future in Space, pp. 456–467
Relate knowledge of the universe to data collected through use of technology.	Section 10.2, Early Models of the Universe, pp. 366–375 Section 12.3, Our Future in Space, pp. 456–467
Calculate the travel time to a distant star at a given speed: define and explain a light year (210-9) using the concept of a light year, calculate the time required for light to travel from the various points in the universe to Earth, including but not limited to – Mars – the Sun – Polaris (The North Star)	Section 12.1, Explaining the Early Universe pp. 426–443 Activity 12-1A, The Light Year, p. 439
Working collaboratively with group members, prepare a comparative data table on various stars and design a model to represent some of these stars relative to our solar system.	Activity 12-2A, Sizes of Stars, p. 451
Identify new questions and problems that arise from the study of the universe. (210-16)	Chapter 11 Review, pp. 424–425
STSE — Space Exploration	
Describe examples of science and technology-based careers in Canada that are associated with space exploration. (112-11)	Activity 11-3A, Canada's Contributions to Space Exploration, p. 413 Section 11.3, The Exploration of Space, pp. 412–423
Describe the science underlying three technologies designed to explore space.	Activity 11-3A, Canada's Contributions to Space Exploration, p. 413
Describe the science behind the following technologies designed to explore space. – rocket propulsion – space suits – satellite orbiting (109-11, 111-5)	Section 11.3, The Exploration of Space, pp. 412–423
Provide examples of how the Canadian Government and/or Canadian Space Agency are involved in research projects about space. (112-6)	Section 11.3, The Exploration of Space, pp. 412–423 Activity 11-3A, Canada's Contributions to Space Exploration, p. 413

CORRELATION TO THE NEWFOUNDLAND AND LABRADOR GRADE 9 SCIENCE CURRICULUM	
List Canadian contributions and partnerships to space research and exploration. Include: – the Canadarm 1 – the International Space Station – Canadian Space Station Remote Manipulator System (SSRMS) or Canadarm 2 – Special Purpose Dexterous Manipulator (SPDM) or Canadahand	Section 11.3, The Exploration of Space, pp. 412–423
Give examples of Canadian Astronauts. Include: i) Roberta Bondar ii) Marc Garneau iii) Chris Hadfield	Section 11.3, The Exploration of Space, pp. 412–423
Defend a position regarding societal support for space exploration. (113-3, 211-5)	Section 11.3, The Exploration of Space, pp. 412–423 Activity 11-3A, Canada's Contributions to Space Exploration, p. 413
Identify potential scientific and social benefits and negative consequences of Canadian partnerships in space exploration. Include: – medical – industrial – agricultural – meteorological – military	Activity 11-3A, Canada's Contributions to Space Exploration, p. 413

COURSE MATERIALS

The following chart lists the items you may wish to use for a class of 30 using the *Discovering Science 9* program. The activities can be carried out by pairs or small groups of students, unless the instructions clearly specify that students should work on their own. Suppliers of science lab materials and equipment are listed in the suppliers' section of this *Teacher's Resource*.

Item Description	Suggested Quantity	Needed for These Units
NON-CONSUMABLE		
acetate strip	60	3
ammeter	12	3
Astroscan telescope and/or pair of binoculars with lens caps	1 telescope plus 5 pairs of binoculars	4
bar magnet	60	1, 3
batteries: AA, AAA, lantern battery, watch battery, 9.0 V battery	various	3
beaker (100 mL)	50	1
beaker (250 mL)	15	3
beaker (400 mL)	60	1
Bunsen burner	15	1
calculator	30	1, 2, 3, 4
candle and lighter or matches	15	1
clipboard	15	4
compact fluorescent light bulb (13 W)	15	3
conductivity tester	15	1
copper strips	30	3
crucible tongs	15	1
D cell	15	3
desktop lamps	2	3
diffraction-grating glasses	10	2
directional compass	5	4
ebonite rods	30	3
electrical conductivity kit	15	1
electroscope	15	3
felt pens	several	1, 4
flashlight (with red cellophane filter)		4
flashlight bulbs (1.5 V, 2.0 V, 2.5 V, 3.0 V, 6.0 V)	15 of each	3
flour sifter or salt shaker	4	4
forceps or tweezers	15	2
funnel	15	1
galvanometer or ammeter	15	3
gas discharge tubes (for example, mercury, xenon, hydrogen, sodium)	1	4
glass rods	2	3
graduated cylinders (10 mL, 50 mL, 100 mL)	10 of each	1
hand lens	15	1
heat resistant pad	15	1
incandescent light bulb (60 W)	15	3
insulated wire with both ends bare	15	3

Item Description	Suggested Quantity	Needed for These Units
knife switch	15	3
lantern battery (6.0 V) or power supply	15	3
large-diameter test tube (to fit over medium test tube)	15	1
light bulbs (2.0 V)	30	3
light sources (for example, Sun, fluorescent, incandescent, ultraviolet, energy-saver lamp, frosted light, holiday lights)	4 different sources	4
magnet, powerful, bar	15	1, 3
magnet, small neodymium disk	15	3
marbles	100	2
measuring tape	5	4
medicine dropper or toothpick	15	2
medicine droppers	2	1
metre stick	5	4
microscope	5	1, 2
mortar and pestle	15	1
page of small-print text (such as the page of a newspaper or magazine)	30	4
pencil crayons	several	1, 4
pennies	100	2, 3
petri dish	15	2
plastic petri dish with lid	15	3
plastic tub	15	4
power supply	3	3
powerful bar magnet	15	3
pushpins	2	4
ring stand and ring	15	1
rubber stopper fitted with glass tubing	15	1
rubber tubing	2 m	1
ruler	15	2, 3, 4
scissors	15	4
scoopula	30	1
seasonal star chart	30	4
selection of elements	15 samples of each of 5 elements	1
small round rocks and/or balls of different sizes, about 1–3 cm in diameter	3–5	4
small spoons	30	1
soft materials such as wool, paper towel, plastic wrap, fur	various	3
solid materials such as plastic straw, comb, plastic ruler, acetate strip, vinyl strip, glass rod, aluminum strip, iron strip, brass strip	various	3
spectroscope	5	4
spoon	15	2
star chart showing the night sky and positions of planet(s)	30	4
stopwatch	15	3
test tubes, medium and small	100	1
test tube clamp or tongs	15	1
test tube holder	15	1
test tube rack	15	1

Item Description	Suggested Quantity	Needed for These Units
thermometers	15	2, 3
timer	15	2
tongs	15	1
voltmeter	15	3
watch glass	15	3
wax pencil	15	2
wool cloth	15	3
CONSUMABLE		
adhesive tape	2 rolls	2
aluminum foil	1 roll	1 ,3
aluminum strips	30	3
baking soda	250 g	1
balloon, large round	30	3, 4
beads (stars)	125	4
bromothymol blue	125 mL	1
C or D cell	15	3
calcium chloride powder	100 g	1
calcium chloride solution ($CaCl_2$)	250 mL	1
cardboard squares (30 cm × 30 cm)	30	4
cardboard tube	30	3
cell (1.5 V)	100	3
cereal, O-shaped	1 box	2
chart paper	1 pad	4
chopsticks	10 sets	2
clear adhesive tape	2 rolls	3, 4
cocoa powder	3 kg	4
convex lenses (approximately 4.5 cm in diameter)	60	4
copper ribbon	15 pieces	1
cotton ball	15	2
cover slip	100	2
distilled water	3 L	2
duckweed plants	50	2
filter paper	30 sheets	1
flour	5 kg	4
fruit juices or other beverages	2 L	1
fruits	various	3
fur	15 pieces	3
glue	1 bottle	4
graph paper	100 sheets	4
hydrochloric acid (1.0 mol/L solution)	200 mL	1
hydrogen peroxide (H_2O_2) solution	1 L	1
index cards	500	4
insulated copper wire (about 26 gauge)	20 m	3
iodine starch solution	250 mL	1
iron nail	200	3

Item Description	Suggested Quantity	Needed for These Units
jars or culture dishes	30	2
Knop's solution	1 L	2
liquid dish soap	250 mL	1
lithium carbonate solution (Li_2CO_3)	300 mL	1
magnesium metal	15 samples	1
materials to model the Sun and planets: ball bearings or similar-sized ball (~28 mm diameter), coarse- and fine-grained sand, salt, cake sprinkles, and small candies or cake decorations	several	4
metal strips (5 cm) of aluminum, magnesium, iron, copper, silver, lead	15 of each	1
microscope slide	50	1, 2
paper towel tube (approximately 4.3 cm in diameter)	30	4
plastic bag	30	3
plastic disposable cup	30	3
plastic straw	300	2, 3
potassium iodide (KI) crystals	100 mL	1
prepared slide of an onion root tip	15	2
puffed rice cereal	1 box	3
raisins	100	1
resealable plastic bags	30	1
resistors of different sizes (50–1000 Ω)	11	3
shoebox	30	4
silver nitrate solution in dropper bottles	100 mL	1
small pieces of aluminum, magnesium, iron, copper, silver, lead	15 of each	1
sodium hydrogen carbonate powder	50 mL	1
solution of a copper compound	150 mL	1
steel wool	1 box	1, 3
sticks	40	4
stirring rod	15	1
string	1 ball	4
sucrose (table sugar)	100 g	2
switch	30	3
toilet paper tube (approximately 4 cm in diameter)	30	4
toothpicks	1 box	2
twist tie	15	4
vinegar	5 L	1
vitamin C tablet (100 mg or less)	15	1
wires. conducting	30	3
wires, connecting	150	3
wire, copper (stripped on both ends)	3 m	3
wooden skewer	30	2
wooden splints	200	1
yeast, dry	100 mL	3
zinc metal (mossy)	15 pieces	1
zinc strips	30	3