Science

Grade 7

Newfoundland Labrador

Curriculum Guide

2013

Contents

Acknowledgements

The Department of Education would like to thank the provincial Grade 7 Science curriculum committee members for their contribution:

James Butler, Science Teacher, Frank Roberts Jr. High, Conception Bay South

Bradley Clarke, Program Development Specialist - Science, Division of Program Development, Department of Education

Jennifer Clarke, Science Teacher, St. Peter's Jr. High, Mt. Pearl

Cheryl Donovan-White, Science Teacher, Villanova Jr. High, Conception Bay South

Sheldon Gillam, Science Teacher, Gill Memorial Academy, Musgrave Harbour

Cheryl Gordon, Science Teacher, Glovertown Academy, Glovertown

Ronald Smith, Test Development Specialist - Science, Division of Evaluation, Testing and Certification, Department of Education

Jessica Webb, Science Teacher, St. Paul's Jr. High, St. John's

Craig White, Implementation Specialist - Avalon East School District, St. John's

Todd Woodland, Science Teacher, Leary's Brook Jr. High, St. John's

The Department of Education also appreciates the comments and suggestions from the many teachers who used the various draft versions of the document.

Foreword

The Pan-Canadian *Common Framework of Science Learning Outcomes K to 12* released in October 1997, assists provinces in developing a common science curriculum framework.

Science curriculum for the Atlantic Provinces is described in *Foundation for the Atlantic Canada Science Curriculum (1998)*.

This curriculum guide is intended to provide teachers with the overview of the outcomes framework for science education. It outlines course-specific curriculum outcomes and provides suggestions for learning, teaching, and assessment.

Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* and in *Grade 7 Science Curriculum Guide* was planned and developed collaboratively by teacher committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the science framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Rationale

The aim of science education in the Atlantic provinces is to develop scientific literacy. 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; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences which provide opportunity to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their futures.

Program Design and Components

Learning and Teaching Science

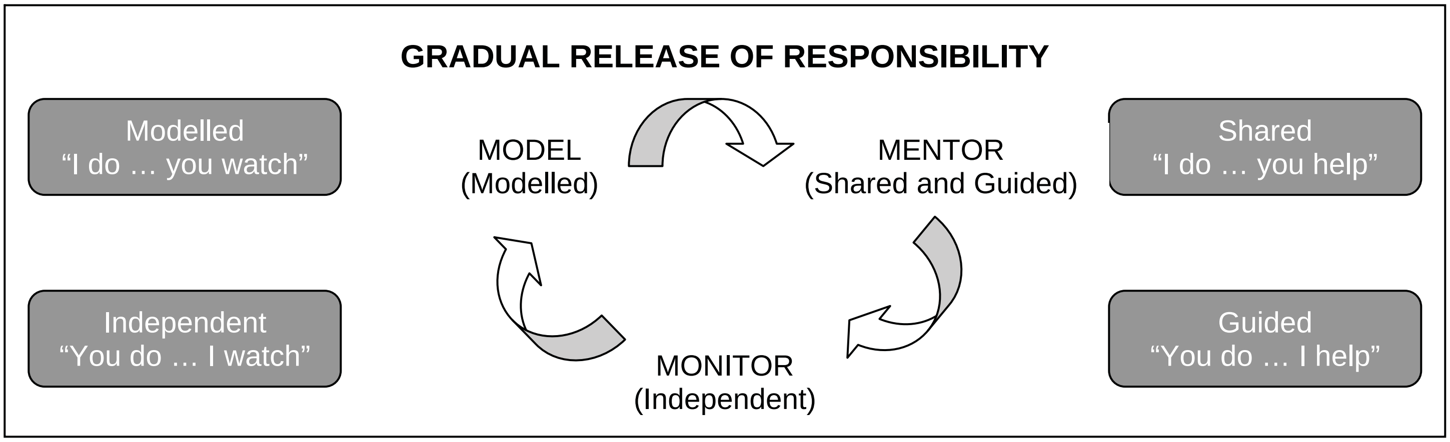
What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include:

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- analyzing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire
- challenging students to develop strategies to increase scientific literacy

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment which reflects a constructive, active view of the learning process. Learning occurs not by passive absorption, but rather as students actively construct their own meaning and assimilate new information to develop new understanding.

Teachers must determine when students can work independently and when they require assistance. In an effective science program, teachers choose their instructional activities to model inquiry, problem solving and decision making that is just beyond the student's independence level. In the gradual release of responsibility approach, students move from a high level of teacher support to independent practice, as students become more skilled at using the new strategies. If necessary, the teacher increases the level of support when students need further assistance.

The goal is to empower students to make the strategies their own, and to know how, when, and why to apply them when faced with a problem. Guided practice supports student independence. As a student demonstrates success, the teacher gradually decreases his or her support.



The development of students’ scientific literacy is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum. Students’ disposition towards science is also shaped by these factors.

Learning experiences in science education should vary and include opportunities for group and individual work, discussion among students, as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations, and the evaluation of the evidence accumulated, provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

Contexts for Teaching and Learning

The science curriculum provides students with opportunities to become scientifically literate citizens who will be contributing members of society. By drawing upon personal experiences, students experience the nature of science and develop a sense of wonder about the world around them.

Students learn through purposeful and powerful learning strategies designed around stimulating ideas, concepts, issues, and themes that are meaningful to them. Students learn best when they are aware of the strategies and processes they use to construct meaning and to solve information-related problems.

Adolescent learners must have opportunities to communicate their learning through various modes in addition to frequent opportunities to self-assess their learning, strengths, needs and performance. Descriptive feedback from peers, teachers and others at home and in the community provides direction for student learning and achievement.

The development of scientific literacy is the underlying principle of the science curriculum.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging in science. These activities provide students opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimum solution to a given problem.

Decision Making

The process of decision-making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are not only important in their own right; they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Considerations for Program Delivery

The Nature of the Adolescent Learner

The adolescent learner in the intermediate grades is involved in a period of rapid and significant change with respect to physical, emotional, social, intellectual, spiritual, and moral development. Because the nature of these changes is often intense and varied, they need to be acknowledged by the teacher. While some general characteristics of adolescents have been identified, there is a need to recognize that changing characteristics are on a continuum with many variations at each grade and for different ages. Each student is unique and any attempt to classify must be regarded as extremely general.

Cultural and social influences shape adolescence in many ways and such influences must be recognized in the learning and teaching context. Critical awareness of self and other influences is essential to the adolescent learner and this skill must be developed in the intermediate classroom.

The Characteristics of the Intermediate Learner

Adolescence "is a time of transition between dependence and independence, a time to explore new alternatives and try out new identities, a time to experiment with new points of view and a time to learn how to interact with others." (Knowles and Brown, 2002)

The intermediate learner:

- perceives peer relationships as more important than family relationships
- attempts to define self independent of the family
- may become more involved in risk taking behaviors
- appears to fluctuate between independence and dependence
- displays a multitude of emotions in varying degrees
- grows physically and cognitively at varying rates
- moves from morality based on convention to morality based on personal values
- refines his/her sense of humour
- uses diverse communication skills
- is enthusiastic about sharing ideas and experiences
- continues to develop reasoning skills
- reflects on feelings, emotions, and responsibilities
- is developing the ability to handle abstract and hypothetical concepts
- applies problem solving approaches to complex issues
- is self-conscious
- learns to interact cooperatively
- asks questions and questions answers
- responds best when expectations are clear
- uses rigid definitions for right and wrong

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equal opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of and make adaptations to accommodate the diverse range of learners in their classes. In order to adapt to the needs of all learners, teachers must create opportunities that permit students to have their learning styles addressed.

By using differentiated instruction teachers can work towards meeting the needs of all learners. Ideally, every student should find his/her learning opportunities maximized in the science classroom.

Differentiated Instruction

Differentiated instruction is instruction that responds to students of different abilities, interests or learning needs so they may acquire appropriate ways to learn, use, develop, and present concepts. It involves actively planning for student differences in a learning situation in terms of the core concepts and skills being taught, the process by which the content is delivered, and the product that students will create based on their readiness and interests.

Teachers continuously make decisions about how to select teaching strategies and structure learning activities to meet the diverse learning styles of their students. Given the changing nature of adolescents' development, creating such a responsive environment will provide all students with a safe place to grow and succeed in a dynamic and personalized space.

Differentiating instruction is an essential tool for engaging students and addressing their individual needs. Teachers can differentiate in the content, process, product, or environment of the classroom.

Differentiating the Content

Content can be described as the knowledge, skills, and attitudes we want students to learn. Differentiating content requires teachers to pre-assess students to identify those who do not require direct instruction. Students who demonstrate an understanding of the concept may move past the instruction step and proceed to apply the concepts to the task of solving a problem. Another way to differentiate content is simply to permit the apt student to accelerate their rate of progress. They can work ahead independently on some projects, i.e., they cover the content faster than their peers.

Teachers should consider the following examples of differentiating by content:

- using reading materials at varying readability levels
- presenting ideas through both auditory and visual means
- meeting with small groups to re-teach an idea or skill or to extend the thinking or skills when necessary

Differentiating the Process

Differentiating the process means varying learning activities or strategies to provide appropriate methods for students to explore the concepts and make sense of what they are learning. The content and product is kept consistent for all students, but activities that lead to task completion will vary depending on the learner. A teacher might assign all students the same product (giving a presentation, for example) but the process students use to create the presentation will differ, with some students working in groups to peer critique while others meet with the teacher alone. The same assessment criteria is used for all students.

Teachers should consider flexible groupings of students which include whole class, small group or individual instruction. Students can be grouped according to their learning needs and the requirements of the content or activity presented. It may be necessary to form short-term groups of students for specific purposes.

Teachers should consider the following examples of differentiating by process:

- using activities through which all learners work with the same important understandings and skills, but proceed with different levels of support, challenge, or complexity
- providing activities and resources that encourage students to further explore a topic of particular interest to them
- providing students with activities that contain both in-common work for the whole class and work that addresses individual needs and interests of learners
- offering manipulatives or other supports for students who need them
- varying the length of time a student may take to complete a task in order to provide additional support for a struggling learner or to encourage an advanced learner to pursue a topic in greater depth

Differentiating the Product

Differentiating the product means varying the complexity of the product that students create to demonstrate learning outcomes. Teachers provide several opportunities for students to demonstrate and show evidence of what they have learned. When students have a choice in what the end product can be, they will become more engaged in the activity.

Teachers should consider the following examples of differentiating by product:

- giving students options of how to express required learning (e.g., create an online presentation, write a letter, or develop a mural)
- using rubrics that match and extend students' varied skills levels
- allowing students to work alone or in small groups on their products
- encouraging students to create their own product assignments as long as the assignments contain required elements

Offering students a choice in how they demonstrate their understanding is a powerful way to engage students. It is important to offer students learning activities that are appropriate to their learning needs, readiness, and interests. When learning goals are clearly defined, it is easier to determine whether students should have free choice, a guided choice, or no choice at all.

Differentiating the Product (continued)

Examples of free choice in learning activities include allowing students to

- choose whether or not to work with a partner, and with whom to work
- choose an assessment task they wish to complete
- choose topics for independent study projects

Examples of guided choice in learning activities might include allowing students to

- choose from teacher selected options (e.g., the teacher identifies three articles on a topic, and students choose which one to read based on what their interests are)
- demonstrate their understanding of new concepts by using previously developed skills (e.g., a teacher may allow students who have already developed videography or Power Point presentation skills to demonstrate their understanding of new concepts using one of these mediums)

At times it is appropriate for teachers to provide no choice of learning activities for students. Students will understand and accept not having a choice about a learning activity when the teacher feels it is not in the best interest of students to do so and if the teacher offers choice on a regular basis.

Differentiating the Learning Environment

The learning environment of a classroom is the way a classroom works and feels. It embodies the physical and affective tone or atmosphere in which teaching and learning take place. It also includes the noise level in the room, whether student activities are static or mobile, and how the room is furnished and arranged. A classroom may include tables of different shapes and sizes, spots for quiet individual work, and areas for collaboration.

Teachers can divide the classroom into sections, create learning centres, or have students work both independently and in groups. The structure should allow students to move from whole group, to small group, pairs, and individual learning experiences and support a variety of ways to engage in learning. Teachers should be sensitive and alert to ways in which the classroom environment supports their ability to interact with students individually, in small groups, and as a whole class.

Teachers should consider the following examples of differentiating the learning environment:

- making sure there are places in the room for students to work quietly and without distraction, as well as places that invite student collaboration
- providing materials that reflect a variety of cultures and home settings
- establishing clear guidelines for independent work that matches individual needs
- developing routines that allow students to get help when teachers are busy with other students and cannot help them immediately

Learning Preferences

Students have many ways of learning, knowing, understanding, and creating meaning. How students receive and process information and the ways in which they interact with peers and their environment are indicated by and contribute to their preferred learning styles. Most learners have a preferred learning style, depending on the situation and the type of information the student is dealing with, just as most teachers have a preferred teaching style. Learning experiences and resources that engage students' multiple ways of understanding allow them to focus on their learning processes and preferences.

Teachers should...

Recognize teaching styles and strengths	▪ present authentic and relevant communication situations ▪ manage routines and class organization ▪ provide realistic and motivating classroom experiences
Vary teaching strategies	▪ allow students to construct meaning and connect, collaborate and communicate with each other in a positive learning community ▪ form essential links between the worlds of texts and the students' worlds
Recognize differences in student preferences	▪ allow students to make contemporary, relevant and meaningful choices ▪ give students a sense of ownership of learning goals and empowering a gradual increase of responsibility ▪ allow students multiple ways to demonstrate their learning

Preparing students means engaging them with texts and with people from whom they can learn more about themselves and their world. Prior knowledge and experience has a large impact on their ability to make meaning, and what they will take away from the experience. The learning environment must be structured in such a way that all students can gain access to information and to the community, while developing confidence and competence in applying science to real-life situations. Through the science curriculum, students must be encouraged to question their assumptions and attitudes, and to develop a deeper understanding of the nature of science.

The Inclusive Classroom

Valuing Equity and Diversity

In addition to differentiating instruction, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must strive to actively address cultural and gender stereotyping with respect to student interest and success in science and mathematics. Research supports the position that, when science curriculum is personally meaningful, and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science, and, indeed, for all students.

Effective inclusive schools have the following characteristics: supportive environment, positive relationships, feelings of competence and opportunities to participate. (The Centre for Inclusive Education, 2009)

An inclusive classroom values the social and ethnocultural backgrounds of all students while creating opportunities for community building. Students can learn much from the diverse backgrounds, experiences, and perspectives of their classmates in a community of learners where participants discuss and explore their own and others' customs, histories, traditions, values, beliefs and ways of seeing and making sense of the world. Students from different social and cultural backgrounds can come to understand each other's perspectives, to realize that their ways of seeing and knowing are not the only ones possible, and to probe the complexity of the ideas and issues they are examining. Learning resources should include a range of materials that allows students to hear diverse social and cultural voices and to broaden their understanding of social and cultural diversity.

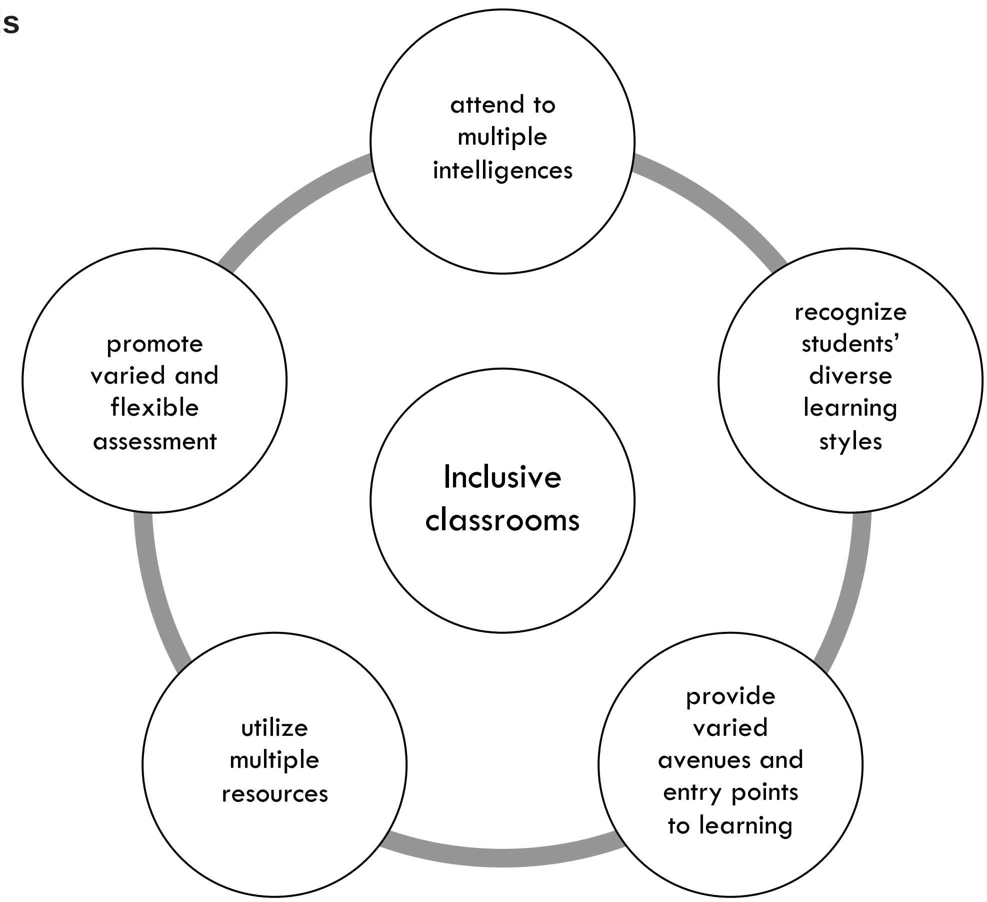
Science activities can provide opportunities in a safe and caring environment for students to express feelings, to think critically about problem solving, or to simply reflect on current issues. All students need to see their lives and experiences reflected in their school community. It is important that the curriculum reflect the experiences and values of both genders and that learning resources include and reflect the interests, achievements, and perspectives of all students. The promotion of inclusive attitudes builds respect for one another, creates positive interdependence and allows for varied perspectives.

Students with Language and Communication Exceptionalities

Some students may need specialized equipment such as braillers, magnification aids, word processors with spell checkers, and other computer programs and peripherals such as voice synthesizers or large print to help achieve outcomes.

Teachers should adapt learning contexts to provide support and challenge for all students, using the continuum of curriculum outcomes statements in a flexible way to plan learning experiences appropriate to students' learning needs. When specific outcomes are not attainable or appropriate for individual students, teachers can use statements of general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes for previous and subsequent grade levels as reference points in setting learning goals for individual students.

Meeting the Needs of Students with Exceptionalities



Students with Advanced Abilities

Advanced learners need experiences working in a variety of grouping arrangements, including partnering, mixed-ability and similar-ability cooperative learning groups, and interest groups. Many of the suggestions for teaching and learning in this curriculum guide provide contexts for acceleration and enrichment (e.g., the emphasis on inquiry, problem solving and decision making). The flexibility with regard to the choice of learning resources also offers opportunity for challenge and extension to advanced learners.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity, and validate students when they achieve the outcomes to the maximum of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equal opportunities to experience success as they work toward the achievement of designated outcomes. A teacher should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Communicating in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to learn. Students, at all grade levels, should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note-making is also an intrinsic part of learning in science that can help students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawings, and diagrams to represent data and results helps students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in and demonstration of the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

Assessment and Evaluation

What learning is assessed and evaluated, how it is assessed and evaluated, and how results are communicated send clear messages to students and others about what is really valued—what is worth learning, how it should be learned and what elements or qualities are considered important.

Assessment techniques are used to gather information for evaluation. Information gathered through assessment helps teachers determine students' strengths and needs in their achievement of science and guides future instructional approaches. Practices must meet the needs of diverse learners in classrooms and should accept and appreciate learners' linguistic and cultural diversity.

Teachers are encouraged to be flexible in assessing the learning success of all students and to seek diverse ways in which students might demonstrate what they know and are able to do. Assessment criteria and the methods of demonstrating achievement may vary from student to student depending on strengths, interests, and learning styles.

Evaluation involves the weighing of the assessment information against a standard in order to make an evaluation or judgment about student achievement. Assessment can be a preliminary phase in the evaluation process.

Foundation for the Atlantic Canada Science Curriculum suggests experiences that support learning within Science-Technology-Society and the Environment (STSE), skills, knowledge, and attitudes. It also reflects the three major processes of science learning: inquiry, problem solving, and decision making. When assessing student progress, it is helpful for teachers to know some activities/skills/actions that are associated with each process of science learning. Examples of these are illustrated in the following lists. Student learning may be described in terms of ability to perform these tasks.

Inquiry

- define questions related to a topic
- refine descriptors/factors that focus practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment which tests relationships and variables
- write lab reports that meet a variety of needs (limit the production of "formal" reports) and place emphasis on recorded data
- recognize that the quality of both the process and the product are important

Problem Solving

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a product or device intended to solve a problem
- construct a variety of acceptable prototypes, pilot test, evaluate, and refine to meet a need
- present the refined process/product/device and support why it is "preferred"
- recognize that the quality of both the process and the product are important

Decision Making

- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information in a balanced manner
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a "best" solution

Assessment Techniques

Assessment techniques should match the style of learning and instruction employed. Several options are suggested in this curriculum guide from which teachers may choose depending on the curriculum outcomes, the class, and school/district policies. It is important that students know the purpose of an assessment, the method used, and how it will be scored. To support formative assessment, the results, when reported to students, should indicate the improvements expected. Assessment techniques suggested in column three of the guide include:

- Observation
- Performance
- Journal
- Interview
- Paper and Pencil
- Presentation
- Portfolio

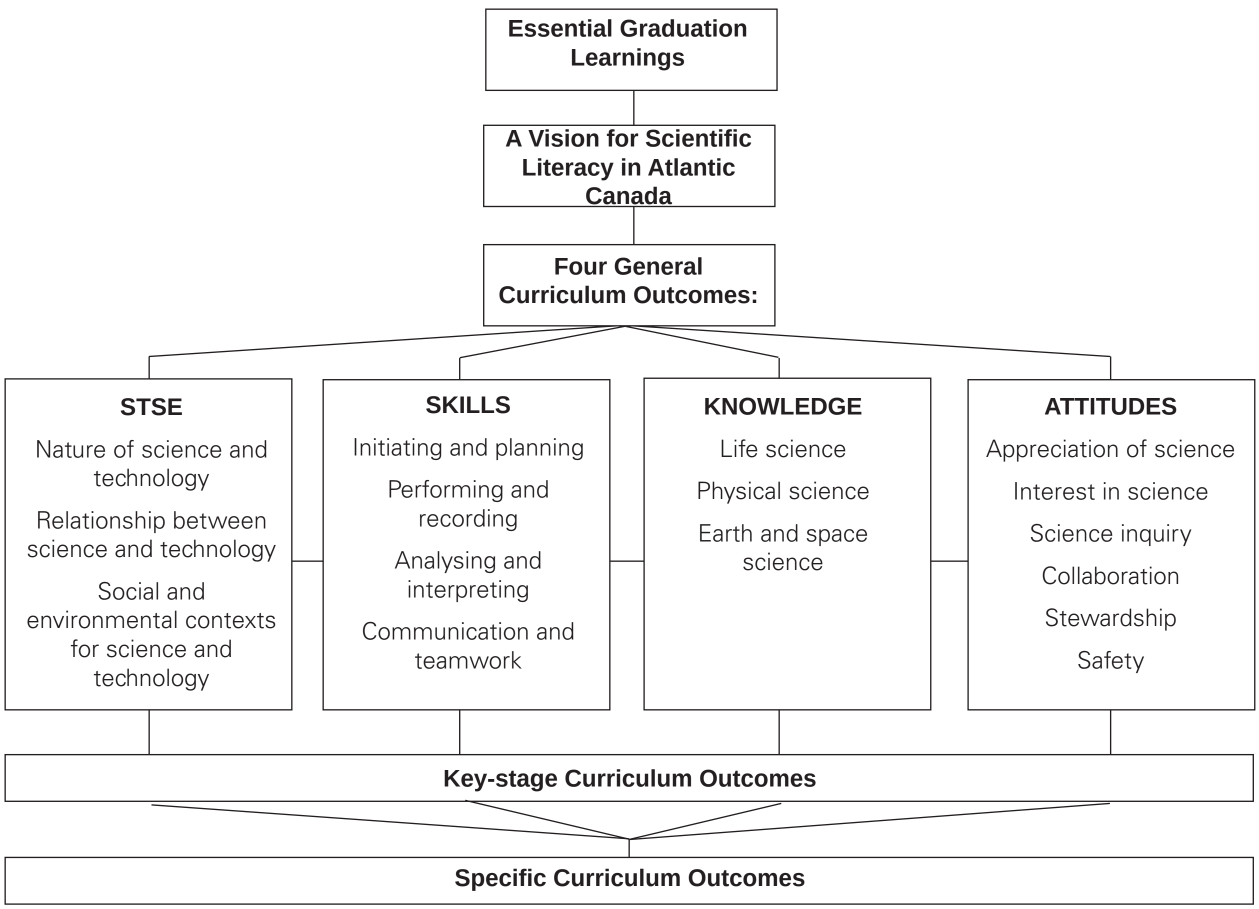
For a description of these techniques and a detailed discussion on assessment and evaluation refer to Appendix C.

Outcomes

Outcomes Framework

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The conceptual map shown in Figure 1 provides the blueprint of the outcomes framework.

FIGURE 1



This curriculum guide outlines course-specific curriculum outcomes and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes. Teachers should consult the *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are:

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Spiritual and Moral Development

Graduates will demonstrate understanding and appreciation for the place of belief systems in shaping the development of moral values and ethical conduct.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four categories of general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K to 12*.

Specific Curriculum Outcomes

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings. Specific curriculum outcomes are organized in units for each grade level.

Curriculum Guide Organization

Specific curriculum outcome statements describe what students should know and be able to do at the end of each course. They are intended to serve as the focus for the design of learning experiences and assessment tasks. Specific curriculum outcomes represent a reasonable framework for assisting students to achieve the key-stage, general curriculum outcomes, and, ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in units for each course. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a course appear in the guide is meant to suggest a sequence. In some cases the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit may introduce a concept which is then extended in a subsequent unit. Likewise, it is possible that one unit focuses on a skill or context which will then be built upon later in the year.

It is also possible that units or certain aspects of units can be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. The intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful and socially and culturally relevant contexts.

Unit Organization

All units comprise a two-page layout of four columns as illustrated in Figure 2, p. 20. In some cases the four-column spread continues to the next two-page layout. Each unit comprises outcomes grouped by a topic which is indicated at the top of the left hand page.

Column One: Specific Curriculum Outcomes

The first column lists a group of related specific curriculum outcome statements. These are written in the context of Newfoundland and Labrador Grade 7 Science and based on the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in brackets after the outcome statement. Some STSE and skills outcomes have been written in an age-appropriate context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary in order to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column Two: Elaborations - Strategies for Learning and Teaching

The second column provides suggestions for the learning environment and experiences that will support students' achievement of the outcomes listed in the first column. Elaborations of the outcomes may be included in this column as well as background information.

The suggestions in this column are intended to provide a holistic approach to instruction. In some cases, the suggestions in this column address a single outcome; in other cases, they address a group of outcomes.

Column Three: Suggestions for Assessment

The third column provides suggestions for ways that students' achievement of the outcomes may be assessed. These suggestions reflect a variety of assessment techniques which include, but are not limited to, informal/formal observation, performance, journal, paper and pencil, interview, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Resources

The fourth column identifies sources of materials and ideas, which may assist in the learning and teaching of the outcomes. These resources do not address the entire scope of the science curriculum. Since a resource-based learning philosophy is espoused, teachers are encouraged to use other appropriate resources, which will contribute to the achievement of the outcomes.

FIGURE 2
Curriculum Outcomes Organization:
The Four-Column, Two-Page Spread

Topic

Outcomes	Strategies for Learning and Teaching	Suggestions for Assessment	Resources
• Outcome based on pan-Canadian outcomes (###,###) – clarification outcomes	Suggested activities and elaborations of outcome	*Informal/Formal Observation* *Performance* • sample assessment item (###) *Journal*	Authorized and recommended resources that address the outcome
• Outcome based on pan-Canadian outcomes (###) – clarification outcomes – clarification outcomes	Suggested activities and elaborations of outcome	*Paper and Pencil* *Interview* • sample assessment item (###) *Presentation* *Portfolio*	Authorized and recommended resources that address the outcome

Unit Overview

At the beginning of each unit, there is a two-page synopsis. On the first page, introductory paragraphs give a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, and/or decision making) and possible contexts for the unit. Finally, a curriculum-links paragraph specifies how this unit relates to science concepts and skills that will be addressed at later grades so teachers will understand how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that will be addressed in the unit. The numbering system used is the one followed in the Pan-Canadian document:

100s - Science-Technology-Society-Environment (STSE) outcomes

200s - Skills outcomes

300s - Knowledge outcomes

400s - Attitude outcomes (see pages 18-19)

These code numbers appear in brackets after each specific curriculum outcome (SCO).

Within each unit Pan-Canadian outcomes are written in the context of Newfoundland and Labrador's Grade 7 Science curriculum.

FIGURE 3
Unit Overview

Unit Title: Unit Overview		Unit Title: Curriculum Outcomes		
Introduction	Synopsis of the unit	**STSE**	**Skills**	**Knowledge**
Focus and Contexts	Focus: inquiry, decision making, or problem solving. Possible contexts suggested	###Science-Technology-Society-Environment outcomes from C*ommon Framework of Science Learning Outcomes K to 12*	###Skills outcomes from *Common Framework of Science Learning Outcomes K to 12*	###Knowledge outcomes from *Common Framework of Science Learning Outcomes K to 12*
Curriculum Links	Links to concepts studied within the K to 12 science curriculum			

Attitude Outcomes

It is expected that certain attitudes will be fostered and developed throughout the entire science program, entry to grade 12. The STSE, skills, and knowledge outcomes contribute to the development of attitudes and opportunities for fostering these attitudes are highlighted in the *Suggestions for Learning and Teaching* section of each unit.

Attitudes refer to generalized aspects of behaviour that are modelled for students by example and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcomes statements for attitudes are written for the end of grades 3, 6, 9, and 12. These outcomes statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12*.

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

Appreciation of Science

For grades 7 to 9 it is expected that students will be encouraged to . . .

422 appreciate the role and contribution of science and technology in our understanding of the world

423 appreciate that the applications of science and technology can have advantages and disadvantages

424 appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds

Evident when students, for example,

- consider the social and cultural contexts in which a theory developed
- use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on an STSE issue
- recognize the usefulness of being skilled in mathematics and problem solving
- recognize how scientific problem solving and the development of new technologies are related
- recognize the contribution of science and technology to the progress of civilizations
- discuss the pros and cons associated with the applications of science and technology
- recognize that western approaches to science are not the only ways of viewing the universe
- consider the research of both men and women

Interest in Science

For grades 7 to 9 it is expected that students will be encouraged to . . .

425 show a continuing curiosity and interest in a broad scope of science-related fields and issues

426 confidently pursue further investigations and readings

427 consider many career possibilities in science- and technology-related fields

Evident when students, for example,

- conduct research to answer their own questions
- have an interest in further studies in science
- use a variety of methods and resources to increase their own knowledge and skills
- are interested in science and technology topics not directly related to their formal studies
- explore where further science- and technology-related studies can be pursued
- use scientific vocabulary in everyday discussions
- readily investigate STSE issues

Scientific Inquiry

For grades 7 to 9 it is expected that students will be encouraged to . . .

428 consider observations and ideas from a variety of sources during investigations and before drawing conclusions

429 value accuracy, precision, and honesty

430 persist in seeking answers to difficult questions and solutions to difficult problems

Evident when students, for example,

- ask questions and conduct research to confirm and extend their understanding
- recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen
- expend the effort and time needed to make valid inferences
- assess their opinion of the value of science and its applications
- criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist
- seek explanations when confronted with discrepant events or evidence

Collaboration

For grades 7 to 9 it is expected that students will be encouraged to . . .

431 work collaboratively in carrying out investigations as well as in generating and evaluating ideas

Evident when students, for example,

- willingly work with any classmate or group of individuals, regardless of their age, gender, or physical and cultural characteristics
- assume a variety of roles within a group, as required
- accept responsibility for any task that helps the group complete an activity
- give the same attention and energy to the group's product as they would to a personal assignment

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

- are attentive when others speak
- are capable of suspending personal views when evaluating suggestions made by a group
- seek the points of view of others and consider diverse perspectives
- accept constructive criticism when sharing their ideas or points of view
- criticize the ideas of their peers without criticizing the person
- evaluate the ideas of others objectively
- encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision-making
- contribute to peaceful conflict resolution
- encourage the use of a variety of communication strategies during group work
- share the responsibility for errors made or difficulties encountered by the group

Stewardship

For grades 7 to 9 it is expected that students will be encouraged to . . .

432 be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment

433 project, beyond the personal, consequences of proposed actions

Evident when students, for example,

- willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation
- assume part of the collective responsibility for the impact of humans on the environment
- participate in civic activities related to the preservation and judicious use of the environment and its resources
- encourage their peers or members of their community to participate in a project related to sustainability
- consider a variety of perspectives when addressing issues, weighing scientific, technological, and ecological factors
- participate in social activities that influence environmental policy in their community
- examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans
- willingly promote actions that are not injurious to the environment
- make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations
- are aware of the short- and long-term consequences of sustainability

Safety

For grades 7 to 9 it is expected that students will be encouraged to . . .

434 show concern for safety in planning, carrying out, and reviewing activities

435 become aware of the consequences of their actions

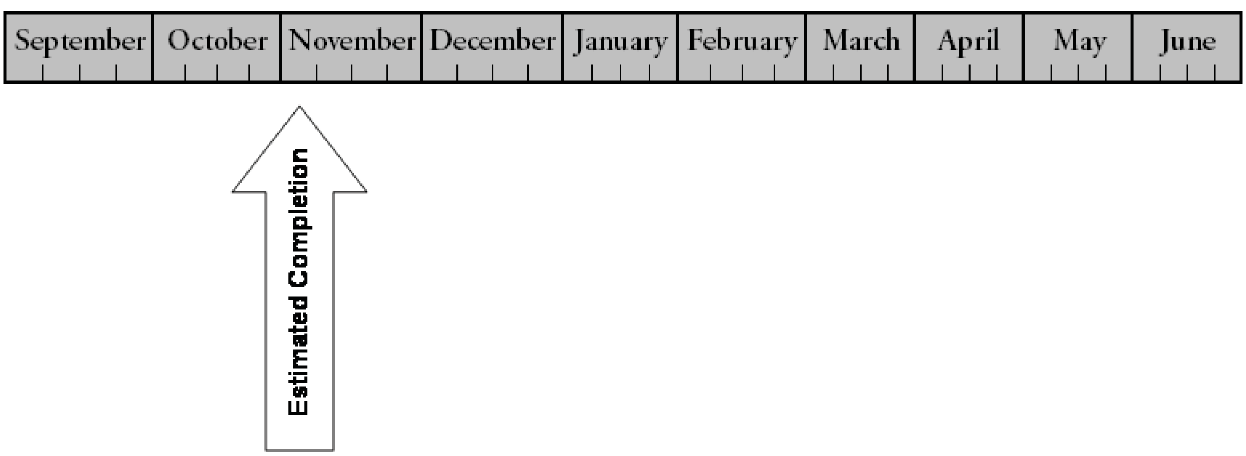
Evident when students, for example,

- read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood
- recognize procedures that are not safe or that could have a negative impact on the environment
- consider safety a positive, limiting factor in scientific and technological endeavours
- be aware of the risks and potential consequences of their actions in the laboratory
- consider safety and waste-disposal concerns when conducting laboratory activities
- be aware that inappropriate disposal of wastes can have a long-term impact on the environment and the quality of life of living organisms
- assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place
- seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions
- keep the work station uncluttered, with only appropriate lab materials present

Unit 1

Interactions Within Ecosystems

Suggested Percentage: 22%



Unit Overview

Introduction

Ecosystems are comprised of both living and nonliving things. Some ecosystems can be very large and cover vast areas of the Earth. Other ecosystems, such as a small pond or a rotting log, can be localized to a very small area. Each ecosystem can be described by the types of organisms that live there and by the physical (nonliving) conditions that exist there. The interactions between the organisms and the physical conditions work to create the ecosystem. By the end of grade 6, students have learned that the variety of living things on Earth, as well as the places in which they live, are seemingly endless. Through their study of the concepts in this unit, students will further refine their understanding of the places in which organisms live and how the interactions between living and nonliving things create these special living spaces as well as how humans can affect these spaces.

Focus and Context

The focus of this unit should be on inquiry and decision-making. Students should be encouraged to think about the ecological concepts they are learning with reference to their local community. While they are learning about the often fragile relationships that exist between the living and nonliving parts of ecosystems, they should consider what impact they, individually and as part of a larger human population, have upon the ecosystems in their local area. Students should also be encouraged to think beyond the borders of their local community when thinking about human impacts on ecosystems.

Questions directed to students concerning local ecosystems and the changes (or proposed changes) to them could elicit interest and discussion at the beginning of the unit. Questions such as, “What do you think will happen to the wildlife in an area if a golf course is constructed?” or “What kinds of animals would a community attract if a proposed land fill site were built?” could be used to heighten student interest in their local ecosystems. The answers to these questions could be developed throughout this unit.

Science Curriculum Links

By the end of elementary grades, students have learned that there is a great variety of living things on earth. They have also learned that these living things live in a variety of habitats. They have also learned that the habitats in which organisms live are often specific to that organism (i.e., the habitat provides things the organism needs in order to survive). In this unit students will further refine these understandings and will learn that living things interact with each other and with the nonliving things in the habitat to create an ecosystem and how humans can impact these ecosystems. These concepts will be further developed in Science 1206, Science 2200, Biology 2201 and Environmental Science 3205.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

109-12 distinguish between terms that are scientific or technological and those that are not

109-13 explain the importance of choosing words that are scientifically or technologically appropriate

Relationships Between Science and Technology

111-1 provide examples of scientific knowledge that have resulted in the development of technologies

111-6 apply the concept of systems as a tool for interpreting the structure and interactions of natural and technological systems

Social and Environmental Contexts of Science and Technology

112-3 explain how society's needs can lead to developments in science and technology

112-4 provide examples of Canadian institutions that support scientific and technological endeavours

112-8 provide examples to illustrate that scientific and technological activities take place in a variety of individual or group settings

112-9 identify science- and technology-based careers in their community

113-1 identify some positive and negative effects and intended and unintended consequences of a particular scientific or technological development

113-9 make informed decisions about applications of science and technology, taking into account environmental and social advantages and disadvantages

113-11 propose a course of action on social issues related to science and technology, taking into account personal needs

Skills

Students will be expected to

Initiating and Planning

208-2 identify questions to investigate arising from practical problems and issues

208-3 define and delimit questions and problems to facilitate investigation

208-5 state a prediction and a hypothesis based on background information or an observed pattern of events

208-6 design an experiment and identify major variables

Performing and Recording

209-1 carry out procedures controlling the major variable

209-3 use instruments effectively and accurately for collecting data

209-4 organize data using a format that is appropriate to the task or experiment

Analyzing and Interpreting

210-1 use or construct a classification key

210-2 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

Communication and Teamwork

211-2 communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means

211-3 work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

211-4 evaluate individual and group processes used in planning, problem solving, decision making, and completing a task

211-5 defend a given position on an issue or problem, based on their findings

Knowledge

Students will be expected to

304-1 explain how biological classification takes into account the diversity of life on Earth.

304-2 identify the roles of producers, consumers, and decomposers in a local ecosystem, and describe both their diversity and their interactions

306-1 describe how energy is supplied to, and how it flows through, a food web

306-2 describe how matter is recycled in an ecosystem through interactions among plants, animals, fungi and microorganisms

306-3 describe interactions between biotic and abiotic factors in an ecosystem

306-4 identify signs of ecological succession in a local ecosystem

Ecosystems

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• identify questions related to a local ecosystem such as "What types of organisms live in a particular ecosystem?" (208-2, 208-3)	Teachers could begin this unit with a brainstorming session in which students express their current conceptions of what an ecosystem is and what it looks like. From personal experiences and the elementary science program, students may generate examples of local areas, living things or local conditions (such as, wet, sunny, etc.). Students will have investigated and studied components and elementary relationships of and in ecosystems in grades 4 and 6. A "K-W-L" (What I **K**now **-** **W**ant to Learn **-** **L**earned) chart could be started. With this approach, previous knowledge and understanding could be assessed and areas of common interests could be identified. Refer to Appendix B for more details on this and other teaching strategies mentioned in this guide.
- describe an ecosystem as a group of interacting living and nonliving things	Teachers could build a list of student "terms" or "concepts" that help describe ecosystems. These could be used to build a class definition of an ecosystem. The definition could be refined throughout the unit as more scientific concepts regarding ecosystems are covered. Students should realize that an ecosystem is not defined by its geographic size; they can be very small (e.g., a rotting log) or very massive (e.g., Atlantic Ocean). Therefore, there are many, many different ecosystems throughout the province, country and world.
- identify examples of ecosystems within Newfoundland and Labrador, including: (i) coastline and ocean (ii) freshwater (iii) arctic (iv) forest	To broaden student perception and ensure that more than the immediate local ecosystem is described, teachers could show pictures of various Newfoundland and Labrador ecosystems. Many videos and television shows are available that illustrate ecosystems. Teachers could provide examples of the different organisms found in each of these ecosystems. When addressing the topic of "food chains" and "food webs" later in this unit, teachers could incorporate organisms from these ecosystems in their examples.

Ecosystems

Suggested Assessment Strategies

Journal

- Two questions I would like to investigate related to my local habitat are ..... (208-2, 208-3)
- “The thing that I would like to investigate the most when I visit our ecosystem is...” (304-2, 306-3)

Presentation

- Students can create a multimedia presentation depicting pictures of various Newfoundland and Labrador ecosystems. (210-2, 306-3)
- Create a poster/collage showing several examples from typical Newfoundland and Labrador ecosystems. (210-2, 306-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 4-6

BLM 1-3

TR AC 24

ST pp. 8-9

ST pp. 10-12

Conventions used in Resources Column

ST - Student Text

TR - Teacher Resource

TR AC - Assessment Checklist

TR PS - Process Skills Rubric

TR AR - Assessment Rubric

BLM - Black Line Master

BLM 7 Activity # - Additional BLMs for each grade level

Components of an Ecosystem

Outcomes

Students will be expected to

- demonstrate the importance of choosing words that are scientifically appropriate (109-12, 109-13)
  - define and use terms in context, including:
    - (i) ecosystem
    - (ii) abiotic
    - (iii) biotic
    - (iv) species
    - (v) organism
    - (vi) population
    - (vii) community
    - (viii) habitat
    - (ix) niche

Elaborations - Strategies for Learning and Teaching

Teacher should note that these terms appear throughout the unit. All terms could be introduced and defined at once, or when required within the unit. Students would have encountered many of these terms in previous grades. They should be encouraged to use the appropriate language when discussing and exploring ecosystems.

After the terminology has been introduced teachers could use a Quiz-Quiz-Trade activity (Appendix B) to provide students with opportunity to practice and use these terms. Quiz cards could contain definitions of the terms, the term with an example, a question (with answer) associated with the term, etc. For example one Quiz card could have the term "abiotic" written on one side and the definition on the reverse side. Another Quiz-Quiz-Trade card could have the term "population" on one side and an example of this or question related to it on the other (e.g., "Which term best describes 200 moose, including males, females, and young in an area?"). Quiz cards for each of the terms could be created in this manner. Refer to Appendix B for more information on using Quiz-Quiz-Trade activities.

Teachers should conduct an activity to introduce the use of scientifically appropriate language to describe ecosystems. For example, students could write a paragraph, using scientific terms, to describe a forest. While students may not be able to use all the terms, they should be encouraged to use as many as they can. Students should be able to demonstrate their understanding of the terminology and related concepts associated with the interactions within one of the ecosystems previously discussed. Students are not expected to simply give definitions for these terms. These terms and concepts should be introduced in the context of the chosen ecosystem and students should be able to use them appropriately in context.

Teachers could have students start a mind map with "ecosystems" at the centre (see Appendix B).

Components of an Ecosystem

Suggested Assessment Strategies

Paper and Pencil

- Students can create a foldable vocabulary book in which they can store definitions for the unit. (211-2)

Performance

- Create a poem or rap that uses as many of the “ecosystem” terms as possible. (109-13, 211-2)
- Write a letter to a friend that uses the “ecosystem” terms properly.
- Create a foldable to explain and illustrate the “ecosystem” terms. Share your creation with your classmates. (109-12, 109-13)

Journal

- How would you explain the following terms so that a grade 3 or 4 student would understand their meanings and relationships: niche, ecosystem, community, population, and habitat? (109-13)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 8-9, 17-19, 24-25

TR AC 13

Components of an Ecosystem (continued)

Outcomes

Students will be expected to

- investigate the biotic and abiotic factors of a local ecosystem (306-3)
  - define range of tolerance
  - describe the following abiotic factors of local ecosystems
    - (i) intensity of sunlight
    - (ii) air, soil and water temperature
    - (iii) wind direction and speed
- define and delimit questions to investigate in a local ecosystem (208-3)
- organize and record information collected in an investigation of an ecosystem using instruments effectively and accurately (209-3, 209-4)
- communicate questions, ideas, plans, and results, using lists, notes in point form, sentences, oral language, and other means (211-2)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (211-3)
- evaluate individual and group processes used in planning, decision making, and completing a task (211-4)
- use a key to identify the biotic factors observed in the local ecosystem (210-1)

Elaborations - Strategies for Learning and Teaching

Many other abiotic factors could be discussed, however it is important to note that a much more in-depth examination of this concept occurs in Science 1206 and Science 2200.

Teachers should ensure that students understand that organisms may have a wide range of tolerance for one abiotic factor (e.g., temperature) and a narrow range of tolerance for another (e.g., soil acidity).

Teachers could ask students to engage in a Think Pair Share (Appendix B) on which abiotic factors they think have the greatest impact on the local ecosystems.

Core Laboratory Activity: Field Trip to the Schoolyard

The laboratory outcomes 208-3, 209-3, 209-4, 211-2, 211-3, 211-4 and, in part, 306-3 are addressed by completing CORE LAB 1-2A “Field Trip to the Schoolyard”.

Students should brainstorm possible questions to investigate when visiting and observing a local ecosystem. Teachers should ensure that the brainstorming session elicits questions related to concepts such as the intensity of sunlight, air, soil or water temperature, wind direction and speed, soil type as well as the different species that inhabit the ecosystem. Teachers should inform students of the questions that will be investigated on the field trip to the local ecosystem.

In groups, students should decide how they will record their observations. Teachers should realize that not all students will choose the same method of recording (e.g., anecdotal recording vs. creating a table or chart). This may provide an opportunity for teachers to discuss the strengths and weaknesses of the different methods.

Students could use instruments such as magnifying glasses, field binoculars, digital cameras, and hand-held microscopes to closely observe organisms in the ecosystem. Students could use thermometers (air and soil), light meters, anemometers (wind meters) and weather vanes to collect abiotic data. Students could use field guides or classification keys to identify some of the biotic factors present such as wild flowers or trees.

Upon return to class, students should be prepared to look for specific items. For example, students should attempt to identify the biotic factors of the ecosystem they observed. Field guides or teacher-created posters/photos of local flora and fauna could be used. Identification should be based on observable characteristics only.

Components of an Ecosystem (continued)

Suggested Assessment Strategies

Performance

- Use a key, provided by the teacher, to identify the biotic factors from the ecosystem you observed in the field trip. (210-1, 209-3, 209-4)

Presentation

- Students can collect track impressions and scat samples during field excursions and display them on poster boards in the classroom. This could show diversity of fauna. Ensure students follow proper safety protocols. (208-3, 306-3)
- Create a poster showing collected and identified flora from a local ecosystem. (210-2, 306-3)

Paper and Pencil

- Describe how abiotic factors such as sunlight intensity and wind speed differ as one moves from a forest to a bog. (306-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 17-19

BLM 1-4

Core Lab #1: Field Trip to the Schoolyard, p. 20

TR 1.12-1.13

TR AC 1, 18, 21, 22

TR PS 2, 8, 10

TR AR 3, 5, 6

ST p. 455 (Science Skills)

Interactions Within an Ecosystem

Outcomes

Students will be expected to

- describe interactions between biotic and abiotic factors in an ecosystem, including:
  - (i) biotic-abiotic
  - (ii) abiotic-abiotic
  - (iii) biotic-biotic

  (306-3)

Elaborations - Strategies for Learning and Teaching

Students could describe interactions such as; worms aerate soil (biotic-abiotic), sunlight evaporates water (abiotic-abiotic), and insects eat plants (biotic-biotic).

Teachers should focus on more than just feeding interactions as examples of biotic-biotic interactions (i.e., a bird makes its nest in a tree).

Students could use terrariums, jars or pop bottles to construct their own ecosystem. In constructing these systems, students will need to make various decisions, such as: What organisms will be included? How will I make it sustainable? What biotic and abiotic factors must be taken into account in the design? Will I include animals or just plants? Can I construct an aquatic ecosystem?

- investigate an interaction between a biotic and an abiotic factor in an ecosystem (306-3)
- design and carry out an experiment controlling major variables (208-6, 209-1)
- organize, compile and display data using tables (209-4, 210-2)
- defend a given position on an issue or problem based on their findings (211-5)

Core Laboratory Activity: Salty Seeds

The laboratory outcomes 208-6, 209-1, 209-4, 210-2, 211-5 and , in part, 306-3 are addressed by completing CORE LAB 1-2B “Salty Seeds”.

This will be the first lab in the Intermediate Curriculum to follow a formal methodology. Teachers should review the main components of scientific methodology with a focus on variables (manipulated, responding and control), the importance of controlling all but the manipulated variable, the role of careful observation and recording of data. Teachers should also emphasize the importance of safety in the lab setting. Teachers could also take this opportunity to discuss Nature of Science topics including the fact that there is no such thing as one “scientific method”. Teachers should note that the student textbook uses the terms independent and dependent instead of manipulated and responding respectively. The use of either is acceptable.

Teachers may wish to use the resources Science Skill 1 and 2 at the back of the text book to review with students before starting the lab.

Students could add the information on biotic-abiotic interactions to their mind map.

Interactions Within an Ecosystem

Suggested Assessment Strategies

Paper and Pencil

- Sketch a local ecosystem (pond, lake, forest, bog, etc.) that you have recently visited. Include all living and non-living parts of the ecosystem. (306-3)
- Why is soil necessary for plant growth? (306-3)
- Create a list of all biotic and abiotic factors you interact with everyday. (306-3)

Journal

- Draw a natural ecosystem of the setting for a television show or novel. (306-3)
- Describe the biotic-biotic, biotic-abiotic, abiotic-abiotic interactions you have had today. (306-3)

Presentation

- Create a poster display to illustrate examples of each type of interaction (biotic-biotic, biotic-abiotic, abiotic-abiotic). (306-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST p. 34

BLM 1-5, 1-7

Core Lab #2: Salty Seeds, p. 22

TR 1.13-1.14

TR AC 1, 4, 18

TR PS 2, 3, 5, 7, 8

TR AR 3, 5

ST pp. 455, 459-463, 472 (Science Skills)

Interactions Within an Ecosystem (continued)

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• identify the niche of producers, consumers, and decomposers in a local ecosystem (304-2)	By discussing the roles and the needs of the living things identified in the ecosystem, students could extend their understanding of the roles and relationships among the producers, consumers, and decomposers.
- define and use in context the terms producer, consumer, and decomposer	At this point in the unit, students should be able to define these terms in a general way such as; producers make their own food (green plants), consumers rely on other organisms for food and decomposers break down dead organisms. Teachers could also refer to microorganisms and fungi when referring to decomposers since both are used in the student textbook.
- define herbivores, carnivores and omnivores in terms of different types of consumers	Teachers should clarify that herbivores eat plants, carnivores eat animals, and omnivores eat both plants and animals.
• given a diverse group of organisms, classify them as producers, consumers, or decomposers (304-1)	Students could identify the organisms of their schoolyard ecosystem as producers, consumers, or decomposers. Students should realize that scientists often classify or organize information in order to simplify it, i.e., make it more useful. For example, one way biologists classify living things is to use categories such as, producers, consumers, or decomposers. Teachers could point out that ecosystems can be classed or described by the types of organisms that are found there. For example, water striders, trout, frogs, lily pads, and sedges would allow one to classify the ecosystem as a pond ecosystem. The presence of moose, spruce, birds, foxes, and mosses denotes a forest ecosystem. Providing students with examples of a variety of organisms that could be classified as producers, consumers or decomposers will help students understand that a wide range of organisms can be associated under these categories. For example, students would come to understand that organisms as diverse as spiders, cats and moose can all be classified as consumers because of their reliance on producers or other consumers. Students could add this information to their mind map. As enrichment or as a further STSE connection, teachers could point out that decomposers pose problems to human food supply and that many techniques have been developed to protect food from decomposers. The student textbook provides several examples of these methods.

Interactions Within an Ecosystem (continued)

Suggested Assessment Strategies

Paper and Pencil

- What happens to the remains of a moose that dies of natural causes deep in the woods? (304-2, 306-2)
- Describe the niche of the decomposers in an ecosystem. (304-2)
- Plants are producers and fungi are decomposers. Use a Venn diagram to show which conditions, essential for growth and development, might be common for both? (304-2)
- After observing some form of media application (video, television show, magazine article, newspaper article, novel, web site, etc.), classify organisms in the application as producers, consumers, or decomposers. (304-1, 210-1)

Performance

- Prepare a model of an ecosystem from modeling clay and identify the producers and consumers in their habitats. (304-1)

Presentation

- Use a bar graph or pie chart to represent the diversity of producer populations in your backyard. (304-1)
- Collect pictures of living organisms from various sources and label them as producers, consumers, and decomposers. (210-1, 304-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 25, 40-42

ST pp. 40-41

ST pp. 40-42

Energy Flow in an Ecosystem

Outcomes

Students will be expected to

- describe how energy is supplied to, and how it flows through, a food chain (306-1)
  - recognize that producers use light energy, carbon dioxide, and water (photosynthesis) to produce energy for the ecosystem
  - define food chain
  - construct simple food chains using local examples
  - classify the organisms within food chains as producers, herbivores, and carnivores

Elaborations - Strategies for Learning and Teaching

While this is the first introduction to photosynthesis, it is not a major component or focus of the unit. The depth of treatment should be limited to that which allows students to explain that a plant's energy is derived from the conversion of light energy, carbon dioxide from the air and water into food energy. Students could use a word equation to illustrate the process of photosynthesis as follows: Carbon dioxide + Water --> (in the presence of sunlight) glucose + Oxygen

Students should describe that the most important role green plants have in any ecosystem is that of being a food (energy) source for consumers and decomposers. Production of oxygen would be considered a by-product of this process.

Students could do a Two-minute Review activity (Appendix B).

Students should construct simple food chains (introduced in grade 4) using the organisms identified in the local ecosystem. Their chains should have a maximum of four links. Teachers should emphasize that the direction of the arrows represent the flow of energy from producers to consumers. Teachers should provide examples of both terrestrial and aquatic food chains.

Teachers could prepare cards with the names of organisms that are part of local food chains written on them. The number of food chains required would depend on the number of students in the class. To conduct the activity, each student would be given a card and instructed to find the other members of their chain. They must also place themselves in the correct position within the chain. Once this is done, the various chains created could be copied down and students could be asked whether changes could be made. This activity could also be extended to concretely introduce students to the concept of the food web.

Students could make a journal entry using the prompt "without plants, no living organisms could exist". After they have made their entry, teachers could engage them in a Think-Pair-Share (Appendix B) to discuss their thoughts on this.

Energy Flow in an Ecosystem

Suggested Assessment Strategies

Paper and Pencil

- Students can create a cartoon representing the feeding interactions of a food chain. (306-1)

Presentation

- In small groups, students perform a role play showing a local food chain. (306-1)

Performance

- In groups of two or three, create a food chain using index cards. The cards represent different organisms. Connect each organism with a string by placing holes in the cards. When completed, connect all food chains created by the groups to form one large food web. Display the food web in the classroom from the wall or ceiling. (111-6, 210-2, 306-1)
- Students can be given cards showing arrows and a variety of Newfoundland and Labrador plants and animals. In groups (or with whole class) they can sort them to create food chain examples. (210-2, 306-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 41, 50-53

ST p. 50

BLM 1-12

ST pp. 40-41, 50-53

BLM 1-11

BLM 7 Activity 2

Energy Flow in an Ecosystem (continued)

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• apply the concept of a food web as a tool for interpreting the structure and interactions of an ecosystem (111-6)	Students should use their knowledge and understanding of food chains to interpret various food webs. It is important that students appreciate the potential complexity of a food web and that an organism in one food web may be part of other food webs.
- define food web	As a supplementary activity teachers could ask students to construct “living food webs”. Each student could represent a different organism in the ecosystem and yarn could be passed between them to represent the flow of energy. Students should gain an appreciation for the complexity of interactions within an ecosystem.
- interpret food webs using organisms from local ecosystems	Students could build on their observations and discussions of previously investigated ecosystems. Given diagrams or models to depict a food web, students should be able to identify relationships and individual food chains. They could identify a number of food chains previously constructed and begin to link the food chains together to form food webs. The flow of energy in food chains should be extended to food webs. Students should come to understand that many producers are usually required to provide the energy/food required for a small number of consumers. Teachers should limit this to a qualitative understanding. This new information could be added to their mind map. Students could engage in a Quiz-Quiz-Trade activity as a review of the terms and concepts to this point.
• describe how energy flows through a food chain and food web (306-1) - recognize that energy flows through food chains and food webs from producers to herbivores to carnivores/ omnivores as well as to decomposers	Students will learn about pyramids of energy in high school, so teachers should limit their discussion on energy flow to the points listed in the outcome. Students should recognize that producers get their energy from the sun, herbivores get their energy from consuming plants and carnivores get their energy from consuming herbivores. At the end of the food chain decomposers get energy from consuming waste or waste products. In this way energy flows through the different levels of the food chain or food web. Using a simple food chain, such as plants --> hare--> fox, teachers could construct a pyramid to illustrate this concept with plants at the bottom, hares in the middle, and foxes at the top. At this point, teachers could discuss that not all energy gets transferred from one level to the next. The “missing energy” in each level has either been used for living functions such as growth, movement, and reproduction or lost as heat from the bodies of the herbivores and carnivores involved. Students are not responsible for quantifying the amount of energy transferred or lost from one level to the next. Teachers should clarify the fact that energy is transformed into other types of energy and is not always used just for growth.

Energy Flow in an Ecosystem (continued)

Suggested Assessment Strategies

Paper and Pencil

- Some people say: "All flesh is grass". Explain what is meant by this statement. (111-6, 306-1)
- Given a blank pyramid and a local food chain (examples of plants/animals) students can correctly place the members of the food chain on the pyramid. They can also draw the pyramid themselves. (210-2, 306-1)

Performance

- Draw a food web of organisms from researching various media sources and illustrate the flow of energy throughout the food web in the form of a poster. (111-6, 210-2, 306-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST p. 54

BLM 1-13

BLM 7 Activity 3

ST pp. 55-56

Energy Flow in an Ecosystem (continued)

Outcomes

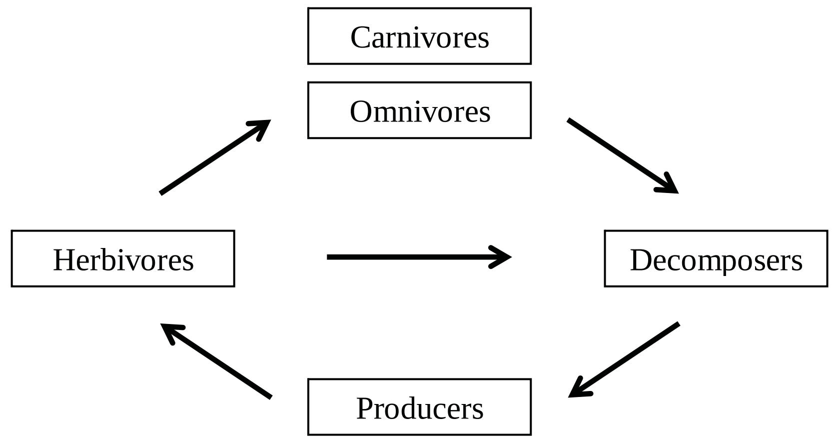
Students will be expected to

- describe how matter is recycled in an ecosystem through interactions among plants, animals, fungi and microorganisms (306-2)
  - illustrate and explain the nutrient cycle

Elaborations - Strategies for Learning and Teaching

It is important that students begin to extend their understanding of the relationships in an ecosystem by including the role of decomposers and looking at the cyclic nature of an ecosystem.

Teachers should emphasize that nutrients are recycled in an ecosystem. All organisms are eventually recycled and their nutrients are returned to the soil through the action of decomposers. The following diagram could be used to illustrate the nutrient cycle:



This nutrient cycle should not be extended to include specific biogeochemical cycles such as nitrogen, water, and carbon-oxygen cycles. These are covered in more detail in Science 1206 and Science 2200.

Students could perform activities in which decomposers can be more broadly and carefully studied to emphasize the fact that most decomposers are microscopic. For example, students could observe mould growing on a piece of bread or fruit. Observation and discussions about such things as rotting logs or stumps and compost in compost bins would help students understand and recognize the essential role decomposers play in an ecosystem.

Students could do a Two-minute Review (Appendix B) to clarify their thinking on this topic.

Energy Flow in an Ecosystem (continued)

Suggested Assessment Strategies

Paper and Pencil

- In an essay, flow chart, or cartoon explain how vegetable peels are recycled in an ecosystem. (111-6, 210-2, 306-1, 306-2)

Journal

- Imagine that you are a nutrient in the soil. Describe your journey through the nutrient cycle back to the soil. (306-2)

Performance

- Create a role play to describe a nutrient's journey through the nutrient cycle. (306-2)
- Write a poem that describes the flow of energy from the sun to decomposer. (111-6, 306-1, 306-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 60-62

Ecological Succession

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• identify changes that have occurred in a local ecosystem over time (306-4) - define succession	The depth of treatment of this topic is limited because the concept of succession will be covered in greater detail and depth in Science 1206 and Science 2200. Teachers could ask students to view pictures, videos, or participate in a field trip to a local area to illustrate the changes that occur in an ecosystem over time. For example, an old farm field may be overgrown with shrubs and trees such as pin cherry, alders and aspen. Students should come to understand that ecosystems are very dynamic. The change may be slow and difficult to perceive over short periods of time as in the establishment of pioneer species such as mosses and lichens in a mined-over area or it may be rapid as in the case of a forest fire.
• construct a flow chart of images to illustrate the changes that will take place in an ecosystem based on the characteristics of the area, including: (i) bare rock to forest (primary succession) (ii) forest re-growth after fire (secondary succession) (208-5, 210-2)	Two types of ecological succession are generally recognized and should be addressed. First, there is primary succession which takes place in areas lacking soil (bare rocks, sand dunes, surface mining areas, and cooled volcanic lava). More common and recognizable to most students is secondary succession. Examples of secondary succession include abandoned farm land, burned forests, and polluted areas. Students should be asked to prepare before and after pictures of local ecosystems. For example, a forest immediately after a fire and 50 years later. It could be advantageous to involve and ask older relatives and/or community members for historical information in order to gain a better appreciation of the magnitude of change over time within a particular ecosystem. Students could engage in a Quiz-Quiz-Trade activity to review the terms and concepts in this section to date.
- recognize that as succession occurs in an area, the ecosystem of the area will also change	Teachers could address this outcome while they are doing the previous one. Teachers should limit the discussion to general statements regarding ecosystem changes such as: “as larger plants grow, there is less light available at the ground level”; “as more plants grow, there are more habitats for animals”; and “as plants grow, there is food available for new animals to move into the area.”

Ecological Succession

Suggested Assessment Strategies

Presentation

- Using various sources, collect pictures of a certain area over a period of at least three decades. Use the changes in the pictures to illustrate the various stages of succession and to describe the processes that are taking place. (306-4)
- Prepare a video presentation of several local areas in which a number of stages of ecological succession are taking place at once. (208-5, 306-4)
- Role play or debate various points of view regarding the preservation of a local habitat that is about to undergo development (e.g., bridge over a salmon river, highway through a forest, building in a recreation area, etc.). Students should be assigned the roles of the different stakeholders. (211-5)
- Describe or illustrate what a sidewalk, an abandoned farm, or a clearcut forest might look like ten years in the future. (208-5)

Performance

- Draw a profile of the landscape surrounding a local pond. Describe how the differences in the landscape as you go further away from the pond represent succession. (306-4)
- Interview an individual who works in an ecosystem (e.g., farmers, loggers, fishers, etc.) to prepare a report on ecological succession in a local area. (306-4)
- Order a series of photographs that show several phases of succession. (306-4)
- Draw a ditch/pond/flower bed/woodlot, etc., 20 years ago, at present, and 20 years in the future. (208-5, 306-4)

Paper and Pencil

- Research why black spruce trees are the first type of tree to grow after a forest fire. (208-5)
- Create a Venn Diagram to illustrate similarities and differences between primary and secondary succession. (208-5, 306-4)

Journal

- Why are blueberries common in an area where a forest was destroyed by fire? (208-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 68-72

ST pp. 68-72

BLM 1-17, 1-18, 1-19

TR AC 14, 15

ST p. 479 (Science Skills)

Ecological Succession (continued)

Outcomes

Students will be expected to

- describe how our need for a continuous supply of wood resulted in the development of silviculture practice (112-3)
- make informed decisions about forest harvesting techniques, taking into account the environmental advantages and disadvantages (113-9)
- provide examples of how our understanding of boreal forest ecology has influenced our harvesting practices, identifying the positive effects of these practices (111-1, 113-1)
- identify various science- and technology-based careers related to forest management and harvesting (112-9)

Elaborations - Strategies for Learning and Teaching

The CORE STSE component of this unit incorporates a broad range of grade 7 science outcomes. More specifically, it targets, in whole or in part, 112-3, 113-9, 111-1, 113-1 and 112-9. The STSE component, “The Two Centimetre Forest” can be found in Appendix A.

Ecological Succession (continued)

Suggested Assessment Strategies

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Appendix A

Environmental Action

Outcomes

Students will be expected to

- defend a course of action to protect the local habitat of a particular organism (113-11)
  - recognize that humans have influenced the natural environment Including:
    - (i) habitat loss/ destruction
    - (ii) harvesting resources
    - (iii) pollution
    - (iv) introduced species
  - discuss the pros and cons of habitat conservation

    Pros
    - (i) sustainability of resource
    - (ii) preservation of biodiversity
    - (iii) eco-tourism

    Cons
    - (i) artificial habitats
    - (ii) economic loss (job loss, etc.)
    - (iii) limited human use

Elaborations - Strategies for Learning and Teaching

Students could go to the federal government's Committee on the Status of Endangered Wildlife in Canada (COSEWIC) web site and use their "wildlife species search" feature to identify endangered or threatened organisms in a local ecosystem or in the province.

Teachers could conduct a brainstorming session to generate the many ways humans have affected their environment. Some examples of this could include the use of ATV's in wetland areas, logging, and open-pit mining.

Students could Think-Pair-Share which of these topics have had the greatest impact on their local ecosystems.

Teachers could use a variety of strategies to discuss the pros and cons of habitat conservation. For example, students could be instructed to write a letter to the editor, create a poster or participate in a role-play. Students could be asked to take a stand on the issue and conduct research to be able to support their position. Teachers could use the ideas generated by students, in these various activities, to engage in a class discussion of this topic.

Teachers could incorporate a discussion of sustainable development into this topic. Students could be challenged to identify the environmental, economic, and social/cultural implications of decisions made related to how their local environment is used. During their discussions, students should recognize that appropriate use of resources often involves compromise in one or more of the three aspects of sustainable development. For example, choosing to drain a bog for development or logging a forested area can result in negative environmental impacts (e.g., destroying ecosystems, removing habitat for certain species thereby reducing biodiversity); positive economic impacts (e.g., good paying jobs, money for government to build hospitals, etc.); negative economic impacts (e.g., as people's income goes up, the price of housing also increases and some people may not be able to afford to buy a house); negative social/cultural impacts (e.g., can change the way of life for many communities, may increase the gap between rich and poor, etc.); and positive social/cultural impacts (e.g., more government money may mean better schools and a better quality education for everyone, etc.).

Students should develop an understanding that decisions to develop any resource should include a discussion of the potential positive and negative effects. Often the decision to develop, or not develop, a particular resource is made after consideration of the positive and negative effects and a "weighing" of these pros and cons.

Environmental Action

Suggested Assessment Strategies

Paper and Pencil

- Write a letter to the editor of a local newspaper outlining your stand for or against an issue related to habitat conservation. (113-11)

Presentation

- Prepare and deliver an oral presentation based on the preservation and protection of a particular habitat. (113-11)
- Explain what might happen to a bog ecosystem if it was exposed to excessive use by all terrain vehicles (ATVs). (306-3)

Performance

- Interview a politician or community leader about a decision made to alter an ecosystem and find out how/if science was used to make the decision. (113-10)
- Participate in a role play/debate on the pros and cons of habitat conservation. (113-11, 211-2)
- Role play or debate various points of view regarding the preservation of a local habitat that is about to undergo development (e.g., bridge over a salmon river, highway through a forest, building in a recreation area, etc.). Students should be assigned the roles of the different stakeholders. (113-11, 211-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 76-83

TR AC 5

BLM 1-20, 1-22

BLM 7 Activity 1

Environmental Action (continued)

Outcomes

Students will be expected to

- recognize that a variety of groups and individuals are interested in protecting the environment (112-4, 112-8)

Elaborations - Strategies for Learning and Teaching

It is not intended that students be knowledgeable of all the individuals or groups working to protect the environment. Students should realize that many groups and individuals are interested in protecting the environment. While teachers may wish to list some of the individuals/ groups, students are not expected to be familiar with them all. Teachers may wish to choose one individual or group to look at in more detail (e.g., when they formed, where they are located, if they have local chapters, their mission and goals, their current and past projects, etc.). Teachers could ask students to work in groups to investigate various local, regional, or national environmental organizations and present what they learn about the group to the class. The following lists provide a starting point for learning about the vast number of individuals and groups working to protect the environment in this province, country, and around the world.

Local groups and individuals could include:
- Protected Areas Association
- Conservation Corps Newfoundland and Labrador
- Department of Environment and Conservation
- Bill Montevecchi

National groups and individuals could include:
- Parks Canada
- Canadian Nature Federation
- Nature Conservancy of Canada
- David Suzuki

International groups could include:
- Friends of the Earth
- World Wildlife Fund
- Ducks Unlimited

This list may change over time and teachers are encouraged to select current examples.

Depending on available time, teachers could ask students to expand their investigation of impacts on local habitats/ecosystems to regional, national and/or international groups that work to address this issue. This would help students identify and associate environmental conservation groups, federal and/or provincial government departments and even Canadians who are well-known for being responsible for, or interested in, aspects of environmental protection.

After completing outcomes 113-11, 112-4 and 112-8, students could use the “What? So What? Now What?” format to create a journal entry (Appendix B) related their thoughts on these issues. Teachers could ask students to share their ideas with the class.

Environmental Action (continued)

Suggested Assessment Strategies

Paper and Pencil

- Write to a group such as the Canadian Wildlife Federation to determine their position on a particular topic or to get information regarding the organization. (112-4, 112-8)

Performance

- Students could engage in an activity to protect and/or enhance a local environment. For example, a beach clean-up, recycling program, or planting trees. (113-11, 211-3)

Presentation

- Give an oral presentation based on the research of a Canadian environmental organization. (112-4, 112-8)

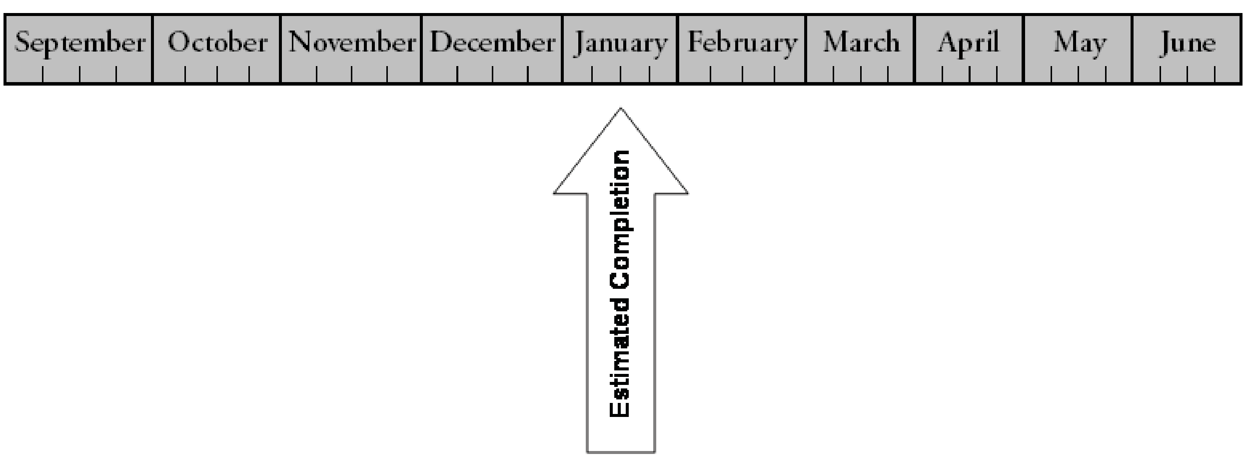
Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Unit 2

Heat

Suggested Percentage: 25%



Unit Overview

Introduction

Through their study of science in the primary and elementary grades, as well as in their everyday life activities, students have encountered the concepts of heat and temperature. To this point, their understanding of these concepts will be general in nature and associated with room and body temperature, foods, weather, warming/cooling buildings, etc. In this unit, students will learn more precise ways of describing and measuring temperature. They will also learn how scientists describe temperature of substances at the sub-microscopic level and the ways in which heat can be transferred from one area or object to another.

Focus and Context

Inquiry and problem solving form the basis of this unit. Students engage in a variety of hands-on-minds-on activities throughout this unit as they develop an understanding of how temperature and heat are related and different. Students should be encouraged to relate the concepts they encounter in this unit to their everyday life and to raise these observations in class.

Science Curriculum Links

At this point in their educational career, students have received little or no formal information related to heat and temperature. While the concepts heat, temperature and kinetic energy will be touched upon in chemistry, this is the only place in the K – 12 science curriculum where these concepts receive this depth of treatment.

Curriculum Outcomes

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** 109-4 provide examples of how technologies used in the past were developed through trial and error 109-7 identify different approaches taken to answer questions, solve problems, and make decision 109-10 relate personal activities in formal and informal settings to specific science disciplines 110-7 provide examples of technologies used in the past to meet human needs 110-8 describe examples of how technologies have been improved over time **Relationships between science and technology** 111-1 provide examples of scientific knowledge that have resulted in the development of technologies **Social and Environmental Contexts of Science and Technology** 112-1 describe how an individual's needs can lead to developments in science and technology 112-9 identify science- and technology-based careers in their community 113-8 make informed decisions about applications of science and technology, taking into account personal and social advantages and disadvantages	*Students will be expected to* **Initiating and Planning** 208-3 define and delimit questions and problems to facilitate investigation 208-5 state a prediction and a hypothesis based on background information or an observed pattern of events 208-6 design an experiment and identify major variables 208-8 select appropriate methods and tools for collecting data and information and for solving problems **Performing and Recording** 209-1 carry out procedures controlling the major variables 209-4 organize data using a format that is appropriate to the task or experiment 209-6 use tools and apparatus safely **Analyzing and Interpreting** 210-2 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 210-11 state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes and initial idea 210-13 test the design of a constructed device or system	*Students will be expected to* 308-1 compare various instruments used to measure temperature 308-2 explain temperature using the concept of kinetic energy and the particle model of matter 308-3 explain how each state of matter reacts to changes in temperature 308-4 explain changes of state using the particle model of matter 308-5 compare transmission of heat by conduction, convection, and radiation 308-6 describe how various surfaces absorb radiant heat 308-7 explain, using the particle model of matter, differences among heat capacities of some common materials

Describing Temperature

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• relate personal activities in formal and informal settings to temperature (109-10)	Teachers could begin this unit by providing an opportunity for students to think about temperature and how it is used in everyday language. This could then be related to the scientific meaning developed in this unit. Students could discuss topics such as what they consider to be “comfortable temperatures” and why some people are cold when others feel warm. As an example, students may feel cold in their classroom despite the temperature being relatively high. As an additional example, students may feel very warm while playing pond hockey on a cold winter day. Students could try to measure with their hands the temperatures of warm and cold water to demonstrate that some ways of measuring temperature are very subjective. The need for standardizing a way to measure temperature should be introduced. This need led to the development of a variety of thermometers. Teachers should leave any discussions regarding the variety of thermometers for later in the unit. Students could make a journal entry on how temperature affects their daily life. Teachers could ask students to share their thoughts with the class to generate discussion.
- define temperature operationally - relate temperature to everyday experiences, including: (i) daily temperature changes (ii) cooking temperatures (iii) refrigeration temperatures (iv) average temperatures in different geographic areas	Temperature should be defined initially as how hot or cold something is. A scientific definition will be presented later in the unit. Students could use weather data from internet sites such as Environment Canada’s weather office or The Weather Network to track and graph temperature changes over time (hourly, daily, weekly).
- predict and identify the temperature of various familiar objects, including: (i) human body temperature (ii) temperatures of boiling and freezing water (iii) comfortable room temperature	Teachers could engage students in activities where they match familiar objects or events with their actual temperatures using teacher created cards. For example, all students could be assigned a card and directed to move around the room to find their match. Once correctly matched students could be asked to organize themselves from coldest to warmest.

Describing Temperature

Suggested Assessment Strategies

Performance

- Students could complete an activity where they place one hand in a beaker of cold water and the other hand in a beaker of hot water at the same time for one minute. They then place their hands in two beakers of water at room temperature (the temperature should be unknown to them). Students can estimate the temperature of the water in each beaker and then measure and record the actual temperature with a thermometer. Students should be challenged to explain any discrepancies between their estimates and actual temperatures. (109-10)

Journal

- "I would define temperature as..." (109-10)

Portfolio

- Complete a survey in which you and 4 other people outside of your class predict the temperature of various objects such as:

Object	Your Prediction °C	Subject 1 Prediction °C	Subject 2 Prediction °C	Subject 3 Prediction °C	Subject 4 Prediction °C
Human body					
Room temperature					
Outside temperature					
Inside a refrigerator					
Deep freeze					
Average temperature of North Pole					

Is there consistency among the predictions? Why or why not? (208-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 106-119

ST pp. 110-118

Conventions used in Resources Column

ST - Student Text

TR - Teacher Resource

TR AC - Assessment Checklist

TR PS - Process Skills Rubric

TR AR - Assessment Rubric

BLM - Black Line Master

BLM 7 Activity # - Additional BLMs for each grade level

Measuring Temperature

Outcomes

Students will be expected to

- provide examples of temperature measuring technologies used in the past, including:
  - (i) Galileo's air thermometer
  - (ii) early liquid thermometers (110-7)
- identify scales used in temperature measurement, including:
  - (i) Celsius
  - (ii) Fahrenheit
  - (iii) Kelvin
- select appropriate methods and tools in order to construct and test a thermometer (208-8, 210-13)
- compile and display data collected in the test of the design of the constructed thermometer (210-2)

Elaborations - Strategies for Learning and Teaching

A survey of the early thermometers (originally called thermoscopes) illustrates that a variety of temperature-measuring technologies have developed over time. Students could use various print and electronic sources to research the historical development of the thermometer and temperature scales. Students could create a time line from their research.

Early thermometers did not have scales attached to them. Scales are necessary for accuracy of measurement as well as comparison of temperatures. The first widely used measuring scale for temperature was developed by Daniel Gabriel Fahrenheit. Anders Celsius based his scale on the freezing and boiling points of water. William Thomson (Lord Kelvin) developed a scale to start at the coldest temperature possible - absolute zero (-273^{o}C).

Students could be asked if they have had any experience with inflatable objects (balls, bicycle tires, etc.) at warm and cold temperatures. Teachers could demonstrate this concept using two balloons. Mylar balloons work very well in this demonstration. Avoid using latex balloons due to prevalence of latex allergies. The balloons could be inflated to the same size at room temperature and then stored in warm and cold locations until next class, at which time they could be examined and compared. This should lead to a discussion of expansion and contraction of matter. These concepts are necessary to understanding how most thermometers work and will be developed in more detail later in the unit.

Students could be presented with the problem of how to measure air temperature in the classroom. Teachers could supply the basic components needed to construct an air thermometer and they or the students could construct, calibrate, and test the air thermometer.

In addition, teachers could supply students with non-calibrated thermometers which can be calibrated using an ice bath and boiling water.

Measuring Temperature

Suggested Assessment Strategies

Paper Pencil

- What types of materials were used in the early types of thermometers? (110-7)

Presentation

- Prepare a poster illustrating the steps in designing, testing, and calibrating an air thermometer. (208-8, 210-13)

Performance

- Using your constructed and calibrated thermometer, test the temperature of the room and compare your results to that of the class and a standard thermometer. Prepare a class bar graph to display the results. (208-8)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 120-123

ST pp. 123-124
TR AC 11
TR AR 4

ST pp. 128-129
BLM 2-3, 2-4, 2-5

Measuring Temperature (continued)

Outcomes

Students will be expected to

- describe various instruments used to measure temperature, including:
  - (i) liquid-in-glass thermometer
  - (ii) thermocouple
  - (iii) resistance thermometer
  - (iv) bimetallic strip (thermostat)
  - (v) infrared thermometer (308-1)

Elaborations - Strategies for Learning and Teaching

Students should have the opportunity to explore and examine a variety of instruments used to measure temperature, particularly to relate each instrument to its particular use. Centres that highlight the various types of thermometers could be set up in the classroom, and groups of students could rotate through centres, using the thermometers to measure the classroom air temperature or the temperature of a variety of substances. They could also conduct research on the various types of thermometers. Most students will have had some experience with liquid in glass thermometers and/or digital thermometers used to take the body's temperature.

The alcohol thermometer should be introduced and students should learn to use the thermometer to measure temperature. Computer temperature probes, if available, could be utilized to take temperature readings. Teachers should clarify that some of these instruments may also provide digital readings.

If possible teachers should avoid the use of mercury thermometers throughout this unit. **Teachers should refer to Newfoundland and Labrador School Science Safety Manual concerning the use of mercury in school settings.**

A detailed explanation of how each instrument is used to measure temperature is not necessary. Teachers should limit this discussion to a brief description of the device and a comparison of situations in which these instruments are used.

Students could create a mind map to summarize the information they have received to this point. "Heat" should be at the centre. The main branch should be labelled "measuring temperature". Sub-branches could be created for the various pieces of information relating to this main branch.

Measuring Temperature (continued)

Suggested Assessment Strategies

Paper Pencil

- Design and illustrate a thermometer outlining the material used for each part and explain why the material was chosen for that part. (208-8, 210-13)
- Create a time line going back to the first thermometer and record the date and devices created to measure temperature from that period until now. (110-7)
- Students should also include when the scales (Celsius, Fahrenheit, and Kelvin) were created. (110-7)
- Compare a modern digital thermometer with a liquid thermometer in terms of safe use when taking the temperature of young children. (308-1)
- Research the dangers of mercury and design an information bulletin warning of any potential hazards. (308-1)

Presentation

- Students research and present their findings as to the origin and design of a specific instrument used to measure temperature. Students should include a summary poster to be displayed in sequence as a time line. Suggested topics:
  - thermoscouples
  - bimetallic strips
  - infrared thermometer
  - alcohol thermometer
  - mercury thermometer
  - the Celsius scale
  - the Fahrenheit scale
  - thermoscope (308-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 125-127
TR AC 11

Temperature and Matter

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• define temperature using the particle theory of matter (308-2)	
- define matter	Teachers should limit this to a definition of matter as anything that takes up space and has mass.
- describe the particle theory of matter, including: (i) all matter is made up of tiny particles (ii) these particles are always moving - they have energy and the more energy the particles have, the faster they move (iii) there is space between all particles (iv) there are attractive forces between the particles (v) the particles of one substance differ from the particles of other substance	Teachers should provide varied opportunities, such as models and analogies, to enable students to visualize the particles within a substance. For example, teachers could use marbles in a clear container (Petri dish) as a model of particles. This model could be used to illustrate the five points of the particle theory of matter by placing it on a lit overhead projector allowing students to observe the marbles as they are projected unto a wall or screen. As an alternative, some lab supply companies produce manufactured devices to illustrate this concept. Alternatively, teachers could have students engage in a role play to "act out" how particles behave according to the particle theory. Students could engage in a Two-minute Review (Appendix B) to help clarify their understanding of the particle theory. Students could add a main branch to their mind map and label it "Particle Theory" and subdivide with other branches to summarize the information to this point.
- define kinetic energy as the energy that particles have due to motion	Students should know that kinetic energy is the energy of movement. Numerous computer or video simulations exist that show the effect of temperature on kinetic motion. These visual aids can assist students in better understanding this concept.

Temperature and Matter

Suggested Assessment Strategies

Paper and Pencil

- Write an article for grade 4 or 5 students that would help them to understand the difference between temperature and heat. (308-2)

Journal

- How has kinetic energy helped in your preparation to go to school in the morning? (308-2)
- "All particles in a glass of room temperature water are moving at the same speed." Explain whether this statement is true or false. (308-2)

Presentation

- Students, placed in small groups, could create a 3-D model (using Styrofoam balls for example) to illustrate the five points of the particle theory of matter and present their model to the class. (308-2)
- Students, placed in large groups, could kinesthetically model changes in matter at the particle level due to an increase or decrease in temperature, using themselves to represent particles. (308-2)

Performance

- In small groups, students could present an analogy which explains the concept of temperature in terms of kinetic energy. Students must use physical items to represent molecules in their presentation. (i.e., people, marbles, styrofoam balls, etc.). (308-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 136-138

TR AC 6
BLM 2-11

ST p. 138

Temperature and Matter (continued)

Outcomes

Students will be expected to

- define temperature using the particle theory of matter (308-2) **(continued)**
  - define temperature as a measure of the average kinetic energy of the particles of a substance

Elaborations - Strategies for Learning and Teaching

To demonstrate concretely the concept of temperature as the average kinetic energy of particles, teachers could use a graphic that shows a beaker containing five particles, each arbitrarily assigned an amount of kinetic energy (choose amounts that when added together are easily divisible by five). Students could then calculate the average kinetic energy of the particles and hence the temperature of the contents of the beaker.

Teachers could use the temperature of a room as an example to further illustrate this concept. Teachers could ask a student to check the temperature of the room. Then, through the use of guiding questions such as, “Will the particles of air closest to a sunny window possess the same amount of kinetic energy as those near the floor?”, students should recognize that not all particles have the same amount of kinetic energy. The temperature recorded with the thermometer is the average kinetic energy of the particles of air in the room.

Teachers could also return to the clear container model and shake it to highlight that not all marbles are moving at the same speed.

Teachers could use the analogy of test results within the classroom and class average to further illustrate this concept.

Students could construct a table to compare the three states of matter.

- explain how each state of matter reacts to changes in temperature (308-3)
  - describe and compare the three states of matter using the particle theory of matter in terms of:
    (i) volume
    (ii) shape
    (iii) arrangement of particles
    (iv) movement of particles

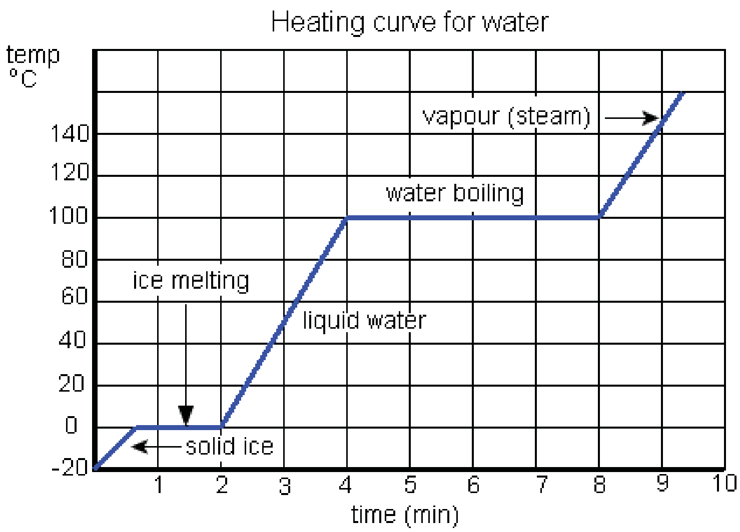
	Solid	Liquid	Gas
Volume	does not change	does not change	expands to fill the container
Shape	does not take shape of container	takes shape of container	takes shape of any closed container
Arrangement of Particles	particles are tightly packed together	particles are in contact with each other but they can slip and slide past one another	particles have large spaces between one another
Movement of Particles	particles vibrate in position, not moving away from each other	particles slide past on another, moving away from one neighboring particle and attracting another particles	particles can move freely in all directions

Temperature and Matter (continued)

Suggested Assessment Strategies

Performance

- On the following heat curve graph, indicate:
  - the melting/freezing point of water
  - the boiling point of water (210-2)



Graph courtesy of www.saskschools.ca/curr_content/physics20/heat/latent_heat_old.htm

Presentation

- Students, in small groups, can be asked to act out how particles of a solid, liquid, or gas behave at different temperatures. (308-3)

Paper and Pencil

- Make a list of observable examples of thermal expansion and contraction for each of the three states of matter. (308-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 138-141

ST pp. 144-148
BLM 7 Activity 8

Temperature and Matter (continued)

Outcomes

Students will be expected to

- explain how each state of matter reacts to changes in temperature (308-3) **(continued)**
- describe and compare the three states of matter using the particle theory of matter in terms of:
  (i) volume
  (ii) shape
  (iii) arrangement of particles
  (iv) movement of particles

Elaborations - Strategies for Learning and Teaching

It is important that students have many varied opportunities to witness the effects that temperature changes have on different materials and states of matter. These experiences will help students better relate what they see and experience to the concept of kinetic energy and the particle theory of matter. Students could be challenged to develop scenarios, using themselves as particles, to represent solids, liquids, and gases at different temperatures. Students could produce drawings to compare the arrangement and movement of particles in solids, liquids and gases.

Teachers could engage students in a Quiz-Quiz-Trade activity (Appendix B) to summarize and review the terms and concepts covered to date.

- define expansion and contraction
- use the particle theory of matter to explain expansion and contraction in the three states of matter

Students could add this information to their mind maps.

Teachers should refer to the effect that temperature has on air, as demonstrated in the construction of the air thermometer, to help students conceptualize what is happening at the particle level in gases. At this point students can determine the general relationship between temperature changes and volumes of solids, liquids, and gases.

Useful questions or scenarios include explaining why air pressure in tires increases during a car trip and why footballs or soccer balls deflate when they are taken outside on a cold day. This can be used to illustrate the concepts of expansion and contraction. Students can experience the effect of temperature change on metals, such as a ball and ring apparatus or a bimetallic strip.

Students could engage in activities 5-2B, 5-2C, and 5-2D as a means of addressing and reinforcing this topic.

Temperature and Matter (continued)

Suggested Assessment Strategies

Presentation

- Demonstrate, through a musical composition or performance, how particles might be acting in the various states of matter. (308-3)

Paper and Pencil

- Students can design a comic strip illustrating how particles behave in the expansion/contraction of different substances. For example: gas particles in a balloon, particles of a metal, or particles of water. (308-3)
- In a series of drawings, explain what is happening to a substance when it is warmed using the particle theory of matter. (110-7)

Performance

- Write properties of the three states of matter and examples of each on index cards. Write solid, liquid and gas across the white board. Hand out the index cards to the class and ask each student to place his/her card under the appropriate heading. (308-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 149-150
BLM 2-16, 2-17, 2-18

Temperature and Matter (continued)

Outcomes

Students will be expected to

- explain changes of state using the particle theory of matter, including:
  - (i) melting
  - (ii) freezing
  - (iii) evaporation

  (308-4)

Elaborations - Strategies for Learning and Teaching

Students have had many everyday experiences, especially with water, where temperature has had an impact on the state of matter. Having ice cubes melt in their soft drinks, watching water boil in a pot on the stove, and seeing the formation of ice-covered ponds are all common experiences. Demonstrations, activities, and discussion of common experiences will reinforce the concept that a temperature change has an effect on matter. Holding three tennis balls in your hand can represent, for example, particles in a solid state. Rolling the three balls in your hand can demonstrate particle movement in a liquid. Tossing the tennis balls to others can represent particle motion in a gas. These activities will permit students to move toward a more abstract understanding and explanation of these experiences, using the particle theory of matter.

Teachers should limit discussion to the effect of energy only. A discussion of condensation (vapour --> liquid) and sublimation (solid --> vapour) will provide students with an additional opportunity to better understand how particles behave when heated or cooled. Teachers could use a graph of a heating curve to further illustrate this concept.

Students could update their mind map.

- state a hypothesis, carry out an experiment, identify and control major variables and state a conclusion based on experimental data (208-5, 208-6, 210-11)
- use heating and measuring tools accurately and safely (209-6)
- organize, compile and display data using tables and graphs (209-4, 210-2)

Core Laboratory Activity: The Plateau Problem.

The laboratory outcomes 208-5, 208-6, 209-4, 209-6, 210-2, 210-11 and, in part, 308-4 are addressed by completing CORE LAB 5-3C “The Plateau Problem”.

Temperature and Matter (continued)

Suggested Assessment Strategies

Journal

- Describing yourself as a particle, explain how your behavior changes as you undergo one of the following:
  - melting
  - freezing
  - evaporation
  - sublimation
  - condensation (308-4)

Portfolio

- Create a graphical presentation that illustrates how each state of matter reacts to changes in temperature. (308-3)

Presentation

- Create an illustrated flowchart which highlights state changes between the three states of matter (solid, liquid, and gas). Students must include the terms melting, freezing, evaporation, condensation and sublimation with specific everyday examples for each change. (308-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 158-165
BLM 2-14, 2-19, 2-20
TR AC 14

Core Lab #3: The Plateau Problem, p. 166
BLM 2-15,
TR AC 4, 19
TR 2.29-2.30
ST pp. 455-458, 470
(Science Skills)

Heat Transfer

Outcomes

Students will be expected to

- compare transmission of heat by conduction, convection, and radiation (308-5)
  - define conduction, convection and radiation in terms of:
    - (i) particle movement
    - (ii) state(s) in which it occurs

Elaborations - Strategies for Learning and Teaching

Teachers could ask students to do a Think-Pair-Share activity as a way of introducing this topic. Each student could take a turn listing as many examples of each type of heat transfer as possible. Then, as a class, they could generate a K-W-L Chart which the teacher could record on the board or on chart papers.

Activities in which students are engaged with heat transfer should be part of this unit. Students should experience how thermal energy is transferred from one object to another.

Students could create a new branch on their mind map and label it "Heat Transfer".

Students could explore conduction by placing a number of different objects of similar lengths that have butter on one end (i.e., stainless steel spoon, wooden spoon, plastic spoon, copper rod) in a container. Add hot water to the container and see which material conducts heat the fastest. Students should come to realize that metals are some of the best conductors of heat. Conductometers or overhead projector conduction apparatus can be purchased from lab supply companies to illustrate that different metals conduct heat at different rates.

Students should come to understand that conduction can occur in all three states of matter but decreases in efficiency from solids to liquids to gases. Students simulating the various phases of matter using themselves as particles, could investigate and propose reasons why conduction of heat energy would be more efficient in solids.

Students can investigate convection of heat by observing grains of rice placed into a beaker of boiling water. Convection currents in the water carry the particles up and down. Some students may refer to similar convection currents in a pot of soup on the stove. Placing a light object next to a radiator or heating source in the classroom would provide proof of convection currents in air. Students may be able to relate experience of "drafts" at home that are caused by convection currents in the air. Convection can occur in liquids and gases.

Teachers could also demonstrate convection currents using a convection box or convection tube available from lab supply companies.

Heat Transfer

Suggested Assessment Strategies

Performance

- Design a working model that would illustrate convection currents. (308-5)
- Students construct an "ice cube protector" out of household items which takes into consideration heat transfer by convection, conduction and radiation. Students then use an ice cube to test their "ice cube protector" to see how long it takes before the ice cube melts. Students can compare their results with those of their classmates and then try to make improvements to their design. (308-5)
- Students construct a 3D model of a house using household items to represent consturction materials where necessary. The house should be well insulated with the type and location of heat sources indicated. Considerations must be made for heat transfer by convection, conduction and radiation. (308-5)

Interview

- Describe a food container that would keep a meal hot for a long trip. (210-13, 308-5, 308-6)
- Why does tile floor feel colder on your feet than carpet when you get up in the morning? (308-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 172-181, 188-189
TR AC 6
BLM 2-26

Heat Transfer (continued)

Outcomes

Students will be expected to

- compare transmission of heat by conduction, convection, and radiation (308-5) **(continued)**
  - define conduction, convection and radiation in terms of:
    - (i) particle movement
    - (ii) state(s) in which it occurs
  - list common examples of the three processes of heat transfer, including:
    - (i) conduction - cook ware, ice pack
    - (ii) convection - air currents, heating a liquid
    - (iii) radiation - fireplace, sunlight

Elaborations - Strategies for Learning and Teaching

Radiant energy is heat energy that is transmitted by electromagnetic waves that do not need matter in order to travel. Unlike conduction and convection, radiant energy can travel through a vacuum (no particles). Students will have had experiences with radiant energy when they feel the warmth of the sun on their bodies or sit close to a fireplace or stove. Radiant energy from the sun is the source of energy for much of the conduction and convection of heat energy on earth.

To help illustrate the difference among the types of heat transfer, teachers may choose to incorporate an analogy. For example, given the chore of moving a parcel from one end of a corridor to another, the person could pass the parcel from one person to another, analogous to conduction. However, the person may choose to walk the length of the corridor carrying the parcel, analogous to convection, or they may choose to throw the parcel from one end to the other, analogous to radiation.

Students could engage in a Quiz-Quiz-Trade activity to review and clarify the terms and concepts presented in this section.

Students could revisit the K-W-L Chart after this topic is completed and individually fill in the “L” (Learned) column. Students could update their mind map.

- design and conduct an experiment to test identified questions, state a hypothesis, identify and control major variables (208-3, 208-5, 209-1)
- use experimental apparatus and tools safely (209-6)
- organize and display data using tables and graphs (209-4, 210-2)
- state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea (210-11)
- describe how various surfaces absorb radiant heat (308-6)

Core Laboratory Activity: Absorb That Energy.

The laboratory outcomes 208-3, 208-5, 209-1, 209-6, 209-4, 210-2, 210-11 and, in part, 308-5 and 308-6 are addressed by completing CORE LAB 6-1D “Absorb That Energy”.

Water can be used in place of oil but will require a longer time period to show temperature change. Plasticine can be used to seal the opening in the can to prevent accidental spills.

Teachers should highlight that surfaces react to radiant heat in much the same way as visible light. It goes through some, reflects off some, and is absorbed by others. The amount of absorption depends upon the type of material. Dark coloured, dull materials absorb more radiant heat than light coloured, shiny materials.

Heat Transfer (continued)

Suggested Assessment Strategies

Paper and Pencil

- How could one use a wood stove to explain the transmission of heat by radiation, conduction and convection? (308-5)
- Given a cross-sectional sketch of a home, indicate areas where conduction, convection, and radiation are occurring. (308-5)
- Predict how convection currents form in your classroom when the thermostat is turned up. Sketch your prediction. (308-5)

Presentation

- Design a poster comparing conduction, convection, and radiation. Provide pictorial examples of each. (308-5)
- Prepare a 4-page website which lists 3 types of heat transfer on the homepage and links to an individual page explaining each of convection, conduction, and radiation. (308-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

TR AC 11

ST pp. 176-181, 188-189, 214
BLM 7 Activity 5

Core Lab #4: Absorb That Energy, p. 184
BLM 2-22
TR 2.38-2.39
TR AC 18
ST pp. 459, 462, 470 (Science Skills)
ST pp. 183-185

Heat Transfer - Home Heating Technologies

Outcomes

Students will be expected to

- provide examples of heat technologies used past and present to heat homes in Newfoundland and Labrador, including:
  - (i) wood stove
  - (ii) electric heat
  - (iii) oil furnace
  - (iv) air to air heat pump
  - (v) hot water radiation
  - (vi) geothermal
  - (vii) solar

  (110-7)
- identify different approaches taken to solve the problem of heating homes during cold times of the year (109-7)
- make informed decisions about the various technologies used to hear our homes, taking into account potential advantages and disadvantages (110-7, 113-8)
- provide examples of how the technologies used to heat homes have improved over time (110-8)
- provide examples of how our understanding of evaporation and condensation of liquids resulted in the development of heat pumps (111-1)

Elaborations - Strategies for Learning and Teaching

Students should approach the concept of heat transfer by brainstorming historic and modern methods of heating homes in Newfoundland and Labrador. This discussion could include fire places, wood/coal stoves, and more recent innovations, such as forced air heating, hot water radiation, electric heating, geothermal, and solar heating.

The broad range of heating technologies discussed will expose students to examples of conduction, radiation, and convection. Student questions about how each of these technologies work can provide direction for a series of activities which have students investigating three types of heat transfer and develop a working definition for each. Teachers could use the Jigsaw instructional strategy (Appendix B) to address this outcome.

The CORE STSE component of this unit incorporates a broad range of grade 7 Science outcomes. More specifically, it addresses, in whole or in part, 109-7, 110-7, 110-8, 111-1, and 113-8. The STSE component, “Heat Pumps: An Alternative Way to Heat Homes”, can be found in Appendix A.

Heat Transfer - Home Heating Technologies

Suggested Assessment Strategies

Journal

- Explain why people put coffee in a thermos to keep it hot and can also put milk in the same thermos to keep it cold. (308-5)
- How do you think convection currents help hang gliders and large birds of prey stay in the air? (308-5)
- Do you think it's possible for two different containers of water to have the same temperature but different amounts of heat? Why or why not? (308-5)
- Interview your grandparents or an elderly person in your community as to how they heated their homes in the past and what they did to maximize and contain the heat generated. (110-7)
- With reference to conduction, convection, and radiation, describe the heating technologies that are being used in your school. (110-7)

Portfolio

- Which has the greater amount of heat, a lit match or a large ice sculpture? Why? (308-5)
- Explain why a flat thin baking sheet will cool faster than a thicker smaller sheet of the same mass and made of the same material. (308-5)
- Explain why a 100 g ice cube will melt before a 1000 g ice cube placed under the same conditions. (308-5)
- In the process of designing a new home, a primary heat source must be chosen. Based on their current knowledge, students can decide which heat source they would choose. Options can include fire places, wood/coal stoves, forced air heating, hot water radiation, electric heating, and solar heating. (110-7)

Paper and Pencil

- Place the following items in rank in order of their ability to absorb radiant heat. Explain your choices.
  - white paper
  - aluminum foil- black plastic
  - brown cloth
  - red vinyl (308-6)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 185-187
BLM 2-30

Appendix A

Heat Transfer - Conductors and Insulators

Outcomes

Students will be expected to

- provide examples of insulating technologies used today and in the past, including:
  - (i) animal fur
  - (ii) sod
  - (iii) fibreglass
  - (iv) thermos (109-4)
  - - distinguish between thermal conductors and insulators

Elaborations - Strategies for Learning and Teaching

The evolution of insulating materials used in and around some dwellings could be investigated. These could include straw, sawdust, seaweed, newspaper, fibreglass, and foam insulation. The foundations of many homes in the Atlantic provinces were insulated with straw or seaweed. Students could interview seniors in their community to find out if other materials were ever used and how some materials came to be preferred insulators.

Students could be encouraged to investigate various technologies that reduce heat transfer such as thermos bottles, styrofoam, and fibreglass insulation in homes in order to learn about their insulating properties. Students should understand that different materials have different degrees of thermal conduction.

Teachers could challenge students to completely melt uniformly sized blocks of ice. No electric devices are permitted in this challenge. Student focus should be on trying different materials to see which will conduct heat the best. Teachers may wish to provide some materials such as: a sheet of aluminum foil, styrofoam trays, plastic trays, and a piece of wood, and glass plate. This should help students to better appreciate the difference between conductors and insulators.

Heat Transfer - Conductors and Insulators

Suggested Assessment Strategies

Presentation

- Create a chart that communicates the results of an experiment which investigates how various surfaces absorb heat. (308-6)
- Create a display or mural illustrating the development of materials and clothes used for insulation. (109-4)
- Construct an appropriate computer or graphic calculator generated graph to communicate the results of colour versus heat absorption investigations. (210-2)

Interview

- Describe a food container that would keep a meal hot for a long trip. (109-4, 308-5, 308-6)

Performance

- Teachers could use a rubric to assess student demonstration of science skills during experiments to test the heat absorption of various surfaces. (209-4)

	Rarely			**Always**
Follows steps carefully	1	2	3	4
Identifies major variables	1	2	3	4
Works safely with materials	1	2	3	4
Works collaboratively	1	2	3	4
Records data effectively	1	2	3	4

Paper and Pencil

- What are several potential sources for error in data in the experiment to determine how various surfaces absorb heat? (210-11)
- Describe how you use a “fair test” to evaluate the relationship between colour and heat absorption in materials. (210-11, 210-13)
- Make a list of conductors and insulators you can find in your home. (109-4, 209-4, 308-5)

Conductor	Insulator

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 192-204

Temperature Versus Heat - Specific Heat Capacity

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• compare, in qualitative terms, the specific heat capacities of some common materials (308-7) - distinguish between heat and temperature	Teachers should note the difference between heat capacity and the specific heat capacity of a material. The teaching of heat capacity is not a part of this unit. Students should define heat as energy which is transferred from hotter substances to colder ones. A common misconception among students is that "cold" travels to warm objects cooling them off. For example, students may think that a cold drink placed on the table in a warm room will begin to get warmer because the "coldness" is being transferred to the warmer surrounding air. In fact, the drink warms because the heat is transferred from the surrounding air to the drink. Teachers could also use the example of heat loss in homes through windows, doors, poorly insulated areas, etc.
- define specific heat capacity	A common misconception is to directly relate specific heat capacity to the length of time it takes to heat up or cool down a particular substance (this is "heat capacity"). Specific heat capacity is not a measure of rate of heat loss or gain, but can be used to measure the amount of heat transfer. For example, when identical masses of aluminum and water cool by 1^{o}C, water will release more energy. Because the water releases more energy, under equal conditions, it will usually take longer to cool than aluminum. Different materials have different capacities for storing heat energy. Teachers should help students relate personal experiences to the concept of specific heat capacity. For example, teachers could pose questions such as: Why do metal objects often feel colder than the surrounding air temperature? Why does a piece of aluminum foil feel cool after taken out of the oven for only minutes? Why should you be cautious when eating an apple pie which has been taken from the oven for twenty minutes? The answer to each question can be attributed to a material's specific heat capacity. For example, a metal feels colder to our touch than the surrounding environment (i.e., metal tap in a washroom) because heat from our hands is transferred to the metal, thereby lowering the temperature of our fingers at point of contact. This occurs because of the low specific heat capacity of the metal and its ability to readily absorb heat. Students could add a new branch to their mind map and label it "Specific Heat". They could then add sub-branches to describe this concept.

Temperature Versus Heat - Specific Heat Capacity

Suggested Assessment Strategies

Performance

- Create a limerick comparing and contrasting any terms discussed up to this point. Example: heat and temperature. (308-7)

Interview

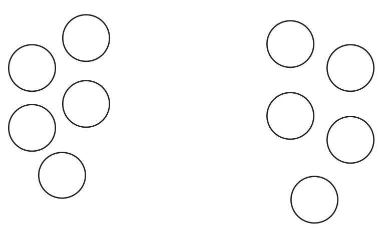
- Is it accurate to assume if a piece of ice absorbs and holds more heat than a piece of aluminum of the same size, then it has a higher specific heat capacity? (308-7)

Presentation

- In small groups, students design and create a review board game of the topics covered in this unit. Consider heat transfer concepts in the design of the game board as well. Share the games with other groups for unit review. (308-7)

Paper and Pencil

- Make a list of things that you can eat that have a high specific heat capacity. (308-7)
- To demonstrate the definition of temperature, ask students to fill in the molecules (circles) with random numbers from 1-10. Complete the chart below and compare results. (308-7)



	Sample A	Sample B
Heat (sum total of numbers)		
Temperature (average of numbers)		

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 206-209
BLM 2-28

ST pp. 209-211

Temperature Versus Heat - Specific Heat Capacity (continued)

Outcomes

Students will be expected to

- compare, in qualitative terms, the specific heat capacities of some common materials (308-7) **(continued)**
  - compare the specific heat capacity of the following substances:
    - (i) water
    - (ii) alcohol
    - (iii) soil (dry)
    - (iv) steel
    - (v) wood

Elaborations - Strategies for Learning and Teaching

Teachers can use the following data table to compare the specific heat capacities of five substances. NOTE: although the quantitative values are provided in this table, students are not required to know these values. The values are provided so that qualitative comparisons can be made; for example: "water has a higher specific heat capacity than alcohol."

Substance	Specific Heat Capacity (J/g ^{o}C)
Water	4.18
Alcohol	2.43
Dry soil	0.80
Steel	0.42
Wood	1.71

The specific heat capacity of water is greater than the specific heat capacity of soil. This means that in order to warm an equal mass of water and soil, water will require more energy. Students may apply this to their experiences living near the ocean as compared to living in the interior regions of our province. This relationship is exemplified in the discussion of sea and land breezes.

Teachers may wish to challenge their students by asking them to predict the specific heat capacity of wet soil (1.480 J/g ^{o}C).

Note: when using examples to compare the specific heat capacities of different materials, it is important to simplify the comparison. It is essential, therefore, that teachers keep the mass of the materials constant (e.g., Conduct and Investigation 6-3B - "Keeping it Cool"). For example, when comparing water to aluminum, it is much easier for students to compare the energy required for equal masses.

Temperature Versus Heat - Specific Heat Capacity (continued)

Suggested Assessment Strategies

Performance

- Identify the controlled variables in a fair test to evaluate the relationships between colour and heat absorption. (209-1)
- Create a table to record the temperature change of different liquids over time. (209-4)
- Use a program such as Excel to create a line graph indicating the increase in temperature for each liquid over specific time intervals. (210-2)
- Use a program such as Excel to create a bar graph comparing the highest temperature reached by each liquid over a specific time period. (210-2)

Interview

- Family Feud - In small groups, students design an experiment regarding some aspect of temperature. Each group decides on and ranks their top 5-7 most important controls for their experiment. Each group presents their experiment after which other groups guess their top control choices. (209-1)

Paper and Pencil

- Create a child's book which highlights safety procedures to follow when using hot liquids and thermometers in the lab. (209-6)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 210-213

Temperature, Heat, and Technology

Outcomes	*Elaborations - Strategies for Learning and Teaching*
Students will be expected to	
• describe how our needs related to heat can lead to developments in science and technology (112-1)	The context here could be heat loss and personal survival in a Canadian winter. Students will have had numerous everyday experiences with a variety of winter clothing. Students could also research the clothes worn by our ancestors in the harsh North Atlantic climates when resources were extremely limited. For example, fisherman during the early 1900s wore wool sweaters coated in linseed oil. Why? Discussion of why various materials are better insulators than others could be a starting point. Students could research the development of certain types of clothing and the types of materials used in their design. Students could compare, for example, wool sweaters and Gore-tex jackets. Some types of clothing have been developed to absorb the perspiration that is produced by the body to keep it cool. Other types of clothing have been developed to help reduce the amount of heat reaching the body (light-colored clothes) or to permit heat to escape easily to prevent over heating. Students could research first aid treatments (heat/cold technologies) to deal with injuries such as sprains, shock and hypothermia (i.e., cold packs, heat packs, foil blankets). Students should have the opportunity to make links to everyday technologies that they use or come into contact with that are associated with temperature and heat. Students could create a “Temperature, Heat, and Technology” wall display or mural and over the course of the unit, additions could be made to the display/mural. Students could make a journal entry related to this and share their ideas with the class.
• identify examples of science- and technology-based careers that are associated with heat and temperature (112-9)	Students could research various science- and technology- based careers associated with the technologies identified and discussed in class. Examples could include health care workers, furnace service technicians, light bulb manufacturers, and blacksmiths. Students could add another branch to their mind map and label it “Heat Technology”. Using sub-branches they could outline the related information. Students could engage in a Quiz-Quiz-Trade activity to review this entire unit.

Temperature, Heat, and Technology

Suggested Assessment Strategies

Presentation

- Compare various home designs and their heating/cooling systems. Indicate why there are differences in their different environments. (112-1, 109-4)
- Students are to design a means of removing or keeping snow off their driveway. Students will then present and explain an illustration or model of their design to the class. (112-1)

Interview

- Why are vapour barriers important when insulating your home? (112-9)
- Interview a person who has a science and/or technology-based job associated with heat production and/or control (furnace repair person, home insulation representative, styrofoam package manufacturer, etc.). Report to the class. (112-9)

Performance

- Using a computer, create a business card for a person with a career associated with heat and temperature. Include responsibilities required for the job. (112-9)

Resources

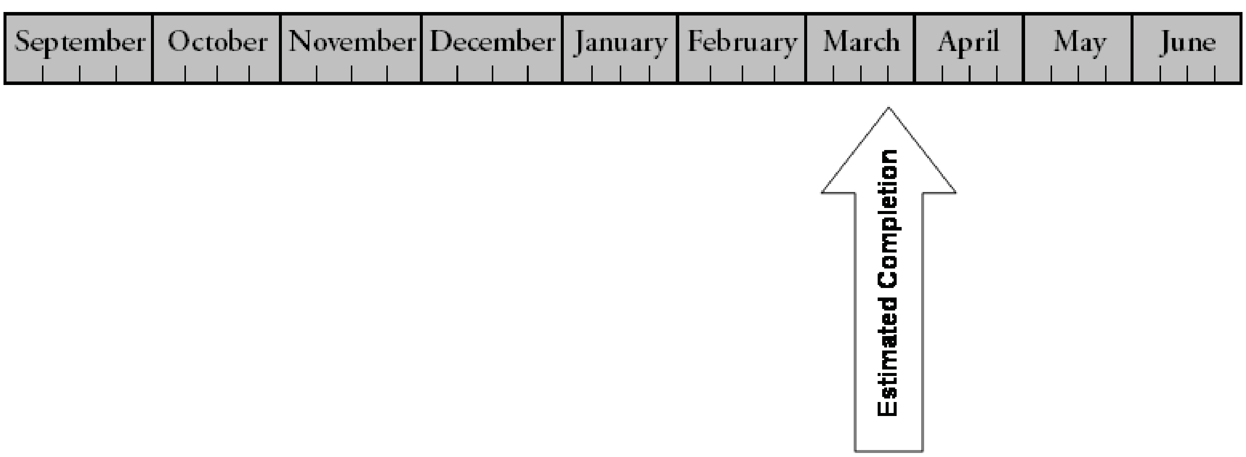
www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 203, 221

Unit 3

Mixtures and Solutions

Suggested Percentage: 25%



Unit Overview

Introduction

All matter can be classified as either mixtures or pure substances. By the end of grade 6, students have encountered and studied many of the properties of matter and how matter can change from one form to another. Through their study of mixtures and solutions, students will further refine their understanding of matter. They will also explore and develop an appreciation of how various types of matter are important in their daily lives and will be introduced to several techniques for separating mixtures into their constituent parts.

Focus and Context

The focus of this unit should be on inquiry and investigation. Students should be encouraged to identify and explore the variety of mixtures and pure substances they use or encounter in their daily lives. In particular, mixtures are so commonplace in our lives that they are virtually "transparent" in our daily experience. Students should be encouraged to explore the variety of mixtures that are important in our lives and to investigate how separating these mixtures into their constituent parts provides other valuable or important substances on which we depend.

Science Curriculum Links

In primary grades students are introduced to materials and their properties. By the end of elementary grades, students have developed an understanding of the chemical and physical properties of matter.

In this unit, the physical properties of matter will be used to discuss the nature of mixtures, solutions, and pure substances. These properties will also be used to investigate how mixtures can be separated into their constituent components. The concepts introduced in this unit will be expanded upon in Science 1206 and high school chemistry.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

109-4 using distillation as an example show how refining and separation techniques have evolved

Relationships Between Science and Technology

111-1 describe how our understanding of the properties of solutions has resulted in better road de-icing technologies

111-5 describe the science underlying a distillation apparatus using the following terms: boiling, evaporation, condensation

Social and Environmental Contexts of Science and Technology

112-7 provide examples of how science and technology affect their lives and community

113-1 identify some positive and negative effects and intended and unintended consequences of using salt on highways

113-9 make an informed decision about the use of road salt as our main road de-icing chemical taking into account the environmental, social, and economic advantages and disadvantages

Skills

Students will be expected to

Initiating and Planning

208-1 develop a testable hypothesis on the effect of temperature on solubility

208-2 identify questions to investigate arising from practical problems and issues

208-3 define and delimit questions and problems to facilitate investigation

208-5 state a hypothesis based on background information or an observed pattern of events

Performing and Recording

209-1 carry out procedures controlling the major variables to study the effect of temperature on solubility

209-3 use instruments effectively and accurately for collecting data

209-6 use tools and apparatus safely

Analyzing and Interpreting

210-5 identify the line of best fit and interpolate or extrapolate based on the line of best fit

210-16 answer new questions that result from the mixture separation activities

Knowledge

Students will be expected to

307-1 distinguish between pure substances and mixtures using the particle theory of matter

307-2 identify and separate the components of mixtures

307-3 describe the characteristics of solutions using the particle theory of matter

307-4 describe the concentrations of solutions qualitatively and quantitatively

307-5 describe qualitatively the factors that affect the solubility of a solid and a gas

Mixtures and Pure Substances - The Particle Theory

Outcomes

Students will be expected to

- distinguish between pure substances and mixtures using the particle theory of matter (307-1)
  - define particle theory of matter
  - using observations, categorize substances as pure or mixtures

Elaborations - Strategies for Learning and Teaching

Students will have encountered the particle theory of matter in elementary science as well as in the Heat unit. Teachers should review this theory with students and highlight the following two important points: all matter is made up of extremely tiny particles; and each pure substance has its own kind of particle which is different from the particles of other pure substances.

Students could write their thoughts and perceptions of the differences between pure substances and mixtures using a K-W-L activity (Appendix B). Later in this unit these ideas/thoughts can be revisited as students develop a more complete understanding of these terms. Students could start a mind map for this unit. At the centre put “Mixture and Solutions”. As they encounter new information, branches and detail could be added.

Students should attempt to categorize substances into mixtures or pure substances. Students should be exposed to a variety of materials, both pure substances and mixtures. Teachers should note that at this point substances chosen should be obvious examples of mixtures (or mixed in front of the students) and pure substances. For example: mixtures - salt water, iron fillings and sand, muddy water, wood chips and marbles, vegetable oil and water; pure substances: salt, distilled water, aluminum bar (or other solid metal bar). Teachers should refrain from introducing the terms heterogeneous and homogeneous mixtures until later in the unit. From their observations, students should conclude:

1. mixtures may have distinct visible components;
2. mixtures may appear uniform throughout (like pure substances);
3. pure substances always appear uniform throughout.

Mixtures and Pure Substances - The Particle Theory

Suggested Assessment Strategies

Performance

- Create a K-W-L chart in which you write what you already know about pure substances and mixtures in the “K” column. In the “W” column, write two or three questions you would like answered or two or three things you “wonder” about mixtures and pure substances. (307-1)
- Create your own models of pure substances and common mixtures. (307-1)

Paper and Pencil

- Students could record all examples of the solid, liquid, and gas pure substances they encounter in a day. (307-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 138, 232-239
TR 3.2-3.4
BLM 3-6
TR AC 24

ST pp. 232-236
BLM 3-4
BLM 7 Activity 8

Conventions used in Resources Column

ST - Student Text

TR - Teacher Resource

TR AC - Assessment Checklist

TR PS - Process Skills Rubric

TR AR - Assessment Rubric

BLM - Black Line Master

BLM 7 Activity # - Additional BLMs for each grade level

Mixtures and Pure Substances - The Particle Theory (continued)

Outcomes

Students will be expected to

- distinguish between pure substances and mixtures using the particle theory of matter (307-1) **(continued)**
  - define the terms pure substance and mixture using the particle theory of matter

Elaborations - Strategies for Learning and Teaching

Students should recognize that matter is often categorized into two main groups: pure substances and mixtures. Pure substances contain only one kind of particle and are the same throughout. The particle can be a single atom or two or more atoms chemically combined to form a different particle. For example, gold is a pure substance composed of only gold atoms while distilled water is a pure substance composed of hydrogen and oxygen atoms bonded together to form water molecules. As demonstrated earlier, mixtures are the physical combination of two or more pure substances. For example, bread is a mixture of yeast, sugar, flour, carbon dioxide/air and other chemicals, and a soft drink is a mixture of water, sugar, carbon dioxide gas and other chemicals. NOTE: As the terms “atom” and “molecule” are not introduced until grade 9, teachers should discuss this topic using the term “particle” as opposed to atom or molecule.

Teachers could use models to illustrate the difference between pure substances and mixtures at the particle level. For example, water particles can be represented with red balls (small styrofoam balls, ping pong balls, etc.). A container of these balls would represent the pure substance, distilled water. Similarly, sugar particles can be represented with blue balls and carbon dioxide gas particles with yellow balls. A container of the red, blue and yellow balls would represent a mixture such as a soft drink.

Teachers should clarify that a uniform mixing of the balls depicts one type of mixture while two or three distinct layers of balls represents a different type of mixture. This will lead into the concepts of homogeneous and heterogeneous mixtures.

Students could engage in a think-pair-share in which they explain how they distinguish between pure substances and mixtures using the particle theory.

Mixtures and Pure Substances - The Particle Theory (continued)

Suggested Assessment Strategies

Performance

- Provide students with a collection of pure substances and mixtures. Students can classify them into two groups based on their observations. (307-1)

Paper and Pencil

- How is the term “pure” used in everyday life? How is this different from how it is used in science? (307-1)

Journal

- Students could complete the following sentence: ‘The way I use the word “pure” in my everyday life is different from how I use it in science because...’ (307-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 232, 236
BLM 3-6
TR PS 1

Mixtures and Pure Substances - The Particle Theory (continued)

Outcomes

Students will be expected to

- distinguish between pure substances and mixtures using the particle theory of matter (307-1) **(continued)**
  - identify examples of various pure substances, including:
    - (i) distilled water (H_2O)
    - (ii) sugar ($C_{12}H_{22}O_{11}$)
    - (iii) copper (Cu)
    - (iv) oxygen (O_2)
    - (v) carbon dioxide (CO_2)
  - identify examples of various mixtures that are found in or around student homes, including:
    - (i) salad dressing
    - (ii) chocolate chip cookie
    - (iii) Kool-Aid
    - (iv) concrete
    - (v) air

Elaborations - Strategies for Learning and Teaching

Teachers should note that there is no need to discuss or illustrate chemical bonding or chemical ratios at this point. Commonly held misconceptions of students include the following: (i) a pure substance is one that is safe to ingest, (ii) a pure substance is a substance that is free of additives, (iii) only elements are pure substances, (iv) “pure” and “clear” are sometimes taken to mean the same thing. When using substances such as water, sugar, and salt as examples of mixtures, teachers should be aware of the possible misconceptions held by their students and take care to emphasize the scientific use of “pure” in relation to these substances which are composed of two or more different types of particles or atoms. Teachers should be careful that the examples of pure substances covered are not limited to elements. For example, compounds such as salt, sugar and baking soda are all examples of pure substances because they contain different elements in fixed proportions.

Students could brainstorm and identify examples of pure substances such as gold and distilled water. Many of the substances provided by students may be examples of elements. If so, teachers may view this as an opportunity to briefly present the Periodic Table of Elements. However, students will learn about the periodic table in grade 9. Although it is sometimes useful to identify pure substances using chemical formulae, it is not necessary for students to recognize a substance by its formula.

Students could brainstorm to identify mixtures that are commonly used such as detergents, cleaners (formed by adding water to the cleaner), cake mixes and gasoline-oil mixtures (for example, lawn mower engines require specific amounts of oil to be mixed with gasoline). To determine if household products are mixtures or pure substances, students could be directed to view the ingredient list on the product label. Students may realize that many commonly used household substances are mixtures, and examples of pure household substances are extremely rare.

As a means of providing time to process this information, students could create a journal entry in which they discuss the most important pure substance and the most important mixture they come in contact with each day.

Mixtures and Pure Substances - The Particle Theory (continued)

Suggested Assessment Strategies

Performance

- Write a letter to a friend explaining what a pure substance is. (307-1)

Journal

- Do you think our understanding of how the term "pure" is used in science will change how you use it in everyday life? Why/why not? (307-1)
- What are the most important mixtures and pure substances you come in contact with each day? Why do you think they are important? (307-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST p. 236

ST pp. 234-235

Homogeneous and Heterogeneous Mixtures

Outcomes

Students will be expected to

- distinguish between heterogeneous (mechanical) and homogeneous (solution) mixtures using the particle theory of matter (307-3)
  - identify that homogeneous mixtures appear as one substance and light will pass through unaffected
  - identify that heterogeneous mixtures may appear as one substance and light will scatter as it passes through

Elaborations - Strategies for Learning and Teaching

The ball analogy described previously can be used to illustrate the differences between heterogeneous and homogeneous mixtures. Teachers should ask students to observe various mixtures to recognize that some mixtures appear as one substance, (i.e., they are the same throughout) while other mixtures are obviously the combination of two or more substances.

Students should recognize that the particles of a homogeneous mixture mix so that none of the original substances are visible, even with a microscope. Homogeneous mixtures are referred to as solutions which are discussed in the next topic of the unit.

In a heterogeneous mixture the substances are clearly visible because the particles do not mix evenly. Teachers could prepare a known set of solutions and non-solutions in front of the students. For example, <u>solutions:</u> copper (II) sulfate solution (teachers could use both the anhydrous and hydrated forms to demonstrate that the colour of the crystal does not always indicate the colour of the solution), salt water, sugar water, (if available, potassium permanganate and potassium chromate could be used to create dilute solutions that demonstrate coloured solutions); <u>non-solutions:</u> vegetable oil and water, pepper and water, sugar and vegetable oil, vinegar and salad oil. In order to compare and contrast, a list of characteristics could be developed to describe the solutions and non-solutions in the set. Teachers should note that using water to prepare the majority of solutions and non-solutions in the previous activity may lead students to believe that water is a common component of solutions and non-solutions. However, this is not the case, so teachers should clarify that water is only used because of accessibility. There are many other solvents used to make solutions. For example, lemon juice can dissolve in vinegar to make a solution.

The characteristic of light scattering or not scattering is one way to distinguish between these two mixtures. In the homogeneous mixture (solutions), light will pass through unaffected. In a heterogeneous mixture light will scatter as it is reflected off the particles in the mixture. This phenomenon is known as the Tyndall Effect. Note: this is not an outcome of this course. By turning off the lights in the classroom and using a light source such as a flashlight, teachers can demonstrate that while “pure air”, such as that contained in a breathing apparatus, is a homogeneous mixture of oxygen, nitrogen, carbon dioxide, and other gases, the air in the classroom is actually a heterogeneous mixture because light from the flashlight will reflect off the dust particles. The hairs and moisture in our nose filter out the dust so that normally pure air enters our lungs.

Homogeneous and Heterogeneous Mixtures

Suggested Assessment Strategies

Performance

- Create a poem, song, rap or rant about the types of mixtures you encounter or use on a regular basis. (307-3)
- Create a booklet of labels from household products which are mixtures, include the household hazard symbols. (209-6)
- Using a "Draw" application or illustration by hand, highlight the differences between
  - pure substances and mixtures
  - heterogeneous mixtures and homogeneous mixtures.

  (307-1, 307-3)
- Describe the appearance of a beam of light as it is shone through:

  (a) a glass of cola, (b) a glass of orange juice, (c) a glass of milk

  (d) a glass of water, (e) an empty glass.

  What can you conclude about each substance based on the appearance of the light beam? (307-3)

Paper and Pencil

- Make a list of 15-20 solutions and mixtures that you encounter in a day and identify those that may pose any safety risks. (209-6)
- Name one example of a heterogeneous mixture and one example of a homogeneous mixture. Explain how you are able to tell the two types of mixtures apart. (307-3)
- Using the table below, make a list of 20 substances you use or encounter in your daily life. Categorize each as "pure substance", "heterogeneous mixture", or "homogeneous mixture". Briefly describe your reason for each classification. (307-1)

Substance Name	Category	Reason

- Mixtures that we sometimes separate are... (307-1)

Journal

- The most important solution in my everyday life is... (112-7)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 234-239, 242-247
BLM 3-5, 3-8, 3-11

Homogeneous and Heterogeneous Mixtures (continued)

Outcomes

Students will be expected to

- distinguish between heterogeneous (mechanical) and homogeneous (solution) mixtures using the particle theory of matter (307-3) **(continued)**
  - identify some mixtures as combinations of heterogeneous and homogeneous mixtures, including:
    (i) orange juice
    (ii) milk
    (iii) soft drink

Elaborations - Strategies for Learning and Teaching

Students should recognize that a large number of mixtures cannot be classified as either homogeneous or heterogeneous but rather are combinations of both. For example, orange juice is a complex combination of solid orange pulp, water, sugars and so on. The pulp in water implies a heterogeneous mixture, while the sugars in water constitute a homogeneous mixture. Teachers should clarify that mixtures fall on a continuum from homogeneous to heterogeneous dependent on particle size. Since many mixtures do not fit neatly into these categories, teachers should limit classification questions to simple examples that are clearly heterogeneous or homogeneous.

Students could summarize the information in their mind map.

If time permits, as enrichment, students could investigate other categories of mixtures on this continuum such as dispersions, emulsions, and colloids. While these concepts are not core to this unit, this would provide an opportunity for teachers to illustrate that science concepts and terminology are sometimes not clear cut as we are led to believe by the simplification that often occurs in media reports (nature of science).

Homogeneous and Heterogeneous Mixtures (continued)

Suggested Assessment Strategies

Performance

- Create a chart in which you list the various homogeneous and heterogeneous mixtures in your household. (307-3)
- Use coloured discs or coins to model particle arrangement in:

  (a) pure substances

  (b) homogeneous mixtures

  (c) heterogeneous mixtures (307-3)

Paper and Pencil

- As enrichment, research the term “colloid” and explain how it is a special type of mixture. (307-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 244-245, 248
BLM 3-12

Solutions

Outcomes

Students will be expected to

- describe dissolving as a characteristic of solutions using the particle theory of matter (307-3)
  - define:
    - (i) dissolving
    - (ii) solute
    - (iii) solvent
    - (iv) solubility (soluble/ insoluble)
  - identify that solutions can form between the three states of matter, including:
    - (i) solid solute - liquid solvent
    - (ii) gas solute - liquid solvent
    - (iii) gas solute - gas solvent
    - (iv) solid solute - solid solvent
    - (v) liquid solute - liquid solvent

Elaborations - Strategies for Learning and Teaching

Students could dissolve coloured sugar crystals or a sugar cube into warm water and observe what happens to the sugar using light microscopes or dissecting scopes. Students could then be encouraged to explain what they believe is happening to the sugar at the particle level. Teachers could use models to help students gain an emergent understanding of the characteristics of solutions. To ensure students have the appropriate vocabulary to describe what they see, teachers may wish to introduce the terms dissolving, solute, solvent, and solubility first.

Students may question why some substances do not dissolve at all. Teachers could illustrate that the degree of solubility exists on a continuum. That is, some solutes have low solubility where as other solutes have high solubility. The degree of solubility depends on several factors, one of which is the strength of the forces holding the particles of the substance together. A more complete explanation of why certain substances dissolve and other do not, will be addressed in high school chemistry.

Students could engage in a 2 minute review of these terms (Appendix B). Students could do a Quiz-Quiz-Trade activity that includes the terms and concepts covered to this point.

Even though the majority of solutions presented to students involve a solid dissolved in a liquid, students should recognize that solutions can exist in solid, liquid, or gaseous states and can be formed in different ways. For example, brass is a solid in a solid solution (zinc in copper), antifreeze is a liquid in a liquid solution (alcohol in water), soda water is a gas in a liquid solution (carbon dioxide in water) and air is a gas in a gas solution (oxygen and other gases in nitrogen).

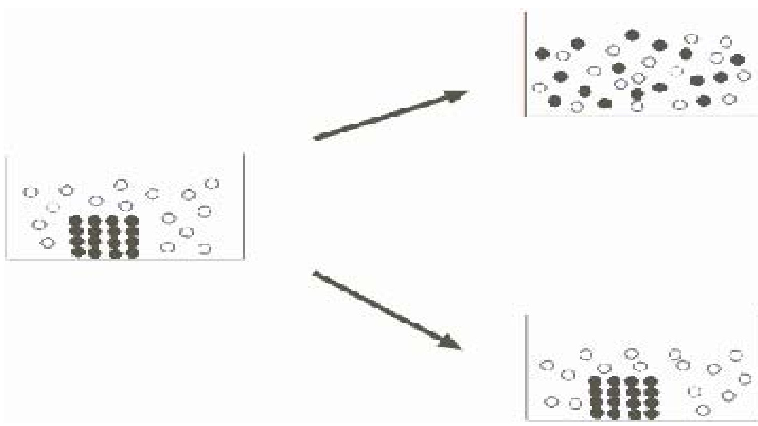
Students could create a new branch for their mind map and label it “solutions.” From this they could create sub-branches for “dissolving”, “solute”, “solvent”, “solubility”, “soluble”, and “insoluble”. They would then define/describe these terms using mind map guidelines (Appendix B).

Solutions

Suggested Assessment Strategies

Paper/Pencil

- “It is important to use the terms solute and solvent properly when creating or separating solutions because...” (307-3)
- Explain/illustrate what happens to both the solute and the solvent in a solution. (307-3)
- Create a list of the different solvents and solutes found around your home. (307-3)
- List three solutions found at home and identify the solute and solvent of each. (307-3)
- Using the diagram below as the first step, sketch what the solution might look like when thoroughly mixed. Indicate the particles representing the solute and the solvent. (307-3)



Performance

- Create a flip book to show what happens as a solute is added to a solvent. (307-3)
- Write a poem, song, or rap that describes or explains that solutions can form between the three states of matter. (307-3)

Portfolio

- Using a table similar to the one below, complete as many blocks as possible with household examples of mixtures that students encounter in one day. (112-7, 307-3)

	Solid	**Liquid**	**Gas**
Solid			
Liquid			
Gas			

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 254-259
BLM 3-14, 3-25

TR AC 13

Solutions (continued)

Outcomes

Students will be expected to

- describe dissolving as a characteristic of solutions using the particle theory of matter (307-3) **(continued)**
  - given an example of a solution and its components, identify the solute and solvent

Elaborations - Strategies for Learning and Teaching

When given relative or specific amounts of the components of a solution, students should be able to identify which is the solvent and which is the solute. Examples:

- vinegar is a solution composed of 5% acetic acid and 95% water (acetic acid is the solute and water is the solvent)
- when given the percentage composition of air, students should be able to recognize nitrogen as the solvent and the other gases as solutes
- when informed that a student put a teaspoon of sugar into a cup of hot water, they should identify sugar as the solute and the water as the solvent
- a 100 g sample of brass is a solution of 35 g of zinc in copper, they should recognize that zinc is the solute and copper is the solvent

Teachers could have students engage in a Quiz-Quiz-Trade activity (Appendix B) using the terminology encountered thus far.

Solutions (continued)

Suggested Assessment Strategies

Performance

- Test the solubility of different substances such as sodium chloride, sugar, copper (II) sulphate, and calcium hydroxide by dissolving the substances in 100 mL of water. Record the number of ¼ teaspoons of each substance that can be added to water before the saturation point is reached. Ensure to stir the solution between each addition. (307-4)
  - Students should create a table to record the number of ¼ teaspoons required for each solution to reach its saturation point.
  - Students should create a bar graph comparing the number of ¼ teaspoons of each substance that could be dissolved before the saturation point is reached.
- Create a comic strip to illustrate dissolving, soluble substances, and/or insoluble substances. (307-3)

Portfolio

- In an advice column about science fair projects in a school newspaper, explain the importance of knowing what the following words mean when doing a related activity:
  - solute - solvent
  - dissolving - soluble (307-3)

Presentation

- Students could create a dramatization of how a solution forms. A small number of boys on one side of the room can represent the solute. A larger number of girls on another side of the room can represent the solvent. The two groups mix together and while constantly moving making note of the positioning of the particles. (307-3)

Paper and Pencil

- Can water act as a solute? If so, can you think of an example? (307-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 254-255, 261
BLM 3-15

Concentration of Solutions

Outcomes

Students will be expected to

- describe the concentrations of solutions qualitatively and quantitatively (307-4)
  - define:
    (i) concentrated
    (ii) dilute
    (iii) concentration
  - distinguish between concentrated and dilute solutions

Elaborations - Strategies for Learning and Teaching

Students will have some experience using quantitative and qualitative descriptions of solution concentrations in everyday activities such as: gas/oil mixtures, cooking, chlorine in swimming pools, mixing beverages such as concentrated juices and Kool-Aid. Note: Teachers may want to impress upon students that scientists often require precise quantitative descriptions of solution concentrations.

A continued exploration and investigation into the particle theory of matter as it relates to mixtures and particularly solutions could be accomplished with opportunities for students to explore the concentrations of solutions both qualitatively and quantitatively. Students could create solutions of varying concentrations of food coloring and water. Next, they can quantitatively and qualitatively describe the solutions they create. For example, teachers could place one drop of food coloring in 100 mL of water. This solution would have a quantitative concentration of 1 drop/100 mL. Next, they may choose to place 5 drops of food coloring in 100 mL of water which would have a quantitative concentration of 5 drops/100 mL. Qualitatively, the latter solution would be more concentrated (darker) than the previous solution. As an extension, students could prepare the following two solutions - 1 drop of food coloring in 20 mL of water and 5 drops of food coloring in 100 mL of water. By comparing these two solutions, students should realize that these two solutions are the same in qualitative and quantitative concentrations. Students could add branches to their mind map to summarize information about concentration, concentrated, and dilute.

- describe the concentrations of solutions qualitatively using the terms:
  (i) saturated
  (ii) unsaturated
  (iii) dilute
  (iv) concentrated

Discussion of everyday experiences related to the terms dilute and concentrated such as “orange juice from concentrate” and “weak Kool-Aid” could allow for a better appreciation of the students’ understanding of the terms before formal investigations and learning activities. For example, a solution with 20 g of salt in 100 mL of water is less concentrated than a solution with 10 g of salt in 25 mL of water. Students should recognize that the ability of a solvent to dissolve a particular solute at a given temperature is limited.

A popular misconception students may have is that concentrated only means adding more solute and keeping the amount of solvent the same. Teachers should make the students aware that concentrated solutions can be prepared by keeping the amount of solute the same and reducing the amount of solvent. Teachers could use the example of simmering a sauce in an open pan as an example. Teachers should ensure students understand that a solution could be considered “concentrated” and still be unsaturated. Students could engage in a Two-minute Review to clarify their understanding of these terms.

Concentration of Solutions

Suggested Assessment Strategies

Paper and Pencil

- Describe a household mixture both qualitatively and quantitatively. (307-4)
- How are the pairs of terms related: dilute-unsaturated, concentrated-saturated? (307-4)
- You have been chosen to teach the concept of concentration to a grade 5 class. What analogy (teacher explanation may be necessary for the term analogy) could you use to help them understand the difference between a concentrated solution and a dilute solution? (307-4)

Journal

- "A concentrated solution is always saturated." Do you agree or disagree with this statement? Explain your reasons. (307-4)

Performance

- Create a poster or collage that explains the differences between the terms dilute, concentrated, saturated and unsaturated. (307-4)
- Taste Test: prepare salt or sugar solutions of concentrations ranging from 0 - 6000 parts per million (ppm) at 1000 ppm intervals. Students should place one drop of each solution on their tongue starting with the 0 ppm solution through to the 6000 ppm solution. Then note when they first detect the salt/sugar. This is a qualitative detection for salt/sugar. Prepare a bar graph of class results showing when students first detected salt/sugar versus the number of students at each detection level. (109-7, 210-9, 307-4)
- Given unknown masses of a solute and unknown volumes of a solvent, students could take mass and volume measurements of each sample. Students could then combine solutes and solvents to create a variety of solutions with different concentrations, express the concentration in g/L, and rank them from least concentrated to most concentrated. (210-9, 307-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 262-264, 471
BLM 3-18

ST pp. 262-264

Concentration of Solutions (continued)

Outcomes

Students will be expected to

- describe the concentrations of solutions qualitatively and quantitatively (307-4)

  (continued)

  - describe the concentrations of solutions quantitatively as the amount of solute per unit volume, including:
    (i) g/L
    (ii) percentage by mass
    (iii) ppm (parts per million)

Elaborations - Strategies for Learning and Teaching

After they have developed a qualitative appreciation of concentration (i.e., dilute or concentrated), students should recognize that the concentration of a solution can be expressed numerically. This can be expressed as the amount of solute per unit volume.

Students should recognize that the ratio of solute to solvent determines the concentration. Students could add different amounts of solute to varying volumes of solvent and then determine a way to compare the results. For example, a solution with a concentration of 20 g/100 mL is more dilute than solutions with concentrations of 25 g/100 mL or 20 g/80 mL. Teachers could help student make the connection that a common volume of solute or solvent would be required to make accurate comparisons. Teachers may wish to use 100 mL of solvent rather than 1L if restricted by the size of lab equipment.

Teachers should note that calculating concentrations of solutions is not a outcome of this unit.

Teachers should ensure that students realize there are different ways to express concentration of a solution (e.g., g/L, g/mL, ppm, etc). Students could investigate more quantitative descriptions of concentrations by noting or bringing to class various commercial product labels and/or newspaper articles in which the concentrations are indicated. Examples of concentrations described in ppm (parts per million) and percentage by mass would permit students to see that concentrations can be described in various ways. It is not expected that students calculate either of these concentration values.

Teachers could add the new terms to the Quiz-Quiz-Trade collection and engage students in a review.

Concentration of Solutions (continued)

Suggested Assessment Strategies

Performance

- Create a collage to show the different concentrations of common household solutions. (109-7)
- Students could weigh four samples of Kool-Aid (1 g, 2 g, 3 g, 4 g) and dissolve them each in 1 L of water. Students should create a table of their observations, recording any differences in colour and taste of the solutions and relate them to concentration. Students should express the concentration of each solution in g/L (e.g., 1 g/L, 2 g/L, etc). (210-9, 109-7)

Paper and Pencil

- When would the use of ppm be important to describe the amount of solute in a solution? (109-7)
- Swimming pools must maintain a specific ppm range of chlorine in order to keep the water clean. Would you use a quantitative or qualitative test to determine if it is safe to swim in the water? Explain your answer. (307-4)

Portfolio

- Collect newspaper or magazine articles that use quantitative descriptions of concentrations of various solutions. (109-7, 210-9, 307-4)
- Ask students to complete a table, like the one show below, from the information given on labels of household items. (109-7, 210-9, 307-4)

ppm		% mass		g/L	
Item	**Chemical**	**Item**	**Chemical**	**Item**	**Chemical**
multivitamin	iron	vinegar	acetic acid	salt water	salt
etc...					

Journal

- Describe personal situations when it is okay to use qualitative measures of the amount of solute in solution and when quantitative measures be used? (109-7, 210-9, 307-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 263-264, 271
BLM 3-19, 3-22

Solutions and Solubility

Outcomes

Students will be expected to

- state a hypothesis based on background information or an observed pattern of events (208-5)
- identify and delimit questions and problems to facilitate investigation (208-2, 208-3)
- identify the line of best fit and interpolate or extrapolate based on the line of best fit (210-5)
- develop a testable hypothesis on the effect of temperature on solubility (208-1)
- carry out procedures controlling the major variables to study the effect of temperature on solubility (209-1)

Elaborations - Strategies for Learning and Teaching

Core Laboratory Activity: How Does Temperature Affect Solubility?

The laboratory outcomes 208-1, 208-2, 208-3, 208-5, 209-1, 210-5, and, in part, 307-5 are addressed by completing CORE LAB 8-2A "How Does Temperature Affect Solubility?"

Teachers may have to provide some structure to assist students as they develop and plan their own solubility study. Students could work in groups to develop their study. Teachers could lead a whole class discussion using the plans from each group to develop one or several "class plans" for students to use in part 2. Teachers should ensure students consider which variables need to be controlled, the type of data they need to collect, as well as safety. The data collected could be quantitative or qualitative depending on the procedure used.

As they work to complete Part 2 of the Core Lab 8-2A, students should be encouraged to develop testable hypotheses and also to recognize and control the major variables in any of the tests carried out. By collecting and recording data observed during the procedures and organizing data in the form of graphs for example, students should be able to make predictions regarding the amount of solute that could be dissolved in a particular solvent. The temperature vs. the amount of solute being dissolved should be highlighted here.

Teachers could demonstrate the use of a hydrometer as an alternative way to calculate solubility.

Teachers should note that the relationship between temperature and solubility is not simple. The solubility of some solutes go down as temperature rises (calcium acetate), whereas the solubility of some others are relatively unaffected by increased temperatures (sodium chloride and calcium carbonate). Other solutes (potassium chloride, sugar) have increased solubility with an increasing temperature. Working with computer spread sheets would enable students to organize data and to possibly create graphs from which to predict the value of a variable such as the amount of solute in a solvent.

Solutions and Solubility

Suggested Assessment Strategies

Performance

- Observation checklist for the assessment of the effect of temperature on solubility. (209-6)

	YES	NO
1. Wears safety equipment properly.		
2. Follows safety rules.		
3. Safely transfers chemicals.		
4. Uses weigh scales properly.		
5. Reads and uses glassware properly.		
6. Reads and uses thermometers properly.		
7. Organizes data collection.		
8. Communicates well with partners.		
9. Keeps lab station clean.		

Paper and Pencil

- Use a specific example to explain why there is only one manipulated variable (independent) in an experiment but there can be more than one responding (dependent) variable. (209-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Core Lab #5: How Does Temperature Affect Solubility?, p. 268
TR 3.20-3.21
TR AC 3, 19, 25
TR AR 3, 5, 6
TR PS 2-10
BLM 3-20, 3-21
ST pp. 455-463
(Science Skills)

Solutions and Solubility (continued)

Outcomes

Students will be expected to

- describe qualitatively the factors that affect the solubility of a solid and a gas, including:
  - (i) temperature
  - (ii) pressure

  (307-5)

Elaborations - Strategies for Learning and Teaching

Many students will have had experiences with soft drinks and the effects pressure has on the solubility of carbon dioxide in the water. When students open a bottle or can of pop, the gas solute comes out of solution (that is, its solubility decreases) due to a decrease in pressure. Students could investigate the effect that changing temperature has on the solubility of gases in pop. Many students will have experienced tasting “flat” pop after a bottle of pop is left open for a period of time or is warm. No expectation is made at this point that students be able to explain these processes in terms of the particle theory of matter.

Students should recognize that as temperature increases, the solubility of a solid generally increases and the solubility of a gas generally decreases. Also, as pressure increases, the solubility of a gas generally increases and vice versa.

Students could add this information to their mind map.

Solutions and Solubility (continued)

Suggested Assessment Strategies

Performance

- Design an experiment to determine the mass of a given amount of solute (salt, sugar) that will dissolve at different temperatures. (208-1, 209-1)
- Design an experiment to determine whether a bottle of soda pop will go flat faster in your refrigerator or if left on the counter. Be sure to include a hypothesis, manipulated variable (independent), responding variable (dependent), and at least five controls for this experiment. (209-1)
- Unit review game. Ask students to prepare quiz cards containing a multiple choice question and answer. Collect all the cards and randomly choose contestants for a game of "Who Wants to be a Millionaire". (112-7)

Paper and Pencil

- How does an increase in temperature usually affect the solubility of:
  - a gas in a liquid?
  - a solid in a liquid? (307-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 267-269

Separating Mixtures

Outcomes

Students will be expected to

- using apparatus safely, identify and separate the components of a variety of mixtures (209-6, 307-2)
  - describe how to use different methods to separate a variety of mixtures, including:
    - (i) mechanical sorting (flotation, magnetism)
    - (ii) filtration
    - (iii) evaporation
    - (iv) distillation
    - (v) paper chromatography

Elaborations - Strategies for Learning and Teaching

Students could engage in an activity or series of activities in which mixtures are separated. The intent of these activities would be to expose students to different separation techniques and to have them conclude that some techniques which might be successful in some cases may not be successful in others. For example, a coffee filter is used to separate coffee grounds from coffee, but can not be used to separate sugar from water; a magnet could be used to separate iron filings from sand but not salt from sand. This activity will result in the identification of new questions such as:

- Are there mixtures that can not be separated?
- Are there mixtures in and around your home that you do not want to separate?
- Why can one mixture be separated with a filter while another can not?

These questions will lay the groundwork for future concept development relating particle size to the type of mixture.

It is more important that students focus on the properties of the materials being separated when they describe how to use the various methods. For example, it is not sufficient to have students explain and describe the process of evaporation but rather to understand that it is used as a separation method when parts of the mixture have different boiling points. Likewise, filtration is used when there is a liquid and solid part to the mixture.

Teachers may emphasize that the separation of mixtures occurs in many branches of science. For example, separation techniques can be associated with food science (tea bags), chemistry (water softeners), engineering (oil and gas filters) and life science (bogs, often considered natural filters, remove impurities from water).

Students could add information about separation techniques to their mind maps.

Separating Mixtures

Suggested Assessment Strategies

Performance

- Observation checklist for assessment of separation of mixtures. (209-6, 307-2)

	Rarely			Always
Follows safety rules	1	2	3	4
Stays on task	1	2	3	4
Carefully observes and records observations	1	2	3	4
Distinguishes between inferences and observations	1	2	3	4

- Create a poem/song/rap that explains how or when to use the various techniques of separating mixtures. (307-2)

Paper and Pencil

- How might a person make maple syrup from maple sap without boiling? (208-2, 307-2)
- Give an example of how some of the methods of separating mixtures are used in everyday life. (307-2)

Journal

- Which of the five methods for separating mixtures do you think is the most widely used at home? Why? (307-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 278-285
BLM 3-26, 3-27, 3-28, 3-29, 3-30

Separating Mixtures (continued)

Outcomes

Students will be expected to

- identify common separation techniques used to separate the components of a variety of mixtures, including:
  - (i) straining spaghetti in a colander
  - (ii) skimming fat off soup
  - (iii) drying clothes (separating water from fabric)
  - (iv) window screens allowing air in while keeping insects out
  - (v) making coffee using ground coffee beans (209-6, 307-2)

  - choose an appropriate separation technique when given a known mixture where students know the identity of the components

Elaborations - Strategies for Learning and Teaching

Students may not realize how many examples of separating mixtures exist in their home For example, dust from carpet, water from clothes, rocks from topsoil, cigarette smoke from air. Students could begin by identifying situations where two or more substances are separated. Students could also identify the various devices used for separating mixtures in or around their homes. For example, colanders, cheese cloth, coffee filters, and vacuum cleaners.

Throughout this section, students could generate a bulletin board display of mixtures and how they can be separated. Examples could include separating out sand-size particles from sediment (mechanical sorting), salad spinner removing water from the lettuce (filtration), drying clothes in a dryer (evaporation), refining oil (distillation), and separating ink mixtures (paper chromatography).

Students could research traditional separation techniques such as mesh size in fishing nets, and how Vikings extracted iron from bog at L'Anse aux Meadows. Students could also research modern separation techniques such as the hydromet process which will be used to extract copper, cobalt, and nickel from Voisey's Bay ore, or the separation of petroleum products from crude oil using fractional distillation.

Students should be able to choose an appropriate separation technique when given the identity of the components of the mixture. Such mixtures may contain three components that would require two different separation techniques. For example, students could be given a mixture of salt, sand, and water. Students could be challenged to develop a method to separate unknown mixtures through a trial and error process when the identity of the two components is not known. Students could be given an unknown mixture such as salt and sand. Since the students are unaware of the materials they may choose a separation technique such as magnetism, which they will discover will not work. Now, they must proceed with a trial and error process until they have successfully separated the components of the mixture.

Other separation activities might include using filter-lined funnels for sand and water, boiling or evaporating salt water, and using magnets to separate iron filings and sand (magnets should be put inside a plastic bag to prevent the filings from sticking directly to the magnet surface).

Teachers could ask students to speculate on the efficiency of their separation techniques, and, if appropriate, suggest better alternatives. Teachers could probe students about the composition of the components they have separated by asking: "Are the components you have separated still mixtures, or are they pure? Why or why not?"

Separating Mixtures (continued)

Suggested Assessment Strategies

Performance

- Create a poster or collage that describes the various techniques used to separate mixtures at home or in the work place. (307-2)
- Separate the component substances from the following mixtures:

  (a) sand and water

  (b) salt water

  (c) oil and water (209-6, 307-2)
- Using software, such as Inspiration, create a mind map illustrating separation techniques in the household. (307-2)
- Using a variety of materials, create a device for separating coins. (307-2)

Presentation

- Prepare a slide show or other multimedia presentation that shows some of the common techniques used to separate mixtures around the home. (307-2)

Journal

- What is the most important piece of information you need before you choose a separation technique? Explain why it is necessary. (307-2)

Paper and Pencil

- Describe three methods you could use to separate stray/unwanted leaves from a bucket of blueberries you have just picked. (307-2)
- How would you separate each of the following mixtures?
  (a) water, salt, marbles
  (b) sawdust, sand, salt
  (c) iron filings, broken pencil "leads", popping corn
  (307-2)
- Describe the different separation techniques we use in the home to separate the components of various mixtures. (307-2)
- Describe how you would separate the component substances from the following mixtures:

  (a) sand and water

  (b) salt water

  (c) oil and water (209-6, 307-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 278-284
TR AR 8

ST pp. 278-284

Distillation

Outcomes

Students will be expected to

- describe the science underlying a distillation apparatus, using the following terms: boiling, evaporation, condensation (111-5)
  - define distillation
  - explain how a distillation apparatus is used to separate a solution
  - describe where boiling, evaporation and condensation occurs in a distillation apparatus

Elaborations - Strategies for Learning and Teaching

Prior to asking students to engage in activities using distillation apparatus, teachers should demonstrate the technique of distillation using a commercial distillation apparatus or one they develop themselves.

Students should recognize that the solvent and the solute are separated and both can be reclaimed by the evaporation and the subsequent condensation of the solvent. Some examples of distillation are: (1) separating crude oil, (2) alcohol from water and (3) salt from water.

An additional class demonstration to show a distillation apparatus could involve a tub with 3 cm of dirty water in it (e.g., soil mixed in water). Put a heavy pot in the middle of the tub. Cover the tub with plastic wrap, and put a stone on the wrap so it is positioned directly over the open pot below. The stone will make an indentation on the plastic wrap. Clean water will condense on the plastic wrap and drip down into the pot. Teachers could connect this to real life by indicating that this method will allow a person to extract water from the surrounding air. The method is to use a sheet of plastic or tarp, positioned on four, one metre long sticks. A container is placed in the centre and a rock is put on the centre of the plastic directly over the container. Over night, as the air temperature cools, water will condense from the air and drip down into the container. This will even work in very dry areas such as deserts!

To provide time for processing this information, students could make a journal entry in which they describe how they distinguish between the terms boiling, evaporation and condensation.

Distillation

Suggested Assessment Strategies

Performance

- Given a specific list of materials (i.e., 2 L pop bottles, plastic wrap, styrofoam plate, rocks, etc.) in small groups, design and build a distillation apparatus. Present your results to the class to determine who produces the largest quantity of pure distillate. (111-5)

Paper/Pencil

- Given the following materials, write the directions for a survival manual to put together a distillation apparatus. (111-5)
  - cup
  - plastic sheet
  - large bowl
- Draw a distillation apparatus and describe the function of each part from the point of view of the distillation process. (111-5)
- Pretend you are a water particle in a sugar solution about to be separated by distillation. Describe your voyage from the solution to distillate. (111-5)
- Describe how you would distinguish between the terms boiling, evaporation, and condensation. (111-5)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST p. 283
BLM 3-29

Distillation (continued)

Outcomes

Students will be expected to

- carry out procedures controlling the major variables to answer questions arising from practical problems (208-2, 209-1)
- use tools and instruments safely and accurately when carrying out procedures and collecting data (209-3, 209-6)
- answer new questions that result from the mixture separation activities (210-16)

Elaborations - Strategies for Learning and Teaching

Core Laboratory Activity: Separating Homogeneous Mixtures

The laboratory outcomes 208-2, 209-1, 209-3, 209-6, 210-16 and, in part, 307-2, are addressed by completing CORE LAB 9-1C "Separating Homogeneous Mixtures".

Safety Note: It is recommended that the flask, in the diagram on page 287 of the student textbook, be secured with a clamp and ring stand to prevent accidental spilling of the hot salt solution.

Teachers could substitute a coloured solute for salt in this core lab as the separation of the mixture will be more obvious. For example, instead of salt use copper (II) sulfate or a coloured drink crystal. Ensure safety procedures are followed when substituting chemicals.

- using distillation as an example show how refining and separation techniques have evolved, including:
  - (i) simple distillation
  - (ii) fractional distillation (109-4)

Many of the technologies and techniques associated with the creation and separation of mixtures and solutions have been developed through trial and error.

Students should recognize that simple distillation generally separates a single solute from its solvent, while fractional distillation separates a mixture of liquids based on their varying boiling points. Students could investigate the difference between simple distillation and fractional distillation to come to understand how refining and separation techniques have evolved. A discussion on the use of distillation technology would help students see the connection between science and technology in their everyday environment.

Teachers could mention that most everyday mixtures require chemical and engineering methods in their formation and separation. Students could be asked if they have ever turned on a tap and noticed dirty water. Questions and discussion could focus on ways in which water is made fit for human consumption. This could provide an opportunity to explore students' understanding of some chemical and engineering techniques used in the separation of mixtures and solutions. Other examples that could be discussed include separating crude oil and extracting minerals from ore.

Distillation (continued)

Suggested Assessment Strategies

Paper and Pencil

- What types of mixtures cannot be separated by settling, sifting, filtering, and distillation? Explain why. (210-16)
- Identify potential problems with the separation of mixtures. (210-16)

Presentation

- Working in groups, prepare a slide show that describes:
    1. the separation of mixtures such as iron from its ore, petroleum products from crude oil, or dust particles from air
    2. the formation of mixtures such as alloys used in jewelry, ice cream, or cement

  Include a slide of the careers involved in the formation/separation of the mixture. (109-4)
- Make a poster of various mixtures and the industries/services that might be associated with them. (112-7)

Performance

- Conduct research on how the science relating to mixtures and solutions are related to jobs that involve chemistry or engineering. Present your findings to the class. (112-7)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Core Lab # 6: Separating Homogeneous Mixtures, p. 286
TR 3.30-3.33
TR AR 3, 5
TR PS 7 - 10
BLM 3-30
ST pp. 459-463, 467-470 (Science Skills)

ST pp. 283, 292-293
BLM 3-31
BLM 7 Activity 7

Applications of Mixture-Science

Outcomes

Students will be expected to

- provide examples of how science, related to mixtures and solutions, affect our lives (112-7)
- identify some positive and negative effects and intended and unintended consequences of using salt on highways (113-1)
- describe how our understanding of the properties of solutions has resulted in better road de-icing technologies (111-1)
- make an informed decision about the use of road salt as our main road de-icing chemical taking into account the environmental, social, and economic advantages and disadvantages (113-9)

Elaborations - Strategies for Learning and Teaching

Students should be encouraged to bring forth and discuss various examples of how the knowledge and use of mixtures and solutions affect our lives. Students could investigate one of the examples discussed and present their findings to the class. Examples could include but are not limited to: sewage treatment, water purification, using solvents to extract stains from clothes, sorting recyclable materials, screening topsoil, smog, or the use of road salt on highways.

Some of these effects may be intentional while others are unintentional. Examples such as the use of road salt on our highways and salt to make ice cream would enable students to see the utility and application of the science involved with mixtures and solutions. Discussing the positive safety aspects of improved driving conditions and the negative effects that salt water solutions have on roadside vegetation, contamination of wells and waterways, and the corrosion of metal in cars would give the students the occasion to bring out the positive and negative effects of using science and technology to solve problems.

The CORE STSE component of this unit incorporates a broad range of grade 7 outcomes. More specifically, it addresses, in whole or in part, 111-1, 112-7, 113-1, and 113-9. The STSE component “Would you like salt on that? Improving winter driving conditions with road salt.” can be found in Appendix A.

Students could use the “What? So What? Now What?” format to write a journal entry using what they have learned about road de-icing technology/methods.

Teachers could cover this CORE STSE by asking students to research various de-icing methods for roads. This could be expanded to an exploration of de-icing methods used by airlines, how wind shield wash helps keep automobile wind shields from icing up, etc.

Applications of Mixture-Science

Suggested Assessment Strategies

Journal

- Using the "What", "So what", "Now what" method, choose an example of how the science of mixtures and solutions affects us in our daily lives. (112-7)
- An understanding of how to separate the different components of mixtures is important in my daily life because... (112-7, 307-2)

Presentation

- Conduct research on the pros and cons of using salt on roads and present your findings to the class. (111-1, 113-1)
- Create a song, jingle, rap, or rant about the use of salt to de-ice our roads in winter. (112-7, 113-9 113-9)

Paper/Pencil

- Research how different industries separate mixtures, and present your findings to the class using diagrams, pictures, or demonstrations to illustrate, for example, extraction of salt from water, separation of aluminum cans, cardboards, and so forth at a recycling depot. (112-7)
- Research the alternatives to using salt to de-ice our roads in winter. (111-1)

Performance

- Create a brochure illustrating the various separation techniques used in the process of water purification. (112-7)

Resources

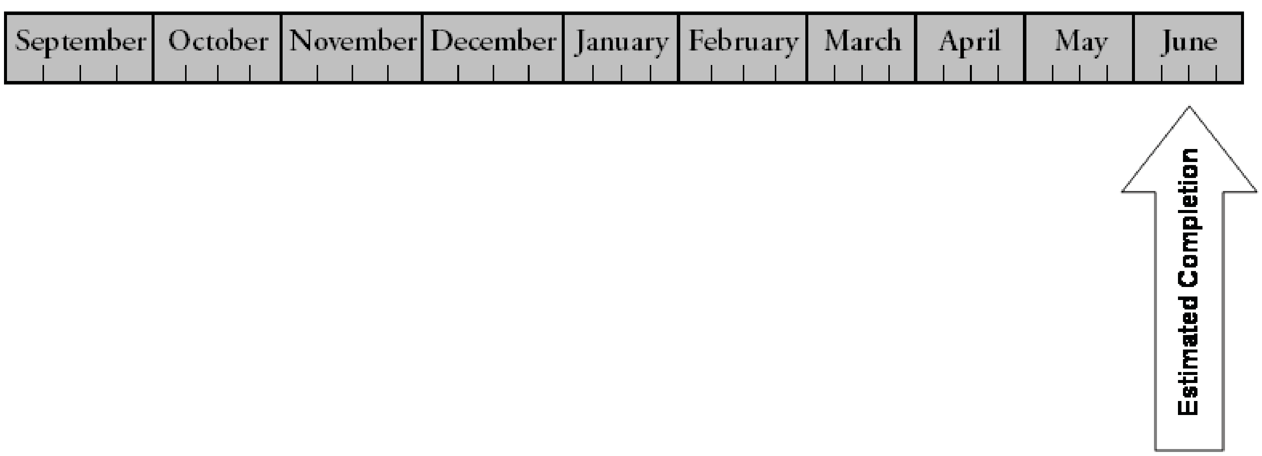
www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Appendix A

Unit 4

Earth's Crust

Suggested Percentage: 28%



Unit Overview

Introduction

By the end of elementary grades, students have explored the components and differences between soils. They have also examined the differences between rocks and minerals and have looked at how rocks and minerals are important in our lives. This unit will extend students' understanding of rocks and minerals by looking at the processes that create the different types of rocks and how volcanoes and earthquakes shape Earth's crust. Students will learn more sophisticated ways of classifying both rocks and minerals as well as how the processes of weathering and erosion of rocks contribute to the formation of soils.

Focus and Context

This unit provides students with many opportunities to engage in inquiry and to practice numerous scientific processes. Through labs and hands-on activities students engage in observing, classifying, reporting, analyzing, predicting, planning, and interpreting. Where possible, field trips to and examples from the local environment should be used to reinforce the various concepts encountered in this unit. Group work and research projects can be used to further investigate the importance of the concepts learned in class to the local area.

Science Curriculum Links

In primary grades, students explored the composition of soils. In elementary grades, they looked at factors that caused changes in the landscape and the relationship between rocks and minerals. In this unit, students will learn about the processes that create the various types of rocks. They will also develop a deeper understanding of the importance of rocks, minerals, and geologic processes. This will provide a sound basis for further study of Earth science at the high school level where students may choose to learn more about Earth's systems, resources, processes, and historical geology.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

109-2 describe and explain the role of collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge

109-7 identify different approaches taken to answer questions, solve problems, and make decisions

110-1 provide examples of ideas and theories used in the past to explain natural phenomena

110-3 identify major shifts in scientific world views

110-4 describe examples of how scientific knowledge has evolved in light of new evidence

110-5 illustrate examples of conflicting evidence for similar scientific questions

Relationships Between Science and Technology

111-2 provide examples of technologies used in scientific research

Social and Environmental Contests of Science and Technology

112-12 provide examples of Canadian contributions to science and technology

Skills

Students will be expected to

Initiating and Planning

208-2 identify questions to investigate arising from practical problems and issues

208-8 select appropriate methods and tools for collecting data and information and for solving problems

209-1 carry out procedures controlling the major variables

209-3 use instruments effectively and accurately for collecting data

209-4 organize data using a format that is appropriate to the task or experiment

Analyzing and Interpreting

210-1 use or construct a classification key

210-2 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

210-6 interpret patterns and trends in data, and infer and explain relationships among the variables

210-11 state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea

Communication and Teamwork

211-2 communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means

Knowledge

Students will be expected to

310-1 describe the composition of Earth's crust

310-2 classify rocks and minerals based on their characteristics and method of formation

310-3 classify various types of soil according to their characteristics, and investigate ways to enrich soils

311-1 explain the processes of mountain formation and the folding and faulting of Earth's surface

311-2 explain various ways in which rocks can be weathered

311-3 relate various meteorological, geological and biological processes to the formation of soils

311-4 examine some of the catastrophic events, such as earthquakes or volcanic eruptions, that occur on or near Earth's surface

311-5 analyze data on the geographical and chronological distribution of catastrophic events to determine patterns and trends

311-6 develop a chronological model or time scale of major events in Earth's history

Rocks and Minerals

Outcomes

Students will be expected to

- classify minerals based on their physical properties (210-1, 310-2)
  - define mineral

Elaborations - Strategies for Learning and Teaching

Using a K-W-L chart, teachers could explore their students' background knowledge on minerals by asking them to list various minerals that they have seen or have used in their everyday life. Students should note that there are hundreds of different minerals on our planet.

Students should recognize that a mineral is a pure, naturally occurring, inorganic, solid substance.

- list and describe properties of minerals, including:
  - (i) colour
  - (ii) streak
  - (iii) lustre
  - (iv) hardness
  - (v) cleavage
  - (vi) fracture

Teachers should stress that not all mineral properties are equally reliable for identification purposes. For example, quartz and feldspar can come in a variety of colours. Quartz can be milky white, smokey grey and even a light red or pink. Feldspar can be pink, white, or blue. Students should be made aware that in order to correctly identify minerals, more than one property must be observed.

Students should recognize that streak is a more reliable characteristic for mineral identification than colour. For example, hematite may occur in a variety of colours but will always have a reddish-brown streak. It is not necessary for students to memorize Mohs hardness scale, however, this is an opportunity for teachers to demonstrate the use of a mnemonic device as a learning strategy. The Mohs Hardness Scale can be remembered using the line: The Good Cop From Avondale Fought Quickly To Catch Dave.

Rocks and Minerals

Suggested Assessment Strategies

Paper and Pencil

- Given several pairs of minerals that look similar, write a note to another student describing several tests that may help differentiate them. (210-1, 310-2)
- Choose a mineral and create a brochure or poster display to show all its properties. (210-1, 310-2)
- If you were given an unknown mineral sample and could only use one property to describe it, which property would you use and why? (210-1, 310-2)
- Can ice be classified as a mineral? (310-2, 210-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

TR AC 1, 24
ST pp. 316-317

ST pp. 318-320

Conventions used in Resources Column

ST - Student Text

TR - Teacher Resource

TR AC - Assessment Checklist

TR PS - Process Skills Rubric

TR AR - Assessment Rubric

BLM - Black Line Master

BLM 7 Activity # - Additional BLMs for each grade level

Rocks and Minerals (continued)

Outcomes

Students will be expected to

- use a mineral classification key to investigate questions arising from practical problems (208-2, 210-1)
- select appropriate methods and tools for collecting and organizing data to identify minerals (208-8, 209-4)
- using a classification key, identify common minerals, including:
  - (i) quartz
  - (ii) calcite
  - (iii) magnetite
  - (iv) mica
  - (v) pyrite
  - (vi) galena
  - (vii) gypsum
  - (viii) talc
  - (ix) feldspar
  - (x) hematite

  (210-1)

Elaborations - Strategies for Learning and Teaching

Core Laboratory Activity: A Mineralogist's Mystery.

The laboratory outcomes 208-2, 208-8, 209-4, 210-1 and 310-2 are addressed, in whole or in part, by completing CORE LAB 10-1C "A Mineralogist's Mystery".

In the Core Lab, students will use a classification key to identify minerals using the physical characteristics of streak colour, lustre, and hardness (refer to identification key). Other properties of minerals that students may observe include magnetic quality, cleavage, and fracture.

Depending upon local availability, other specimens may be added to this list.

Although students should be able to use a classification key to identify minerals, it is not necessary for them to memorize specific characteristics of individual minerals.

Rocks and Minerals (continued)

Suggested Assessment Strategies

Performance

- Use streak plates to determine the streaks left by mica, quartz, calcite, etc., and produce a table that communicates your findings. (210-1, 310-2)
- Using a number of minerals with which to do scratch tests, determine the relative hardness of the minerals using the Mohs scale. (210-1, 310-2)
- Using a dichotomous key, classify minerals by their physical characteristics. (210-1, 310-2)
- Using vinegar, perform the acid test on a variety of minerals to observe effervescence. (210-1, 310-2)

Paper and Pencil

- As an extension, students could research and draw a pie graph to show the abundance of various minerals in Earth's crust. (109-7, 210-2, 310-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Core Lab #7: A Mineralogist's Mystery, p. 322
TR 4.6
TR AC 1, 25
TR AR 3
BLM 4-4, 4-5, 4-8

Rocks and Minerals (continued)

Outcomes	Elaborations - Strategies for Learning and Teaching
Students will be expected to	
• classify rocks based on their characteristics and method of formation (310-2)	Students should be encouraged to propose questions that could lead to investigations about how the main families of rock types form. Questions such as "How do the crystals or minerals form in a rock?", "Why do some rocks have layers?", or "Why do some rocks have rounded particles as opposed to angular particles?", could be investigated as an introduction. When discussing examples of the three rock types, teachers should use actual samples. Students could create a mind map at this point (Appendix B). The centre would be "Earth's Crust". The first branch could be labelled "Rocks & Minerals".
- define rock	Students should define a rock as a combination of two or more minerals.
- define igneous rock and describe their formation	Students should understand that igneous rocks result from the cooling of molten material. As this material cools, crystals are formed. A sub-branch could be added to the mind map and labelled "Igneous Rocks".
- differentiate between magma and lava	Students should be able to identify that molten material below the surface is referred to as magma and molten material on the surface is referred to as lava.
- differentiate between intrusive and extrusive igneous rocks using examples, including: (i) granite (intrusive) - magma (ii) basalt (extrusive) - lava	Students should understand that igneous rocks form both at the surface of the Earth and below it. Those that form above are referred to as extrusive (formed from lava) while those that form below are referred to as intrusive (formed from magma). Students could note that granite and basalt are two of the most common igneous rocks found in the Earth's crust. Teachers could include additional examples of extrusive rocks such as obsidian and rhyolite or intrusive rocks such as gabbro.

Rocks and Minerals (continued)

Suggested Assessment Strategies

Paper and Pencil

- Explain how crystal size and/or shape in rocks may help to describe its origin. (310-2)
- Construct a table to show how the three types of rock differ in formation and texture. (310-2)
- Sketch several outcrops (rock cuts on the side of a road) in your region to show the types of rocks present around you. (310-2)
- Create a list of 5-10 questions one could ask in order to investigate differences in rocks. (310-2)

Performance

- Use a magnifying glass to determine if certain igneous rocks are intrusive or extrusive. (310-2)
- Draw sketches that demonstrate how baking cookies in an oven represents what happens to mineral crystals in sedimentary and igneous rocks when they are subjected to great heat. (310-2)
- Write and perform a song that describes the 3 rock families and how they form. (310-2)
- Prior to learning about the 3 families of rocks, students could be given a variety of rock samples and asked to classify into 3 groups. After the three families are taught, students could return to the rock samples and reclassify. (310-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 326-329
BLM 4-15, 4-10

Classification of Rocks

Outcomes

Students will be expected to

- classify rocks based on their characteristics and method of formation (310-2)

  (continued)

  - define sedimentary rocks and describe their formation

Elaborations - Strategies for Learning and Teaching

Students should recognize that sedimentary rocks form from the compaction and cementation of sediments into visible layers called beds.

Teachers could demonstrate sedimentation using a large glass jar containing water and sediments of various grain sizes.

Students could replicate the process of compaction by stacking three different coloured balls of play-dough between two sheets of aluminum foil. They would then apply various amounts of pressure to simulate the creation of sedimentary rocks (pressed between the hands). Students could observe that compaction causes the pore spaces between the layers to become smaller and smaller as pressure is applied. Students could also note that the colour of the dissolved mineral that cements the sediments together may determine the colour of the sedimentary rock formed.

- list and show examples of sedimentary rocks, including:
  - (i) shale (small particles)
  - (ii) sandstone (medium particles)
  - (iii) conglomerate (large particles)
  - (iv) limestone (plant and animal particles)

Teachers should note that sedimentary rocks are classified by grain size. Teachers should explain that shale has the smallest particles (silt or mud size), sandstone (sand particles – those that can roll between your fingers) and conglomerate (gravel).

Students could add another sub-branch for "Sedimentary Rocks" to their mind map to summarize what they have learned about this class of rocks.

- define metamorphic rock

Students should recognize that metamorphic rocks result when preexisting rocks (parent rocks) undergo changes due to heat and pressure.

- describe the formation of metamorphic rocks

Students should be able to distinguish between the formation of metamorphic rock and igneous rock. When melting occurs the reformed rock will be igneous.

Classification of Rocks

Suggested Assessment Strategies

Paper and Pencil

- Using pictures of vertical cuts through snow banks, show how the formation of snow banks from snowfall events is similar to the formation of sedimentary rocks by sedimentation. (310-2)

Performance

- Given an unknown rock sample, use a classification key to identify the unknown rock. (310-2)

Presentation

- Create a display to show the formation of metamorphic rock from its parent rock (e.g., limestone to marble, shale to slate, granite to gneiss, etc.). (310-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 330-331

ST pp. 332-333

Classification of Rocks (continued)

Outcomes

Students will be expected to

- classify rocks based on their characteristics and method of formation (310-2) **(continued)**
  - list examples of metamorphic rocks and their parent rock, including:
    - (i) slate from shale
    - (ii) marble from limestone
    - (iii) quartzite from sandstone
    - (iv) gneiss from granite

Elaborations - Strategies for Learning and Teaching

These examples include sedimentary rocks (shale, limestone and sandstone) and igneous rocks (granite) that change to metamorphic rocks. Other local examples may be included.

Students could add the third sub-branch to their mind map to summarize "Metamorphic Rocks".

Teachers could use a summary activity to classify rocks into their respective families.

Students could engage in a Quiz-Quiz-Trade activity to review the terminology and differences between the three families of rocks.

Classification of Rocks (continued)

Suggested Assessment Strategies

Presentation

- Students could research the various metamorphic rocks found in their area and present to the class. (310-2)

Paper and Pencil

- Students could create Quiz-Quiz-Trade cards for the terms up to this point. (310-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 332-333
BLM 4-14

Rock Cycle

Outcomes

Students will be expected to

- identify questions to investigate arising from the study of the rock cycle (208-2)
  - sketch and label a diagram of the rock cycle
  - recognize the relationship between various types of rocks (igneous, sedimentary, metamorphic)

Elaborations - Strategies for Learning and Teaching

The rock cycle, like any natural cycle, represents a change process where the same materials are cycled throughout, producing different products under varying conditions. The materials found in rocks undergo constant change to produce new types of rocks under different conditions.

Students should not be expected to replicate the rock cycle diagram from the textbook in its entirety. However, given a framework, students should be able to label missing information.

Students should follow arrows in the rock cycle diagram and should be expected to know how one type of rock can be changed to form another. For example, to form igneous rock from sedimentary rock, the sedimentary rock has to be changed to metamorphic rock first, then melted to form magma, and then cooled to form igneous rock. Students could produce their own rock cycle diagram to support their learning.

Students could be asked to bring in one or more samples of local rocks and examine them in order to identify any similarities and differences in them. Students could examine common rocks such as sandstone, shale, basalt, granite, gneiss and slate. Students could be asked to compare the sample rocks and attempt a personal classification based on their differences and similarities.

Students could engage in a Two-minute Review (Appendix B) on this topic.

Rock Cycle

Suggested Assessment Strategies

Paper and Pencil

- How is the rock cycle similar to the recycling of matter? (208-2)

Presentation

- Create a display to show the differences in how the three main rock types are formed. (310-2)
- Create a poster display showing the 3 rock families with examples and an explanation of their formation (pictures or drawings). (210-2, 310-2)
- Create a collage of the different rocks found in our everyday life. (210-2, 310-2)
- Create a multimedia presentation of the rock cycle. (210-2)

Journal

- Write the diary of a blob of magma which cools to form igneous rock, is then exposed to weathering and erosion on the Earth's crust to form sediments, then compacted and cemented to form sedimentary rock, then metamorphosed by heat and pressure, and then melted to reform magma. (210-2, 310-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 340-343
BLM 4-11, 4-12, 4-16, 4-17
TR AC 14

Structure of the Earth

Outcomes

Students will be expected to

- describe the characteristics of Earth's crust and some of the technologies which have allowed scientists to study geological features in and on the Earth's crust (109-7, 111-2, 310-1)

Elaborations - Strategies for Learning and Teaching

This section provides an excellent opportunity for teachers to include treatment of the nature of science. In particular, teachers could include some of the following points:

- While it may take a great deal of time, scientific ideas are subject to change as new observations and interpretations are made. New ideas are sometimes rejected in favour of the prevailing theories, even when there is overwhelming evidence supporting the new ideas.
- Scientists are human, with all the faults that implies (stubbornness, jealousy, pride, etc). This is the main reason why new ideas, based on empirical evidence, are often rejected when they first appear.
- The often held view of scientists, as lab coat-wearing men who toil away isolated in an office or laboratory, is far from reality. There are both male and female scientists. Some work mainly in laboratory settings but many work outdoors. Some collect samples and make observations that they will study more carefully when they get back to their laboratory.

- sketch and label a model of Earth's layered interior, including:
  - (i) inner core
  - (ii) outer core
  - (iii) mantle
  - (iv) crust

Teachers could use an orange, boiled egg, or peach to illustrate the structure of Earth. If using a boiled egg, the shell would represent the crust, the white of the egg represents the mantle, while the yolk represents the inner and outer core. This analogy can be further developed when discussing crustal plates by simply cracking the egg. The sections of shell would represent the various plates and the cracks would be the boundaries.

- describe the composition of each layer

Students will use this model of Earth's interior later in this unit to explain why plates move and the features of the crust that result from this movement. Students should know the relative position and qualitative size of the layers. The description of each layer should be limited to the following: the crust is solid and varies in depth; the mantle is partly molten; the outer core is liquid and is made mostly of nickel and iron; the inner core is solid and is made mostly of nickel and iron. Students could add another branch to their mind map and call it "Earth's Crust".

- recognize that Earth's crust is broken into plates and movement occurs where plate margins meet (plate tectonics)

A common misconception is that the crustal plates correspond to the continental boundaries. To dispel this misconception, teachers could conduct a jig-saw-puzzle activity in which the crustal plates are the pieces of the puzzle, but drawn on the puzzle pieces are the continents, or parts of continents, that are on these plates. This would help students to understand that the plates carry not only land masses but also oceanic crust.

Structure of the Earth

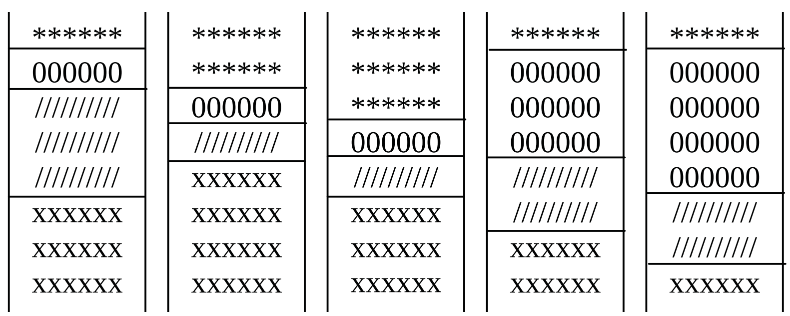
Suggested Assessment Strategies

Presentation

- Research and give a presentation on a technology used to study geological features and resources. (109-7, 111-2, 310-1)

Performance

- Create a series of "collector cards" (like hockey cards) for the different layers of the Earth and the different minerals. Include a picture or diagram on one side and on the other side put the characteristics. (109-7, 310-1)
- Provide students with the pictorial representations found below. They represent five core samples that were taken at equal intervals over a 100 metre, straight line distance. Students can draw the geological profile of the Earth's crust for that 100 metres. (310-1)



- Use a model (e.g., hard boiled egg, apple, orange, etc.) to show the composition of Earth. Use a diagram to show how the model compares to the layers of Earth in terms of thickness and composition. (110-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 356-357

ST pp. 357-359
BLM 4-19

ST p. 359
BLM 4-20

Plate Tectonics Theory

Outcomes

Students will be expected to

- describe how plate tectonic theory has evolved in light of new geological evidence (110-4)

Plate tectonics is explored in the STSE module for this unit. Since students can choose to study this topic in more detail in Earth Systems 3209, teachers should limit discussion to highlight the main events in the development of the theory. Teachers should limit the number of examples used and focus on the evidence, not the detailed workings of the technologies used.

  - identify Alfred Wegener as the person responsible for proposing the continental drift theory

Students should recognize that Alfred Wegener's initial ideas were not globally accepted despite the evidence that seemed to support his theory. He couldn't identify the mechanism that caused the continents to move.

  - describe the continental drift theory and the evidence supporting it, including evidence from:
    (i) continental fit (paleogeographic)
    (ii) fossils (biological)
    (iii) rock layers (geological)
    (iv) climate (meteorological)

Elaborations - Strategies for Learning and Teaching

The concept that continents have moved relative to one another (called continental drift) and the early evidence that led to the development of the plate tectonic theory came to light at the beginning of the 1900s. Students should come to appreciate that mounting evidence from a variety of sources led to our present theory of plate tectonics. Paleogeographic evidence (South America and Africa seem to fit together), structure and rock type evidence (correlation of sequence of layers across the Atlantic), fossils from the Avalon Peninsula consistent with those found in Wales (trilobites), and coal, which forms in warm climates, having been found in Antarctica are used in arguments for continental drift.

Students could engage in a Think-Pair-Share (Appendix B) in which they consider the question: "Of the four pieces of supporting evidence (for continental drift theory), which one do you think was the most important in supporting this theory?"

Plate tectonics arose from the earlier continental drift theory in light of new evidence from technological advancements in data collection and Earth modeling.

Students could engage in a Quiz-Quiz-Trade activity (Appendix B) to review and reinforce the terms and concepts covered to date.

Plate Tectonics Theory

Suggested Assessment Strategies

Paper and Pencil

- Prepare a time line that illustrates the evolution of our understanding of plate tectonic theory. (110-4)
- Why have dinosaur fossils been found in areas where they would not be able to live if they were alive today? (110-4)
- Trilobite fossils discovered along Manuels River in C.B.S., NL, are directly correlated to trilobite fossils found in Wales, UK. How does this support the theory of continental drift? (110-4)
- Draw a diagram to show how convection currents occur in the Earth's crust and how they cause plate movement. (110-4)
- Write two letters to the editor of a scientific newspaper. One letter should defend Alfred Wegener's theory of continental drift while the other should oppose his theory. Use scientific evidence for both arguments. (110-4)

Performance

- Use laminated cutouts of Earth's continents to create super continents. Display your results and provide your own names for the super continents. (110-4)
- Use the Internet to locate satellite images of plate margins. Locate one example of a divergent, convergent, and transform plate margins. (110-4)
- Float flat pieces of styrofoam in a pan of water. Heat gently on a hot plate. Describe how the styrofoam "plates" move with the convection currents. (110-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 360-363
BLM 4-21, 4-22, 4-23

Plate Tectonics Theory (continued)

Outcomes

Students will be expected to

- describe how plate tectonic theory has evolved in light of new geological evidence (110-4) **(continued)**
  - identify the technological advances that have provided evidence to support the current theory of plate tectonics, including:
    - (i) sonar
    - (ii) magnetometers
    - (iii) deep sea drilling

Elaborations - Strategies for Learning and Teaching

Students should have exposure to the ways in which geologists investigate and explore the Earth's crust by looking at some of the technologies used in gathering data about the Earth's crust. They could investigate technologies such as satellite imaging, seismographs, remote sensing, magnetometers, and core sampling.

Students should recognize that these technologies have allowed scientists to develop a more detailed picture of the interior of the Earth, thus supporting the theory of plate tectonics. Sonar provided a more detailed picture of the sea floor, such as the mid-Atlantic Ridge; magnetometers provided evidence for sea floor spreading; and deep sea drilling provided evidence for the internal structure of the crust. Teachers should be aware of the evidence each of these technologies has provided, but it is not necessary to provide this information to students in any detail.

- identify types of plate boundaries, including:
  - (i) divergent (pulling apart)
  - (ii) convergent (pushing together)
  - (iii) transform (sliding past)

Teachers could use any type of student movement activity to simulate the movement of the crustal plates, for example, the "Plate Tectonic Jive" could have students doing divergent, convergent, and transform dance steps, set to music.

Students should come to realize that where crustal plates meet, they can and do move in three main ways. Later in the unit, students could relate crustal plate movement to mountain building processes, earthquakes, and volcanoes. Students can explore plate movement at the various Internet websites.

- identify convection currents in the Earth as a possible explanation of the driving force mechanism behind plate tectonics

Once students understand what happens at plate boundaries they can begin to investigate why this happens. Teachers should review convection currents remembering that this concept has been covered in more detail in the Heat unit.

Students should now be able to use their conceptual model of Earth's crust and mantle to recognize the connection between convection currents and plate movement. The source of energy that creates the heat that drives these convection currents is thought to be the result of intense pressure.

Plate Tectonics Theory (continued)

Suggested Assessment Strategies

Paper and Pencil

- Research a Canadian geologist and report on his/her contribution to the theory of plate tectonics. (112-12)
- Write a report on the contribution of Newfoundland and Labrador geologist Harold "Hank" Williams to the development of the theory of plate tectonics. (112-12)
- Do mountains grow? Why or why not? (110-4)

Presentation

- Create a presentation that outlines Wegener's contribution to the theory of continental drift. (110-4)

Performance

- Dramatize an interview with a Canadian geologist. (112-12)
- Dramatize a debate between Alfred Wegener and his opponents. (112-12)
- Create a model that demonstrates the three types of plate movement. (110-4, 211-2)
- Devise a set of hand gestures to illustrate the three types of plate movement. (110-4, 211-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 364-366
BLM 4-24, 4-25

ST pp. 367, 370-371

ST pp. 368-369
BLM 4-26

Plate Tectonics Theory (continued)

Outcomes

Students will be expected to

- provide examples of Canadian contributions to our understanding of local, regional, and global geology (112-12)

Elaborations - Strategies for Learning and Teaching

Students should be able to identify the following Canadian scientists and list one of their contributions to geologic findings. Include:

a) J. Tuzo Wilson - proposed a third type of plate movement where plates slide past each other along what he called transform boundaries.

b) Joseph Tyrell - discovered dinosaur fossils in Alberta, which proved that the local climate was warmer at an earlier time.

c) Harold Williams - highlighted that plate tectonic activity occurred regionally along the eastern edge of the North American continent.

- describe how our explanations of how the Earth has changed over time are based on the collection of evidence and finding relationships between various observations in imaginative ways (109-2)
- describe how our understanding of the forces that shaped our Earth have changed over time as new evidence was collected (110-5)
- identify the theory of continental drift as one early explanation for how our Earth changed over time (110-1)
- identify the theory of plate tectonics as an example of a major shift in our world view (110-3)

The CORE STSE component of this unit incorporates a broad range of grade 7 science outcomes. More specifically, it addresses, in whole or in part, 109-2, 110-1, 110-3, 110-5 and 310-1. The STSE component, "Seeing the Big Picture", can be found in Appendix A.

The STSE component provides another opportunity for teachers to engage students in discussion of the nature of science. In addition to points previously described on page 136, teachers should engage students in discussion of the following point:

- Our physical world operates in consistent patterns that are understandable through careful and systematic study/observation. Through the use of our intellect, and with the use of instruments to improve our observations, we can discover the patterns in nature.

Plate Tectonics Theory (continued)

Suggested Assessment Strategies

Paper and Pencil

- Write a letter from Wegener to a friend in which he describes his theory of how the continents came to be as they are today. (109-2)
- "The main differences between what Wegener and Wilson believed are..." (109-2, 112-12)

Presentation

- Students could research the life and times of Wegener and present to the class. (109-2, 110-4)
- Create a skit in which Wegener and J. Tuzo Wilson meet and discuss their beliefs of how the continents formed. (109-2)

Portfolio

- Create a time line that illustrates the development of the theory of plate tectonics. (110-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 367, 397

Appendix A

Earthquakes, Volcanos and Mountains

Outcomes

Students will be expected to

- examine some of the catastrophic events that occur on or near Earth's surface, including:
  - (i) earthquakes
  - (ii) volcanic eruptions (311-4)

Elaborations - Strategies for Learning and Teaching

Unlike most geological processes, earthquakes and volcanoes generally occur over a short period of time and are readily observable. This topic could begin with a general discussion about these phenomena. Opening questions such as, "Do we experience volcanoes and earthquakes in our region?", and "Is there evidence for these types of geological processes in our region?" would allow for an assessment of students' prior knowledge as well as motivate the students to begin considering these topics in light of their immediate environment. Students could view videos or use computer software to see actual scenes of volcanoes and earthquakes in the process of occurring and discuss the effects that they have on local environments.

- define earthquake

A simple definition is all that is required here. Students should define an earthquake as "the shaking of the Earth".

In the discussion, teachers could mention that the seismograph is the device used to record earthquakes. Teachers could demonstrate the working of a seismograph by moving a piece of paper under a stationary pencil. Students could also be encouraged to design and create their own seismograph.

Teachers could also expand the discussion to mention that the Richter Scale is the method used to describe earthquake strength. The higher the number, the stronger the quake, thus the more potential for damage.

- explain why earthquakes occur using the concept of plate tectonics

Students should recognize that earthquakes are the result of energy released from forces built up due to plate tectonics (plate movement) in Earth's crust. When this energy is released, it travels in wave form known as seismic waves.

Seismic events do occur in our region and these events, although usually minor, are unpredictable and potentially damaging. As an example, teachers could highlight the tsunami that struck the Burin Peninsula in 1929. Earthquakes in this area occur due to movement along local faults on the floor of the Atlantic Ocean making them more sporadic events.

Teachers could demonstrate the concept of seismic waves by dropping a pebble into a container of water. Alternatively, teachers could ask students to visualize what happens when a rock is thrown into a still body of water. The circular waves that move from the centre are analogous to seismic waves.

Earthquakes, Volcanos and Mountains

Suggested Assessment Strategies

Paper and Pencil

- Write a report that compares volcanoes and earthquakes. (311-4)
- Research the strongest earthquakes that have occurred on Earth since 1990. Draw a bar graph to show the difference in magnitude among these earthquakes from lowest to greatest. (311-4)

Presentation

- Prepare a poem or a song in which volcanoes and earthquakes are compared and contrasted. (210-2, 311-4, 311-5)
- Create a multimedia presentation on the evidence of volcanic activity in Newfoundland and Labrador. (311-4)

Performance

- Place a glass bowl of water over two pieces of wood which are positioned side by side. Describe what happens when you slide the wood back and forth. How does this represent how earthquakes are created? (311-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 374-389

ST p. 376

ST pp. 376-379
BLM 4-28

Earthquakes, Volcanos and Mountains (continued)

Outcomes

Students will be expected to

- examine some of the catastrophic events that occur on or near the Earths surface (311-4) **(continued)**
  - define volcano
  - identify how and where volcanoes form. Include
    - (i) areas where plates converge
    - (ii) areas where plates diverge
    - (iii) areas where plates are thin (hot spots)

Elaborations - Strategies for Learning and Teaching

Students should define a volcano as an opening in the Earth's crust. An introduction to volcanoes could include videos, pictures, or Internet sites.

Students should understand that there are several environments where volcanoes occur most often:

1. Where plates collide at convergent boundaries, intense pressure can melt rock that later flows to the surface as a volcano (the Pacific Ocean is being subducted under Japan).
2. Where plates separate, at divergent boundaries, molten rock flows up to the surface (mid-Atlantic Ridge).
3. Where plates are thin, magma can be forced up through the cracks to the surface (Hawaiian Islands).

Volcanic events do occur on our continent and these events are unpredictable and can cause great damage. Scientists can predict that a dormant volcano will erupt but not with any real accuracy. Teachers could present video material or Internet information on the Mount St. Helens volcanic eruption that occurred in 1980 in the United States.

Outcomes

- organize and analyze data on the geographical distribution of earthquakes and volcanoes to determine patterns and trends (209-4, 210-6, 311-5)

Elaborations - Strategies for Learning and Teaching

Teachers should provide information about the location and dates of major earthquakes and volcanoes in recorded history. Students could record the data on a world map. In this way, students can examine the relationship between the location of these events and the major geological plates. Students could identify the Pacific Rim, also known as the "Ring of Fire", from their organization and analysis of the data.

Students could complete Activity 11-2E "Patterns in Earthquake and Volcano Locations", to address or reinforce these outcomes.

Additionally, students could conduct an Internet search of earthquake locations within the last 7 days.

Earthquakes, Volcanos and Mountains (continued)

Suggested Assessment Strategies

Paper and Pencil

- Research the environmental effects of a volcano on the surrounding ecosystems. (311-4)
- Research how Iceland and the Hawaiian Islands formed? (311-4)

Performance

- Compare satellite imagery of the Pacific Ring of Fire with a map of plate boundaries in the area. (209-4, 210-6, 311-5)
- Use electronic software (e.g., Google Earth) to locate images of the following geological features: (i) volcano (e.g., Mount St. Helen's), (ii) fault (e.g., San Andreas Fault), (iii) mountain ranges (e.g., Himalayans). (311-1, 311-4)
- Choose a particular region prone to earthquakes. Show the frequency and intensity of the quakes in a bar or line graph. (209-4, 210-6, 311-5)
- Given the latitudes and longitudes of certain earthquakes, plot their locations on a world map and compare the pattern of earthquakes with plate boundary locations. (311-4)
- Use the Internet to locate satellite images of volcanoes formed at convergent zones, divergent zones, and hot spots. (311-4)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 380-382
BLM 4-33

ST pp. 386-387
BLM 4-29, 4-32
TR AC 1

Earthquakes, Volcanos and Mountains (continued)

Outcomes	Elaborations - Strategies for Learning and Teaching
Students will be expected to	
• provide examples of theories used in the past to explain volcanic activity, earthquakes, and mountain building (110-1) - identify explanations of volcanic and earthquake activity from the past, including: (i) Pele (ii) Glooscap	Teachers should briefly outline the prior theories related to mountain building, volcanoes and earthquakes. Different cultures throughout history have had ideas and explanations about the origins and causes of volcanic and earthquake activity and mountain formation. Teachers could emphasize that this is part of science; observations are made about happenings in the world and people try to explain the sources or causes of those events. When a formal study and explanation of the observations are made, it may be considered a theory. That "theory" may be revised as new observations are made or may even be dismissed completely. Students could be challenged to investigate prior theories of a particular group or culture. Some possible research ideas might include: - Pele (Hawaiian goddess who makes the mountains shake and lava flow at Kilauea, Hawaii) - Glooscap (Mi'kmaq legend about the Sugarloaf Mountains) - Anaxagoras (Greek who believed that volcanic eruptions were caused by great winds within the Earth) - René Descartes (French philosopher who believed an incandescent Earth core was the source of volcanic heat)
• explain the processes of mountain formation (311-1)	Students could observe maps of continents and ocean basins to locate mountains and ocean ridges and note the natural boundaries formed by these major structural features.
- define folding and faulting	Students should define folds as bends in the rock layers and faults as breaks in rocks layers.
- explain how mountains are formed using the theory of plate tectonics, including: (i) folding (ii) faulting (iii) volcanic eruption	Models, videos and local pictures could be used to have students explore and understand these processes. Modelling clay of various colours can be used to represent layers of the Earth's crust. By pushing together the ends of the modelling clay, students could observe the effects of pressure on forming a fold. Models of faults can also be made in this way but it is important to note that faults involve breaking, thus the material used must be more brittle. Students should be able to relate that lava, ashes and cinders from an active volcano can build up and form a mountain. The volcano Paricutin, a famous example that occurred in a farmer's field in Mexico, is now several hundred meters high. Students could engage in a Quiz-Quiz-Trade activity (Appendix B)to review the terms and concepts covered to date.

Earthquakes, Volcanos and Mountains (continued)

Suggested Assessment Strategies

Presentation

- Prepare a mural of ancient stories that are associated with volcanic activity and mountain building. (110-1)
- Prepare a recording or short dramatization that illustrates how a certain culture explained volcanic or earthquake activity. (110-1)
- Complete a web quest on the topics of volcanoes, earthquakes, and mountain building using Canadian Earth science Internet sites. (112-12, 311-4)
- Create a layered cross-section of the Earth's crust out of soft styrofoam sheets and demonstrate faulting and folding. (311-1)
- Create a 3-D model of a volcano to illustrate how it can become a mountain. (311-4)

Paper and Pencil

- Write a newspaper article that announces the development of plate tectonic theory and how it explains the formation of mountains. (311-1)
- In a written report, describe the relationships between plate boundaries, mountain building, and trenches. (311-1)
- Investigate how people in the past explained catastrophic events such as volcanoes and earthquakes. (110-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

BLM 4-30

ST. pp. 390-393
BLM 4-36

Geological Time Scale

Outcomes

Students will be expected to

- develop a chronological model or geological time scale of major events in Earth's history (209-4, 311-6)

  - describe the geologic time scale in terms of the four main eras and the major events that occurred in each, including:
    - (i) Precambrian era – formation of the Earth and appearance of simple life forms
    - (ii) Paleozoic era – appearance of more complex life forms
    - (iii) Mesozoic era – appearance and extinction of dinosaurs
    - (iv) Cenozoic era – appearance of humans

Elaborations - Strategies for Learning and Teaching

Students should begin to appreciate the magnitude of time involved in most geological processes and events. Students could prepare and construct their own life time scale and compare it to a geological time scale. To introduce this topic, students could be shown how major groups of organisms (reign of the dinosaurs) fit into and define specific time periods. Boundaries ending one era and beginning another reflect major geologic events such as the extinction of the dinosaurs. Teachers could support the concept of geologic time by selecting students as particular organisms and placing them in a relative position along a corridor wall on a time scale.

Students should identify the four main eras and one main event that occurred in each. Teachers should continue to emphasize the magnitude of geological time and stress to students that human existence on Earth represents a very small proportion of that geological time. Students could construct a time line diagram that would enable them to visualize both the order and duration of events in geological time.

A physical model could be created to help students understand the large numbers involved. This could take the form of a 4.6 m length of adding machine tape or paper towel with each meter representing 1 billion years. In this model 4.01 m would represent the Precambrian era.

Students could measure the length of a school corridor or gym floor. The distance could be divided to represent the four eras of geologic time.

It is important that students understand the vast span of time represented by the Precambrian era and that for much of that time the Earth was practically lifeless. Our knowledge of geologic time after the Precambrian era is directly linked to fossil evidence reflective of that time.

Teachers could present material to enrich students' appreciation for geological time by showing how fossil evidence supports the evolution from the beginning of life in the Precambrian to present day. Some students may have already collected fossil specimens that may be placed along a time line. The Government of Newfoundland and Labrador, Department of Natural Resources website (Geological Survey) provides educational support regarding fossils.

Geological Time Scale

Suggested Assessment Strategies

Paper and Pencil

- Why is there little fossil representation in the Precambrian era rock record? (311-6)

Presentation

- Create a poster display showing the four main eras and major events that occurred in each era. (209-4, 311-6)
- Create a physical scale model that shows the respective amounts of time covered by each era. Indicate the major events during each time period. (209-4, 311-6)

Performance

- Research and prepare a report that compares and contrasts the dominant animals and plants in each era of geologic time. (311-6)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 395-398

ST pp. 395-397
BLM 4-35

Weathering and Erosion

Outcomes

Students will be expected to

- explain various ways in which rocks can be weathered and eroded to form soils (311-2, 311-3)

Elaborations - Strategies for Learning and Teaching

Students should be encouraged to consider and propose questions related to the break up or weathering of rocks on or near the Earth's surface. Weathering and erosion (concepts introduced in the elementary grades) are important components of the rock cycle. Questions such as, "Are there different ways in which rocks can be weathered?", and "How long does it take to weather some types of rocks?" could be used to further investigate the phenomena of weathering.

- define weathering

Students should define weathering as the mechanical and/or chemical breakdown of rock. Rocks are exposed to the forces of weathering when at or near the surface of the Earth.

- identify types of weathering, including:
  (i) mechanical
  (ii) chemical

Students should identify mechanical weathering as the physical breakdown of rocks into smaller fragments. The most common type of mechanical weathering is frost wedging. Students should be encouraged to think of examples in which they have seen the action of ice and frost in producing broken rocks. Local cliffs or sea shore embankments are good locations to find this type of weathering. The movement of plants (roots) and animals (worms, rodents, ants) cause rock to be mechanically weathered.

Students should identify chemical weathering as chemical reactions that break down rocks. Students could investigate the effect acids (acid rain) have on some rocks such as chalk. In the first stage of chemical weathering, solutions made with water are created. Salt, gypsum and limestone are all soluble, to some extent, in water. The acidic action of some organisms that live on rocks such as lichens can cause chemical weathering. Students may be able to describe rocks or headstones in their community that are being weathered in this way.

Students could make a journal entry discussing examples of mechanical and chemical weathering they see in their local environment.

Weathering and Erosion

Suggested Assessment Strategies

Presentation

- Research and report on how some structures made of rocks (pyramids, statues, and gravestones) are changed by weathering and erosion. (311-2)
- Create a visual display that distinguishes the two types of weathering. (311-2)

Paper and Pencil

- Imagine you are a writer for a scientific magazine. Write a short article describing how a mountain can be weathered and eroded and how the sediments can create new sedimentary rocks. (311-2)
- Is there a relationship between the amount of weathering on a graveyard headstone and the age of the headstone ? (311-2)
- Use diagrams to describe the processes involved in moving material from a mountain to the bottom of a river over time. (311-2)
- Research the amount of money spent each year in Newfoundland and Labrador for repairing roads that are damaged as a result of weathering. (311-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST p. 408

ST pp. 409-412, 418-419
BLM 4-39, 4-40

Weathering and Erosion (continued)

Outcomes	Elaborations - Strategies for Learning and Teaching
Students will be expected to	
• explain various ways in which rocks can be weathered and eroded to form soils (311-2, 311-3) **(continued)**	
- define erosion	Students should understand that erosion is the process that loosens and moves weathered rock particles (sediment) over Earth's surface.
- identify the various agents of erosion, including: (i) water in motion (ii) meteorological processes (rain and wind) (iii) geological processes (gravity and glaciers)	Teachers should cover these briefly to give the context for differentiating between weathering and erosion. Local examples of water as both a weathering and erosion agent allow students to better understand water as the most powerful of geological forces. Teachers could use a stream table to illustrate the concept of erosion.
- differentiate between weathering and erosion	Students should recognize that erosion means that sediments are being moved. Weathering does not involve movement.

Weathering and Erosion (continued)

Suggested Assessment Strategies

Paper and Pencil

- Why do the Appalachian Mountains in eastern North America have a much lower elevation and a more rounded texture than the Rocky Mountains in Western Canada? (311-2)
- Match and explain the processes below:
  - rain and wind — a. chemical
  - glaciers and gravity — b. meteorological
  - plants and acidic action — c. geological (311-2)
- What is the difference between weathering and erosion? (311-2)
- How can weathering and erosion be harmful to life on Earth? (311-2)

Performance

- Sketch a diagram that illustrates the differences between weathering and erosion. (311-2)
- Create a photo collage of examples of weathering and erosion in your community. (311-2)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST p. 412

ST pp. 413-414

ST pp. 408-415
BLM 4-38

Soil

Outcomes

Students will be expected to

- classify various types of soil according to their characteristics, including:
  - (i) coarse-textured (sandy/gravel) soil
  - (ii) medium-textured (loamy) soil
  - (iii) fine-textured (clay) soil

  (310-3)

Elaborations - Strategies for Learning and Teaching

Teachers should clarify that eroded minerals form the basis of soils. The combination of eroded minerals and decaying plant and animal materials forms a soil.

The soil type that forms depends on the rock type that is being weathered. For example, when shale is weathered, a clay type soil results.

Students should recognize that the classification of soils is generally based on texture or how they feel.

Soils differ in organic matter, parent soil material and the amount of air and water they contain. Students should be able to classify and describe sandy/gravel soils, loamy soils and clay soils. Coarse-textured soils feel gritty, and may roll between your fingers, and students might be able to identify the small grains using the naked eye. Clay soils feel greasy, like toothpaste, with very little texture, especially when wet. A loamy soil is composed of sand, silt and clay in nearly equal proportions and has various textures depending on the percentages of their composite parts.

- define porosity and permeability

Students should define porosity as is the amount of empty space in a soil or rock. Permeability is defined as a measure of the ease with which liquids and gases pass through a soil or a rock.

- relate porosity and permeability to soil types

Students should determine how much water is required to saturate a soil sample (porosity) and drip through in a given amount of time (permeability). Teachers could ask students to reflect on the types of vegetation associated with the different soil types.

Students could engage in a Quiz-Quiz-Trade activity (Appendix B) to review concepts to this point.

Soil

Suggested Assessment Strategies

Performance

- Given a variety of soil types, classify them as closely as possible, into the three main types. (310-3)

Paper and Pencil

- Research methods used to make soils economically valuable (i.e., fertilizers, screening, sand for cement, road building, etc.). (310-3)
- Research the location of agricultural areas in Newfoundland and Labrador and describe the types of soil present in each area. (310-3)
- Give three examples of how the type of soil determines the type of plants present. (310-3)
- Research and write a report on how soils are maintained and fertilized in your region. (310-3)

Presentation

- Collect a soil profile from your community and identify the different types of soil present. Draw a bar graph to represent the composition of the soil profile. Collaborate class data to create a bar graph showing the occurrence of different soils. (311-3)

Interview

- Interview an engineer to explain how soil properties are important in building large structures such as bridges. (310-3)
- Interview a farmer or agricultural technician to find out about the soil types in your region and what grows best in them. (310-3)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

ST pp. 422-423, 427

ST pp. 426-427

Soil (continued)

Outcomes

Students will be expected to

- carry out procedures controlling the major variables to answer questions arising from practical issues (208-2, 209-1)
- use instruments effectively and accurately for collecting data (209-3)
- compile, organize, and display data, using a tabular format (209-4, 210-2, 211-2)
- interpret patterns and trends in data, and infer and explain relationships among the variables (210-6)
- state a conclusion, based on experimental data, and explain how the data gathered supports or refutes an initial idea (210-11)

Elaborations - Strategies for Learning and Teaching

Core Laboratory Activity: Be a Soil Sleuth.

The laboratory outcomes 208-2, 209-1, 209-3, 209-4, 210-2, 210-6, 210-11 and 310-3 are addressed, in whole or in part, by completing CORE LAB 12-2B "Be a Soil Sleuth".

Soil (continued)

Suggested Assessment Strategies

Performance

- Design a fair test to determine the porosity and permeability of different soils. (209-1)

Resources

www.ed.gov.nl.ca/edu/k12/curriculum/documents/science/index.html

Core Lab #8: Be a Soil Sleuth, p. 428
TR 4.52-4.54
TR AR 3
TR PS 8, 10
BLM 4-45, 4-47, 4-48
BLM 7 Activity 9

Appendix A

STSE

Important Notes

1. These STSE modules are intended for teacher reference. Each is designed to target specific outcomes within Grade 7 Science. It should be noted that the questions, extensions, activities, and further research suggestions associated with each module are NOT mandatory. They can be used at the discretion of the teacher.

2. These STSE modules and the associated supplements can be found at www.gov.nl.ca/edu/k12/curriculum/guides/science/index.html#intermediate

The Two-Centimetre Forest

Outcomes:

1. Describe how our need for a continuous supply of wood resulted in the development of silvaculture practice. (112-3)
2. Make informed decisions about forest harvesting techniques taking into account the environmental advantages and disadvantages. (113-9)
3. Provide examples of how our understanding of boreal forest ecology has influenced our harvesting practices identifying the positive effects of these practices. (111-1, 113-1)
4. Identify various science- and technology-based careers related to forest management and harvesting. (112-9)

Introduction

After a hard day at school, it's good to go home and relax, put your feet up on the coffee table and haul out your favourite comic book. It may be raining or snowing outside, but you live in a sturdy home with a solid roof over your head. But have you ever stopped to wonder how that comic book got into your hands? How about the coffee table or the warm and cozy home you live in? All of these things, and many other products we use everyday, are made from wood.

Wood is one of the most versatile products on our planet. We can burn it, bend it, cut it, carve it, paint it, or glue it. It offers incredible strength for its weight, it's renewable, and we have lots of it!

In this module we will explore aspects of the relationship between our people and our forests. We will learn about the economic and cultural value of our forests, our forest type, and the process of forest harvesting in Newfoundland and Labrador. There is a lot more involved than you may think!

What's So Important About Wood?

In Newfoundland and Labrador, we place strong emphasis on our fishing heritage. But for as long as we have been harvesting fish, we have been harvesting wood as well. More than 80 communities in Newfoundland and Labrador owe their existence to the forest industry.

Our forests hold tremendous economic value. The forest industry generates more than $800 million each year and creates thousands of direct and indirect jobs. Using wood from our forests, companies manufacture many products including lumber, newsprint, moldings, furniture, flooring, and cupboards.

While our forests have strong economic value they also have tremendous cultural value. Archaeological evidence has verified the importance of the forest to the Maritime Archaic, Paleo-Eskimo and Beothuck Indians, as well as today's First Nations people. Countless generations of Newfoundlanders and Labradorians still "head out to the cabin" in the woods to hunt, fish, bird watch, pick berries, and enjoy nature.

Our forests are also home to many species of plants and animals, creating an important bond between our forest ecosystem and these species. Without proper care of our forests, many of these plant and animal species would not exist, and our cultural and natural landscape would be altered.

The Largest Ecosystem on Earth

Our forests are part of the boreal forest ecosystem. The boreal forest makes up about one-third of this planet's total forest area. Running through Canada, Russia, and Scandinavia, it has been called the largest ecosystem on Earth.

In North America, the boreal forest extends from Alaska to Newfoundland and Labrador. It borders the tundra to the north and touches the Great Lakes to the south.

The most common tree type in the boreal forest is the conifer; cone bearing evergreen trees with needle-shaped leaves. Conifers are well-adapted to the harsh climate and thin, acidic soils that are found in this ecosystem.

Large numbers of bodies of water are also characteristic of the boreal forest. Bogs, fens, marshes, shallow lakes, rivers and wetlands are mixed in among the forest landscape and hold large volumes of water. Winters are often long and severe, while summers are short and often warm.

Forests of Newfoundland and Labrador

The boreal forests of Newfoundland and Labrador are relatively small and consist primarily of black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*) intermixed with other conifers and deciduous trees.

Black spruce is the most abundant tree in Labrador and the second most abundant on the island. This species is common on both wet and dry environments and is very tolerant of our unfavourable soil conditions. Black spruce also grows well on fertile sites, but it is a poor competitor among faster growing trees.

Repeated fires have established black spruce across much of central Newfoundland. The nature of its cones, which pop open when heated, gives this species a competitive edge on burned sites.

Balsam fir forms about two-thirds of the forests on the island and one-third of the forests in Labrador. The forests of the island's west coast commonly consist of pure stands of balsam fir that prefers moist, well-drained soils. This species can attain heights of 20-24 meters at the age of 70-100 years on the best sites.

Deciduous trees are found on the island in areas where there are better quality soils, especially the deep river valleys of the Western Long Range Mountains and the Humber and Red Indian Lake watersheds. White birch (*Betula papyrifera)* and trembling aspen (*Populus tremuloides)* are characteristic species. These trees, commonly called hardwoods, can attain heights of 22 meters at the age of 80 years.

Forest Harvesting in Newfoundland and Labrador

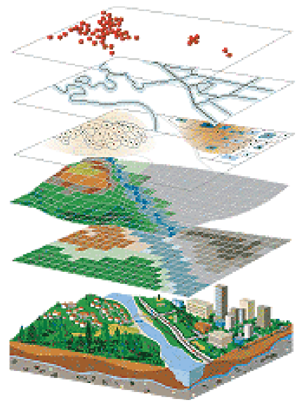
Planning

Forestry harvesting techniques have come a long way since the days of the early loggers, when forest workers put a chain saw over their backs and headed out to harvest the forest's most productive areas.

Today, most of the people who work in the province's forestry sector are highly educated, skilled, and trained individuals. Forest harvesting techniques are now technologically advanced, with a commitment to protect and sustain the environment. Planning shows harvesters what areas to cut. Older trees are cut first, giving younger, developing trees an opportunity to grow.

Before logging companies harvest any forest in the province, an ecosystem inventory is completed. The inventory is essential in the planning process for harvesting timber because it provides information on the height, species, age, and productivity of the forest. Information on wildlife habitat and abundance, soils, ground vegetation, and other features are also collected. This information is used with computer models to determine the impacts that harvesting will have on the local ecosystem.

Forests are dynamic ecosystems. Natural forest disturbances such as forest fires, the blow down of trees due to wind, and insect infestation all occur. Through proper planning, foresters can now harvest areas to "mimic" the look of a naturally occurring event.



Many communities in our province are located within the timber limits of harvesting companies. Protecting essential natural resources such as water sheds and viewscapes for the tourism sector is of huge importance to many residents. Proper planning ensures a buffer zone is left in place to protect water resources against erosion and other factors that may cause negative effects when harvesting. Proper planning also ensures that cut areas are hidden from view in most communities, thus protecting the beauty and features of the surrounding landscape.

Road Access

In many cases, road construction, not cutting, has the potential to have the most severe impact on the forest environment.

To gain access to the forest, hundreds of kilometres of access roads are built every year. These roads must be built in adherence to strict environmental guidelines. Roads are often constructed in areas where they will have the most positive impact for all parties involved. This includes forest operators, recreational users, and local flora (plants), and fauna (animals). For example a road may bypass a sensitive wetland ecosystem instead of going through it.

Roads and ditches are constructed to strict guidelines when it comes to slope. If the roads and associated ditches are too steep, severe erosion may occur.

Harvesting

Loggers no longer venture into the woods with axes and bucksaws. Tree harvesting has become a specialized science. In most areas of the province, large, computerized mechanical harvesters cut trees. Machines called skidders are then used to haul the trees out once they are cut by the harvesters.

One of the main concerns with harvesting is the damage the machines tires caused while traveling to the harvest site and operating in the harvesting area. Thin tires would sink into the soft soil and leave deep ruts that would severely impact the local landscape and take years to return to their natural state.

Many skidders and harvesters are now equipped with wide flotation tires to prevent rutting and damage to the forest floor. Flotation tires look similar to those on an all-terrain vehicle, except the tires are as tall as a fully grown person! Air pressure in these tires is low so that weight is distributed across a wide area, preventing deep ruts from occurring in the soil. This type of tire also ensures seedlings and other growth is not damaged when skidders run over them. Seedlings are not crushed, but spring back up with no permanent damage.

Silviculture is specialized work that also occurs during harvesting. Silviculture workers remove certain types of trees (older or diseased, for example) from a harvest area. This gives the remaining trees in the area more room to breathe, meaning they are able to get more water, sunlight and nutrients from the soil. Replanting trees is also a part of silviculture.

Before harvesting, foresters have to think of what was already living in the forest before they showed up to harvest the wood. A wide assortment of flora (plants) and fauna (animals) flourished in the area long before humans arrived to the harvest the timber. Strict regulations are followed to ensure wildlife is considered when harvesting timber.

Buffer zones are maintained around rivers and streams. This ensures that the critical aquatic habitat is not disturbed during harvesting. The buffer zone prevents erosion and runoff, increased water temperatures, lack of proper camouflage, and loss of breeding areas.

Some forested areas are set aside as “protected areas” because they are home for special or rare wildlife. Forest companies do not harvest in areas classified as protected areas. This ensures that critical plant and animal habitat is protected. An example is the Main River area and the Little Grand Lake reserve. Both are excellent habitat for the Newfoundland marten.

The Two-Centimetre Tall Forest

When you think of the term *clear-cut*, images of vast mowed-down forests often come to mind. Public perception is often that this type of forestry is the result of poor management and destroys both the visual and natural landscape.

But if you look at the science behind “clear cutting,” you will see that it is an effective forest management process that actually mimics natural events such as forest fires and insect infestations.

There is a great amount of science involved in selecting what type of trees to cut, where to cut them, and the type of clear cutting to be involved.

There is a misconception that clear cutting is the same as deforestation. This is not the case. Deforestation is the practice of removing the forest with no intention of regenerating the trees on that area. Usually this involves clearing land for urban expansion or agricultural development. This may occur on a very small scale in Newfoundland and Labrador as some communities grow and expand. Clear cutting in Newfoundland and Labrador is a way of both harvesting and regenerating the forest.

A clear-cut may seem like a dead and barren wasteland. Visually it may appear that all the trees in the area have been harvested. But take a walk through this area and examine the ground. There will be many tree seedlings of spruce, fir, pine and other species – a two-centimetre tall forest. Removing the older trees gives these younger seedlings better access to sunlight and water and gives them the ability to grow and expand. A complete forest ecosystem still remains on a smaller scale until succession regenerates a new, thriving forest.

Foresters don't abandon an area after it is harvested. Trained professionals closely monitor the area for many years to keep a close eye on the succession process. They monitor tree growth, new plant and animal species and other traits.

What about the habitat lost as a result of clear cutting? In some cases, animals may be displaced by clear cutting, but planning ensures the clear-cut is of suitable size so displaced animals will not have far to travel to find a new habitat. Clear cutting is done on a much smaller and localized scale than it used to be.

Clear-cuts often attract a whole new array of animal species. These areas tend to be small and open, and attract many sun-loving plants and tree species. As the trees and plants in the clear-cut grow, shrub and alder species more adapted to a shaded forest will slowly replace the sun lovers.

Clear-cut areas basically do not add or increase animal species. They change what species live and thrive in the area, according to their age, and what they need in terms of living habitat. A new clear-cut may not be a particularly good area for a squirrel, chipmunk, or a Newfoundland pine marten, but it does provide excellent habitat for bear, moose, and young rabbits. As a clear-cut ages and grows, it provides varied structure and food sources suitable for different animals' habitat and food needs.

Clear cutting is ugly at first. Few people would rather stand in a clear cut area than in a lush, boreal forest ecosystem surrounded by fir and spruce. But the ugliness of a clear cut passes, usually sooner than expected! In three to four years, succession has filled in the clearings, the area has lost its brown, disturbed appearance, and the hillside is green in the summer and in the fall, awash in colour. In six to 10 years, the young trees are free to grow above the bramble and smaller shrub like trees. In 10 to 14 years, the young stand of 8- to 10-metre tall trees is again a pleasant place to walk through. Finally, in 35 to 40 years, the growing trees are once again a valuable timber crop and animal habitat.

Conclusion

The Province of Newfoundland and Labrador has a rich and vibrant culture and the forests of our province are a part of the cultural fabric. Our cultural identity, although highly shaped by the sea, has also been shaped by the forests that cover our landscape. Can you imagine Newfoundland and Labrador being the same without logging, hunting, camping and fishing in our forests?

The forest industry makes a huge contribution to our economy and our province. But many people still have the misconception that forest harvesting is a "primitive" operation, and environmental impacts are not considered.

In this module we have shown today's foresters are indeed specialized workers and forestry is a technological field. Foresters undergo specialized training in their field and have a sound grasp on environmental issues concerning their profession.

Humans and forests have had close interaction for thousands of years. The importance of this relationship is often left unnoticed. The human relationship with forests has often been seen in a negative light, but with recent advances in technology, the relationship between humans and the forests has never been stronger.

Questions

1. Identify 3 biotic and 3 abiotic factors that are characteristic of the boreal forest.
2. Why does black spruce dominate in previously burned areas?
3. What is the importance of completing an ecosystem inventory?
4. How has today's forest industry advanced technologically?
5. Identify some jobs created as a result of the forest industry in Newfoundland. Can you think of more than 10?
6. What are the advantages and disadvantages of clear cutting a section of forest?
7. Interactions occur between humans and the forest ecosystem; some of these are positive while others are negative. State 2 positive interactions and 2 negative interactions between humans and the forest ecosystem.
8. Construct a food chain of plants and animals found in the boreal forest.
9. In the two-centimetre forest, young seedlings have better access to sunlight and water. Why is this important for the growth and development of the forest?
10. Describe how a clear-cut changes over time.
11. Explain why the term "regeneration harvesting" might be a better term to use than "clear cutting".

Extensions

1. Research an animal that lives in the boreal forest and create a poster or power point presentation.
2. Visit a recent forest fire or clear cut area. Observe what changes have occurred. Bring a camera and re-visit the site at the end of the year. Keep a record of changes.
3. Ask a NL Forest or Wildlife Conservation Officer or someone else involved with the forest industry to visit your class. Ask them to talk about their jobs and the connection they have to the forest.
4. Research how road construction, in logging operations, can have a negative impact on the forest ecosystem.
5. Conduct research on the harvesting practices and equipment used by logging companies today. How do these practices and equipment reduce the environmental impact logging has on an ecosystem?
6. Investigate the different types of protected areas in Newfoundland and Labrador. What are the criteria for becoming a protected area? Are all protected areas managed and protected in the same way?

References

Bethlehem Olive Wood. Available at:
www.bethlehemolivewood.net/Spindle.

Boreal Forest Ecoregion. Available at:
http://www.sierraclub.org/ecoregions/boreal.asp.

Boreal Forests of the World. Available at:
http://www.borealforest.org/world/can_mgmt01.htm#canmgmt03.

Clear Cut Timber Stands. Available at:

http://www.ces.ncsu.edu/martin/newsletters/newsarticles/twigs/clearcut.html.

Corner Brook Pulp and Paper Sustainable Forest Management Plan. Available at:

http://www.cbppl.com/SFM/locked/SFM%20Plan%20v2.pdfhttp:/www.cbppl.com/SFM/locked/SFM%20Plan%20v2.pdf.

Forest Management Systems. Available at:

http://www.inhs.uiuc.edu/dnr/fur/habitats/forest.html.

Manitoba Model Forest (1996) *Manual for Environmentally Responsible Forestry Operations in Ontario.*

Myth's of Clearcutting. Available at:

http://pfa.cas.psu.edu/news_clearcutting.htm.

Natural Resources Defence Council. Available at:

http://www.nrdc.org/land/forests/boreal/images/page5.jpg.

Newfoundland and Labrador Department of Forest Resources. Available at:

http://www.nr.gov.nl.ca/forestry.

Silviculture in Ontario. Available at:

http://ontariosforests.mnr.gov.on.ca/silvicultureoverview.cfm?lang=FR&lang=EN

Status and Trends in Forest Management. Available at:

http://www.fao.org/docrep/W4345E/w4345e04.htm.

The Canadian Forestry Association (2003) *Canada's Forests-Source of Life: Volume 4, Sustainable Forests.* The Canadian Forestry Association

The Clear Cutting Controversy-Myths and Facts: Available at:

http://www.wvu.edu/~agexten/forestry/clrcut.htm.

The State of Canada's Forests. Available at:

http://www.nrcan-rncan.gc.ca/cfs-scf/national/what-quoi/sof/sof04/special04_e.html.

Transport Models. Available at:

http://www.transportmodels.co.uk/

Tree Regeneration. Available at:

http://www.dof.virginia.gov/mgt/tree-regeneration.shtml

Heat Pumps: An Alternative Way to Heat Homes

Outcomes:

1. Identify different approaches taken to solve the problem of heating homes during cold times of the year (109-7)
2. Make informed decision about the various technologies used to heat our homes, taking into account potential advantages and disadvantages (110-7, 113-8)
3. Provide examples of how the technologies used to heat homes have improved over time (110-8)
4. Provide examples of how our understanding of evaporation and condensation of liquids resulted in the development of heat pumps (111-1)
5. Describe how various surfaces absorb radiant heat (308-6)

Introduction

Heating homes in Newfoundland and Labrador has long been a major concern. Historically, there have been three main sources of heat in this province: (1) wood, (2) oil, and (3) electricity. It takes a great deal of effort to stay comfortable during our cold, damp winters. The effort made may be in labour (e.g., cutting, splitting, and storing wood) or in dollars (e.g., increasing costs of oil or electricity). When building a new house, the choices of the type of heat source for that house has become a very important decision. To make this decision, there are many questions that should be considered about the traditional sources of heat. Some of these are:

Wood:

1. If I cut it myself, will there be places available in the future where I can cut it?
2. If I buy my wood, how expensive will it become?
3. Is there a long term supply of wood in my community?
4. Do I have the time needed to cut it up, store it to dry, and then put it in a shed?
5. Am I aware of the pollution created by burning wood?

Oil:

1. How expensive will it become in the future?
2. Will there be an ample supply in the future?
3. Do I have enough space in my house for the furnace and duct work?
4. Am I able to deal with a spill from the tank or fuel lines?
5. Am I comfortable with the green house gases that are produced?

Electricity:

1. How expensive will it become in the future?
2. What environmental damage results from its production?
3. Will there be enough in the future?
4. Is the source of the electricity environmentally friendly?

The decision of which heat source to install in a new house is not only a costly one, it is a decision that is often not easy to change in the future. For example, changing from oil to electricity (or vice versa) is very costly and, in some cases, is not possible due to how the house was constructed. As a result, the answers to these questions have long term implications for the house owner.

With recent scientific advancements, there are other options to the three “traditional” choices. One of these is the heat pump and is now becoming a very real and practical alternative. A heat pump is an electrical device that moves heat from one source, “concentrates” it, and transfers it to another location. This technology is very similar to that which is found in refrigerators and air-conditioners. In these devices, heat is removed from the fridge or room and transferred somewhere else. As you will see below, this type of heat pump works in the cooling mode only.

The Science Behind Heat Pumps

The heat pump is based on the following two scientific principles:

1. When a liquid is heated it will evaporate (becomes a gas) and when a gas condenses (becomes a liquid), it gives off heat. As you have learned, this is explained using the particle theory of matter. As the particles in the liquid are heated, they have more kinetic energy and are able to move further apart. When particles gain enough kinetic energy, those at the surface can “break free” of the surrounding liquid particles and leave the liquid as a gas.
2. Changes in pressure can make a liquid evaporate, or gases condense, more easily. In other words, if the pressure on a liquid is reduced, the liquid will evaporate more easily. If a gas is put under more pressure, it will condense more easily. A common example of this is a propane tank or propane torch. Propane is placed in a tank under a pressure that causes it to be a liquid (if you shake the tank, you can hear or feel the liquid sloshing around inside). When you release the pressure on this liquid, such as when you open the tap or valve, the liquid evaporates and comes out as a gas. This happens because it is under high pressure inside the tank because the gas is “jammed” into a small space. When you open the valve, the pressure is much less because the gas is entering a much larger space.

These scientific principles are used to make a heat pump in the following way:

1. In the place where heat is to be removed, a liquid, called the refrigerant, is pumped through tubing under low pressure. The refrigerant is a liquid that has a very low boiling point (e.g., where water has a boiling point of 100^oC, the refrigerant might have a boiling point of 10^oC or lower).
2. As the refrigerant passes through the pipes, it absorbs heat energy from the surrounding environment and, because it has a very low boiling point, it evaporates (becomes a gas). At this point, the gas is under low pressure.
3. This low pressure gas is then pumped and compressed (put under high pressure) into a second area where it releases the heat energy it absorbed. The heat energy that is released can then be used to heat air or water. The warm air or water is then transferred to the location that is to be heated (e.g., a room in a house).
4. The compressed refrigerant is then passed through an expansion valve that reduces its pressure. At this point the gas reverts back into a liquid refrigerant and the process repeats itself.

To cool an area, the process is reversed. Because it is fully reversible, a large heat pump is capable of heating or cooling our homes, offices and schools, depending on the outside temperature.

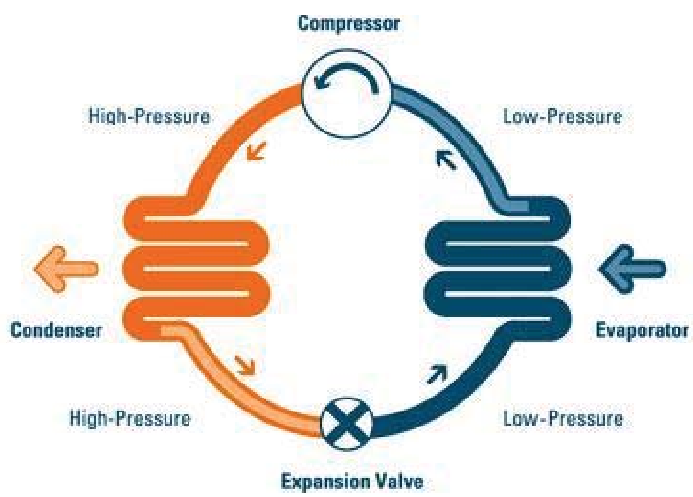


Figure 1: The basic heat pump cycle (photo courtesy of www.nrcan.gc.ca)

You might wonder how this works during the cold winter months. You might ask “where is the source of heat when it’s -18ºC outside?” As you have learned in this unit, all matter contains energy until it reaches absolute zero (-273ºC). So, even at -18ºC, both the ground and the air are sources of heat. Furthermore, once you go below the deepest penetration of frost, the ground is at a comfortable 16ºC (and will get even warmer as you go deeper). So, even on the coldest days, the air always contains heat. In fact, while it might not feel like it as you stand there shivering, air at -18ºC contains about 85% of the heat it contained at 21ºC!

Types of Heat Pumps

1. <u>Air-Source Heat Pumps</u>

This type of heat pump uses the energy that is present in the air as a source of heat. Air-source heat pumps are most efficient when the outside air temperature is above -9ºC. Below this temperature, the commonly used refrigerants can not absorb enough energy from the air efficiently.

There are two types of air-source heat pumps:

(a) Air-to-Air

This type of heat pump removes heat from the air. If it is being used to heat a house, the heat is absorbed from the air outside then transferred to the air inside the house (see Figure 2). The fan, which is part of the heat collection mechanism (outside the house), pulls air across the pipes that contain the low pressure refrigerant. The refrigerant absorbs heat from the outside air and evaporates into a gas. This gas is then passed through the compressor and pumped inside the house and through a series of pipes and heats the surrounding structure. Inside the house, another fan, which is part of the distribution mechanism, pulls cool air from other parts of the house and forces it across the heated tubes that contain the high-pressure refrigerant. As the air passes over these tubes, it warms up. The fan continues to blow this warmed air into ductwork that carries it to the cooler parts of the house. This warm air heats the interior of the house.

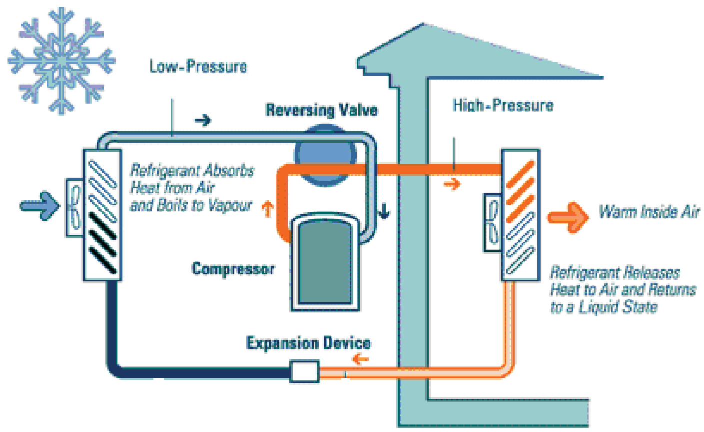


Figure 2: Heat pump in its Heating Cycle (photo courtesy of www.nrcan.gc.ca)

To cool the house, the process is reversed and the refrigerant is pumped in the opposite direction (Figure 3). The fan pulls warm from inside the house, over the pipes that contain refrigerant under low pressure. The refrigerant absorbs the heat from this “inside air” and the heated refrigerant changes into a gas. As the “inside air” looses heat energy, it is cooled. The fan blows this cooler air into the ductwork and throughout the house. The cooler air cools the interior of the house. This gas passes through the compressor and enters the pipes outside the house. Here the fan blows outside air over the surface of the pipes and the outside air absorbs heat energy from the refrigerant. The gas condenses back into a liquid and is under low pressure. It is pumped back into the house and the cycle continues.

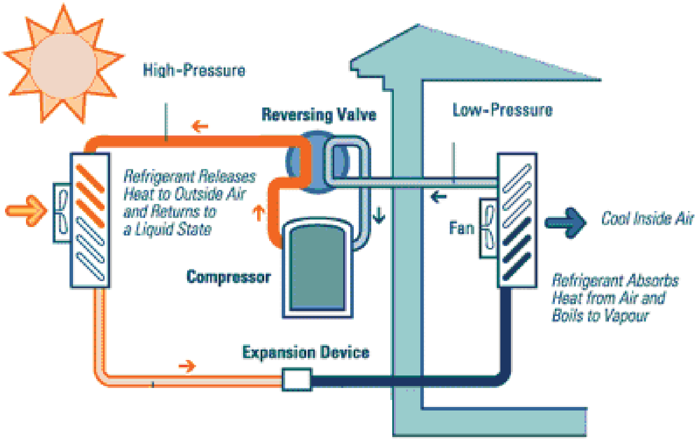


Figure 3: Heat pump in its Cooling Cycle (photo courtesy of www.nrcan.gc.ca)

Notice the differences in the two cycles as displayed in Figures 2 and 3. These are:

i) the "heat in" mode is the reverse of the "heat out" mode

ii) the refrigerant is pumped in opposite directions. During the heating mode, it goes inside the building, while in the cooling mode, it goes outside the building.

(b) Air-to-water

This type of heat pump functions in exactly the same manner as the air-to-air heat pump with the exception that the energy transfer occurs between the air on the outside and water on the inside. For example, during the winter months, the heat pump removes heat from the outside air and transfers it to the water in pipes that are usually placed throughout the sub-floor (under the carpet, canvas or hardwood). This makes the floor warm which in turn heats the home. Or the water may run through a large metal structure called the radiator. The water inside the radiator heats the metal and the heat "radiates" into the room, heating the surrounding air.

2. Ground Source Heat Pumps

The ground-source heat pump takes heat energy from the ground outside the house, when in the heating mode, or deposits heat into the ground outside the house, when it is in the cooling mode.

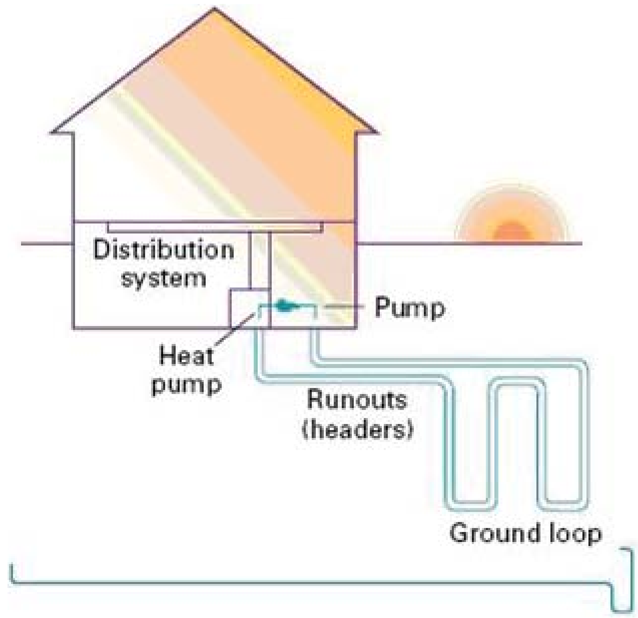


Figure 4: Ground source heat pump (photo courtesy of www.swansea.gov.uk)

The refrigerant is pumped through an underground piping system and picks up heat in the heating cycle or gives up heat in the cooling cycle. The length and depth of the underground piping system depends on a number of factors. These are:

i) the size of the space to be cooled or heated

ii) the difference between the temperature inside the building and the outside temperature

iii) how well the space is insulated

Cost Comparisons

If the home builder is considering the installation of a heat pump as the heat source for the house, there are other questions that need to be considered. Three of the most important ones are: "Which type, air source or ground source is best for me?", "How much will it cost to install a heat pump?" and "Will it save me money on my heating bill?"

The answer to the first question will depend on the general climate in the area. Air source heat pumps are most efficient (i.e., most cost effective) within an average temperature range (which depends on the pump), and if the average temperature in that area falls outside this range, the only real option is the ground source pump. It is difficult to answer the second question as there are many factors that influence the overall cost. Some of the factors that will influence the overall installation cost of a heat pump are: the size of the house, the configuration (i.e., bungalow, 2-storey, etc.), where the house will be located (i.e., the more distant from the supplier, the more it will cost), the temperature range of the outside air, the type of soil that will need to be dug up, etc.

Often, it is the answer to the last question that most people will use to make their final decision. Figure 5 below provides a comparison of the costs involved to heat a 3000 sq. foot house, in a good location and an average temperature range (i.e., -15^{o}C to 25^{o}C).

Analysis

Careful comparison of the various heat sources available will point out pros and cons of each choice. The traditional sources for heating houses in Newfoundland and Labrador (Wood, Oil, and Electric) are cheaper to install but over the long term are more costly to operate. Also, in addition to the negative effects these traditional heat sources have on the environment, the operating costs for these may increase quickly as the supply is reduced. The alternative to the traditional heat sources is the heat pump. There are several positive features related to using heat pumps to heat our homes. These are:

i) they do not have any negative effects on the environment

ii) after they have been installed, they are cheaper to operate than the traditional sources of heat

iii) the operating costs will not change as they are not affected by limited supply or price increases.

Heat Source	Installation Cost	Average cost per month	Yearly cost	Cost in 10 years
electric heat	$2500	$300	$3600	$36,000
oil furnace	$5000	$250	$3000	$30,000
wood furnace	$5000	$130	$1560	$15,600
air-source pump	$12,000	$120	$1440	$14,400
ground-source pump	$25,000	$60	$720	$7200

Figure 5: Cost Comparison for Various Heat Sources

So, with the insignificant effects on the environment along with the stable and relatively low operating costs, why don't more houses have heat pumps installed? The main reason is the up front cost of installation. Even though a heat pump will save the homeowner money in the long run, the decision to add an extra $5000 to $20,000 on the cost of a new house is more than many people are able to afford or are willing to spend.

Conclusion

While there are many decisions that go into the planning and building of a house, the decision of which heat source to use is one that will have long term effects. This is a decision that is not made easily and each individual home builder has to carefully weigh the pros and cons of each option to ensure he or she makes the best decision to fit their lifestyle and budget.

Questions

1. What are the advantages and disadvantages of using a heat pump to heat your home?
2. Explain how a heat pump functions to cool a building rather than heat it.
3. Name three factors that can influence the overall cost of installing a heat pump.
4. What other household appliances use the same technology found in a heat pump?
5. How does an air source heat pump work to heat a home when the temperature of the air outside is $-10^{o}C$?
6. Describe the similarities and differences between air source and ground source heat pumps?
7. Using the table above, explain how using a ground source heat pump can actually save you money.

Would You Like Salt On That? Improving Winter Driving Conditions with Road Salt

Outcomes:

1. Identify some positive and negative effects and intended and unintended consequences of using salt on highways. (113-1)
2. Describe how our understanding of the properties of solutions has resulted in better road de-icing technologies (111-1)
3. Provide examples of how road de-icing technologies have affected our lives, our communities, and our environment (112-7)
4. Make an informed decision about the use of road salt as our main road de-icing chemical taking into account the environmental, social, and economics advantages and disadvantages (113-9)

Introduction

Our winter months provide us with the opportunity for many enjoyable activities, such as snowmobiling, skiing, skating, and tobogganing. However, winter also brings the great danger of slippery road conditions. Canada uses about 4.9 million tonnes of de-icing materials each year. Of these, 4.75 million tonnes of this is sodium chloride (rock salt), 0.11 million tonnes is calcium chloride, and the rest is made up of potassium chloride and magnesium chloride. At the local level, road crews in Newfoundland and Labrador use around 200,000 tonnes of sodium chloride and 800 tonnes of calcium chloride each winter.

Safe driving in the winter requires good traction between the automobile's tires and the road. Good traction will decrease the amount of skidding and slipping when driving or stopping. Slippery road conditions are created when moisture from fog, rain, or snowfall freeze onto the road. Also, when cars and trucks drive over snow it becomes compacted and bonds to the road making it very hard for plows to remove.

Using Salt to De-Ice Roads

To prevent freezing of moisture and compaction of snow on roads, salt (sodium chloride) is often used because it lowers the freezing point of water. When the addition of one substance to another causes the freezing point to lower, this is referred to as a **freezing point depression**. Freezing point depression is a **colligative property** of solvents. A colligative property is one which depends on the number of particles dissolved in the solute (not the type of particle). For example, as the number of salt particles dissolved in water increases, the water's freezing point decreases to its lowest possible temperature of -9^{o}C. The lowest freezing point of -9^{o}C is reached when the water has become saturated with sodium chloride (i.e., when the water can not dissolve anymore solid salt). Since salt can only lower the freezing point of water to a maximum of -9^{o}C, it will not melt ice or snow if the outside temperature is less than -9^{o}C. For temperatures colder than -9^{o}C, a substitute is used.

Sodium chloride is not the only chemical used for de-icing roads, nor is it necessarily the best at melting ice. Sodium chloride, which has the chemical formula NaCl, dissolves into two types of particles: one sodium (Na) particle and one chloride (Cl) particle per sodium chloride unit that dissolves. A compound that yields more particles when put into water would lower the freezing point of water more than salt. For example, calcium chloride, $CaCl_2$, dissolves into three particles; one of calcium (Ca) and two of chloride (Cl). Because there are more particles dissolved in the water, calcium chloride lowers the freezing point of water more than sodium chloride.

The following table provides a list of some other chemicals that are used to de-ice roads. Note that each chemical has different advantages and disadvantages to its use.

Applying salt at the beginning of a storm prevents the precipitation from freezing and creates an immediate brine (saltwater) solution. As a result, snow build up can be more easily plowed and, depending on road and weather conditions, a new application of salt may be applied.

Name	Lowest Practical Temperature	Advantage	Disadvantage
Sodium Chloride	-9°C	keeps road surfaces dry	damages concrete and vegetation causes metals to rust
Calcium Chloride	-29°C	melts ice faster than salt	attracts moisture, surfaces slippery below -18°C
Magnesium Chloride	-15°C	melts ice faster than salt	attracts moisture
Potassium Acetate	-9°C	biodegradable	corrosive
Ammonium Sulfate	-7°C	fertilizer	damages concrete

Figure 1: Some chemicals used to melt ice.

* Further research into these chemicals will give a more detailed account of their negative affects on the environment.

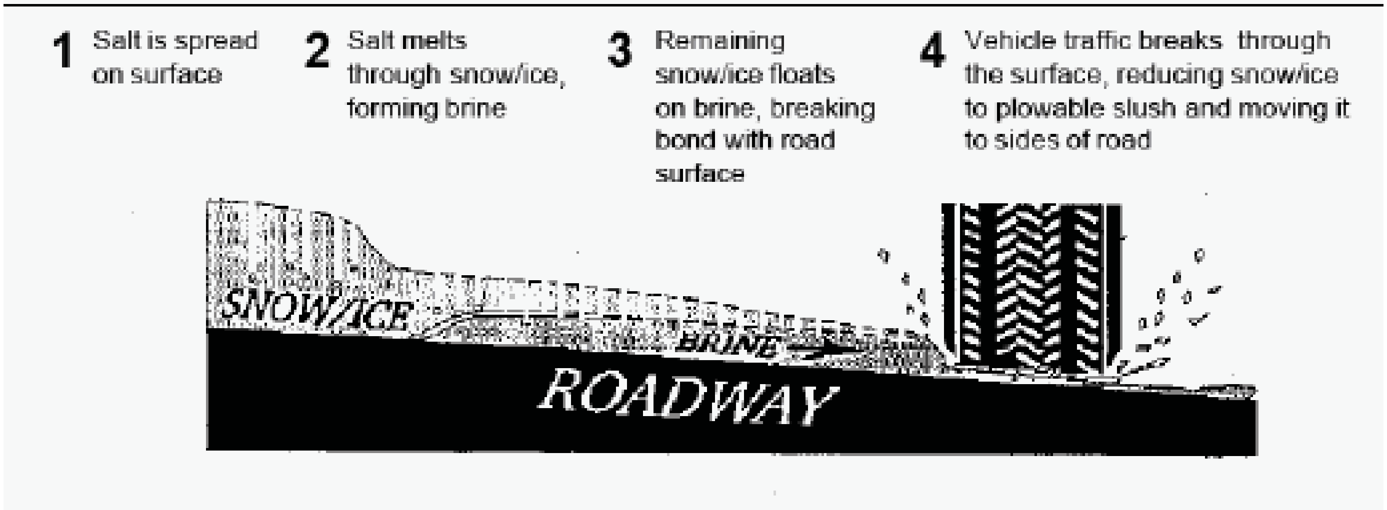


Figure 2: How Salt aids in Ice Removal (Source: http://www.highways.gov.sk.ca/technical-backgrounder/)

Problems with using Salt to De-Ice Roads

Although road salt is very important to help keep our roads and highways safe during the winter months, using too much can have a negative impact on our environment and structures. Some of the problems associated with using salt for de-icing roads are described below.

1. Surface and Groundwater

When salt is spread on the ground it will dissolve in the water that is present in the soil. As a result the groundwater will become salty and this saltwater may then end up in streams, ponds and even in our drinking water supplies. When salt water gets into freshwater ecosystems, it will affect the aquatic life in a negative way and may even kill off some of the living organisms. If communities use the aquatic ecosystem as a source of drinking water, it will affect the quality of our drinking water and may cause it to become dangerous for humans to drink.

2. Impacts on Soil

The sodium part of salt can react with minerals in soil which causes it to become harder. In some cases, the soil is so hard packed that water will not percolate through it easily. Also, because the soil is so hard, it is difficult for plant roots to push their way into the soil. Since plants use some of the minerals in soil for nutrients, this will decrease the soil's fertility and its ability of plants to grow there.

3. Vegetation

High concentrations of salt in soil, groundwater and salt spray from vehicles can damage the trees, grasses and shrubs present along the roadside. As a result, some plants will die off and other, **salt tolerant** plants may move into the area. You may notice that the vegetation along newly constructed roads is different than that along older roads. The vegetation along the side of older roads may have been damaged by salt or may be better able to withstand the salt concentration.

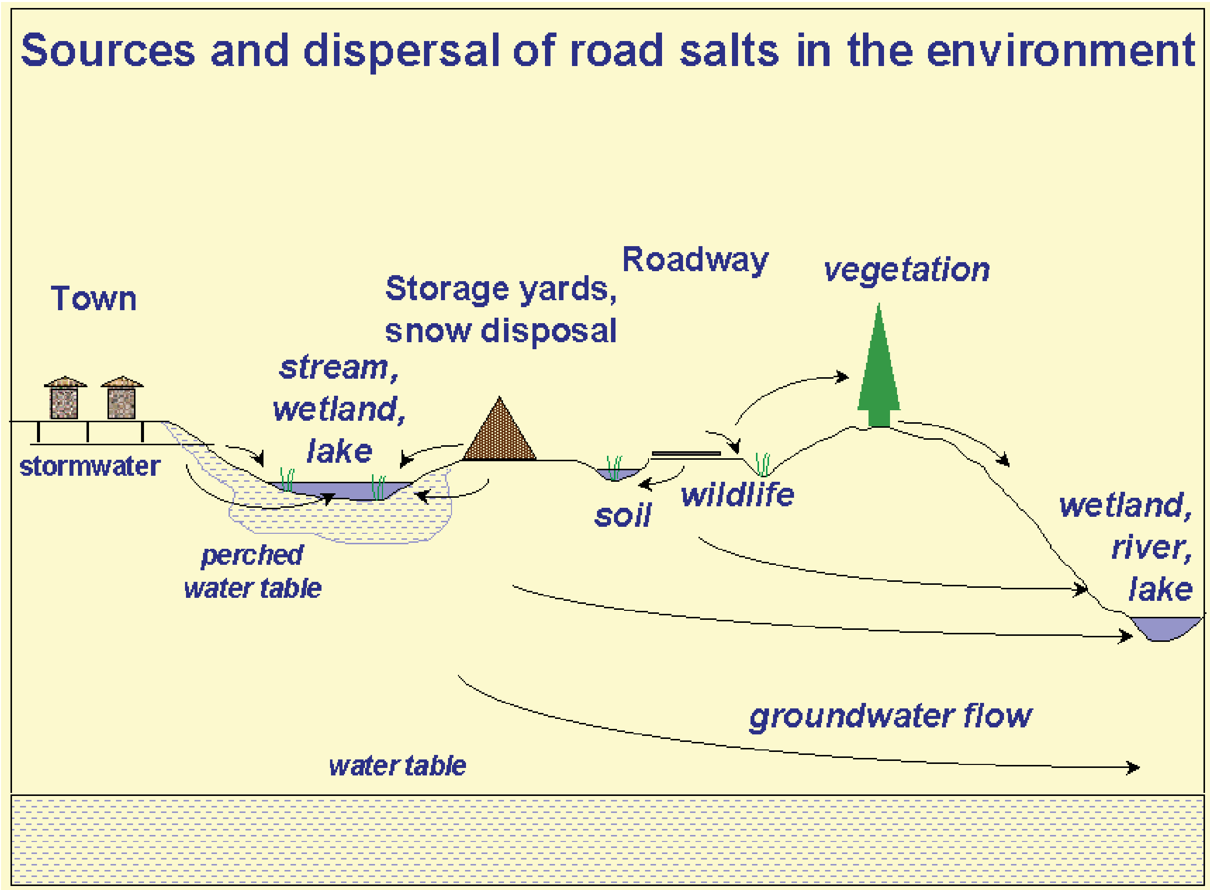


Figure 3: Sources and Dispersal of Road Salts in the Environment

(Source: http://www.ec.gc.ca/EnviroZine/english/issues/14/email_story_e.cfm?page=feature1)

4. Wildlife

Animals, like humans, need a certain amount of salt in their diet to keep them healthy. During the winter plants, which are animals' main source of salt, are not easily available. As a result, animals become "starved" for salt. The roadside provides a readily available and easily accessible source of salt. The salt is not a danger to the animals. However, having animals on or near the roads increases the chance of an animal-vehicle collision.

5. Corrosion of Vehicles and other Structures

Have you ever had the chance to compare the condition of an older car from Labrador with one from the island portion of the province? Road salt (and sea salt) dramatically speeds up the process of rusting. Salt also causes damage to our concrete bridges. Scientists are working to producing better rust resistant paints for vehicles as well as developing salt-resistant concrete.

Reducing the Negative Effects of Salt

In addition to trying to develop paints that slow down the rusting process and salt-resistant concrete, there are several other things that can be done to reduce the negative effects of salt.

1. Anti-icing

To further improve the safety of the roads and reduce the amount of salt used hi-tech Road Weather Information Systems (RWIS) have been set up across our province. These are automatic weather stations that are located near the highway and have sensors on the surface of and under the pavement. The system records the atmospheric conditions, such as relative humidity, wind speed, air temperature, and the temperature and wetness of the road. This information is used by department of highway officials to predict road conditions over a 24 hour period. By using this system, the maintenance crews will know, in advance, if roads will become slippery and will be able to apply salt before this happens. This process, called “anti-icing”, has reduced the amount of salt used by 20 – 30% as well as reducing weather-related accidents by 10 – 15% in some countries.

2. Pre-wetting

Another method used to reduce the amount of salt spread on our roads is to “pre-wet” it. Wetting provides moisture to make a brine, which is then applied to the road, resulting in faster melting action. Also, wet salt has a lower tendency to bounce or be blown off the road by traffic. A savings of 20 to 30% in lost or wasted salt is possible using this method.

Conclusion

Salt has long been the chemical of choice for de-icing our roads. Scientists are continually studying modifications of salt-based de-icing, such as:

i) combining salt with other chemicals
ii) mixing salt with sand in different amounts
iii) pre-wetting the salt before it is applied to the road
iv) ensuring that it is spread on the road in such a way as to maximize its effectiveness and minimize its environmental affects.

While there are some problems associated with using salt to de-ice roads, because of its low cost, abundance and relatively low environmental impact salt is widely used today, and probably will continue to be used into the future.

Questions

1. List and briefly describe the five problems created by using road salt (sodium chloride) on our roads.

2. Explain, with the aid of a diagram, how salt works to create a safer road to drive on.

3. When 10 grams of sodium chloride, NaCl, dissolves in 100 grams of water, the freezing point of the water goes down to -5.9^{o}C. When 10 grams of table sugar, $C_{12}H_{22}O_{11}$, dissolves in 100 grams of water, the freezing point only goes down to -0.56^{o}C. How do you account for this difference?

4. The Department of Transportation use mostly sand on the roads in Labrador. Why? Are the driving conditions in Labrador different from those in places that use salt? Explain your answer.

5. What is the purpose and advantages of Road Weather Information Systems?

6. What are two advantages of pre-wetting the salt before it is put on the road?

Further Research

1. Choose a chemical that may be used instead of sodium chloride as a de-icing chemical. Discuss the cost, advantages and disadvantages of its use.

2. Where are the Road Weather Information Systems located in Newfoundland and Labrador? Discuss how they work and how they are being used by our Department of Transportation.

3. Interview a Department of Transportation worker. Report on the processes of salting, sanding, and clearing our province's roads.

4. Investigate why sugar is used to de-ice aircraft even though it is not as effective as salt in lowering the freezing point of water.

Activity

Design and perform an experiment that tests the effectiveness of different salt concentrations on the: i) the melting time of ice, and, ii) the freezing point depression off the water (this can be studied by adding different amounts of salt to ice and record the lowest temperature reached by the water produced).

Reference Material

http://www.ec.gc.ca/media/index.htm

http://www.ec.gc.ca/substances/ese/eng/psap/final/roadsalts.cfm

http://www.usroads.com/

http://chemistry.about.com/cs/howthingswork/a/aa120703a.htm

http://www.highways.gov.sk.ca/technical-backgrounder/

http://en.wikipedia.org/wiki/Sodium_chloride

http://www.saltinstitute.org/

Seeing The Big Picture

Outcomes:

1. Describe how our explanations of how Earth has changed overtime are based on the collection of evidence and finding relationships between various observations in imaginative ways. (109-2)
2. Describe how our understanding of the forces that shaped our Earth have changed overtime as new evidence was collected. (110-5)
3. Identify the theory of continental drift as one early explanation for how our Earth changed over time. (110-1)
4. Identify the theory of plate tectonics as an example of a major shift in our world view. (110-3)

Introduction

The evidence of the earliest group of humans on our planet dates back 200 000 years. These people were located in the vicinity of Omo Kibish, Ethiopia in eastern Africa. Forty thousand years ago, or 160 000 years later, modern humans spread out of Africa to inhabit the rest of the Earth. It wasn't until relatively recently, less than 600 years ago, that Europeans set sail and explored the continents of North and South America. Over this span of human history the way in which we have pictured our planet has changed significantly.

Figure 1: World view prior to the Columbus 1492 voyage. In Germanus, 1482

(Source: http://www.newberry.org/K12maps/module_01/k-2.html)

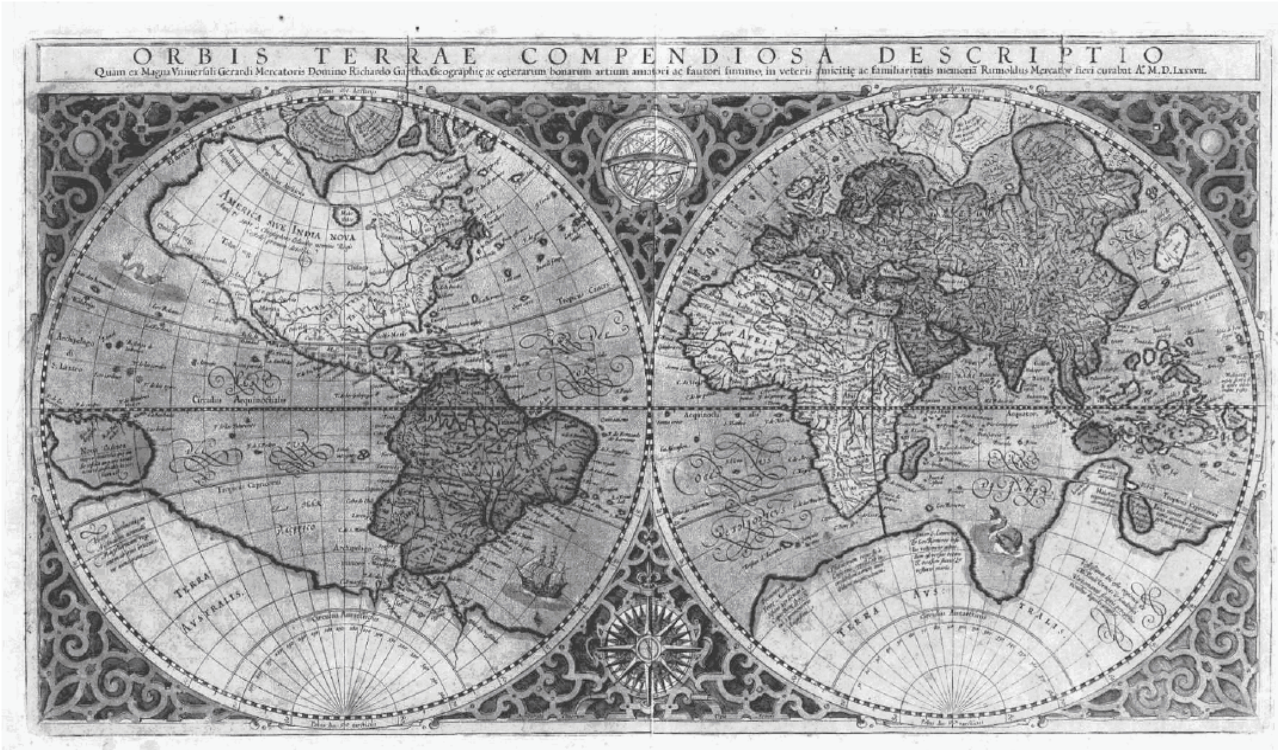


Figure 2: World view after the discovery of the Americas. Mercator, 1587
(Source: http://www.libs.uga.edu/darchive/hargrett/maps/1587m4.jpg)

With European exploration of the Americas the picture of the world changed and so did the thinking of its people. Those who thought of the Earth as being flat were now forced to rethink their old ideas. Early explorers produced maps and from these maps a new picture of our planet emerged.

The Emergence of a New Theory

Try to imagine yourself traveling back, over one hundred years in time, to northern Europe.

You are a teenager who enjoys skating and hiking. You finish school and choose to study meteorology, the science of weather. When you are in your mid twenties you are invited on an expedition to explore Greenland during which time you have an opportunity to observe maps of the Atlantic Ocean. You notice that the shorelines on the eastern part of North and South America seem to match up with Western Europe and Africa. You wonder why this is and question if there is some way in which these two far away continents could have once been joined together as one.

You search for other evidence to support your idea. Remember, the World Wide Web is not available yet so your only alternative for research is to look in books! During your research you discover that fossils of similar species of plants and animals, that are incapable of significant movement, have been discovered on both sides of the Atlantic Ocean. You notice that some fossils of creatures that once lived in the ocean are being found in sedimentary rocks on mountain tops and that minerals that only form in warm climates were being found in polar regions. All of this evidence supports the idea that land masses on our planet have shifted over time. However, one question remains unanswered: What is making them move?

Later in life you are selected to fight for your country in World War I and although you are wounded twice you survive to write down your ideas and publish a book so that others can read about your theory. Most of your friends, including educated members of your own family, still think that your ideas are incorrect. At the age of fifty you have an opportunity to return to Greenland on another expedition and tragically you are lost in a blizzard.

Your imagination has placed you in the shoes of the man who proposed the theory of continental drift, Alfred Wegener. He proposed this theory in 1912 but up until his untimely death in 1930 it still had not been accepted as true because he could not explain how the continents had moved. The explanation of how the continents moved was not provided until 1960, when a scientist named Harry Hess was exploring the Atlantic Ocean. Using sonar Hess was able to map the ocean floor and identify a mountain chain running the length of the Atlantic Ocean. When they drilled into the crust of this area they discovered that the rock got older as they moved away from the ridge. Magnetometer surveys revealed that magnetic reversals occurred in layers parallel to the ridge. These frozen records in the rock also provided evidence to support sea floor spreading and this proved that the continents had moved from their original position because the continents would have moved as the crust moved. It is now thought that convection currents provide the mechanism that causes the plates to spread apart and create new crust.

Over the years, as new observations were made and new evidence was collected, Wegener's theory of continental drift has been refined into our current theory of plate tectonics. The theory of plate tectonics involves large crustal plates that move over the Earth's mantle. In some areas, such as in the mid-Atlantic, the plates are moving apart. In other areas they are pushing together and sliding past one another. Wegener's ideas, supported by the evidence collected by Harry Hess, J. Tuzo Wilson, and others, have given us a global perspective of why the surface of the Earth is shaped the way it is.

Local Effects of Plate Tectonics

Did you know that where you live now was once next door to a different ocean? Long before the Atlantic Ocean formed there was another ocean called Iapetus already there. The Atlantic Ocean was named after the Greek god Atlas. Since the father of Atlas was Iapetus, this was the name given to that old ocean that existed before the Atlantic. Remains of this ancient ocean can be seen in the Central Zone of Newfoundland (see Figure 1).

It is no accident that this island of Newfoundland is such a wonderful place to find marine fossils! The Western Zone represents the eastern edge of the old North American continent and the Eastern Zone represents the western edge of Africa. Using fossil and mineral evidence, scientists have shown that the western edge of Africa was once attached to the Avalon Peninsula. The Iapetus Ocean lay between what is the present day Central Zone. About 500 million years ago, tectonic forces squeezed the Eastern Zone towards the Western Zone pushing up our present day Appalachian Mountains on the west coast of the island and giving rise to the Central Zone, the remains of volcanic islands.

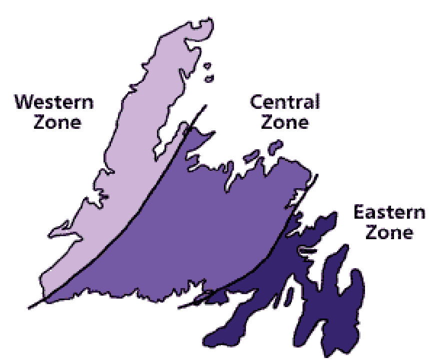


Figure 3: Geological subdivisions of Newfoundland.

(Source: http://www.heritage.nf.ca/environment/nfld_story.html)

The Importance of Plate Tectonics

Scientists have discovered that our continents are moving at a speed of about 3 cm a year. You may wonder why we should be concerned about plate tectonics if the plates are moving so slowly. The small movements that occur in the crustal plates are associated with earthquakes and volcanic activity. For example, on December 26, 2004 an underwater earthquake caused a Tsunami to form which was responsible for the deaths of over 300 000 people in countries around the Indian Ocean. This is equivalent to the number of people who have died due to volcanic activity on our planet since A.D. 1500.

While some plate tectonic forces may be responsible for devastating effects, others may be beneficial. For example, tectonic forces form cracks in the Earth's crust that allow hot fluids from the mantle to seep into the crust and form deposits of precious minerals such as copper and gold. These forces are also responsible for bending the crust and forming shallow seas where salt deposits can form or deeper depressions where oil can be formed. While earthquakes and volcanic activity are relatively sudden events, the processes that form mineral and oil deposits may take millions of years. Many oil and mineral deposits related to these tectonic forces have been discovered in Newfoundland and Labrador.

Plate Tectonics and the Nature of Science

The history of the development of the theory of plate tectonics provides an excellent example of the nature of science. Stop for a minute and consider the following questions: What is a scientist? What do you picture a scientist to be like? What do scientists do on a daily basis? Where do scientists work? What are the characteristics of a scientist?

Does your picture of a scientist portray them as people who wear lab coats as they work in laboratories? Do you think scientists look at the facts that they are presented with and then make an objective decision? Do you think scientists are people who can easily separate their views and opinions from the facts and decisions they have to make? If you said yes to any of these questions then you are not alone. Many people think of scientists as people (mostly male) who work in a laboratory setting, who can put their personal feelings and beliefs aside, and who are not influenced by outside pressures or petty concerns, when they are making decisions related to their work.

Nothing could be further from what happens in reality! Scientists are people just like you, your parents, your teachers, etc., who work in a variety of settings, not just laboratories. And because they are people (both male and female) they make mistakes, they have egos, they ignore evidence that contradicts their viewpoints and beliefs, they are competitive, and they often take their work very personally.

As you have read above, when Wegener first proposed his ideas on how the continents were related to one another, very few scientists believed him. Even when he provided them with very detailed examples from other researchers, his ideas were ignored. You might ask how this could be so… how could the scientists of his day ignore what is plainly obvious to us today? That is a very difficult question to answer. Maybe the senior scientists were jealous of this young upstart. It could have resulted from different interpretation of the data Wegener supplied. It might have had something to do with the fact that it is very difficult to change your opinion about something you have believed in all your life. For whatever reason, many scientists of Wegener's day refused to give any credence to his ideas. In fact, it has been said that, only when the older generation of scientists retire and die off, can a new theory be truly accepted by the scientific community.

Science and scientific activities operate under a set of expectations. To help control personal bias, or even cheating, from affecting scientific decisions, scientists expect that when others provide them with conclusions from experiments, that the data provided is clearly recorded and that the experiments can be repeated to obtain the same data. Science operates from the standpoint that the physical world can be understood through careful, systematic study. Just as in Wegener's time, while scientific ideas are subject to change as new observations are made, normally the new ideas take into account the previous ideas and theories. It is very rare that a scientific theory would be rejected completely. Rather, theories are modified to take into account any new, accepted information. In this way, scientific research is a cumulative process of asking questions, making observations, and, using both the intellect and imagination, trying to make sense out of the observations. If you would like to learn more about the nature of science, refer to the Project 2061 link in the References section.

Conclusion

As humans have evolved on our planet, the way that we frame our thinking has evolved. We are very fortunate that there always seem to be some people that have the ability to see things differently from others. Some individuals pose questions that challenge the things we currently believe. Alfred Wegener was once a young person with an imagination and curiosity about the things that he encountered during his life. These characteristics may have helped him to form his theory. This theory of continental drift evolved into our recent theory of plate tectonics that now shapes the way that we look at the processes that mould our planet. Eventually, knowing where these forces are active may help us to save lives by predicting catastrophic events such as earthquakes and tsunamis. It may also improve our ability to discover new deposits of valuable mineral resources. Many Earth scientists feel that we have just scratched at the surface of the scientific discoveries that will help us understand how our planet, and others throughout the universe, have formed. Most of the mysteries of our planet have yet to be solved. Are you a curious person with an active imagination?

Questions

1. An examination of the map of 1482 reveals significant differences in the way that people viewed the Earth at that time. When compared with the map of 1482, what evidence would Wegener see in the Mercator's map of 1587 that would support his theory of continental drift?

2. What was the missing piece of the puzzle that Wegener needed to support his theory?

3. Does a new discovery always change the way we "see the big picture"? Why/why not?

4. Newfoundland is approximately 4000 km from Africa. If the Earth's crust is moving at a rate of 3 cm per year how long ago would we have been joined together. Do you think that this is possible? Explain your answer.

5. New scientific discoveries seem to spark ideas that lead to other discoveries. The recent technological revolution has created audio and video devices with greater memory capacity in smaller and smaller packages. What technological advances provided evidence to support the theory of plate tectonics?

6. What is a "convection current"? How do convection currents cause crustal plates to move?

7. What are the three pieces of evidence that supports Wegener's theory of continental drift?

References

Alfred Wegener (1880-1930) Available: http://www.ucmp.berkeley.edu/history/wegener.html.

Coleman-Sadd, S and Scott, S.A.(1994). Newfoundland and Labrador: Traveller=s Guide to Geology. Available: http://www.heritage.nf.ca/environment/nfld_story.html.

Project 2061. http://www.project2061.org/publications/sfaa/online/chap1.htm

Ryan, A.B. (1983). Geology of the west coast of Newfoundland. *Newfoundland Journal of Geological Education*, *7*(2). Available:

http://www.nr.gov.nl.ca/mines&en/geosurvey/education/westcoast.stm

Shreeve, J.(2006, March). The greatest journey. *National Geographic, 209*(3), 60-69.

Map References

http://www.heritage.nf.ca/environment/nfld_story.html

http://www.libs.uga.edu/darchive/hargrett/maps/1587m4.jpg

http://www.newberry.org/K12maps/module_01/k-2.html

Research Ideas

Can you find fossils that link the Avalon Peninsula to Northern Africa?

What geological feature links western Newfoundland to the rest of the old North American continent?

What rock types would you expect to make up most of central Newfoundland?

Activity 1

Purpose: To examine the convection currents that are the driving force behind plate tectonics.

Materials: 1 L beaker and 1 teaspoon of rice in 700 mL of water

Procedure: Students will observe the motion of rice as the water is slowly boiled. Ask them to compare their observations to the motion of magma in the Earth's mantle. Students should recognize that these hot spots are analogous to plate boundaries.

Figure 4: Convection currents in boiling water

Activity 2

For a simulation of plate tectonic students should explore: http://www.pbs.org/wgbh/aso/tryit/tectonics/

Google Earth can be used explore the boundaries of the crustal plates. Students may be asked to try and find relationships between the plate boundaries and a particular geological feature such as a mountain range, a deep ocean trench, or locations of earthquakes and volcanoes?

Appendix B

Strategies to Support Learning

Introduction

The strategies in this appendix are not new. Recent research on how the brain works, as it assimilates new information, supports the use of these and similar strategies. Many of these strategies also help with differentiating instruction, thus reaching more students and helping them achieve more. While most of these strategies can be used at anytime, for convenience they have been grouped under three headings. These are:

1. ***Activating Prior Knowledge***.

   Brain research and constructivist approaches point out that all students bring prior knowledge to the classroom. By activating their prior knowledge, teachers put the new information into a familiar context for the students, which gives a context into which they can then assimilate the new information and understanding.

2. ***Active Learning Strategies***.

   These activities are drawn from cooperative learning structures. While simply using the following structures does not constitute a true "cooperative learning" approach, these structures provide students with the opportunity to become actively engaged in their learning as well as opportunity for flexible group processing of the subject matter.

3. ***Summary and Synthesis***.

   It is known that in order for new information to be retained it must be meaningful to students and assimilated into their current cognitive structures. Brain research tells us that our brain can only process so much information at a time and that "processing time" must be provided in order for new information to be assimilated. The acts of summarizing, "putting in your own words", etc., give our brains the necessary time to move the new information from short term memory into longer term memory. Most of the activities in this section require less than 5 minutes to complete and they pay huge dividends in terms of student engagement and achievement.

It is important to note that the strategies are listed under these three headings as a matter of convenience. Several strategies could have been listed under two or three of these headings. The following table can be used as a guide.

Strategy	Activate Prior Knowledge	Active Learning Strategies	Summary and Synthesis	Page
Anticipation/Re-action	☺		☺	192
Mix & Mingle	☺	☺	☺	192
K-W-L	☺	☺	☺	192
Three-Step Interview	☺	☺		193
Roundtable	☺	☺	☺	194
Write Around	☺			194
Give one - Get one	☺		☺	194
Quiz-Quiz-Trade		☺	☺	195
Think-Pair-Share	☺	☺	☺	195
Two-Minute Review		☺	☺	196
Numbered Heads		☺	☺	196
Inside-Outside Circle		☺	☺	196
Jigsaw		☺	☺	197
Round Robin Brainstorming	☺	☺		197
Mind Maps	☺	☺	☺	198
Journaling	☺		☺	199
Conversation Circle		☺	☺	201
Exit Cards			☺	201

Activating Prior Knowledge

Anticipation/Reaction Guide

- This strategy is used before the instruction on new information begins.
- Given a list of statements, students make predictions based upon prior knowledge and evaluate those predictions after exposure to new information.
- The purpose of this strategy is twofold:
  → Activate and evaluate prior knowledge
  → Create a state of curiosity/anticipation or to set the stage for the learning to come.

Procedure:

1. Generate a list of 4-8 statements related to your topic of study. Place these on an Anticipation/Reaction Guide. This can be in list or table format.
2. Provide each student with a copy of your guide.
3. Prior to introducing new information, engage students by having them write whether or not they AGREE or DISAGREE with the statements listed on the guide.
4. Teach your lesson content.
5. After the new content has been taught, have students react to the new information by responding again to the statements on the Anticipation/Reaction Guide.
6. Discuss why their before and after answers are different. What did students learn that caused them to change their answers? This can be done in pairs, groups, or as a whole class activity. Students could use their thoughts on this as journal-writing material.

The Mix & Mingle Party

- This is a modification of the Quiz-Quiz-Trade activity. It is used as a pre-instructional strategy to familiarize students with the upcoming content. It can also be used as a strategy to review content.
- Students are provided with the question/answer cards before they have covered the material in class. They pair up as in the Quiz-Quiz-Trade activity and each student takes a turn providing their partner with the information contained on the card (i.e., the content on the card provides the "small talk" that takes place in a party setting).
- After each partner has shared his or her information, trade cards and partner with someone else. The "small talk" continues for a preset amount of time or until all students have heard and/or read most of the cards.
- At this point the teacher can retrieve the cards or leave them with the students so they can use the information in the lesson. For example, as the teacher is teaching the lesson, using pre-planned questions she can solicit the information from students that is contained on the cards. In this way, students play a more active role in the process.

K-W-L Chart

- This method can be used to introduce a topic, ascertain what students' already know about a topic, or to activate students' prior knowledge, etc.
- This can be used as a whole class activity (i.e. with the teacher or student recording what the students volunteer in a chart on the board) or individually as students complete the chart themselves.
- Either draw the following chart on the board, ask students to create the chart in their notebooks, or print for students to use:

What I ***WANT*** to know (or wonder) about the topic	What I already ***KNOW*** about the topic	What I ***LEARNED*** about the topic

- To activate students' prior knowledge, begin by asking them what they already **K**now about the topic and list it in the appropriate column. This can be followed by having students share what they Know with the class or with a partner.

- To create interest or anticipation in the new topic, then have them identify questions they have on the topic, items they would like clarified, etc. (i.e., **W**ant to know)
- After the topic has been discussed/completed, students return to the chart and record what they have **L**earned and compare this with the other two columns; did they learn anything new? Were their questions answered?
- This strategy works best for research projects and for activities where students will be reading on their own. It is also a good strategy to use to introduce a topic.

A modification of the K-W-L chart is the B-K-W-L-Q which follows the same steps and is used to help build some background knowledge of the topic. Two steps are added to the activity. B is for building background knowledge. Q is for new questions after the initial reading and prior to further reading.

1. The teacher reads a selection to students related to the topic, shows a short video, or leads a quick discussion on the topic. This provides students with some background knowledge related to the topic and will help ensure every student can list something in the K column. In the B column students describe or draw something about the topic.
2. Students list new questions (Q) they have concerning the topic after the initial introduction and prior to studying the topic.
3. Then students use the K-W-L activity as outlined above.

Three-Step Interview

- Three-step interviews can be used as an introductory activity or as a strategy to explore concepts in depth. It is a strategy that is very effective when students are solving problems that have no specific right answers.
- This strategy helps students personalize their learning and listen to and appreciate the ideas and thinking of others. The "interviewer" has to engage in active listening and then paraphrase the comments of the "interviewee".
- There are three steps involved in this process.
    - In step one the teacher presents an issue or topic about which varying opinions exist and poses several questions for the class to address.
    - Step two, one of the students assumes the role of the interviewer and the other becomes the interviewee. The interviewer asks questions of the interviewee to elicit their views or ideas on the issue/topic, within a specified time period. The interviewer paraphrases the key points and significant details that arise.
    - Step three, after the first interview has been completed, the students' roles are switched.

      Example: after viewing a video on an environmental issue, interviews can be conducted to elicit student understanding or views.

      Example: after reading about or discussing a concept or issue, students could engage in the interview process to clarify their understanding.
    - Each pair of students can team up with another pair to discuss each other's ideas and to share interesting points that were raised.
- After each student has had a turn, the pairs can be invited to share points that they found interesting with the class. After all interviews have been done, the class writes a summary report of the interview results. This could be done individually or as a whole group activity.

Roundtable

- The Roundtable is a useful strategy for brainstorming, reviewing, or practicing a skill.
- Students are arranged in a group of 4 to 6. Each group is provided with a single sheet of paper and pen. The teacher poses a question or provides a starting point.
- Students take turns responding to the question or problem by stating their ideas aloud as they write them on the paper. It is important that the ideas be vocalized for several reasons:
  - silence in a setting like this is boring;
  - the other team members are able to reflect on the thoughts of the other students;
  - greater variety of responses will result because teammates learn immediately that someone has come up with an idea that they might have been thinking of; and
  - by hearing the responses said aloud students do not have to spend valuable brainstorming time by reading the previous ideas on the page.
- Team members are encouraged not to skip turns. However, if their thoughts are at a standstill, they are allowed to "Pass".
  - Example: The teacher could display a picture of an ecosystem and ask what are various food chains found within the ecosystem of the picture. One student writes a food chain on a piece of paper then passes the paper to other members of the team for them to write a food chain that they see in the picture. Students continue to pass around the paper until the teacher stops the activity or until a group runs out of answers.
- Roundtable is most effective when used in a carefully sequenced series of activities. The brainstorming can reinforce ideas from the readings or can be used to set the stage for upcoming discussions. The multiple answers encourage creativity and deeper thinking among the team members.

Write Around/Marathon Writing

- This strategy can be used as a way to activate prior knowledge.
- Students are arranged in a group of 4 sitting at a table. When the teacher gives the signal, each student begins writing about the assigned topic. They continue writing until the teacher gives the signal to stop (1 to 2 minutes). Students are to stop immediately; in the middle of a sentence or even in the middle of a word.
- Students exchange their paper with the student to their immediate right. At the signal, students read what was written and continue from where the previous student left off. They write until the teacher gives the signal to stop and pass papers to the right (2 minutes).
- This continues until all four students have written on each other's paper. Additional time should be given to the 3rd and 4th pass as there will be more to read each time the paper is passed along.
- Then the group discusses the content of each paper and chooses one paper to represent their group's collective idea on the topic. One member from each group will read their chosen paper to the class.

Give one – Get one

- This strategy is great for activating prior knowledge or for reviewing a topic.
- If used to activate prior knowledge and to build background knowledge:

  Ask students to fold a piece of paper in half.

  Starting with the left column, students will list as many ideas as they can about a particular topic (2-3 minutes).

  Then students will circulate throughout room and exchange ideas. Each student takes a turn telling what is on their list. Then they will "give one" idea and then "take one" from their peers (i.e., an idea that was not on their individual list). (5 minutes)

After students have exchanged ideas with 3 others, discuss the ideas as a group. The teacher could call on each student to give an idea from their list, not repeating any already given. The teacher records each idea on the board or flip chart; students add any new ideas to their list.

- If used as a summary or review after a topic has been covered, follow the same basic steps. As students will be able to generate more ideas/items, a slightly longer time frame could be used.

Active Learning Strategies

Quiz-Quiz-Trade

- This activity is often used after several lessons have been covered or at the end of a topic or unit to review and reinforce what has been covered in class.
- Questions and answers, based on the information from the lessons, are written on index cards or pieces of paper.
- To set this up, the teacher has to create a set of question and answer cards on the material that was covered. (Alternatively, students can create the cards). At least one card per student is needed. Early on in a unit, the teacher may need to make duplicate cards to ensure each student has a card.
- This is a partner activity and requires students move around the classroom. (See Think-Pair-Share for cues to help students decide who goes first).
- To start the Quiz Quiz Trade, hand out one card to each student, so that each student has a question and the answer. Then ask all students to stand up and partner with another student.

  In each pair:

  QUIZ: Student #1 quizzes Student #2. If Student #2 answers correctly, Student #1 gives positive feedback. If Student #2 answers incorrectly, Student #1 says "It's okay" and provides the correct answer.
  QUIZ: Then Student #2 quizzes Student #1.
  TRADE: After they both quiz each other with their questions, they switch/trade their questions and go on to pair up with someone else. This process is repeated at least 5 times and then students return to their places.

Think-Pair-Share

- This is a very straight forward strategy that allows students to engage in individual and small-group thinking before they are asked to answer questions in front of the whole class. The result is that student answers are more detailed and accurate.
- The Think-Pair-Share (T-P-S) strategy also provides students with an opportunity to process the information they have received and to make it more meaningful.
- T-P-S can be used before the topic is introduced to assess how much students already know, to remind them of material already covered, or to get them thinking about the topic. T-P-S can also be used at anytime to check for understanding, to break up long periods of sustained activity, or whenever it is helpful to share ideas.
- In its simplest form, T-P-S works as follows:
  1. The teacher poses a question to students and gives them some time to independently think of their answer (usually 30 to 60 seconds).
  2. After students have had time to think of their answer, they partner with a nearby student and discuss their responses or ideas to the questions or problem that was posed.
  3. During the discussion, students have opportunity to verbalize their understanding, confirm what they understand, or determine what they do not understand.

- There are ***three variations*** to this procedure: the teacher may set time limits for each student to talk while the partner listens; the teacher may have students write their thoughts down before they discuss with their partner (these can be collected); the teacher can assign or vary partners to keep students from interacting with the same students or to ensure all students are included.
- After students have discussed their thoughts/ ideas with their partner, they can be asked to share with the whole class. Students could also be asked to share something interesting that their partner said that increased their understanding or appreciation of the topic/ issue.
- To ensure little time is lost as students decide who will begin the sharing, the teacher can use a variety of cues to help them decide. For example the teacher could say: “the tallest person will start”, “the person with the most/ least jewellery on will start”, “the person with the longest/shortest hair will start”, “the youngest/oldest person will start”, etc.

For more information on implementing and modifying Think-Pair-Share strategies, refer to http://olc.spsd.sk.ca/DE/PD/instr/strats/think/.

Two-minute Review

- This is a variation of the Think-Pair-Share strategy and provides students opportunity to process new information (time can be varied to suit the content).
- To use this approach, stop any time during a lecture or discussion and allow teams or pairs two minutes to review what has been said with their group.
- Teachers could set this up by saying “turn to the student next to you; each of you take 1 minute to review what we just discussed for the past 10 minutes; assume your partner was out of the room and missed what we talked about (or wrote notes on); summarize the information; your partner will listen to you and when it is his or her turn they will also summarize, including anything you left out; I’ll announce when 1 minute has passed and when to switch”. (See Think-Pair-Share for cues to help students decide who goes first).
- Another way to use this method is to arrange students in groups of 3 or 4. When the two-minute (or three minutes for groups of 3) review starts, group members can ask a clarifying question to the other members or answer questions of others. (e.g., after discussing a multiple step process like the water cycle, students can form teams and review the process or ask clarifying questions.)

Numbered Heads

- The teacher assigns students to teams of four.
- Each member of the team is given a number of 1 through 4. The team is given a question to answer.
- The team works together to answer the question ensuring that all members of the team know the answer and can verbally answer the question.
- The teacher calls out a number (e.g., “number three”) and each student with #3 is required to give the answer. The teacher can vary which “number” answers from each group.

Inside-Outside Circle

- In this activity students are divided into two groups. One group (min. 3 students) forms an inside circle and the second group forms a circle around them (the outside circle). The strategy is used to encourage discussion between the students.
- The teacher poses a question, which the students are to discuss, brainstorm about, etc.
- Students think about how they will respond to the question and then the person on the inside of the circle tells the person on the outside of the circle his or her response. Once he or she finishes sharing they say “Pass”. Then the person on the outside shares his or her ideas, or extends the inside person’s comments.
- Then, at the teacher’s direction, the outside circle

rotates one position to the left or right. In this way the students will have a new person to discuss the same or a different question with.

Jigsaw

- This strategy promotes sharing and understanding of ideas and textual material. In this strategy the teacher divides a project, piece of reading (e.g., an article), or other activity, into 3 to 5 parts.
- Next students are arranged into groups of 3 to 5 depending on the class size and the project they are undertaking. This is their Home Group. Some groups may have duplicate numbers if there is an odd number of students in the class.
- Each student in each Home group is assigned a number: 1, 2, 3, 4, or 5. Have all the students with the same number reassemble into "Expert" groups.
- The students gather in their "expert groups" to process or read selections specific to the assigned topic. Students are to read, recall, reread, take notes, construct graphic organizers for the main ideas and details, and create any visuals they could use to teach others about the topic. The members of the Expert group work to become "experts" on that topic/aspect.

  For example, if an article had four main sections, home groups of 4 would be created. Each member of the group would be assigned a number and a section of the article corresponding to his or her number. Expert groups are formed in which all members will read the section, discuss it, ensure they all understand it, create notes, examples, etc, to ensure they understand it completely. The time devoted to this will depend on the difficulty and complexity of the article.
- After the expert groups have read, summarized, and have a complete understanding of the information, they return to their "Home" group. The #1 Experts teach the "Home" group about the topic/section they were assigned. Then #2, #3, #4, etc, Experts teach the group about the topics they researched.
- After all the "experts" have finished teaching the group, the home group will have all the detail and information on the topic as if they had completed the assignment individually.

For more information on effective use of this strategy, refer to http://www.jigsaw.org/steps.htm or http://olc.spsd.sk.ca/DE/PD/instr/strats/jigsaw/.

Round Robin Brainstorming

- In this strategy, the class is divided into small groups of 4 to 6 students per group with one person appointed as the recorder.
- The teacher poses a question with many possible answers and students are given time to think about answers.
- After the "think time," members of the team share responses with one another in round robin style. The recorder writes down all the answers of the group members.
- The person to the left of the recorder gives his or her answer and the recorder writes it down. This is similar to Roundtable except that one person records the responses.
- Each person in the group in order gives an answer until time is called.

  Example: The teacher could display a picture of an ecosystem and ask what are various food chains found within the ecosystem of the picture. One student is the recorder and writes all of the groups answers on a piece of paper. This strategy continues until the teacher stops the activity or until a group runs out of answers.

  Example: The teacher could ask students to list the pros and cons that a particular practice has on the environment.

Summary & Synthesis

Mind Maps®:

Background & Rationale

The human brain works both linearly and associatively (i.e., by comparing, integrating and synthesizing) as it works to make meaning. Association plays a key role in nearly all our mental functions. “Words” themselves are no exception. Every single word or idea has numerous links attaching it to other words, ideas and concepts.

Mind Maps, developed by Tony Buzan, are an effective method of note-taking and for the summarization of information, as well as being useful for the generation of ideas by associations. Mind maps help students order and structure their thinking, clarify their ideas, as well as make sense of information, by allowing them to create a physical representation (map) of the words and/or concepts. Because of the large amount of association involved, mind maps can be very creative and often tend to generate new ideas and associations that have not been thought of before. Every mind map will be personal to the individual who created it; no two mind maps on a particular subject will be identical. The main difference between mind maps and concept maps is that a mind map has only one main concept, whereas a concept map may have several.

Once created, mind maps provide a way to quickly review what was taught in the lesson/topic/unit. Often it is possible to refresh the information in your mind just by glancing at the map. In the same way, mind maps can be effective mnemonics because we will remember the shape and structure of the map we created and this can give us the cues we need to remember the information within it. This occurs because we engage much more of our brain in the process of assimilating and connecting facts (i.e., when we mind map), compared with conventional notes.

To make a mind map, use letter sized paper or larger, oriented in the landscape position and follow these steps summarized from “How to Make a Mind Map” available at http://www.mind-mapping.co.uk/make-mind-map.htm:

1. Start in the centre. At a minimum, put the topic title in the centre of the page and draw a circle around it. If possible, create an image of the topic you are mapping (e.g., draw a globe if your information is about the earth; draw a river if your information is about rivers, etc).
2. The main points will be arranged on lines that radiate out from the central topic. Each line represents a key idea that will be further delineated. There is one line for each key idea and it is to be drawn freehand. Make these lines thick and curved.
3. Use at least three colours for the lines and the associated text.
4. Limit the textual component to single words or short phrases (maximum 3 words long).
5. Using capital letters, print the key point on these lines. This is the first level of information about the topic you are mapping.
6. Add a second level of information to the key idea by adding lines to the key idea line. Add as many of these second-level lines as necessary to describe the key point. Remember, use only single words and at most, 2- or 3-word phrases. Subdivide these second-level lines further as necessary (i.e., make third- and forth-level lines) to explain or clarify the ideas/concepts.
7. Second-level lines are thinner than the main idea lines. Continue to print the words but these do not need to be capitalized. You may want to bold, underline, or capitalize specific words for emphasis. Continue to add as many sub-level lines as necessary.
8. Use images, sketches, or symbols as much as possible. The image should be meaningful to you and should convey information about the text (e.g., if the topic is “birthdays” you might include a sketch of a birthday cake or present; if the topic is “Holidays” you might sketch a Christmas Tree, etc.).

For more information on mind mapping, refer to http://www.mind-mapping.co.uk/make-mind-map.htm or http://www.peterussell.com/MindMaps/HowTo.php.

Journaling

Background & Rationale

We often think of journals as someone's personal thoughts written in an elegant, leather-bound book. While academic or classroom journals do contain students' personal thoughts and feelings and as such, must be treated as confidential, these journals provide students with the opportunity to reflect and process new information or to share their understanding (or lack of) with the teacher. Journal entries can also be used to encourage students to relate personally to a topic before instruction begins.

The greatest benefit to the teacher is the ability to gain insight into the students' thinking process as well as their understanding about the topics/concepts being addressed in the classroom. As such it provides an excellent opportunity to engage in Assessment FOR Learning. Through reading the students' journals, the teacher is able to ascertain what is causing problems for students, what they find exciting and interesting, any misconceptions they have, etc.

For the student, journaling provides many benefits. Perhaps the most important of these is to provide students with the opportunity to process new information. Processing occurs when students summarize or answer specific questions that are posed to them because writing helps students to clarify their thinking about what they have learned as well as to connect it to what they already know (all in a positive learning environment that is free of fear of criticism). In addition, journaling provides students with the opportunity to reflect on their personal values and goals, to engage in metacognition, and to chronicle their academic growth by reading past entries.

For more information on the benefits of journaling, refer to http://www.accessexcellence.org/MTC/96PT/Share/yorks.html.

Considerations before Implementation:

- ***Use of Instructional Time.*** Limit journaling activity to 5 to 10 minutes per class or incorporate into other activities such as "write-pair-share". Engage in shorter blocks of journaling throughout the lesson (e.g., think about the question/prompt for 30 – 45 seconds and write for 2 minutes and repeat several times during the lesson).
- ***Confidentiality.*** Students' thoughts and opinions, when expressed in a journal, must be kept confidential. Students should be provided with the option to fold over and staple any entry they feel is too personal to share (even with the teacher).
- ***Assessment.*** Journals should NOT be assessed towards the student's mark in the course. Teachers may opt to include "completion of journal activities" as an assessment item but not grade individual entries. Student journals provide teachers with an excellent Assessment For Learning tool. As the teacher reads the entry, it is important to provide positive feedback, to nudge students' thinking a bit further, to question, to teach or to re-teach. Where journal entries indicate a lack of understanding, the teacher should indicate that they are "off track" and that this will be addressed in class.

Implementing Journals

- Ensure students understand why journaling is important to their learning process and that they will not be graded in the traditional manner.
- Clarify that the journals and the entries are confidential. Students may fold over and staple any entry that they do not want the teacher to read. Students can opt to include journal entries in their portfolio.
- Refrain from simply asking students to make

an entry in their journals. Assign specific activities or prompts to ensure students' journals are the most effective. Examples:

- Summarize the main points of the lesson
- Before a lesson starts, ask students to write what they already know or believe about the topic. After the lesson is taught, ask students to revisit what they originally wrote and make any changes they feel necessary to reflect their current understanding, beliefs, etc.
- Restate a concept or definition in your own words.
- Write a question about what they have learned so far. (e.g., How do you feel about the topic? How do you think your best friend/parent/etc would feel about the topic?
- Explain how the new topic relates to a topic already discussed in class.

For more ideas of how to use journals at the beginning, middle, and end of a lesson, refer to http://712educators.about.com/cs/writingresources/l/bljrnlacademic.htm

The "What? So What? Now What?" Reflection Model

This is a three-phase model to promote reflection in learners and can be used as a journaling activity. As with any journaling activity, reflection is an essential component of new learning; some learning theorists believe that we do not learn from doing – rather we learn from thinking about what we do (i.e., making connections with what we already know).

- ❖ The "***What***" phase:
  - This relates to the substance of the activity, presentation, or event
  - While it leads naturally to interpretation, in this phase the learner should objectively report on what happened, what was presented, what was observed, etc (i.e., just the facts, no interpretation; describing in detail what they experienced or observed)
  - Questions that can be used to guide learners include: What happened? What did we do? What problem did we address/solve? What did I observe? What were the results of the event? What were the speaker's main points?
- ❖ The "***So What"*** phase:
  - In this phase, learners analyze the event, presentation, or activity to assess what it means to them, why it is important to them, or how they feel about what has been presented/observed
  - This is the true reflective part of the activity and may be difficult for some learners as it requires that they discuss their feelings as related to the event/information they have experienced
  - Questions that can be used to assist learners with this phase are: What did you learn? How did what you learned affect you personally? What "lesson" can you take away from the activity/presentation/information? How was what you learned (or experienced) different from what you expected? Can you relate this information to events/experiences in your "real life"? Are there any contradictions to what you previously believed about the issue?
- ❖ The "***Now What***" phase:
  - This is the process of taking lessons learned (or insight gained) and looking at how your attitude,view,understanding, etc has changed as a result of the new information and how you might want to change as a result
  - During this phase, learners are encouraged to consider the broader implications of what they have learned, to consider the future, etc. Depending on the activity/presentation/event, learners could be encouraged to identify goals or changes they might want to make in their live to align with what they have learned
  - Questions that can be used to guide this phase include: How can we use what we learned to make a difference in the future? How are you contributing to the problem? What can you do to help address the problem? What factors will support/hinder you from reaching your goals or to incorporate changes in your life? What can you do to be part of the solution? What appears

to be the root cause of the problem/issue? Are there community actions/activities in which I can become involved? What would you like to learn more about, related to this topic/issue? What information can you share with your community or peers that might make a difference?

- ❖ While this can be used solely as a journaling activity, it can also be incorporated into small group or whole class discussions.
  - For example, after a presentation or significant piece of information has been discussed in class, individuals could engage in the "What?-So What?-Now What?" activity.
  - After they have completed the "What?" section, teachers could ask students to share their main points with a partner (see "Two Minute Review below).
  - After the "So What?" phase, students could be asked to share their insight with a partner (see "Think-Pair-Share" below).
  - After the "Now What?" phase, students could be invited to share their thoughts, insight, etc. with the class (Note: student should not be required to share at this stage, as this portion of the activity will be deeply personal). Alternatively, students could be asked to share something their partner said that they found interesting or which they had not thought of before.

Conversation Circles

- This strategy is a great way for students to review and process the information from the lesson.
  - Arrange students in groups of three.
  - Each student is labelled "A", "B", or "C".
  - At the signal, "A" starts talking on the topic until the teacher gives the signal (about 45 to 60 seconds).
  - "B" picks up the conversation. "B" can continue with the topic where "A" left off, add more detail, give examples, or repeat what "A" said if they feel they have nothing new to add.
  - When the teacher gives the signal (45 to 60 seconds), "C" continues the conversation in the same manner as did "B". When the teacher gives the signal, the conversation can end or can go around again starting with "A". Less time might be given on the second pass.
- A related strategy is "wrap-arounds". Students stand in a circle of up to 5 students. Each student takes a turn telling:
  - Something they will use from information or activities learned in the lesson.
  - Something they will remember from the lesson.
  - Something that surprised or interested them in the lesson.

Exit Cards/Exit Passes/Exit Ticket

- This is a simple way to informally assess student learning and promote immediate individual responsibility for learning. Teachers can use these as assessment FOR learning, to identify topics/concepts students may have confused or which may have confused the student. The act of writing the exit card also provides the student with opportunity to synthesize or process the information presented during the lesson.
- They may be used at any grade level and in any subject.
- There are several versions of the exit card but each aims to give the teacher feedback about the learning that has occurred in the class. Instead of using cards, teachers could ask students to use sheets of loose leaf paper or 3-hole punched paper so the "cards" can be stored in a binder or folder.
  - ***Version 1:*** During lesson closure, distribute index cards and write their name on it. Then direct students to explain a certain point or concept from the lesson, summarize the

lesson, write an answer to a question about the lesson, or to indicate a question they still have about the topic. Explain that this card is the exit pass from class, then stand at the door and collect as students leave. Depending on what students have written, teachers may wish to make individual responses or if a theme comes up, this is something the teacher might want to address at the beginning of the next class. Detailed responses should be avoided; anything that requires a detailed response should be done in class or one-on-one. Students could keep the cards in their journal for quick review.

- ***Version 2:*** "Exit 3-2-1". Ask students to list the numbers 3, 2, 1 on their paper leaving lines between each number. Assign a specific writing prompt/task for each number. Prompts will vary according to the content. The 3-2-1 prompts can be anything as long as they are related to the lesson, the next day's work, the unit theme, etc. Some examples are: "write down 3 things you learned, 2 questions you still have, and 1 connection you'd like to share"; "3 similarities between . . . , 2 predictions about . . . , 1 something else"; "3 observations you made while…, 2 connections you made between…, 1 question you still have"; "3 key ideas of the lesson/reading, 2 questions you want answered, 1 thing you didn't understand".

Appendix C

Assessment and Evaluation

Assessment

Assessment should provide students over time with a variety of ways to demonstrate what they know and are able to do with many different types of text. It is the journey of their learning. Teachers collect, interpret, and synthesize information from a variety of student learning activities to gather information about student progress in relation to achieving learning outcomes.

Students must recognize each learning activity as worthwhile and relevant, and understand the expectations for each. Information provided through assessment activities allows teachers to give descriptive feedback to students to support and monitor future learning, and allows for necessary adjustments to instruction.

Designing Effective Assessment

Effective assessment improves the quality of learning and teaching. It can help teachers to monitor and focus their instruction and help students to become more self-reflective and feel in control of their own learning. When students are given opportunities to demonstrate what they know and what they can do with what they know, optimal performance can be realized.

Teachers must collect evidence of student learning through a variety of methods. Valuable information about students can be gained through conversations, observations, and products. A balance among these three sources ensures reliable and valid assessment of student learning.

- Conversations may either be informal or structured in the form of a conference and can provide insight into student learning that might not be apparent through observation or from products. Student journals and reflections provide a written form of conversation with the teacher.
- Observing a student while he or she is engaged in a learning activity allows a teacher insight into this process at various points throughout the activity. Observation is effective in assessing achievement of many of the speaking and listening outcomes.
- Products are work samples completed by a student. Samples can be in the form of written texts, visuals, or oral products.

Effective assessment strategies

- are explicit and communicated to students and parents at the beginning of the course or the school term (and at other appropriate points throughout the school year) so that students know expectations and criteria to be used to determine the quality of the achievement
- must be valid in that they measure what they intend to measure
- involve students in the co-construction, interpretation, and reporting of assessment by incorporating their interests (students select texts or investigate issues of personal interest)
- reflect where the students are in terms of learning a process or strategy and help to determine what kind of support or instruction will follow

Designing Effective Assessment (continued)

- allow for relevant, descriptive, and supportive feedback that give students clear directions for improvement
- engage students in metacognitive self-assessment and goal setting that can increase their success as learners
- are fair in terms of the students' background or circumstances to provide all students with the opportunity to demonstrate the extent and depth of their learning
- accommodate the diverse needs of students with exceptionalities including those with strategies outlined in individual learning plans
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility
- are transparent, pre-planned, and integrated with instruction as a component of the curriculum
- are appropriate for the learning activities used, the purposes of instruction, and the needs and experiences of the students
- are comprehensive to enable all students to have diverse and multiple opportunities to demonstrate their learning consistently, independently, and in a range of contexts in everyday instruction
- include the use of samples of students' work that provide evidence of their achievement
- are varied in nature, administered over a period of time, and designed to provide opportunities for students to demonstrate their full range of their learning

Rubrics

Rubrics clarify expectations and ensure that student creations are judged based on common criteria. This helps to ensure that the students truly understand what the task is and what the expectations are. Rubrics also provide students with information and direction for the future. Consider the following suggestions for creating rubrics:

- involve the students in creation of the rubric
- try to avoid or limit the use of words and phrases such as "very", "often", "sometimes", and "to a great extent"
- limit the number of criteria being focused on at one time; individual students may require modified criteria
- consider the range of descriptors provided – three as a minimum, five a maximum
- decide if certain criteria require only two descriptors (this may be necessary if a criterion is simply met or not, with no range in between)
- decide if some criteria are more important than others; weight these criteria more heavily, especially if grades are being assigned as a result of the rubric
- use student work samples of a variety of strengths to generate criteria and descriptors; students can examine them and build a rubric with these in mind

Purpose of Assessment

According to research, assessment has three interrelated purposes:

- assessment *for* learning to guide and inform instruction
- assessment *as* learning to involve students in self-assessment and setting goals for their own learning
- assessment *of* learning to make judgments about student performance in relation to curriculum outcomes

Other research indicates that assessment *as* learning should be viewed as part of assessment *for* learning, because both processes enhance future student learning. In all circumstances, teachers must clarify the purpose of assessment and then select the method that best serves the purpose in the particular context.

The interpretation and use of information gathered for its intended purpose is the most important part of assessment. Even though each of the three purposes of assessment *(for, as, of)* requires a different role for teachers and different planning, the information gathered through any one purpose is beneficial and contributes to an overall picture of an individual student's achievement.

Assessment *for* Learning

Assessment *for* learning involves frequent, interactive assessments designed to make student understanding visible to enable teachers to identify learning needs and adjust teaching accordingly. It is teacher-driven and an ongoing process of teaching and learning.

Assessment *for* learning

- integrates strategies with instructional planning
- requires the collection of data from a range of assessments as investigative tools to find out as much as possible about what students know
- uses curriculum outcomes as reference points along with exemplars and achievement standards that differentiate quality
- provides descriptive, specific, and instructive feedback to students and parents regarding the next stage of learning
- actively engages students in their own learning as they assess themselves and understand how to improve performance
- allows for judgments to be made about students' progress for reporting purposes
- provides information on student performance that can be shared with parents/guardians, school and district staff, and other educational professionals for the purposes of curriculum development

This type of assessment provides ways to engage and encourage students to acquire the skills of thoughtful self-assessment and to promote their own achievement. Students' achievement is compared to established criteria rather than on the performance of other students.

Assessment *as* Learning

Assessment *as* learning actively involves students' reflection on their learning and monitoring of their own progress. Student-driven and supported with teacher guidance, it focuses on the role of the student as the critical connector between assessment and learning, thereby developing and supporting metacognition in students.

Assessment *as* learning is ongoing and varied in the classroom and

- integrates strategies with instructional planning
- focuses on students as they monitor what they are learning, and use the information they discover to make adjustments, adaptations, or changes in their thinking to achieve deeper understanding
- supports students in critically analyzing their learning related to learning outcomes
- prompts students to consider how they can continue to improve their learning
- enables students to use information gathered to make adaptations to their learning processes and to develop new understandings

The goal of assessment *as* learning is for students to acquire the skills to be metacognitively aware of their increasing independence as they take responsibility for their own learning and constructing meaning for themselves with support and teacher guidance. Through self-assessment, students think about what they have learned, and what they have not yet learned, and decide how to best improve their achievement.

Assessment *of* Learning

Assessment *of* learning involves strategies designed to confirm what students know, demonstrate whether or not they have met curriculum outcomes or the goals of their individualized learning plans, or to certify proficiency and make decisions about students' future learning needs. Assessment *of* learning occurs at the end of a learning experience that contributes directly to reported results.

Traditionally, teachers relied on this type of assessment to make judgments about student performance by measuring learning after the fact and then reporting it to others. However, used in conjunction with the other assessment processes previously outlined, assessment *of* learning is strengthened.

Assessment *of* learning

- provides opportunities to report evidence to date of student achievement, in relation to learning outcomes, to parents/guardians, school and district staff, and other educational professionals for the purposes of curriculum development
- confirms what students know and can do
- occurs at the end of a learning experience using a variety of tools
- may be either criterion-referenced (based on specific curriculum outcomes) or norm-referenced (comparing student achievement to that of others)
- provides the foundation for discussions on student placement or promotion

Because the consequences of assessment *of* learning are often far-reaching and affect students seriously, teachers have the responsibility of reporting student learning accurately and fairly, based on evidence obtained from a variety of contexts and applications.

Involving Students in the Assessment Process

Students should know what they are expected to learn, as designated by learning outcomes, and the criteria that will be used to determine the quality of their achievement. This information allows students to make informed choices about the most effective ways to demonstrate what they know and are able to do.

It is important that students participate actively in assessment by co-creating criteria and standards which can be used to make judgments about their own learning. To get an idea of some possible criteria, students may benefit from examining various scoring criteria, rubrics, and student exemplars.

Teachers can involve students in the process by using the following suggestions:

- incorporating students' interests into assessment tasks (for example, students can select texts to read/view that relate to their interests and select a forum for response)
- providing opportunities for students to self-assess their learning
- co-creating assessment criteria with the student, working to describe how a specific skill or product is judged to be successful
- using student exemplars to illustrate a range of skill development (students can use them to compare to their own work, or practice using the assessment criteria that would be used for their own activities)

Students are more likely to perceive learning as its own reward when they have opportunities to assess their own progress. Rather than asking teachers, “What do you want?”, students should be asking themselves questions such as, “What have I learned? What can I do now that I couldn’t do before? What do I need to learn next?” Assessment must provide opportunities for students to reflect on their progress, evaluate their learning, and set goals for future learning.

Assessment Techniques

Several assessment techniques have been suggested throughout this guide and are listed in the section Considerations for Program Delivery. These techniques are described below.

Observation (formal and informal)

This technique provides a way of gathering information fairly quickly while a lesson is in progress. When used formally students would be made aware of the observation and the criteria being assessed. Informally, it could be a frequent, but brief, check on a given criterion. Observation may offer information about the participation level of a student for a given task, use of a piece of equipment or application of a given process. The results may be recorded in the form of checklists, rating scales or brief written notes. It is important to plan in order that specific criteria are identified, suitable recording forms are ready, and that all students are observed in a reasonable period of time.

Performance

This curriculum encourages learning through active participation. Many of the curriculum outcomes found in the guide promote skills and their application. There is a balance between scientific processes and content. In order that students appreciate the importance of skill development, it is important that assessment provide feedback on the various skills. These may include the correct manner in which to use a piece of equipment, an experimental technique, the ability to interpret and follow instructions, or to research, organize and present information. Assessing performance is most often achieved through observing the process.

Journal

Although not assessed in a formal manner, journals provide an opportunity for students to express thoughts and ideas in a reflective way. By recording feelings, perceptions of success, and responses to new concepts, a student may be helped to identify his or her most effective learning style. Knowing how to learn in an effective way is powerful information. Journal entries also give indicators of developing attitudes to science concepts, processes and skills, and how these may be applied in the context of society. Self-assessment, through a journal, permits a student to consider strengths and weaknesses, attitudes, interests, and new ideas. Developing patterns may help in career decisions and choices of further study.

Interview

This curriculum promotes understanding and applying scientific concepts. Interviewing a student allows the teacher to confirm that learning has taken place beyond simply factual recall. Discussion allows a student to display an ability to use information and clarify understanding. Interviews may be a brief discussion between teacher and student or they may be more extensive and include student, parent, and teacher. Such conferences allow a student to be pro-active in displaying understanding. It is helpful for students to know which criteria will be used to assess formal interviews. This assessment technique provides an alternate method of expression to students whose verbal presentation skills are stronger than their written skills.

Paper and Pencil (assignment and test)

These techniques can be formative or summative. Several curriculum outcomes call for displaying ideas, data, conclusions, and the results of practical or literature research. These can be in written form for display or direct teacher assessment. Whether as part of learning or a final statement, students should know the expectations for the exercise and the rubric by which it will be assessed. Written assignments and tests can be used to assess knowledge, understanding, and application of concepts. They are less successful at assessing skills, processes and attitudes. The purpose of the assessment should determine what form of pencil and paper exercise is used.

Presentation

The curriculum includes outcomes that require students to analyze and interpret information, to identify relationships between science, technology, society, and environment, to be able to work in teams, and to communicate information. Although it can be time-consuming, these activities are best displayed and assessed through presentations. These can be given orally, in written/pictorial form, by project summary (science fair), or by using electronic systems such as video or computer software. Whatever the level of complexity, or format used, it is important to consider the curriculum outcomes as a guide to assessing the presentation. The outcomes indicate the process, concepts, and context for which and about which a presentation is made.

Portfolio

Portfolios offer another option for assessing student progress in meeting curriculum outcomes over a more extended period of time. This form of assessment allows the student to be central to the process. There are decisions about the portfolio and its contents which can be made by the student. What is placed in the portfolio, the criteria for selection, how the portfolio is used, how and where it is stored, how it is evaluated, are some of the questions to consider when planning to collect and display student work in this way. The portfolio should provide a long-term record of growth in learning and skills. This record of growth is important for individual reflection and self-assessment, but it is also important to share with others. For all students, but particularly younger students, it is exciting to review a portfolio and see the record of development over time.

In planning assessment, teachers should use a broad range of techniques to give students multiple opportunities to demonstrate their knowledge, skills, attitudes, and ability to meet curriculum outcomes. The following chart outlines other techniques for consideration:

	Assessment Techniques	
	Technique	Purpose
Gathering Information	Questioning	• asking focused questions to elicit understanding
	Rich assessment tasks	• complex tasks that encourage students to show connections that they are making among concepts they are learning
	Technology applications	• systematic and adaptive software applications connected to curriculum outcomes; digital presentations
	Simulations	• simulated or role-playing tasks that encourage students to show connections they are making among concepts they are learning
	Learning logs	• descriptions students maintain of the process they go through in their learning
	Projects and investigations	• opportunities for students to show connections in their learning through investigation and production of reports or artifacts
Interpreting Information	Developmental continua	• profiles describing student learning to determine extent of learning, next steps, and to report progress and achievement
	Checklists	• descriptions of criteria to consider in understanding students' learning
	Rubrics	• descriptions of criteria with graduations of performance described and defined
	Self assessment	• processes in which students reflect on their own performance and use defined criteria for determining the status
	Peer assessment	• processes in which students reflect on the performance of their peers and use defined criteria for determining the status of the learning of their peers

	Technique	Purpose
Record-Keeping	Anecdotal Records	• focused, descriptive records of observations of student learning over time
	Student profiles	• information about the quality of students' work in relation to curriculum outcomes or a students' individual learning plan
	Video or audio tapes, photographs	• visual or auditory images that provide artifacts of student learning
Communicating	Parent-student-teacher conferences	• opportunities for teachers, parents, and students to examine and discuss the student's learning and plan next steps
	Records of achievement	• detailed records of students' accomplishments in relation to the curriculum outcomes
	Report cards	• periodic symbolic representations and brief summaries of student learning
	Learning and assessment newsletters	• routine summaries for parents, highlighting curriculum outcomes, student activities, and examples of student learning

September 2013

ISBN: 978-1-55146-507-4