Ontario

The Ontario Curriculum
Grades 1–8

REVISED

Science and Technology

2007

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THE CURRICULUM EXPECTATIONS

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INTRODUCTION

This document replaces *The Ontario Curriculum, Grades 1–8: Science and Technology, 1998*. Beginning in September 2008, all science and technology programs for Grades 1 to 8 will be based on the expectations outlined in this document.

THE GOALS OF THE SCIENCE AND TECHNOLOGY PROGRAM

> *A scientifically and technologically literate person is one who can read and understand common media reports about science and technology, critically evaluate the information presented, and confidently engage in discussions and decision-making activities that involve science and technology.*
>
> Science Co-ordinators' and Consultants' Association of Ontario (SCCAO) and Science Teachers' Association of Ontario (STAO/APSO), "Position Paper: The Nature of Science" (2006), p. 1

During the twentieth century, science and technology played an increasingly important role in the lives of all Canadians. Science and technology underpin much of what we take for granted, including clean water, the places in which we live and work, and the ways in which we communicate with others. The impact of science and technology on our lives will continue to grow. Consequently, scientific and technological literacy for all has become the overarching objective of science and technology education throughout the world.

Achievement of both excellence and equity underlies the three major goals of the science and technology program at the elementary level. Accordingly, *The Ontario Curriculum, Grades 1–8: Science and Technology, 2007* outlines the skills and knowledge that students will develop, as well as the attitudes that they need to develop in order to use their knowledge and skills responsibly. The three goals are the following:

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

THE NATURE OF SCIENCE AND TECHNOLOGY

> *The primary goal of science is to understand the natural and human-designed worlds. Science refers to certain processes used by humans for obtaining knowledge about nature, and to an organized body of knowledge about nature obtained by these processes. Science is a dynamic and creative activity with a long and interesting history. Many societies have contributed to the development of scientific knowledge and understanding.…Scientists continuously assess and judge the soundness of scientific knowledge claims by testing laws and theories, and modifying them in light of compelling new evidence or a re-conceptualization of existing evidence.*
>
> *Technology involves the development and use of materials, tools, and processes for solving human problems and helping to satisfy human needs and desires. Many of the products of technology help humans accomplish tasks that would otherwise be very difficult or impossible to carry out. Although technology provides many benefits, it also produces associated costs and risks. Science often uses and requires tools and processes developed by technology, and conversely, technology often employs principles, laws, theories, and processes developed by science.*
>
> SCCAO and STAO/APSO, "Position Paper: The Nature of Science" (2006), pp. 1–2

Science is a way of knowing that seeks to describe and explain the natural and physical world. An important part of scientific and technological literacy is an understanding of the nature of science, which includes an understanding of the following:

- what scientists, engineers, and technologists do as individuals and as a community
- how scientific knowledge is generated and validated
- how science interacts with technology, society, and the environment

Occasionally, theories and concepts undergo change but, for the most part, the basic ideas of science – ideas such as the cellular basis of life, the laws of energy, and the particle theory of matter – have proven to be stable.

Technology is also a way of knowing, and is also a process of exploration and experimentation. Technology is both a form of knowledge that uses concepts and skills from other disciplines (including science) and the application of this knowledge to meet an identified need or to solve a specific problem using materials, energy, and tools (including computers). Technological methods consist of inventing or modifying devices, structures, systems, and/or processes.

An understanding of the nature of technology includes knowing the following:

- what technology is, in its broadest terms (much more than the knowledge and skills related to computers and their applications)
- how technology and science are interrelated
- how thinking about technology's benefits, costs, and risks can contribute to using it wisely

Science and technology are closely linked, especially through the skills of scientific investigation, technological problem solving, and communication. The world as we know it today has been affected in many important ways by science and technology. For example, science has radically altered and expanded our understanding of Earth and space, of the

workings of the human mind and body, and of the ways in which living organisms interact; and technology has revolutionized the way we communicate and has made vast changes in our lives through the discovery of new drugs and materials. It is important, therefore, that students see science and technology in this wider context – as endeavours with important consequences for people and other living things – and that they learn to connect their knowledge of science and technology to the world beyond the school.

Fundamental Concepts

Fundamental concepts are key ideas that provide a framework for the acquisition of all scientific and technological knowledge. They also help students to integrate scientific and technological knowledge with knowledge in other subject areas, such as mathematics and social studies. The fundamental concepts that are addressed in the curricula for science and technology in Grades 1 to 8 and for science in Grades 9 to 12 are *matter, energy, systems and interactions, structure and function, sustainability and stewardship*, and *change and continuity*.

As students progress through the curriculum from Grades 1 to 12, they extend and deepen their understanding of these fundamental concepts and learn to apply their understanding with increasing sophistication. These fundamental concepts are described in the following chart.

Fundamental Concepts	
Matter	Matter is anything that has mass and occupies space. Matter has particular structural and behavioural characteristics.
Energy	Energy comes in many forms, and can change forms. It is required to make things happen (to do work). Work is done when a force causes movement.
Systems and Interactions	A system is a collection of living and/or non-living things and processes that interact to perform some function. A system includes inputs, outputs, and relationships among system components. Natural and human systems develop in response to, and are limited by, a variety of environmental factors.
Structure and Function	This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.
Sustainability and Stewardship	Sustainability is the concept of meeting the needs of the present without compromising the ability of future generations to meet their needs. Stewardship involves understanding that we need to use and care for the natural environment in a responsible way and making the effort to pass on to future generations no less than what we have access to ourselves. Values that are central to responsible stewardship are: using non-renewable resources with care; reusing and recycling what we can; switching to renewable resources where possible.
Change and Continuity	Change is the process of becoming different over time, and can be quantified. Continuity represents consistency and connectedness within and among systems over time. Interactions within and among systems result in change and variations in consistency.

"Big Ideas"

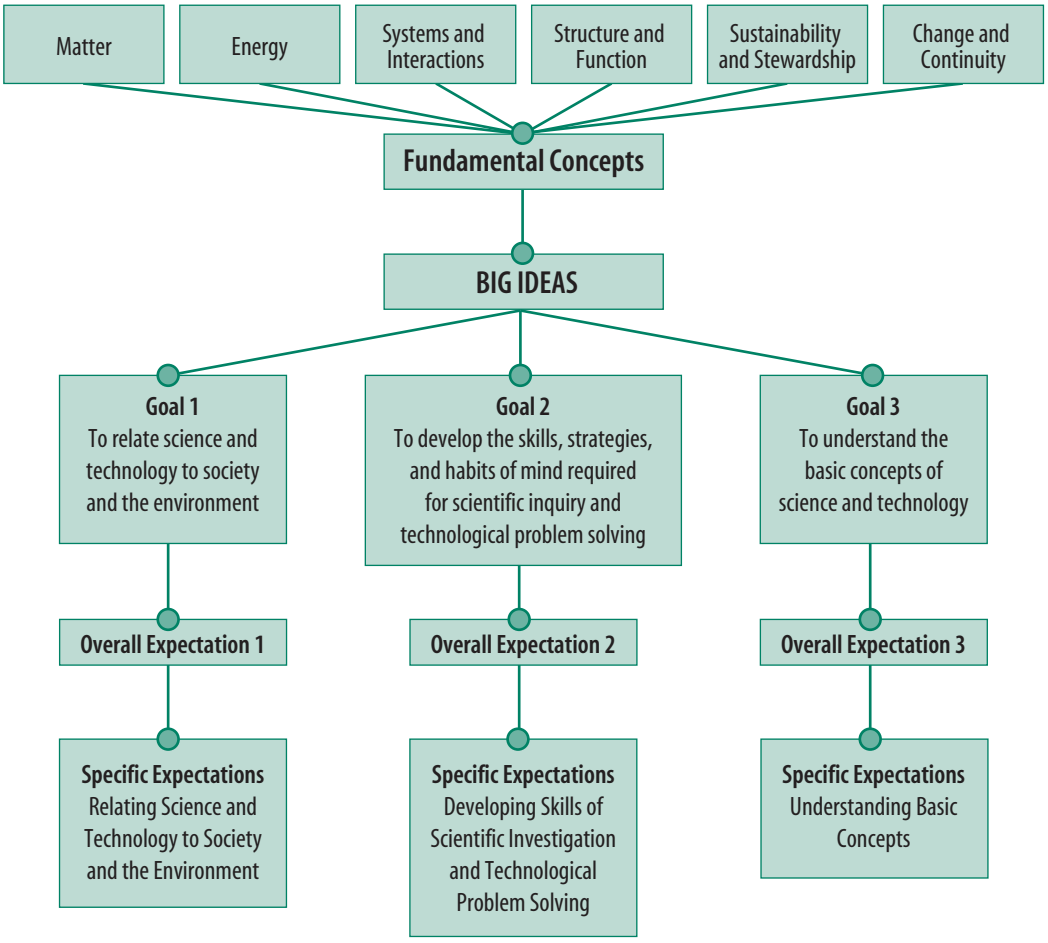
Big ideas "go beyond discrete facts or skills to focus on larger concepts, principles, or processes."

Grant Wiggins and Jay McTighe, *Understanding by Design* (1998), p. 10

"Big ideas" are the broad, important understandings that students should retain long after they have forgotten many of the details of something that they have studied. In this document, big ideas describe aspects of the fundamental concepts that are addressed at each grade level. Developing a deeper understanding of the big ideas requires students to understand basic concepts, develop inquiry and problem-solving skills, and connect these concepts and skills to the world beyond the classroom. For example, in the Understanding Life Systems strand in Grade 3, one fundamental concept addressed is systems and interactions, and two big ideas related to this concept are the following:

- Plants are the primary source of food for humans.
- Humans need to protect plants and their habitats.

The relationships between the fundamental concepts, big ideas, goals of the science and technology program, and the overall and specific expectations are indicated in the chart that follows.



ROLES AND RESPONSIBILITIES IN THE SCIENCE AND TECHNOLOGY PROGRAM

Students

Students have many responsibilities with regard to their learning, and these increase as they advance through elementary and secondary school. Students who are willing to make the effort required, and who are able to monitor their thinking and learning strategies and to apply themselves, will soon discover that there is a direct relationship between this effort and their achievement, and will therefore be more motivated to work. Students who develop mental attitudes and ways of behaving that contribute to success in life will benefit as learners.

Successful mastery of concepts, scientific investigation skills, and technological problem-solving skills requires a sincere commitment to work and the development of skills of cooperation. Furthermore, students should actively pursue opportunities outside the classroom to extend and enrich their understanding of science and technology. For example, it is recommended that they explore subject-related recreational reading materials, and be aware of scientific and technological events happening in their community and beyond.

Parents

Studies show that students perform better in school when their parents[1] are involved in their education. Parents who are familiar with the curriculum expectations know what is being taught in each grade and what their child is expected to learn. With such information, parents can better understand how their child is progressing in school and can work with teachers to improve their child's learning.

Effective ways in which parents can support their children's learning include the following: attending parent-teacher interviews, participating in parent workshops and school council activities (including becoming a school council member), and encouraging their children to complete their assignments at home.

The science and technology curriculum has the potential to stimulate interest in lifelong learning not only for students, but also for their parents and all those with an interest in education. In addition to supporting regular school activities, parents may wish to take an active interest in current events and issues in the fields of science and technology, and to provide their children with opportunities to question and reflect on the impact of these developments on their immediate lives, the environment, and society. Parents can also provide valuable support by encouraging their children to take part in activities that develop responsible citizenship (such as participating in an environmental clean-up program in their neighbourhood) or that further their interest in science and technology (such as volunteering at local science centres and/or children's museums).

Throughout the elementary science and technology program, students will have opportunities to interact with living things and to work with a variety of tools, materials, and equipment. To help ensure students' safety, parents can inform teachers of any allergies that their children may have. Parents can also encourage their children to go to school prepared to participate safely in technology activities. Simple precautions such as wearing closed-toe shoes, tying back long hair, and removing loose jewellery (or taping it down in the case of Medic Alert bracelets) contribute to a safe environment when working with technological equipment.

1. In this document, *parent(s)* is used to refer to parent(s) and guardian(s).

Teachers

Teaching is key to student success. Teachers are responsible for developing appropriate instructional strategies to help students achieve the curriculum expectations, as well as appropriate methods for assessing and evaluating student learning. Teachers bring enthusiasm and varied teaching and assessment approaches to the classroom, addressing individual students' needs and ensuring sound learning opportunities for every student.

Using a variety of instructional, assessment, and evaluation strategies, teachers provide numerous hands-on opportunities for students to develop and refine their inquiry skills, problem-solving skills, critical and creative thinking skills, and communication skills, while discovering fundamental concepts through investigation, exploration, observation, and experimentation. The activities offered should enable students to relate and apply these concepts to the social, environmental, and economic conditions and concerns of the world in which they live. Opportunities to relate knowledge and skills to these wider contexts will motivate students to learn in a meaningful way and to become lifelong learners.

Teachers can help students understand that problem solving of any kind often requires a considerable expenditure of time and energy and a good deal of perseverance. Teachers can also encourage students to investigate, to reason, and to explore alternative solutions, and to take the risks necessary to become successful problem-solvers.

Science and technology can play a key role in shaping students' views about life and learning. Science and technology exist in a broader social and economic context. Both are affected by the values and choices of individuals, businesses, and governments, and in turn have a significant impact on society and the environment. Teachers must provide opportunities for students to develop habits of mind appropriate for science and technology, which include a commitment to precision and integrity in observation, experimentation, and reporting; respect for evidence; adherence to safety procedures; and respect for living things and the environment.

Teachers are also responsible for ensuring the safety of students during classroom activities and for encouraging and motivating students to assume responsibility for their own safety and the safety of others. They must also ensure that students acquire the knowledge and skills needed for safe participation in science and technology activities.

Principals

The principal works in partnership with teachers and parents to ensure that each student has access to the best possible educational experience. The principal is also a community builder who creates an environment that is welcoming to all, and who ensures that all members of the school community are kept well informed.

To support student learning, principals ensure that the Ontario curriculum is being properly implemented in all classrooms through the use of a variety of instructional approaches, and that appropriate resources are made available for teachers and students. To enhance teaching and student learning in all subjects, including science and technology, principals promote learning teams and work with teachers to facilitate teacher participation in professional development activities. Principals are also responsible for ensuring that every student who has an Individual Education Plan (IEP) is receiving the modifications and/or accommodations described in his or her plan – in other words, for ensuring that the IEP is properly developed, implemented, and monitored.

Community Partners

Community partners in the areas of science and technology can be an important resource for schools and students. They can provide support for students in the classroom, and can be models of how the knowledge and skills acquired through study of the curriculum relate to life beyond school. As mentors, they can enrich not only the educational experience of students, but also the life of the community. For example, schools can make use of community groups that recruit practising scientists (e.g., engineers, optometrists, veterinarians) to provide in-class workshops for students that are based on topics, concepts, and skills from the curriculum.

Schools and school boards can play a role by coordinating efforts with community partners. They can involve community volunteers in supporting science and technology instruction and in promoting a focus on scientific and technological literacy in and outside the school. Community partners can be included in events held in the school (such as parent education nights and science and technology fairs), and school boards can collaborate with leaders of existing community science and technology programs for students, including programs offered in community centres, libraries, and local museums and science centres.

THE PROGRAM IN SCIENCE AND TECHNOLOGY

CURRICULUM EXPECTATIONS

The Ontario Curriculum, Grades 1–8: Science and Technology, 2007 identifies the expectations for each grade and describes the knowledge and skills that students are expected to acquire, demonstrate, and apply in their class work and investigations, on tests, and in various other activities on which their achievement is assessed and evaluated.

Two sets of expectations are listed for each grade in each *strand*, or broad area of the curriculum, in science and technology for Grades 1 to 8 – overall expectations and specific expectations.

The *overall expectations* describe in general terms the knowledge and skills that students are expected to demonstrate by the end of each grade. There are three overall expectations for each strand in each grade in science and technology.

The *specific expectations* describe the expected knowledge and skills in greater detail. The specific expectations are organized under numbered headings, each of which indicates the overall expectation to which the group of specific expectations corresponds. Taken together, the overall expectations and specific expectations represent the mandated curriculum. The organization of expectations into groups is not meant to imply that the expectations in any one group are achieved independently of the expectations in the other groups. The subheadings are used merely to help teachers focus on particular aspects of knowledge and skills as they develop and present various lessons and learning activities for their students.

Many of the specific expectations are accompanied by examples, given in parentheses, as well as "sample issues", "sample guiding questions", "sample problems", and "sample prompts". (Prompts consist variously of questions and ideas, and are designed to stimulate student thinking, especially in the primary grades.) The examples and the sample issues, questions, problems, and prompts help to clarify the requirements specified in the expectations, and suggest the intended depth and level of complexity of the expectations. They have been developed to model appropriate practice for the grade and are meant to serve as illustrations for teachers. Teachers can choose to use the examples and samples that are appropriate for their classrooms, or they may develop their own approaches that reflect a similar level of complexity. Whatever the specific ways in which the requirements

outlined in the expectations are implemented in the classroom, they must, wherever possible, be inclusive and reflect the diversity of the student population and the population of the province.

The Expectations and the Goals of the Science and Technology Program

In each grade, the three overall expectations in each strand, and their related sets of specific expectations, are closely connected with the three goals of the science and technology program (see page 3). The relationship between the goals and the expectations is briefly described below:

1. ***to relate science and technology to society and the environment***
   The overall expectation of relating science and technology to society and the environment (STSE) and the related cluster of specific expectations are placed first to better align the curriculum with the teaching and learning of science and technology, and to emphasize the importance of scientific, technological, and environmental literacy for all students. In addition, the STSE expectations set the context for developing the related skills and conceptual knowledge that are necessary for making connections between scientific, technological, social, and environmental issues. Many of the STSE expectations also focus on various aspects of environmental education.

2. ***to develop the skills, strategies, and habits of mind required for scientific investigation and technological problem solving***
   The skills needed for developing scientific and technological literacy are outlined in the second overall expectation and in the related specific expectations found under the heading Developing Skills of Scientific Investigation and Technological Problem Solving.

3. ***to understand the basic concepts of science and technology***
   The conceptual knowledge requirements are outlined in the third overall expectation and in the related specific expectations found under the heading Understanding Basic Concepts.

The three goals and their interrelationship within the curriculum expectations reinforce the notion that learning in science and technology cannot be viewed as merely the learning of facts. Rather, science and technology is a subject in which students learn, in age-appropriate ways, to consider both the knowledge and skills that will help them to understand and consider critically the impact of developments in science and technology on modern society and the environment.

STRANDS IN THE SCIENCE AND TECHNOLOGY CURRICULUM

The science and technology curriculum expectations are organized in four strands, which are the major areas of knowledge and skills in the science and technology curriculum. The four strands are as follows:

- Understanding Life Systems
- Understanding Structures and Mechanisms
- Understanding Matter and Energy
- Understanding Earth and Space Systems

It should also be noted that the transition from Grade 8 to Grade 9 is a smooth one because of the close alignment of both the elementary and the Grade 9 program strands.

Elementary Science and Technology	Grade 9 Science
Understanding Life Systems	Biology
Understanding Structures and Mechanisms	Physics
Understanding Matter and Energy	Chemistry
Understanding Earth and Space Systems	Earth and Space Science

THE SKILL CONTINUA FOR SCIENTIFIC INVESTIGATION AND TECHNOLOGICAL PROBLEM SOLVING

> *Learning science [and technology] is something students do, not something that is done to them.*
>
> *National Science Education Standards* (1996), p. 20

Along with a knowledge foundation, the study of science and technology offers students varied opportunities to learn and master skills that are relevant to their everyday world.

In the specific expectations, reference is made to the following three skill areas:

- scientific inquiry/experimentation skills
- scientific inquiry/research skills
- technological problem-solving skills

Skill continua are provided on the following pages for these skill areas. The continua present an ordered series of descriptive statements that mark out students' development along the road to mastery of these specific skills. The continua provide teachers with a way of looking at what students can do so that they can plan for further development of their students' skills. In general terms, the skills involved in scientific investigation and technological problem solving are the following:

- initiating and planning (e.g., asking questions, clarifying problems, planning procedures)
- performing and recording (e.g., following procedures, accessing information, recording observations and findings)
- analysing and interpreting (e.g., organizing data, reflecting on the effectiveness of actions performed, drawing conclusions)
- communicating (e.g., using appropriate vocabulary, communicating findings in a variety of ways)

The Scientific Inquiry/Experimentation Skill Continuum

Although there is no single scientific method, there are scientific methodologies – practices that are followed when investigating questions in a scientific manner.

In scientific inquiry, students engage in activities that allow them to develop knowledge and understanding of scientific ideas in much the same way as scientists would. Like

scientists, students must also develop skills in the two major components of scientific investigation – experimentation and research. Experimentation involves conducting "fair tests" to determine whether changing one factor in the experimental set-up affects the results, and, if so, in what ways. In a fair test, the scientist/student identifies variables that may affect the results of the experiment; selects one variable to be altered (tested), and keeps other variables constant; measures all trials in the same way; and repeats tests to determine the validity of the results.

SCIENTIFIC INVESTIGATION: CONTINUUM FOR INQUIRY/EXPERIMENTATION SKILLS

Beginning →	Exploring →	Emerging →	Competent →	Proficient
Initiating and Planning				
The student:				
asks questions that demonstrate curiosity about the world around him or her	asks questions that can be answered through tests/experimentation, and chooses one to investigate	asks questions that can be answered through tests/experimentation, and formulates a specific question to investigate	asks questions that arise from practical problems and issues, and formulates a specific question to investigate	
with support, follows the steps in a simple, teacher-prepared procedure for a test/experiment	follows the steps in a simple, teacher-prepared procedure for a test/experiment	creates, from a variety of possible methods, a plan to find an answer to the question he or she has formulated	plans for safe experimentation, showing some awareness of variables to be considered	
recognizes when a test is fair or unfair	recognizes when a test is fair or unfair	with support, builds fair testing elements into plans for an experimental procedure designed to answer the question he or she has formulated	builds fair testing elements into plans for an experimental procedure designed to answer the question he or she has formulated	
makes "guesses" about possible outcomes of simple procedures	with support, makes simple predictions about the outcome of the procedure prepared by the teacher	makes predictions, based on personal experience, about the results of the investigation	makes predictions, based on prior knowledge from explorations and investigations, about the results of the investigation	
Performing and Recording				
The student:				
safely uses teacher-selected tools and equipment to extend the senses for observation	selects, with support, and safely uses tools and equipment to extend the senses for observation	selects and safely uses tools and equipment to observe and measure	selects and safely uses tools and equipment to observe and measure	
records data orally, in pictures, in written words, and/or in tally charts	records data orally, in pictures, and/or in written words or sentences	records and organizes data using standard measurements, sentences, lists, and/or simple labelled diagrams	records and organizes data using standard measurements in simple tables, graphs, or charts, or in labelled diagrams	

Analysing and Interpreting			
The student:			
discusses data, and asks new questions based on data	identifies patterns in the data, and summarizes the data	identifies patterns and discrepancies in the data, and summarizes the data	identifies patterns in the data, suggests explanations for discrepancies, and summarizes the data
proposes an answer to the question being investigated, on the basis of observations	draws a simple conclusion on the basis of observations	draws simple conclusions on the basis of data gathered	draws conclusions on the basis of data gathered
describes what was done and what was observed	makes a simple evaluation of the experiment	evaluates the experimental procedure, explains changes that could be made to improve it, and gives reasons for the changes	evaluates the experimental procedure, explains changes that could be made to improve it, and gives reasons for the changes
Communicating			
The student:			
orally recounts steps in and results of an investigation to answer a specific question	orally presents steps in and results of an investigation to answer a specific question	presents steps in and results of an experimental procedure orally; in charts, graphs, or diagrams; and/or in sentences	presents steps in and results of an experimental procedure using numeric, symbolic, graphical, and/or linguistic methods

The Scientific Inquiry/Research Skill Continuum

Research includes both primary research, which is done through first-hand, direct observation of objects and processes, and secondary research, which is done by reviewing the work and the findings of others.

SCIENTIFIC INVESTIGATION: CONTINUUM FOR INQUIRY/RESEARCH SKILLS*

Beginning →	Exploring →	Emerging →	Competent →	Proficient
Initiating and Planning				
The student:				
asks questions that demonstrate curiosity about the world around him or her	asks questions that could lead to investigations, and chooses one that will be the basis for an investigation	asks questions that could lead to investigations, and formulates a specific question that will be the basis for an investigation	asks questions that arise from practical problems and issues, and formulates a specific question that will be the basis for an investigation	
	uses a teacher-prepared organizational system for gathering and organizing information	plans an organizational system for gathering and organizing information, using a variety of graphic organizers (e.g., Venn diagram) and organizational patterns (e.g., cause and effect)	plans an organizational system for gathering and organizing information, using a variety of strategies (e.g., sketchboard outlines of a series of events) and organizational patterns (e.g., order of importance)	
	with support, selects print and multimedia resources from those provided by the teacher	independently selects print, multimedia, and electronic resources from those provided by the teacher	independently selects print, multimedia, and electronic resources	
Performing and Recording				
The student:				
selects information from prior knowledge, other people, and observations made during his or her explorations	with support, selects information from print and multimedia resources provided by the teacher	selects information from print and multimedia resources that he or she has found independently, and from electronic resources provided by the teacher	selects information from print, multimedia, and electronic resources that he or she has found independently	
	records information gathered, using a teacher-prepared organizational system	records information gathered, using a variety of graphic organizers (e.g., Venn diagram) and organizational patterns (e.g., cause and effect)	records information gathered, using a variety of strategies (e.g., sketchboard outlines of a series of events) and organizational patterns (e.g., order of importance)	
	matches information to research needs (e.g., differentiates between factual information and information based on opinion)	reviews information for currency and bias	selects sources of information, showing awareness of currency and bias	

*A blank box indicates that no inquiry/research skill is expected in the particular category at that level.

Performing and Recording (continued)			
The student:			
acknowledges the use of information sources (e.g., specific people)	references sources by title, author, date	references sources by title, author, date, URL	uses appropriate academic referencing, including publisher, volume, date of document, location and date of interview
Analysing and Interpreting			
The student:			
proposes an answer to the question being investigated, on the basis of information gathered	states a simple conclusion in answer to the question being investigated, on the basis of information gathered	states a conclusion in answer to the question being investigated, on the basis of information gathered	states a conclusion in answer to the question being investigated, on the basis of information gathered
describes steps taken to answer the question	makes a simple evaluation of research procedures used	makes an evaluation of the research procedure used, suggests changes that could be made to it, and gives reasons for the suggested changes	makes an evaluation of the research procedure used, suggests changes that could be made to it, and gives reasons for the suggested changes
	demonstrates understanding that the accuracy and value of information will vary from source to source	considers and compares information from different sources	verifies the validity of and compares information gathered from research
	summarizes the information, using pictures and words	summarizes relevant information, using words, T-charts, pictures	summarizes relevant information, using jot notes, outlines
Communicating			
The student:			
recounts steps and shares results of research orally, in pictures, and/or in written words to answer the question investigated	presents research orally; in charts, graphs, or labelled drawings; and/or in written words to answer the question investigated	presents research orally; in charts, graphs, or diagrams; and/or in written sentences to answer the question investigated	presents research in numeric, symbolic, graphical, and/or linguistic forms of communication to answer the question investigated

The Technological Problem-Solving Skill Continuum

Through technological problem solving, students develop the ability to design solutions to problems. Students create models of new devices or new processes to help address human needs and desires, as well as new knowledge about those devices or processes. When engaged in technological problem solving, students should be given opportunities to be creative in their thinking, rather than merely to find a prescribed answer. Critical aspects of technological problem solving are: careful planning; purposeful selection of tools and materials; testing, retesting, and modifications of a product or process; communicating about the solution; and recommending of changes or improvements.

CONTINUUM FOR TECHNOLOGICAL PROBLEM-SOLVING SKILLS

Beginning →	Exploring →	Emerging →	Competent →	Proficient
Initiating and Planning				
The student:				
recognizes a practical problem in a given context	identifies practical problems to solve in the immediate environment	identifies practical problems to solve in the local community	identifies practical problems to solve	
with support (e.g., as a class or in small groups), brainstorms possible solutions to a practical problem	with support (e.g., as a class or in small groups), generates a list of possible solutions to a practical problem and determines which are realistic in the classroom and/or the real world	identifies possible solutions to a practical problem and explains how each might solve the problem	identifies possible solutions to a practical problem and prioritizes them with regard to their potential for solving the problem	
with support (e.g., as a class or in small groups), selects one possible solution to implement	selects a possible solution to implement	selects a possible solution to implement, and provides reasons for the choice	selects a possible solution, and provides reasons for the choice that take into account considerations such as function, aesthetics, environmental impact	
with support (e.g., as a class or in small groups), makes a simple plan to carry out the solution	makes a simple plan (individually or in small groups), including simple drawings and/or diagrams, to carry out the solution	outlines (individually or in small groups) the steps of a plan, including labelled drawings and/or diagrams, to solve the problem	outlines in detail, including technical drawings and/or diagrams, each step of a plan to solve the problem	
with support (e.g., as a class or in small groups), establishes a limited number of criteria for evaluating proposed solutions to the problem	with support (e.g., as a class or in small groups), establishes a limited number of criteria for evaluating proposed solutions to the problem	contributes to establishing general criteria for evaluating objects or devices designed to solve the problem	contributes to establishing general criteria for evaluating objects or devices designed to solve the problem	
Performing and Recording				
The student:				
with support (e.g., as a class or in small groups), carries out the pre-determined plan	with support (e.g., as a class or in small groups), carries out the pre-determined plan	carries out the pre-determined plan (individually or in pairs or small groups)	carries out the pre-determined plan	
with support, designs, builds, and tests (on the basis of pre-determined criteria) a device or an object to solve the problem	with support, designs, builds, and tests (on the basis of pre-determined criteria) a device or an object to solve the problem	designs, builds, and tests (on the basis of pre-determined criteria) a device or an object to solve the problem	designs, builds, and tests (on the basis of pre-determined criteria) a device or an object to solve the problem	
records results using pictures and/or tally charts	records results in a variety of ways, such as sentences, simple drawings, diagrams, and/or charts	records results in a variety of ways, such as sentences, drawings, labelled diagrams, graphs, and/or charts	records results in a variety of ways, such as sentences, technical drawings, labelled diagrams, graphs, and/or charts	

Analysing and Interpreting			
The student:			
with support, identifies how well the chosen solution solved the practical problem, using the pre-determined criteria	identifies how well the chosen solution solved the practical problem, using the pre-determined criteria	explains how well the chosen solution solved the practical problem, and suggests possible changes to the criteria and the solution	explains how well the chosen solution solved the practical problem, using qualitative and/or quantitative data, and suggests possible changes to the criteria and the solution
with support, suggests something that might be changed about the solution to the problem	identifies some things that could be done differently to improve the solution to the problem	identifies and explains what changes could be made to the plan and how to improve the solution to the problem, and gives reasons for the changes	identifies and explains what changes could be made to the plan and the testing process, and how to improve the solution to the problem, and gives reasons for the changes
	identifies some possible beneficial and non-beneficial impacts of the chosen solution for himself/herself or others	identifies the effects of the chosen solution on himself/herself, others, and/or the environment, considering things such as cost, materials, time, and/or space	identifies the effects of the chosen solution on himself/herself, others, and/or the environment, considering things such as cost, materials, time, and/or space, and suggests ways in which undesirable effects could be lessened or eliminated
Communicating			
The student:			
describes orally, and/or using drawings, pictures, and/or simple sentences, the problem and how he or she solved it	describes orally, and/or using drawings, pictures, and/or simple sentences, the problem and how he or she solved it	describes orally, and using labelled drawings and diagrams, charts, graphs, and/or written descriptions, the problem and how he or she solved it	describes orally, and using labelled drawings and diagrams, charts, graphs, and/or written descriptions, the problem and how he or she solved it
uses grade-appropriate science and technology vocabulary correctly	uses grade-appropriate science and technology vocabulary correctly	uses grade-appropriate science and technology vocabulary correctly	uses grade-appropriate science and technology vocabulary correctly

TOPICS IN SCIENCE AND TECHNOLOGY

The topics for the strands for Grade 1–8 science and technology are aligned with the topics for Grade 9 and 10 science and Grade 9 and 10 technological education. The following chart provides an outline of these topics.

Elementary Science and Technology Curriculum Overview				
	Understanding Life Systems	**Understanding Structures and Mechanisms**	**Understanding Matter and Energy**	**Understanding Earth and Space Systems**
Grade 1	Needs and Characteristics of Living Things	Materials, Objects, and Everyday Structures	Energy in Our Lives	Daily and Seasonal Cycles
Grade 2	Growth and Changes in Animals	Movement	Properties of Liquids and Solids	Air and Water in the Environment
Grade 3	Growth and Changes in Plants	Strong and Stable Structures	Forces Causing Movement	Soils in the Environment
Grade 4	Habitats and Communities	Pulleys and Gears	Light and Sound	Rocks and Minerals
Grade 5	Human Organ Systems	Forces Acting on Structures and Mechanisms	Properties of and Changes in Matter	Conservation of Energy and Resources
Grade 6	Biodiversity	Electricity and Electrical Devices	Properties of Air and Principles of Flight	Space
Grade 7	Interactions in the Environment	Form and Function	Pure Substances and Mixtures	Heat in the Environment
Grade 8	Cells	Systems in Action	Fluids	Water Systems
Grade 9 and 10 Science Curriculum Overview				
	Biology	**Physics**	**Chemistry**	**Earth and Space Science**
Grade 9 Academic	Sustainable Ecosystems	The Characteristics of Electricity	Atoms and Elements	The Study of the Universe
Grade 9 Applied	Sustainable Ecosystems and Human Activity	Electrical Applications	Exploring Matter	Space Exploration
Grade 10 Academic	Tissues, Organs, and Systems of Living Things	Light and Geometric Optics	Chemical Reactions	Climate Change
Grade 10 Applied	Human Tissues, Organs, and Systems	Light and Applications of Optics	Chemical Reactions and Their Practical Applications	Earth's Dynamic Climate

Grade 9 and 10 Technological Education Curriculum Overview				
Grade 9	**Exploring Technologies** Students will be given the opportunity to explore technology concepts that they will need in order to create designs, utilize software, fabricate products, document events, and prepare goods and services. This exploratory course provides a link between the concepts and skills studied in the elementary science and technology strand called Understanding Structures and Mechanisms and the topics studied in various subject areas of broad-based technology. Students will gain awareness of educational and training requirements for technology-related opportunities.			
Grade 10	Hairstyling and Aesthetics Health Care Hospitality and Tourism	Technological Design Manufacturing Technology Construction Technology	Communications Technology Computer Technology Introduction to Computing Computer Engineering Transportation Technology	Green Industries

ASSESSMENT AND EVALUATION OF STUDENT ACHIEVEMENT

BASIC CONSIDERATIONS

The primary purpose of assessment and evaluation is to improve student learning. Information gathered through assessment helps teachers to determine students' strengths and weaknesses in their achievement of the curriculum expectations in each subject in each grade. This information also serves to guide teachers in adapting curriculum and instructional approaches to students' needs and in assessing the overall effectiveness of programs and classroom practices.

Assessment is the process of gathering information from a variety of sources (including assignments, day-to-day observations, conversations or conferences, demonstrations, projects, performances, and tests) that accurately reflects how well a student is achieving the curriculum expectations in a subject. As part of assessment, teachers provide students with descriptive feedback that guides their efforts towards improvement. Evaluation refers to the process of judging the quality of student work on the basis of established criteria, and assigning a value to represent that quality. In Ontario elementary schools, the value assigned will be in the form of a letter grade for Grades 1 to 6 and a percentage grade for Grades 7 and 8.

Assessment and evaluation will be based on the provincial curriculum expectations and the achievement levels outlined in this document.

In order to ensure that assessment and evaluation are valid and reliable, and that they lead to the improvement of student learning, teachers must use assessment and evaluation strategies that:

- address both what students learn and how well they learn;
- are based both on the categories of knowledge and skills and on the achievement level descriptions given in the achievement chart on pages 26–27;
- are varied in nature, administered over a period of time, and designed to provide opportunities for students to demonstrate the full range of their learning;
- are appropriate for the learning activities used, the purposes of instruction, and the needs and experiences of the students;

- are fair to all students;
- accommodate students with special education needs, consistent with the strategies outlined in their Individual Education Plan;
- accommodate the needs of students who are learning the language of instruction;
- ensure that each student is given clear directions for improvement;
- promote students' ability to assess their own learning and to set specific goals;
- include the use of samples of students' work that provide evidence of their achievement;
- are communicated clearly to students and parents at the beginning of the school year and at other appropriate points throughout the school year.

All curriculum expectations must be accounted for in instruction, but evaluation focuses on students' achievement of the overall expectations. A student's achievement of the overall expectations is evaluated on the basis of his or her achievement of related specific expectations. The overall expectations are broad in nature, and the specific expectations define the particular content or scope of the knowledge and skills referred to in the overall expectations. Teachers will use their professional judgement to determine which specific expectations should be used to evaluate achievement of the overall expectations, and which ones will be covered in instruction and assessment (e.g., through direct observation) but not necessarily evaluated.

The characteristics given in the achievement chart (pages 26–27) for level 3 represent the "provincial standard" for achievement of the expectations. A complete picture of achievement at level 3 in science and technology can be constructed by reading from top to bottom in the shaded column of the achievement chart, headed "Level 3". Parents of students achieving at level 3 can be confident that their children will be prepared for work in the next grade.

Level 1 identifies achievement that falls much below the provincial standard, while still reflecting a passing grade. Level 2 identifies achievement that approaches the standard. Level 4 identifies achievement that surpasses the standard. It should be noted that achievement at level 4 does not mean that the student has achieved expectations beyond those specified for a particular grade. It indicates that the student has achieved all or almost all of the expectations for that grade, and that he or she demonstrates the ability to use the knowledge and skills specified for that grade in more sophisticated ways than a student achieving at level 3.

The Ministry of Education has provided teachers with materials that will assist them in improving their assessment methods and strategies and, hence, their assessment of student achievement. These materials include samples of student work (exemplars) that illustrate achievement at each of the four levels. (Adaptations can be made in the exemplar documents to align them with the revised curriculum.)

THE ACHIEVEMENT CHART FOR SCIENCE AND TECHNOLOGY

The achievement chart that follows identifies four categories of knowledge and skills in science and technology. The achievement chart is a standard province-wide guide to be used by teachers. It enables teachers to make judgements about student work that are based on clear performance standards and on a body of evidence collected over time.

The achievement chart is designed to:

- provide a framework that encompasses all curriculum expectations for all grades and subjects represented in this document;
- guide the development of assessment tasks and tools (including rubrics);
- help teachers to plan instruction for learning;
- assist teachers in providing meaningful feedback to students;
- provide various categories and criteria with which to assess and evaluate student learning.

Categories of Knowledge and Skills

The categories, defined by clear criteria, represent four broad areas of knowledge and skills within which the subject expectations for any given grade are organized. The four categories should be considered as interrelated, reflecting the wholeness and interconnectedness of learning.

The categories of knowledge and skills are described as follows:

Knowledge and Understanding. Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding).

Thinking and Inquiry. The use of critical and creative thinking skills and inquiry and problem-solving skills and/or processes.

Communication. The conveying of meaning through various forms.

Application. The use of knowledge and skills to make connections within and between various contexts.

Teachers will ensure that student work is assessed and/or evaluated in a balanced manner with respect to the four categories, and that achievement of particular expectations is considered within the appropriate categories.

Criteria

Within each category in the achievement chart, criteria are provided, which are subsets of the knowledge and skills that define each category. The criteria for each category are listed below:

Knowledge and Understanding

- knowledge of content (e.g., facts; terminology; definitions; safe use of tools, equipment, and materials)
- understanding of content (e.g., concepts, ideas, theories, principles, procedures, processes)

Thinking and Inquiry

- use of initiating and planning skills and strategies (e.g., formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources, developing plans)
- use of processing skills and strategies (e.g., performing and recording, gathering evidence and data, observing, manipulating materials and using equipment safely, solving equations, proving)
- use of critical/creative thinking processes, skills, and strategies (e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence)

Communication

- expression and organization of ideas and information (e.g., clear expression, logical organization) in oral, visual, and/or written forms (e.g., diagrams, models)
- communication for different audiences (e.g., peers, adults) and purposes (e.g., to inform, to persuade) in oral, visual, and/or written forms
- use of conventions, vocabulary, and terminology of the discipline in oral, visual, and written forms (e.g., symbols, formulae, scientific notation, SI units)

Application

- application of knowledge and skills (e.g., concepts and processes, use of equipment and technology, scientific investigation skills) in familiar contexts
- transfer of knowledge and skills (e.g., concepts and processes, use of equipment and technology, scientific investigation skills) to unfamiliar contexts
- making connections between science, technology, society, and the environment (e.g., assessing the impact of science and technology on people, other living things, and the environment)
- proposing courses of practical action to deal with problems relating to science, technology, society, and the environment

Descriptors

A "descriptor" indicates the characteristic of the student's performance, with respect to a particular criterion, on which assessment or evaluation is focused. In the achievement chart, *effectiveness* is the descriptor used for each criterion in the Thinking and Inquiry, Communication, and Application categories. What constitutes effectiveness in any given performance task will vary with the particular criterion being considered. Assessment of effectiveness may therefore focus on a quality such as appropriateness, clarity, accuracy, precision, logic, relevance, significance, fluency, flexibility, depth, or breadth, as appropriate for the particular criterion. For example, in the Thinking and Inquiry category, assessment of effectiveness might focus on the degree of relevance or depth apparent in an analysis; in the Communication category, on clarity of expression or logical organization of information and ideas; or in the Application category, on appropriateness or breadth in the making of connections. Similarly, in the Knowledge and Understanding category, assessment of knowledge might focus on accuracy, and assessment of understanding might focus on the depth of an explanation. Descriptors help teachers to focus their assessment and evaluation on specific knowledge and skills for each category and criterion, and help students to better understand exactly what is being assessed and evaluated.

Qualifiers

A specific "qualifier" is used to define each of the four levels of achievement – that is, *limited* for level 1, *some* for level 2, *considerable* for level 3, and *a high degree* or *thorough* for level 4. A qualifier is used along with a descriptor to produce a description of performance at a particular level. For example, the description of a student's performance at level 3 with respect to the first criterion in the Thinking category would be: "The student uses initiating and planning skills and strategies with considerable effectiveness".

The descriptions of the levels of achievement given in the chart should be used to identify the level at which the student has achieved the expectations. Students should be provided with numerous and varied opportunities to demonstrate the full extent of their achievement of the curriculum expectations, across all four categories of knowledge and skills.

ACHIEVEMENT CHART – SCIENCE AND TECHNOLOGY, GRADES 1–8

Categories	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding – Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding)				
	The student:			
Knowledge of content *(e.g., facts; terminology; definitions; safe use of tools, equipment, and materials)*	demonstrates limited knowledge of content	demonstrates some knowledge of content	demonstrates considerable knowledge of content	demonstrates thorough knowledge of content
Understanding of content *(e.g., concepts, ideas, theories, principles, procedures, processes)*	demonstrates limited understanding of content	demonstrates some understanding of content	demonstrates considerable understanding of content	demonstrates thorough understanding of content
Thinking and Inquiry – The use of critical and creative thinking skills and inquiry and problem-solving skills and/or processes				
	The student:			
Use of initiating and planning skills and strategies *(e.g., formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources, developing plans)*	uses initiating and planning skills and strategies with limited effectiveness	uses initiating and planning skills and strategies with some effectiveness	uses initiating and planning skills and strategies with considerable effectiveness	uses initiating and planning skills and strategies with a high degree of effectiveness
Use of processing skills and strategies *(e.g., performing and recording, gathering evidence and data, observing, manipulating materials and using equipment safely, solving equations, proving)*	uses processing skills and strategies with limited effectiveness	uses processing skills and strategies with some effectiveness	uses processing skills and strategies with considerable effectiveness	uses processing skills and strategies with a high degree of effectiveness
Use of critical/creative thinking processes, skills, and strategies *(e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence)*	uses critical/ creative thinking processes, skills, and strategies with limited effectiveness	uses critical/ creative thinking processes, skills, and strategies with some effectiveness	uses critical/ creative thinking processes, skills, and strategies with considerable effectiveness	uses critical/ creative thinking processes, skills, and strategies with a high degree of effectiveness
Communication – The conveying of meaning through various forms				
	The student:			
Expression and organization of ideas and information *(e.g., clear expression, logical organization)* **in oral, visual, and/or written forms** *(e.g., diagrams, models)*	expresses and organizes ideas and information with limited effectiveness	expresses and organizes ideas and information with some effectiveness	expresses and organizes ideas and information with considerable effectiveness	expresses and organizes ideas and information with a high degree of effectiveness

Categories	Level 1	Level 2	Level 3	Level 4
Communication (continued)				
	The student:			
Communication for different audiences *(e.g., peers, adults)* **and purposes** *(e.g., to inform, to persuade)* **in oral, visual, and/or written forms**	communicates for different audiences and purposes with limited effectiveness	communicates for different audiences and purposes with some effectiveness	communicates for different audiences and purposes with considerable effectiveness	communicates for different audiences and purposes with a high degree of effectiveness
Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms *(e.g., symbols, formulae, scientific notation, SI units)*	uses conventions, vocabulary, and terminology of the discipline with limited effectiveness	uses conventions, vocabulary, and terminology of the discipline with some effectiveness	uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness	uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness
Application – The use of knowledge and skills to make connections within and between various contexts				
	The student:			
Application of knowledge and skills *(e.g., concepts and processes, use of equipment and technology, scientific investigation skills)* **in familiar contexts**	applies knowledge and skills in familiar contexts with limited effectiveness	applies knowledge and skills in familiar contexts with some effectiveness	applies knowledge and skills in familiar contexts with considerable effectiveness	applies knowledge and skills in familiar contexts with a high degree of effectiveness
Transfer of knowledge and skills *(e.g., concepts and processes, use of equipment and technology, scientific investigation skills)* **to unfamiliar contexts**	transfers knowledge and skills to unfamiliar contexts with limited effectiveness	transfers knowledge and skills to unfamiliar contexts with some effectiveness	transfers knowledge and skills to unfamiliar contexts with considerable effectiveness	transfers knowledge and skills to unfamiliar contexts with a high degree of effectiveness
Making connections between science, technology, society, and the environment *(e.g., assessing the impact of science and technology on people, other living things, and the environment)*	makes connections between science, technology, society, and the environment with limited effectiveness	makes connections between science, technology, society, and the environment with some effectiveness	makes connections between science, technology, society, and the environment with considerable effectiveness	makes connections between science, technology, society, and the environment with a high degree of effectiveness
Proposing courses of practical action to deal with problems relating to science, technology, society, and the environment	proposes courses of practical action of limited effectiveness	proposes courses of practical action of some effectiveness	proposes courses of practical action of considerable effectiveness	proposes highly effective courses of practical action

SOME CONSIDERATIONS FOR PROGRAM PLANNING IN SCIENCE AND TECHNOLOGY

When planning a program in science and technology, teachers must take into account considerations in a number of important areas, including those discussed below.

INSTRUCTIONAL APPROACHES

> *Trying to understand how the world works is what children do naturally, and it is what you need to take advantage of when teaching science [and technology]. Just remember: Avoid being the knowledge authority. … Instead, cultivate a sense of excitement for exploring and inquiring about our world and for generating and testing possible explanations.*
>
> Jeffrey W. Bloom, *Creating a Classroom Community of Young Scientists*, 2nd ed. (2006), p. 4

One of the primary objectives of elementary science and technology curricula has always been, and must continue to be, development of curiosity and wonder. Students come to school with a natural curiosity. They also bring with them individual interests and abilities as well as diverse personal and cultural experiences, all of which have an impact on their prior knowledge about science, technology, the environment, and the world in which they live. Effective instructional approaches and learning activities draw on students' prior knowledge, capture their interest, and encourage meaningful practice both inside and outside the classroom. Students will be engaged when they are able to see the connection between the scientific and technological concepts they are learning and their application in the world around them and in real-life situations.

Typically, students demonstrate diversity in the ways they learn best. It is important, therefore, that students have opportunities to learn in a variety of ways – individually, cooperatively, independently, with teacher direction, through hands-on experiences, and through examples followed by practice. In addition, science and technology requires students to learn concepts and procedures, acquire skills, and learn and apply scientific and technological processes. These different areas of learning may involve different

teaching and learning strategies. Thus, the strategies teachers employ will vary according to both the object of the learning and the needs of the students.

> *At its most basic level, differentiating instruction means "shaking up" what goes on in the classroom so that students have multiple options for taking in information, making sense of ideas, and expressing what they learn. In other words, a differentiated classroom provides different avenues to acquiring content, to processing or making sense of ideas, and to developing products so that each student can learn effectively.*
>
> Carol Ann Tomlinson, *How to Differentiate Instruction in Mixed-Ability Classrooms*, 2nd ed. (2001), p. 1

In order to learn science and technology and to apply their knowledge and skills effectively, students must develop a solid understanding of scientific and technological concepts. Research and successful classroom practice have shown that an inquiry approach, with emphasis on learning through concrete, hands-on experiences, best enables students to develop the conceptual foundation they need. When planning science and technology programs, teachers will provide activities and challenges that actively engage students in inquiries that honour the ideas and skills students bring to them, while further deepening their conceptual understanding and essential skills.

Students will investigate scientific and technological concepts using a variety of equipment, materials, and strategies, and both manual and technological tools and skills. Equipment, tools, and materials are necessary for supporting the effective learning of science and technology by all students. These concrete learning tools invite students to explore and investigate abstract scientific and technological ideas in rich, varied, concrete, and hands-on ways. Moreover, using a variety of equipment, tools, and materials helps deepen and extend students' understanding of scientific and technological concepts and further extends the development of scientific inquiry and technological problem-solving skills.

All learning, especially new learning, should be embedded in well-chosen contexts for learning – that is, contexts that are broad enough to allow students to investigate initial understandings, identify and develop relevant supporting skills, and gain experience with varied and interesting applications of the new knowledge. In the elementary science and technology curriculum, many of these contexts come from the Relating Science and Technology to Society and the Environment (STSE) expectations. Such rich contexts for learning enable students to see the "big ideas" of science and technology. This understanding of "big ideas" will enable and encourage students to use scientific and technological thinking throughout their lives. As well, teachers can gain useful insights into their students' thinking, their understanding of concepts, and their ability to reflect on what they have done. This insight allows teachers to provide supports to help enhance students' thinking.

HEALTH AND SAFETY IN SCIENCE AND TECHNOLOGY EDUCATION

Teachers must model safe practices at all times and communicate safety expectations to students in accordance with school board and Ministry of Education policies.

To carry out their responsibilities with regard to safety, it is important not only that teachers have concern for their own safety and that of their students, but also that they have:

- the knowledge necessary to use the materials, tools, and procedures involved in science and technology safely;

- knowledge concerning the care of living things – plants and animals – that are brought into the classroom;
- the skills needed to perform tasks efficiently and safely.

Note: Teachers supervising students using power equipment such as drills, sanders, saws, and lathes need to have *specialized* training in handling such tools.

Students demonstrate that they have the knowledge, skills, and habits of mind required for safe participation in science and technology activities when they:

- maintain a well-organized and uncluttered work space;
- follow established safety procedures;
- identify possible safety concerns;
- suggest and implement appropriate safety procedures;
- carefully follow the instructions and example of the teacher;
- consistently show care and concern for their safety and that of others.

CROSS-CURRICULAR AND INTEGRATED LEARNING

In cross-curricular learning, students are provided with opportunities to learn and use related content and/or skills in two or more subjects. All subjects, including science and technology, can be related to the language curriculum. For example, teachers can use science and technology reading material in their language lessons, and incorporate instruction in how to read non-fiction materials into their science and technology lessons. In science and technology, students use a range of language skills: they build subject-specific vocabulary, interpret diagrams and charts, and read instructions relating to investigations and procedures. Moreover, they communicate what they have learned, orally, graphically, and in writing.

In integrated learning, students are provided with opportunities to work towards meeting expectations from two or more subjects within a single unit, lesson, or activity. By linking expectations from different subject areas, teachers can provide students with multiple opportunities to reinforce and demonstrate their knowledge and skills in a range of settings. One example would be a unit linking expectations from the science and technology curriculum and the social studies curriculum. Connections can be made between these curricula in a number of areas, including expectations relating to variations in habitat and ecosystems across the regions of Canada, the use of natural resources, historical changes in technology, and the impact of science and technology on different peoples and the environment. In addition, a unit combining science and technology and social studies expectations could focus on inquiry/research skills common to the two subjects.

PLANNING SCIENCE AND TECHNOLOGY PROGRAMS FOR STUDENTS WITH SPECIAL EDUCATION NEEDS

Classroom teachers are the key educators of students who have special education needs. They have a responsibility to help all students learn, and they work collaboratively with special education teachers, where appropriate, to achieve this goal. They commit to assisting every student to prepare for living with the highest degree of independence possible.

Education for All: The Report of the Expert Panel on Literacy and Numeracy Instruction for Students With Special Education Needs, Kindergarten to Grade 6, 2005 describes a set of beliefs, based in research, that should guide all program planning for students with special education needs. Teachers planning science and technology programs need to pay particular attention to these beliefs, which are as follows:

- All students can succeed.
- Universal design and differentiated instruction are effective and interconnected means of meeting the learning or productivity needs of any group of students.
- Successful instructional practices are founded on evidence-based research, tempered by experience.
- Classroom teachers are key educators for a student's literacy and numeracy development.
- Each student has his or her own unique patterns of learning.
- Classroom teachers need the support of the larger community to create a learning environment that supports students with special education needs.
- Fairness is not sameness.

In any given classroom, students may demonstrate a wide range of learning styles and needs. Teachers plan programs that recognize this diversity and give students performance tasks that respect their particular abilities so that all students can derive the greatest possible benefit from the teaching and learning process. The use of flexible groupings for instruction and the provision of ongoing assessment are important elements of programs that accommodate a diversity of learning needs.

In planning science and technology programs for students with special education needs, teachers should begin by examining both the curriculum expectations for the appropriate grade level of the individual student and his or her strengths and learning needs to determine which of the following options is appropriate for the student:

- no accommodations[2] or modifications; or
- accommodations only; or
- modified expectations, with the possibility of accommodations; or
- alternative expectations, which are not derived from the curriculum expectations for a grade and which constitute alternative programs.

If the student requires either accommodations or modified expectations, or both, the relevant information, as described in the following paragraphs, must be recorded in his or her Individual Education Plan (IEP). More detailed information about planning programs for students with special education needs, including students who require alternative programs, can be found in *The Individual Education Plan (IEP): A Resource Guide, 2004* (referred to hereafter as the *IEP Resource Guide, 2004*). For a detailed discussion of the ministry's requirements for IEPs, see *Individual Education Plans: Standards for Development, Program Planning, and Implementation, 2000* (referred to hereafter as *IEP Standards, 2000*). (Both documents are available at www.edu.gov.on.ca.)

2. "Accommodations" refers to individualized teaching and assessment strategies, human supports, and/or individualized equipment.

Students Requiring Accommodations Only

Some students with special education needs are able, with certain accommodations, to participate in the regular curriculum and to demonstrate learning independently. (Accommodations do not alter the provincial curriculum expectations for the grade level.) The accommodations required to facilitate the student's learning must be identified in his or her IEP (see *IEP Standards, 2000*, page 11). A student's IEP is likely to reflect the same accommodations for many, or all, subject areas.

Providing accommodations to students with special education needs should be the first option considered in program planning. Instruction based on principles of universal design and differentiated instruction focuses on the provision of accommodations to meet the diverse needs of learners.

There are three types of accommodations:

- *Instructional accommodations* are changes in teaching strategies, including styles of presentation, methods of organization, or use of technology and multimedia.
- *Environmental accommodations* are changes that the student may require in the classroom and/or school environment, such as preferential seating or special lighting.
- *Assessment accommodations* are changes in assessment procedures that enable the student to demonstrate his or her learning, such as allowing additional time to complete tests or assignments or permitting oral responses to test questions (see page 29 of the *IEP Resource Guide, 2004* for more examples).

If a student requires "accommodations only" in science and technology, assessment and evaluation of his or her achievement will be based on the appropriate grade-level curriculum expectations and the achievement levels outlined in this document. The IEP box on the student's Provincial Report Card will not be checked, and no information on the provision of accommodations will be included.

Students Requiring Modified Expectations

In science and technology, for most students with special education needs, modified expectations will be based on the regular grade-level curriculum, with changes in the number and/or complexity of the expectations. Modified expectations must represent specific, realistic, observable, and measurable achievements, and must describe specific knowledge and/or skills that the student can demonstrate independently, given the appropriate assessment accommodations.

Modified expectations must indicate the knowledge and/or skills the student is expected to demonstrate and have assessed in each reporting period (*IEP Standards, 2000*, pages 10 and 11). Modified expectations should be expressed in such a way that the student and parents can understand exactly what the student is expected to know or be able to do, on the basis of which his or her performance will be evaluated and a grade or mark recorded on the Provincial Report Card. The student's learning expectations must be reviewed in relation to the student's progress at least once every reporting period, and must be updated as necessary (*IEP Standards, 2000*, page 11).

If a student requires modified expectations in science and technology, assessment and evaluation of his or her achievement will be based on the learning expectations identified in the IEP and on the achievement levels outlined in this document. On the Provincial

Report Card, the IEP box must be checked for any subject in which the student requires modified expectations, and the appropriate statement from the *Guide to the Provincial Report Card, Grades 1–8, 1998* (page 8) must be inserted. The teacher's comments should include relevant information on the student's demonstrated learning of the modified expectations, as well as next steps for the student's learning in the subject.

Students Requiring Alternative Programs With Alternative Expectations

Alternative expectations are developed to help students acquire knowledge and skills that are not represented in the Ontario curriculum. Because they are not part of a subject outlined in the provincial curriculum policy documents, alternative expectations are considered to constitute alternative programs.

Examples of alternative programs include speech remediation, daily living skills, social skills, orientation/mobility training, and personal care programs. For the vast majority of students, alternative expectations are provided in addition to modified or regular grade-level expectations from the Ontario curriculum. Alternative programs are provided in both the elementary and secondary school panels.

"Alternative" (ALT) is the term used to identify alternative programs on the IEP form.

PROGRAM CONSIDERATIONS FOR ENGLISH LANGUAGE LEARNERS

Ontario schools have some of the most multilingual student populations in the world. The first language of approximately 20 per cent of the children in Ontario's English-language schools is a language other than English. Ontario's linguistic heritage includes several Aboriginal languages; many African, Asian, and European languages; and some varieties of English, such as Jamaican Creole. Many English language learners (children who are learning English as a second or additional language in English-language schools) were born in Canada and raised in families and communities in which languages other than English were spoken, or in which the variety of English spoken differed significantly from the English of Ontario classrooms. Other English language learners arrive in Ontario as newcomers from other countries; they may have experience of highly sophisticated educational systems, or they may have come from regions where access to formal schooling was limited.

When they start school in Ontario, many of these children are entering a new linguistic and cultural environment. All teachers share in the responsibility for their English-language development.

English language learners bring a rich diversity of background knowledge and experience to the classroom. These students' linguistic and cultural backgrounds not only support their learning in their new environment but also become a cultural asset in the classroom community. Teachers will find positive ways to incorporate this diversity into their instructional programs and into the classroom environment.

Most English language learners in Ontario schools have an age-appropriate proficiency in their first language. Although they need frequent opportunities to use English at school, there are important educational and social benefits associated with continued development of their first language while they are learning English. Teachers need to encourage parents

to continue to use their own language at home in rich and varied ways as a foundation for language and literacy development in English. It is also important for teachers to find opportunities to bring students' languages into the classroom, using parents and community members as a resource.

During their first few years in Ontario schools, English language learners may receive support through one of two distinct programs from teachers who specialize in meeting their language-learning needs:

English as a Second Language (ESL) programs are for students born in Canada or newcomers whose first language is a language other than English, or is a variety of English significantly different from that used for instruction in Ontario schools.

English Literacy Development (ELD) programs are primarily for newcomers whose first language is a language other than English, or is a variety of English significantly different from that used for instruction in Ontario schools, and who arrive with significant gaps in their education. These children generally come from countries where access to education is limited or where there are limited opportunities to develop language and literacy skills in any language. Some Aboriginal students from remote communities in Ontario may also have had limited opportunities for formal schooling, and they also may benefit from ELD instruction.

In planning programs for children with linguistic backgrounds other than English, teachers need to recognize the importance of the orientation process, understanding that every learner needs to adjust to the new social environment and language in a unique way and at an individual pace. For example, children who are in an early stage of English-language acquisition may go through a "silent period" during which they closely observe the interactions and physical surroundings of their new learning environment. They may use body language rather than speech or they may use their first language until they have gained enough proficiency in English to feel confident of their interpretations and responses. Students thrive in a safe, supportive, and welcoming environment that nurtures their self-confidence while they are receiving focused literacy instruction. When they are ready to participate, in paired, small-group, or whole-class activities, some students will begin by using a single word or phrase to communicate a thought, while others will speak quite fluently.

With exposure to the English language in a supportive learning environment, most young children will develop oral fluency quite quickly, making connections between concepts and skills acquired in their first language and similar concepts and skills presented in English. However, oral fluency is not a good indicator of a student's knowledge of vocabulary or sentence structure, reading comprehension, or other aspects of language proficiency that play an important role in literacy development and academic success. Research has shown that it takes five to seven years for most English language learners to catch up to their English-speaking peers in their ability to use English for academic purposes. Moreover, the older the children are when they arrive, the greater the language knowledge and skills that they have to catch up on, and the more direct support they require from their teachers.

Responsibility for students' English-language development is shared by the classroom teacher, the ESL/ELD teacher (where available), and other school staff. Volunteers and peers may also be helpful in supporting English language learners in the science and

technology classroom. Teachers must adapt the instructional program in order to facilitate the success of these students in their classrooms. Appropriate adaptations include:

- modification of some or all of the subject expectations so that they are challenging but attainable for the learner at his or her present level of English proficiency, given the necessary support from the teacher;
- use of a variety of instructional strategies (e.g., extensive use of visual cues, graphic organizers, scaffolding; previewing of textbooks; pre-teaching of key vocabulary; peer tutoring; strategic use of students' first languages);
- use of a variety of learning resources (e.g., visual material, simplified text, bilingual dictionaries, and materials that reflect cultural diversity);
- use of assessment accommodations (e.g., granting of extra time; use of oral interviews, demonstrations or visual representations, or tasks requiring completion of graphic organizers or cloze sentences instead of essay questions and other assessment tasks that depend heavily on proficiency in English).

While the degree of program adaptation required will decrease over time, students who are no longer receiving ESL or ELD support may still need some program adaptations to be successful. If a student's program has been modified, a checkmark must be placed in the ESL/ELD box on the student's report card. If the student requires modified expectations, the appropriate statement from the *Guide to the Provincial Report Card, Grades 1–8, 1998* (page 8) must be inserted.

For further information on supporting English language learners, refer to *English Language Learners – ESL and ELD Programs and Services: Policies and Procedures for Ontario Elementary and Secondary Schools, Kindergarten to Grade 1* (2007); *Supporting English Language Learners in Kindergarten: A Practical Guide for Ontario Educators* (resource guide, 2007); *Many Roots, Many Voices: Supporting English Language Learners in Every Classroom* (resource guide, 2005); and *The Ontario Curriculum, Grades 1–8: English As a Second Language and English Literacy Development – A Resource Guide* (2001).

ENVIRONMENTAL EDUCATION

> *Environmental education is education about the environment, for the environment, and in the environment that promotes an understanding of, rich and active experience in, and an appreciation for the dynamic interactions of:*
>
> - *The Earth's physical and biological systems*
> - *The dependency of our social and economic systems on these natural systems*
> - *The scientific and human dimensions of environmental issues*
> - *The positive and negative consequences, both intended and unintended, of the interactions between human-created and natural systems.*
>
> *Shaping Our Schools, Shaping Our Future: Environmental Education in Ontario Schools* (June 2007), p. 6

As noted in *Shaping Our Schools, Shaping Our Future: Environmental Education in Ontario Schools*, environmental education "is the responsibility of the entire education community. It is a content area and can be taught. It is an approach to critical thinking, citizenship, and personal responsibility, and can be modelled. It is a context that can enrich and enliven

education in all subject areas, and offer students the opportunity to develop a deeper connection with themselves, their role in society, and their interdependence on one another and the Earth's natural systems" (page 10).

The increased emphasis on science, technology, society, and the environment (STSE) within this curriculum document provides numerous opportunities for teachers to integrate environmental education effectively into the curriculum. The STSE expectations provide meaningful contexts for applying what has been learned about the environment, for thinking critically about issues related to the environment, and for considering personal action that can be taken to protect the environment. Throughout the grades and strands, teachers have opportunities to take students out of the classroom and into the world beyond the school, to observe, explore, and investigate. One effective way to approach environmental literacy is through examining critical inquiry questions related to students' sense of place, to the impact of human activity on the environment, and/or to systems thinking. This can be done at numerous points within the science and technology curriculum. The following are some examples:

- A sense of place can be developed as students investigate structures and their functions in their neighbourhood, consider different ways in which food is grown in their community, and explore the impact of industries on local water systems.
- An understanding of the effects of human activity on the environment can develop as students consider the impact of their actions (e.g., taking part in tree planting at a local park, walking or biking to school instead of riding in the car, packing a litterless lunch) on their local environment.
- Systems thinking can be developed as students understand what a system is and how changing one part of it (e.g., introducing zebra mussels into a local lake or non-native invasive plants into a wetland) can affect the whole system.

ANTIDISCRIMINATION EDUCATION IN THE SCIENCE AND TECHNOLOGY PROGRAM

The implementation of antidiscrimination principles in education influences all aspects of school life. It promotes a school climate that encourages all students to work to high standards, affirms the worth of all students, and helps students strengthen their sense of identity and develop a positive self-image. It encourages staff and students alike to value and show respect for diversity in the school and the wider society. It requires schools to adopt measures to provide a safe environment for learning, free from harassment, violence, and expressions of hate. Antidiscrimination education encourages students to think critically about themselves and others in the world around them in order to promote fairness, healthy relationships, and active, responsible citizenship.

Schools also have the opportunity to ensure that school–community interaction reflects the diversity in the local community and wider society. Consideration should be given to a variety of strategies for communicating and working with parents and community members from diverse groups, in order to ensure their participation in such school activities as plays, concerts, and teacher interviews. Families new to Canada, who may be unfamiliar with the Ontario school system, or parents of Aboriginal students may need special outreach and encouragement in order to feel comfortable in their interactions with the school.

The science and technology program provides students with access to materials that reflect diversity with respect to gender, race, culture, and ability. Diverse groups of people involved in scientific and technological activities and careers should be prominently displayed. In planning the science and technology program, teachers should consider issues such as access to laboratory experiences and equipment. Laboratory benches and lighting should be adjustable and appropriate for students with physical disabilities. Tools, equipment, and construction materials can also be adapted in ways that make them accessible to all students.

The examples used to illustrate knowledge and skills, and the practical applications and topics that students explore as part of the learning process, should vary so they appeal to both boys and girls and relate to students' diverse backgrounds, interests, and experiences. For example, cooking activities can be used to teach concepts relating to physical properties, heat, and energy. Cooking utensils can be considered as tools, and many technological applications can be grounded in domestic contexts.

In many instances, variations in culture and location (whether rural, urban, or suburban) can be found in a single classroom. Students living in apartment buildings will have different access to plants and animals than students living in a rural setting or on a Native reserve. There may be cultural sensitivities for some students in areas such as the use of biological specimens. For example, a number of religions have prohibitions regarding pigs. It may be important for some Muslim students to have a lab partner of the same sex. Although it is impossible to anticipate every contingency, teachers should be open to adjusting their instruction, if feasible, when concerns are brought to their attention.

It is important that learning activities include opportunities for students to describe, study, or research how women and men from a variety of backgrounds, including Aboriginal peoples, have contributed to science and technology or used science and technology to solve problems in their daily life and work. The calendar systems of various cultures or the use that Aboriginal peoples have made of medicinal plants might be considered. Different technologies and scientific processes from around the world, such as methods for making paper, metal, glass, dyes, and perfumes, could be compared, or the impact of technologies or technological processes in use in different countries can be explored in relation to the food chain, the environment, or the ozone layer. There are also expectations in the curriculum that require students to look at the perspectives or world views of Aboriginal cultures as they relate to science and technology.

All students should learn to operate equipment and use a variety of hand tools. This can be accomplished, in part, by booking specific times for each student, or for groups of students, to use the tool centre or specific tools. Access to computers should be monitored, and a range of software applications provided. A problem-solving approach can benefit students who are having difficulties with technology or equipment. For example, rather than demonstrating a specific solution to a technological problem, a teacher might begin by referring students to a manual or providing a series of guiding questions (e.g., "Have you tried ___." You might think about ___." "I wonder what would happen if ___.") in order to help students develop self-confidence in their own competence. For younger students, offering building materials and construction toys in pastel colours serves to widen their appeal. Because access to equipment at home will vary, it is important to offer challenges for or support to students whose levels of prior knowledge differ.

CRITICAL THINKING AND CRITICAL LITERACY IN SCIENCE AND TECHNOLOGY

Critical thinking is the process of thinking about ideas or situations in order to understand them fully, identify their implications, and/or make a judgement about what is sensible or reasonable to believe or do. Critical thinking includes skills such as questioning, predicting, hypothesizing, analysing, synthesizing, examining opinions, identifying values and issues, detecting bias, and distinguishing between alternatives.

Students use critical thinking skills in science and technology when they assess, analyse, and/or evaluate the impact of something on society and the environment; when they form an opinion about something and support that opinion with logical reasons; or when they create personal plans of action with regard to making a difference. In order to do these things, students need to examine the opinions and values of others, detect bias, look for implied meaning in their readings, and use the information gathered to form a personal opinion or stance.

As they work to achieve the STSE expectations, students are frequently asked to identify the implications of an action. As they gather information from a variety of sources, they need to be able to interpret what they are reading, to look for instances of bias, and to determine why that source might express that particular bias.

In developing the skills of scientific inquiry/research, students must ask good questions to frame their research, interpret information, and detect bias. Depending on the topic, they may be required to consider the values and perspectives of a variety of groups and individuals.

Critical literacy is the capacity for a particular type of critical thinking that involves looking beyond the literal meaning of a text to determine what is present and what is missing, in order to analyse and evaluate the text's complete meaning and the author's intent. Critical literacy goes beyond conventional critical thinking by focusing on issues related to fairness, equity, and social justice. Critically literate students adopt a critical stance, asking what view of the world the text advances and whether they find this view acceptable.

In science and technology, students who are critically literate are able, for example, to read or view reports from a variety of sources on a common issue. They are able to assess how fairly the facts have been reported, what biases might be contained in each report and why that might be, how the content of the report was determined and by whom, and what might have been left out of the report and why. These students would then be equipped to produce their own interpretation of the issue.

LITERACY AND NUMERACY IN THE SCIENCE AND TECHNOLOGY PROGRAM

Aside from developing students' scientific, technological, and environmental literacy, the activities and tasks undertaken by students in the science and technology curriculum build on, reinforce, and enhance certain aspects of the language and mathematics curricula. Care has been taken to ensure that expectations in science and technology are consistent with the expectations for language and mathematics in the same grade.

Fostering students' communication skills is an important part of the teachers' role in the science and technology classroom. Students need to be able to use oral communication,

reading, writing, and media literacy skills to gain new learning in science and technology and to communicate their understanding of what they have learned.

Oral communication skills are fundamental to the development of scientific and technological literacy and are essential for thinking and learning. Through purposeful talk, students not only learn to communicate information but also explore and come to understand ideas and concepts, identify and solve problems, organize their experience and knowledge, and express and clarify their thoughts, feelings, and opinions.

To develop their oral communication skills, students need numerous opportunities to listen to information and talk about a range of subjects in science and technology. The science and technology program provides opportunities for students to engage in various oral activities in connection with expectations in all the strands, such as brainstorming to identify what they know about a new topic they are studying, discussing strategies for solving a technological problem, presenting and defending ideas or debating issues, and offering critiques of models and results produced by their peers.

Students' understanding is revealed through both oral and written communication, but it is not necessary for all science and technology learning to involve a written communication component. Young students especially need opportunities to focus on their oral communication without adding the additional responsibility of writing.

Whether students are talking or writing about their scientific and technological learning, teachers can prompt them to explain their thinking and reasoning behind a particular solution, design, or strategy, or to reflect on what they have done, by asking questions. Because a rich, open-ended question provides the starting point for an effective scientific inquiry or for addressing a technological problem, it is important that teachers model rich, open-ended questions for their students and allow students multiple opportunities to ask, and find answers to, their own questions.

When reading science texts, students use a different set of skills than they do when reading fiction. They need to understand vocabulary and terminology that are unique to science and technology, and must be able to interpret symbols, charts, and diagrams. In addition, as they progress through the grades, the ability to make sense of the organization of science and technology textbooks becomes critical. To help students construct meaning, it is essential that teachers of science and technology model and teach the strategies that support learning to read while students are reading to learn in this subject area.

Writing in science and technology employs special forms and therefore also requires specific and direct learning opportunities. Students may be asked, for example, to write step-by-step instructions for replicating an experiment with plants or for building a mousetrap car. The purpose of these instructions is two-fold: to record what they have done, and to allow someone else to replicate their experiment or design. Therefore their instructions need to be organized, clear, and precise.

Scientific writing serves many purposes: "… scientists … take meticulous notes to form hypotheses, document observations, conduct experiments, and solve problems. Writing for them is much more than data collection; it is exploring, revising, and thinking on paper. Writing helps them learn facts, work out what the facts mean, and use facts to make new discoveries and refine old theories" (Laura Robb, *Teaching Reading in Social Studies, Science and Math* [2003], page 59).

The Ministry of Education has facilitated the development of materials to support literacy instruction across the curriculum. Helpful advice for integrating literacy instruction in science and technology may be found in the following resource documents:

- *Think Literacy: Cross-Curricular Approaches, Grades 7–12, 2003*
- *Think Literacy: Cross-Curricular Approaches – Subject-Specific Examples: Science and Technology, Grades 7 and 8, Reading Strategies, 2004*
- *Think Literacy: Cross-Curricular Approaches – Subject-Specific Examples: Science and Technology, Grades 7 and 8, Writing Strategies, 2005*

Whether students are talking or writing about their scientific and technological learning, teachers can ask questions to prompt them to explain their thinking and reasoning behind a particular solution, design, or strategy, or to reflect on what they have done.

In addition to providing opportunities for literacy development, science and technology provides many valuable opportunities for students to apply the concepts and skills of mathematics and deepen their mathematical understanding. Science and technology also supports the development of a student's ability to apply the mathematical processes of problem solving, communicating, representing, connecting, reasoning and proving, reflecting, and selecting appropriate tools and strategies. For example, clear, concise communication often involves representing quantitative information numerically using charts and tables or graphically using diagrams and graphs. The science and technology curriculum provides opportunities for students to interpret and use graphic texts. Students apply the knowledge and skills they acquire in their study of data management in mathematics to gather, interpret, and describe data collected through hands-on investigations of relationships in science and technology.

Making real-world connections between science and technology and mathematics is extremely important. Students in Grade 2 should begin to make connections between the study of movement (in the Understanding Structures and Mechanisms strand) in science and technology and the study of location and movement (in the Geometry and Spatial Sense strand) in mathematics. When comparing and ordering the growth of germinated seeds, students in Grade 3 should be making connections to measurement by estimating, measuring, and recording lengths in centimetres and to data management by collecting and organizing categorical and discrete primary data. Grade 6 students can use proportional reasoning and the concept of unit rates when thinking about energy consumption and the cost of using electricity. The relationship between the distribution of weights on a lever and the position of the fulcrum can be used to develop a better understanding of the relationship between the distribution of data and the mean of the data.

THE ROLE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY IN SCIENCE AND TECHNOLOGY EDUCATION

Information and communications technologies (ICT) provide a range of tools that can significantly extend and enrich teachers' instructional strategies and support students' learning in science and technology. Computer programs can help students collect, organize, and sort the data they gather and to write, edit, and present reports on their findings.

ICT can also be used to connect students to other schools, at home and abroad, and to bring the global community into the local classroom. Technology also makes it possible to use simulations when field studies on a particular topic are not feasible.

Whenever appropriate, therefore, students should be encouraged to use ICT to support and communicate their learning. For example, students working individually or in groups can use computer technology and/or Internet websites to gain access to museums and archives in Canada and around the world. Students can also use digital cameras and projectors to present multimedia presentations that document the testing and retesting of their design projects.

Although the Internet is a powerful learning tool, all students must be made aware of issues of privacy, safety, and responsible use, as well as of the ways in which the Internet can be used to promote hatred.

Teachers will find the various ICT tools useful in their teaching practice, both for whole class instruction and for the design of curriculum units that contain varied approaches to learning to meet diverse student needs.

THE ROLE OF THE SCHOOL LIBRARY IN SCIENCE AND TECHNOLOGY PROGRAMS

The school library program can help to build and transform students' knowledge to support a lifetime of learning in an information- and knowledge-based society. The school library program supports student success in the science and technology curriculum by encouraging students to read widely, teaching them to read for understanding and enjoyment, and helping them to improve their research skills and to use information gathered through research effectively. The school library program enables students to:

- develop a love of reading for learning and for pleasure;
- acquire an understanding of the richness and diversity of literary and informational texts produced in Canada and around the world;
- obtain access to programs, resources, and integrated technologies that support all curriculum areas;
- understand and value the role of public library systems as a resource for lifelong learning.

The school library program plays a key role in the development of information literacy and research skills. In collaboration with classroom or content-area teachers, teacher-librarians develop, teach, and provide students with authentic information and research tasks that foster learning, including the ability to:

- access, select, gather, critically evaluate, create, and communicate information;
- use the information obtained to solve problems, make decisions, build knowledge, create personal meaning, and enrich their lives;
- communicate their findings for different audiences, using a variety of formats and technologies;
- use information and research with understanding, responsibility, and imagination.

GUIDANCE IN SCIENCE AND TECHNOLOGY EDUCATION

The guidance and career education program should be aligned with the science and technology curriculum. Teachers need to ensure that classroom learning across all grades and subjects provides ample opportunity for students to learn how to work independently (e.g., complete homework independently), cooperate with others, resolve conflicts, participate in class, solve problems, and set goals to improve their work.

The science and technology program can also offer opportunities for a variety of career exploration activities, including contacts with career mentors and visits from guest speakers whose occupations make use of scientific and technological knowledge and skills. These might include veterinarians, opticians, sound engineers, architects, city planners, road builders, or car designers.

GRADE **1**

GRADE 1 | UNDERSTANDING LIFE SYSTEMS
NEEDS AND CHARACTERISTICS OF LIVING THINGS

OVERVIEW

Young children have an inherent curiosity about things in nature. This topic takes advantage of that curiosity by beginning a study of a variety of living things, including humans. The focus is on investigating the basic needs and characteristics of living things, observing their similarities and differences, and developing an understanding of their general characteristics. Students will discover that all living things have some similar needs, and many also have unique needs. Students will recognize that humans have a special responsibility for maintaining a healthy environment, so that they and other living things can continue to have their needs met by that environment. Students will learn why all living things are important and why they should be treated with care and respect. During discussions of human physical and sexual characteristics, care should be taken to ensure that a positive discussion takes place.

Grade 1 students have a natural tendency to ask questions and an increasing ability to solve problems. They benefit from having numerous opportunities to be outside exploring their schoolyard and surrounding natural areas, activities that can nourish their curiosity and help them develop a caring and respectful attitude towards all living things. Care must be taken to ensure that all students, including students with special education needs, have comparable opportunities to explore the natural world.

The study of plants and animals in Grade 1 presents very few hazards for young students. However, it is important that they be able to identify general practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why it is important to wash their hands before and after handling animals, and why they should never put any part of a plant in their mouths unless under the direction of the teacher.

Connections can be made with another Grade 1 science and technology topic, Understanding Earth and Space Systems: Daily and Seasonal Changes, as students investigate how seasonal changes affect living things and recognize the importance of living things in our environment.

Fundamental Concepts	Big Ideas
Sustainability and Stewardship	Living things grow, take in food to create energy, make waste, and reproduce. *(Overall expectations 2 and 3)* Plants and animals, including people, are living things. *(Overall expectations 2 and 3)* Living things have basic needs (air, water, food, and shelter) that are met from the environment. *(Overall expectations 1, 2, and 3)* Different kinds of living things behave in different ways. *(Overall expectations 2 and 3)* All living things are important and should be treated with care and respect. *(Overall expectations 1, 2, and 3)*

OVERALL EXPECTATIONS

By the end of Grade 1, students will:

1. assess the role of humans in maintaining a healthy environment;
2. investigate needs and characteristics of plants and animals, including humans;
3. demonstrate an understanding of the basic needs and characteristics of plants and animals, including humans.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 1, students will:

1.1 identify personal action that they themselves can take to help maintain a healthy environment for living things, including humans *(e.g., walk to school instead of being driven in the car; be careful what they put down the drain at home; practise cleanliness to reduce the spread of germs when helping in the kitchen; show care and concern for all living things)*

Sample guiding questions: What happens to humans when part of their environment is not healthy? What happens to other animals and plants when part of their environment is not healthy? What are some ways that humans help and hurt other living things? What can we do at home to help keep our environment healthy? What can we do here at school? What does our community do to help keep our environment healthy?

1.2 describe changes or problems that could result from the loss of some kinds of living things that are part of everyday life *(e.g., if we lost all the cows, all the insects, all the bats, all the trees, all the grasses)*, taking different points of view into consideration *(e.g., the point of view of farmers, children, parents)*

Sample guiding questions: What are some living things that we see every day? Which are plants? Which are animals? What makes them important to us and to the environment? How would things be different for us as humans if there were no cows (trees, insects, bats, grass)? How would things be different for other living things? How would the environment be different? What are some things we can do to show that we care for other living things and appreciate what they do for us and for the environment?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 1, students will:

2.1 follow established safety procedures and humane practices during science and technology investigations *(e.g., show care and concern when handling animals)*

2.2 investigate and compare the basic needs of humans and other living things, including the need for air, water, food, warmth, and space, using a variety of methods and resources *(e.g., prior knowledge, personal experience, discussion, books, videos/DVDs, CD-ROMs)*

Sample guiding questions: What is the difference between living things and non-living things? What are some of the things that humans need to live and grow? What do other living things need to live and grow? In what ways are all living things alike? What are some ways in which they are different? In what ways might humans interfere with the ability of other living things to get what they need to live (e.g., by polluting the water that animals drink and live in; by removing plants from their natural growing places and putting them in their gardens)? Why do some Aboriginal people consider rocks to be living things?

2.3 investigate and compare the physical characteristics of a variety of plants and animals, including humans *(e.g., some plants produce flowers and some do not; most plants have roots; some animals have two legs, while others have four; all animals have sense organs)*

2.4 investigate the physical characteristics of plants *(e.g., basic parts, size, shape, colour)* and explain how they help the plant meet its basic needs *(e.g., roots anchor the plant and help provide the plant with food and water; some plants have brightly coloured flowers to attract bees)*, using a variety of methods and resources

(e.g., direct observation of live plants in the classroom and in the schoolyard, prior knowledge, personal experience, diagrams and/or charts)

Sample guiding questions: What are the things that plants need in order to grow and survive? What parts do most plants have? How does each of these parts help the plant to get what it needs to grow and survive?

2.5 investigate characteristics of parts of the human body, including the five sense organs, and explain how those characteristics help humans meet their needs and explore the world around them *(e.g., our hands have fingers and a thumb that are flexible to allow us to pick up food; our legs have the two biggest bones in our bodies, to carry us around to do the things we need to do; our tongue has bumps that help us to determine if our food is too hot, too cold, or tastes bad; our ears are shaped like cones to catch sounds that warn us that danger is near and to hear the beautiful sounds of nature)*, using a variety of methods and resources *(e.g., observation of themselves and other animals, outdoor experiences, prior knowledge, personal experience, diagrams and/or charts)*

2.6 use appropriate science and technology vocabulary, including *investigation, explore, needs, space,* and *food*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., create a diorama to illustrate the basic needs of plants and animals, including humans)*

3. Understanding Basic Concepts

By the end of Grade 1, students will:

3.1 identify *environment* as the area in which something or someone exists or lives

3.2 identify the physical characteristics *(e.g., size, shape, colour, common parts)* of a variety of plants and animals *(e.g., sunflowers are tall, with a long stalk, leaves, and big, round, yellow flowers with hundreds of seeds; dogs can be big or small, come in many shapes and colours, have four legs, and usually have a tail and are covered with fur)*

3.3 identify the location and function of major parts of the human body, including sense organs *(e.g., lungs are in my chest and are used for breathing; teeth are in my mouth and are used for eating; hair is on my head for protection from the cold; ears are on the sides of my head and are used for hearing)*

3.4 describe the characteristics of a healthy environment, including clean air and water and nutritious food, and explain why it is important for all living things to have a healthy environment

3.5 describe how showing care and respect for all living things helps to maintain a healthy environment *(e.g., leaving all living things in their natural environment; feeding birds during cold winter months; helping to plant and care for plants in the gardens that attract birds and butterflies; caring for the school and the schoolyard as an environment)*

3.6 identify what living things provide for other living things *(e.g., trees produce the oxygen that other living things breathe; plants such as tomatoes and apple trees and animals such as cows and fish provide food for humans and for other animals; a tree stump provides a home for a chipmunk; porcupines chew off the tips of hemlock limbs, providing food for deer in winter)*

3.7 describe how the things plants and animals use to meet their needs are changed by their use and are returned to the environment in different forms *(e.g., the food animals eat and the water they drink are returned to the earth as scat and urine)*

GRADE 1 | UNDERSTANDING STRUCTURES AND MECHANISMS

MATERIALS, OBJECTS, AND EVERYDAY STRUCTURES

OVERVIEW

We are surrounded by a wide variety of common objects and structures that have distinctive shapes, patterns, and purposes. There are different categories of structures and different materials from which structures are made. This topic focuses on helping students to make the distinction between objects and materials through investigation of the observable characteristics of objects and the specific properties of the materials from which the objects are made. Students will learn that a structure is not only an object in itself but also the supporting framework that holds an object together. They will also investigate how the materials and structure of an object determine its purpose and how choices of materials for objects and structures have a direct effect on the environment.

For students in Grade 1, things are either right or wrong, good or bad, with little middle ground. This is a good time to begin to ask them to consider viewpoints other than their own. Asking them to think about the issue of classroom waste from the point of view of the people most directly involved can help them to see that every issue has several perspectives.

In their explorations of materials and objects, students in Grade 1 should be able to identify practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why spills of any kind should be cleaned up immediately, and why it is important to put all tools, equipment, and materials away where they belong at the end of their explorations.

Fundamental Concepts	Big Ideas
Structure and Function Matter	Objects have observable characteristics and are made from materials. *(Overall expectation 3)* Materials have specific properties. *(Overall expectations 2 and 3)* An object is held together by its structure. *(Overall expectation 2)* The materials and structure of an object determine its purpose. *(Overall expectations 1 and 3)* Humans make choices related to their use of objects and materials that have a direct effect on the environment. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 1, students will:

1. assess the impact on people and the environment of objects and structures and the materials used in them;
2. investigate structures that are built for a specific purpose to see how their design and materials suit the purpose;
3. demonstrate an understanding that objects and structures have observable characteristics and are made from materials with specific properties that determine how they are used.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 1, students will:

1.1 identify the kinds of waste produced in the classroom, and plan and carry out a classroom course of action for minimizing waste, explaining why each action is important

Sample prompts: Many children in our class bring their lunch to school, and after lunch our garbage can is full of soft-drink cans, tinfoil, plastic wrap, apple cores, and orange rinds. Where else might we put some of these things? Our class likes to do cut-and-paste activities, and we all like the fresh new sheets of paper. How else might we find the paper that we need? When we tidy up, we put all of the scraps in the garbage pail. What else might we do with them?

1.2 assess objects in their environment that are constructed for similar purposes *(e.g., chairs at home and at school; different kinds of shoes; different kinds of floor coverings)* in terms of the type of materials they are made from, the source of these materials, and what happens to these objects when they are worn out or no longer needed

Sample guiding questions: What is the purpose of the objects you have chosen? In what ways are your objects the same? In what ways are they different? Where might someone get the materials from which one of your objects is made (e.g., wood from trees, cotton from plants)? In what ways is each of your objects well suited for the place it is in or the task that it does? What happens to your object when it can no longer do the job it was designed to do? What might be some alternative ways of "disposing" of your object (e.g., shoes that no longer fit can be given to a younger sibling or to a community group for distribution to someone who can use them; the wood from an old chair might be used to build a play table and chairs)?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 1, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., wear safety goggles when using saws and hammers)*

2.2 investigate characteristics of various objects and structures, using their senses

2.3 investigate, through experimentation, the properties of various materials *(e.g., the best materials for absorbing or repelling water, for flexibility, for strength: the flexibility of plastic makes plastic wrap useful for covering food in order to keep it fresh; the impermeability of rubber enables rubber boots to keep feet dry)*

2.4 use technological problem-solving skills (see page 16), and knowledge acquired from previous investigations, to design, build, and test a structure for a specific purpose *(e.g., a tent, a model of a swing set or other playground equipment, a bird feeder, a wigwam for people who need to move throughout the year)*

Sample guiding questions: What is the purpose of your structure? What materials did you use to build your structure? Why did you choose those materials instead of _____ to build your structure? What did you use to fasten your structure together? What might happen to the materials in your structure when it is no longer being used?

2.5 use appropriate science and technology vocabulary, including *experiment, explore, purpose, rigid, flexible, solid,* and *smooth*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., orally explain their choices of materials and design decisions when presenting their structures)*

3. Understanding Basic Concepts

By the end of Grade 1, students will:

3.1 describe objects as things that are made of one or more materials

3.2 describe structures as supporting frameworks

3.3 describe materials as the substances from which something is made

3.4 describe the function/purpose of the observable characteristics *(e.g., texture, height, shape, colour)* of various objects and structures, using information gathered through their senses *(e.g., sandpaper is rough to help take the rough edges off wood; a traffic light is tall so it can be easily seen; a stop sign is the same shape and colour in many countries around the world to make it easily recognizable)*

3.5 identify the materials that make up objects and structures *(e.g., wood, plastic, steel, paper, polystyrene foam, cloth)*

3.6 distinguish between objects (including structures) and materials found in nature *(e.g., tree: sap)* and those made by humans *(e.g., toy: plastic)*

3.7 describe the properties of materials that enable the objects and structures made from them to perform their intended function

3.8 list different kinds of fasteners *(e.g., tape, glue, button, zipper)*, and describe the uses of each

3.9 identify the sources in nature of some common materials that are used in making structures *(e.g., paper and rubber come from trees; plastic comes from petroleum; steel comes from metals and minerals in the ground)*

GRADE 1 | UNDERSTANDING MATTER AND ENERGY
ENERGY IN OUR LIVES

OVERVIEW

Energy is a commonly used term that describes an important part of daily life. Since the concept of energy can be abstract, it is important to approach this topic in a practical, hands-on manner. Students will explore and identify different ways in which energy is used every day, especially by living things as a means of survival. Students will also develop an understanding that they have a variety of choices when using energy, and that these choices should be made responsibly. Because the amount and types of energy we use can change with the seasons, this topic could be combined with another Grade 1 science and technology topic, Understanding Earth and Space Systems: Daily and Seasonal Changes.

Students in Grade 1 will encounter very few hazards in their explorations of energy. However, it is important that they be able to identify general practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why work spaces should be kept tidy and uncluttered, and why it is important to follow the teacher's instructions carefully.

Fundamental Concepts	Big Ideas
Energy Sustainability and Stewardship	Everything that happens is a result of using some form of energy. *(Overall expectations 1, 2, and 3)* The sun is the principal source of energy for the earth. *(Overall expectation 3)* Humans need to be responsible for the way in which we use energy. *(Overall expectations 1 and 2)*

OVERALL EXPECTATIONS

By the end of Grade 1, students will:

1. assess uses of energy at home, at school, and in the community, and suggest ways to use less energy;
2. investigate how different types of energy are used in daily life;
3. demonstrate an understanding that energy is something that is needed to make things happen, and that the sun is the principal source of energy for the earth.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 1, students will:

1.1 describe their own and their family's uses of energy *(e.g., to operate lights, video games, cars, computers)*; identify ways in which these uses are efficient or wasteful, taking different points of view into consideration *(e.g., the point of view of a parent, a sibling, a member of their extended family)*; suggest ways to reduce personal energy consumption; and explain why it is important for people to make these choices

Sample issues: "My house is a few blocks from my school, but every day my dad drives me to and from school in the car, because he wants me to be safe." "My brothers and sisters all have MP3 players and video games, and they use a lot of batteries to keep them running." "We try to turn out the lights when we aren't in a room, but Grandma needs the lights to move around the house safely."

1.2 describe how the everyday lives of different people and other living things would be affected if electrical energy were no longer available *(e.g., families, farmers, businesses and stores, a company that offers alternative energy sources such as solar-powered devices, the plants in a hydroponic greenhouse, the tropical animals in a Canadian zoo)*

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 1, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., keep work spaces neat and tidy by putting all tools, materials, and equipment back where they belong)*

2.2 investigate how the sun affects the air, land, and/or water, using a variety of methods *(e.g., standing outside on a sunny and a cloudy day and noting the differences; putting a dish of water in the sun and the shade and observing what happens)* and resources *(e.g., books, videos/DVDs, CD-ROMs, the Internet)*

2.3 design and construct a device that uses energy to perform a task *(e.g., a kite that flies using the wind; a musical instrument that uses human energy to make sounds)*

2.4 investigate and compare seasonal differences in the ways we use energy and the types of energy we use *(e.g., we keep warm in winter by wearing a sweater and using furnaces and woodstoves; we stay cool in summer by sitting in the shade or going to places that are air conditioned; we adjust the amount of light we need by opening or closing the curtains and turning lights on or off)*

2.5 use scientific inquiry/experimentation skills (see page 12), and knowledge acquired from previous investigations, to explore the effects of light and heat from the sun *(e.g., by growing plants in the presence and absence of sunlight; by feeling the temperature of dark papers that have been in the sun and in the shade; by covering a portion of a piece of coloured paper and exposing the paper to the sun)*

2.6 investigate how the sun's energy allows humans to meet their basic needs, including the need for food *(e.g., trace the flow of energy from the sun, which provides energy to plants, which make food for animals to eat, and then from plants and animals, which provide food for humans to eat)*

2.7 use appropriate science and technology vocabulary, including *explore, investigate, design, energy,* and *survival*, in oral and written communication

2.8 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use labelled diagrams to show what happened when plants were grown in varying light conditions)*

3. Understanding Basic Concepts

By the end of Grade 1, students will:

3.1 demonstrate an understanding that energy is what makes the things they do or see happen

3.2 demonstrate an understanding that the sun, as the earth's principal source of energy, warms the air, land, and water; is a source of light for the earth; and makes it possible to grow food

3.3 identify food as a source of energy for themselves and other living things

3.4 identify everyday uses of various sources of energy *(e.g., food to help animals, including humans, survive and move; natural gas to heat homes and schools; petroleum to power cars and buses; electricity to power lights; batteries to power toys)*

3.5 demonstrate an understanding that humans get the energy resources they need from the world around them *(e.g., the wood, oil, and gas to heat our homes and cook our food)* and that the supply of many of these resources is limited so care needs to be taken in how we use them

GRADE 1 | UNDERSTANDING EARTH AND SPACE SYSTEMS
DAILY AND SEASONAL CHANGES

OVERVIEW

In observing their environment, students become aware of changes that take place in it, including changes in temperature, wind, and light and in plants and animals. The study of Daily and Seasonal Changes focuses on easily observed changes that occur in cycles, including day and night and the four seasons, and on how these changes affect living things. Since many of these cycles depend upon the light and/or heat of the sun, combining this topic with the Grade 1 topic Energy in Our Lives would enable the students to have a fuller understanding of the relationship among events in their environment and between the environment and themselves.

This topic presents very few safety challenges for young children. However, it is important that they be able to identify general practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why it is important to be protected from the sun when conducting investigations outdoors and why they should always stay within the space being studied.

Connections can be made with another Grade 1 science and technology topic, Understanding Life Systems: Needs and Characteristics of Living Things, as students investigate how living things adapt to seasonal changes and recognize the importance of living things in our environment. Connections can also be made with Understanding Matter and Energy: Energy in Our Lives with regard to the use of energy in various seasons.

Fundamental Concepts	Big Ideas
Change and Continuity	Changes occur in daily and seasonal cycles. *(Overall expectations 1, 2, and 3)* Changes in daily and seasonal cycles affect living things. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 1, students will:

1. assess the impact of daily and seasonal changes on living things, including humans;
2. investigate daily and seasonal changes;
3. demonstrate an understanding of what daily and seasonal changes are and of how these changes affect living things.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 1, students will:

1.1 assess the impact of daily and seasonal changes on human outdoor activities *(e.g., farming, gardening, swimming, skating, soccer)* and identify innovations that allow for some of these activities to take place indoors out of season *(e.g., greenhouses allow farming and gardening to happen in cold weather; arenas can make ice in all seasons for skating and hockey; community centres can provide warm places in all seasons for swimming)*

Sample guiding questions: Why do you and your family do different things outdoors during the day than at night? What are some outdoor human activities that can go on in any season? Why can this happen? What are some outdoor activities that can happen only in certain seasons? Why? How might it be possible for these activities to happen in other seasons? What might be some advantages and disadvantages of making this happen?

1.2 assess ways in which daily and seasonal changes have an impact on society and the environment *(e.g., In winter, some people suffer from seasonal disorders because there is less light from the sun than in summer. When the weather gets cold, people turn on heat in their homes; when the weather gets hotter they turn on fans, air conditioners, and pool heaters and pumps, all of which means that more energy is being used. At night in winter, when people get home from work and school, they all turn on appliances at around the same time [peak hours], which puts a strain on the power supplies. In summer, people increase their use of water to wash their cars and water their lawns and gardens; unless there is plenty of rain, this usage of water puts a strain on water supplies. In winter, it is harder for birds that do not migrate and animals that do not hibernate to find food and water. Some plants die when summer is over; others undergo changes, such as losing their leaves and going dormant until spring. The Anishinaabe people tell their stories only in the winter when there is snow on the ground.)*

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 1, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., never look directly at the sun; wear a hat and sunscreen when working outdoors)*

2.2 investigate the changes in the amount of light from the sun that occur throughout the day and year *(e.g., compare the amount of light observed at bedtime during summer vacation with the amount observed at bedtime during winter vacation)*

2.3 investigate the changes in the amount of heat from the sun that occur throughout the day and in the various seasons *(e.g., use their prior experience of the sun's warmth, and measure, record, and compare outdoor temperatures at different times of day and in different months of the year)*

2.4 use scientific inquiry/research skills (see page 15), including generating questions and knowledge acquired from previous investigations, to identify daily and/or seasonal changes and their effects *(e.g., the sun shines during the day, and the moon and stars are visible at night; leaves change colour in the fall; there are fewer birds in winter; dogs' fur gets thicker in winter; trees and flowers bloom in spring)*

Sample guiding questions: What are some changes that take place between day and night? What changes in plants, animals, and the weather take place between summer and fall? Between fall and winter? Between winter and spring? How do these changes affect your activities and those of your family?

2.5 use appropriate science and technology vocabulary, including *investigate, temperature, hibernate, dormant, energy,* and *survival*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., contribute to a class book about their observations of seasonal changes; keep a weekly pictorial journal in which they record and describe the weather through the seasons)*

3. Understanding Basic Concepts

By the end of Grade 1, students will:

3.1 identify the sun as Earth's principal source of heat and light

3.2 define a cycle as a circular sequence of events

3.3 describe changes in the amount of heat and light from the sun that occur throughout the day and the seasons

3.4 describe and compare the four seasons *(e.g., in terms of amount of daylight, type of precipitation, temperature)*

3.5 describe changes in the appearance or behaviour of living things that are adaptations to seasonal changes *(e.g., in fall, some plants shed their leaves and some birds migrate; in winter some animals change colour)*

3.6 describe how humans prepare for and/or respond to daily and seasonal changes *(e.g., by wearing appropriate clothing, carrying an umbrella, turning on an air conditioner or heater)*

GRADE **2**

GRADE 2 | UNDERSTANDING LIFE SYSTEMS
GROWTH AND CHANGES IN ANIMALS

OVERVIEW

Growth and Changes in Animals focuses on investigating the distinct characteristics of animals related to appearance, behaviour, growth, and change. Students will study a variety of animals and identify important similarities and differences among them. As well as making the obvious physical comparisons, students will look at ways in which human activities have an impact on specific animals and their survival, and ways in which the animals' environment has an impact on their development. They will also examine the importance of animals and the need for humans to protect animals and the places where they live.

This topic provides opportunities for students to observe live animals. Caring for them in the classroom, even for short periods of time, helps students to learn about their needs and characteristics. It also helps to foster concern and respect for living things. Teachers should respect the fact that some students may not wish to handle or pet animals, for personal or religious reasons. It is important that students be able to identify practices that ensure their own personal safety and the safety of others and demonstrate an understanding of these practices. This includes knowing why it is important to make the teacher aware of any allergies to animal fur and/or dander, to wash their hands before and after handling animals, and to properly clean and maintain the animals' housing.

Fundamental Concepts	Big Ideas
Structure and Function Sustainability and Stewardship	Animals have distinct characteristics. *(Overall expectations 2 and 3)* Humans are animals. *(Overall expectations 1, 2, and 3)* There are similarities and differences among different kinds of animals. *(Overall expectation 2)* Humans need to protect animals and the places where they live. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 2, students will:

1. assess ways in which animals have an impact on society and the environment, and ways in which humans have an impact upon animals and the places where they live;
2. investigate similarities and differences in the characteristics of various animals;
3. demonstrate an understanding that animals grow and change and have distinct characteristics.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 2, students will:

1.1 identify positive and negative impacts that animals have on humans (society) and the environment, form an opinion about one of them, and suggest ways in which the impact can be minimized or enhanced

Sample prompts: Because interacting with dogs can have a calming effect on humans (e.g., lowering blood pressure and relieving tension), dog visits are used in hospitals and retirement homes as therapy for the patients/residents. Dogs and monkeys can be trained to be the eyes and ears of visually and hearing impaired people. Birds can destroy crops such as blueberries and apples.

1.2 identify positive and negative impacts that different kinds of human activity have on animals and where they live *(e.g., actions of animal lovers and groups that protect animals and their rights, the home owner who wants a nice lawn, people who visit zoos and wildlife parks, pet owners)*, form an opinion about one of them, and suggest ways in which the impact can be minimized or enhanced

Sample prompts: Humans try to protect endangered and/or sensitive species by minimizing pollution and protecting the places where they live. Humans raise a variety of animals on farms, for food. Humans use pesticides on their lawns and gardens and to kill insects such as black flies and mosquitos. Humans use lands where animals live to build houses for themselves. Humans take animals, some of which may be endangered, from the wild and put them in zoos. Humans use animal skin and fur for clothing, for furniture, and for decoration. Humans create animal shelters for unwanted pets. Humans provide protected parks or wildlife reserves as special places for animals to live.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 2, students will:

2.1 follow established safety procedures and humane practices specific to the care and handling of live animals, where appropriate, during science and technology investigations *(e.g., make the teacher aware of any allergies; handle animals gently or know when it is better not to handle them at all; wash hands after handling animals)*

2.2 observe and compare the physical characteristics *(e.g., fur or feathers; two legs or no legs)* and the behavioural characteristics *(e.g., predator or prey)* of a variety of animals, including insects, using student-generated questions and a variety of methods and resources *(e.g., observation of live animals in the schoolyard; books, videos/DVDs, CD-ROMs, and/or Internet sources that depict animals in a positive light)*

2.3 investigate the life cycle of a variety of animals *(e.g., butterflies, frogs, chickens)*, using a variety of methods and resources *(e.g., observation of live animals in the classroom and in the schoolyard; books, videos/DVDs, CD-ROMs, and/or the Internet)*

2.4 observe and compare changes in the appearance and activity of animals as they go through a complete life cycle *(e.g., frog, butterfly)*

2.5 investigate the ways in which a variety of animals adapt to their environment and/or to changes in their environment, using various methods *(e.g., read simple non-fiction texts and Aboriginal stories; observe animal activity in the schoolyard and surrounding areas, and record findings)*

2.6 use scientific inquiry/research skills (see page 15), and knowledge acquired from previous investigations, to investigate the basic needs, characteristics, behaviour, and adaptations of an animal of their choice

2.7 use appropriate science and technology vocabulary, including *life cycle, migration, adaptation, body coverings*, and *classify*, in oral and written communication

2.8 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use a model constructed of modelling clay and a tree branch to explain how a caterpillar feeds)*

3. Understanding Basic Concepts

By the end of Grade 2, students will:

3.1 identify and describe major physical characteristics of different types of animals *(e.g., insects, mammals, reptiles)*

3.2 describe an adaptation as a characteristic body part, shape, or behaviour that helps a plant or animal survive in its environment *(e.g., some birds migrate to a warmer climate for the winter; the design of a whale's flipper allows the whale to turn, steer, and balance; the cecropia moth has the pattern of a snake's head on its wings: the hypothesis is that this is to frighten its predators away)*

3.3 identify ways in which animals are helpful to, and ways in which they meet the needs of, living things, including humans, to explain why humans should protect animals and the places where they live *(e.g., bats control mosquito populations; birds and wildlife provide pleasurable viewing experiences; the buffalo provided some Aboriginal people with everything they needed to survive: food, shelter, clothing, tools, ornamentation, and weapons; horses can be used for labour; cats and dogs provide companionship for humans; animals, including humans, disperse plant seeds)*

3.4 identify ways in which animals can be harmful to humans *(e.g., some people have an allergic reaction to bee and wasp venom when they are stung; deer, moose, and bears on roads can pose a hazard to people driving at night)*

GRADE 2 | UNDERSTANDING STRUCTURES AND MECHANISMS
MOVEMENT

OVERVIEW

The study of moving things helps students develop both a sense of spatial relationships and an understanding of the relationship between stationary and moving objects. Students will learn about the basic nature of movement as a change in position of an object. They will learn about the six basic types of simple machines (lever; inclined plane; pulley; wheel and axle, including gear; screw; wedge), and how they help humans to move objects. They will also learn that mechanisms are moving parts that incorporate simple machines for changing the type and direction of movement and that mechanisms and machines help make our lives easier and/or more enjoyable. It is necessary for teachers to provide opportunities for students with special education needs to participate in design-and-build, or comparable, activities.

As students design, build, and test their mechanisms, it is important that they do so in a manner that ensures their personal safety and the safety of others. This includes understanding why it is important to use the appropriate tools for a task (e.g., a paper punch or paper drill for making holes for wheels and axles), and why they should not put small objects such as wood fragments into their ears or nose.

Fundamental Concepts	Big Ideas
Structure and Function Energy	Movement is a change in position of an object. *(Overall expectations 2 and 3)* Simple machines help objects to move. *(Overall expectations 1, 2, and 3)* Mechanisms are made up of one or more simple machines. *(Overall expectation 2)* Simple machines and mechanisms make life easier and/or more enjoyable for humans. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 2, students will:

1. assess the impact on society and the environment of simple machines and mechanisms;
2. investigate mechanisms that include simple machines and enable movement;
3. demonstrate an understanding of movement and ways in which simple machines help to move objects.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 2, students will:

1.1 assess the impact on society and the environment of simple machines that allow movement

Sample prompts: Some simple machines add enjoyment to our lives (e.g., the wheel and axle on devices such as skateboards, the lever on devices such as teeter totters and the keys on a piano). Common mechanisms and simple machines make it easier to carry out tasks that require movement because less force is needed (e.g., using a pulley makes it easier to lift a load), and make it possible for people with disabilities to lead a more active life (e.g., using a wheelchair allows people with disabilities to be more independent; using a ramp allows people in wheelchairs to move from one level to another). The use of simple machines to make life easier has created a more sedentary lifestyle that has created health problems for many humans. Some mechanisms use a lot of energy and pollute the air and water. Some mechanisms are a source of danger to humans and animals.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 2, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., return tools to their designated area when they are done with them; carry tools and materials safely)*

2.2 investigate and describe different kinds of movement *(e.g., by observing how toys and other everyday objects move)*

2.3 investigate the structure and function of simple machines *(e.g., by building a wheel and axle for a toy car; by exploring the effects of changing the slope of a ramp)*

2.4 use technological problem-solving skills (see page 16), and knowledge and skills acquired from previous investigations, to design, build, and test a mechanism that includes one or more simple machines *(e.g., a toy, a model vehicle)*

Sample guiding questions: What is the purpose of your mechanism? What simple machine(s) does it use? Explain how it does what it does. What kind of movement does it demonstrate? What were some of the challenges in designing and making your mechanism? Based on the tests you conducted, what might you change about your mechanism?

2.5 use appropriate science and technology vocabulary, including *push, pull, beside, above, wheel, axle,* and *inclined plane*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., orally explain to the class the process they followed in building a mechanism that includes one or more simple machines)*

3. Understanding Basic Concepts

By the end of Grade 2, students will:

3.1 describe different ways in which objects move *(e.g., turning, spinning, swinging, bouncing, vibrating, rolling)*

3.2 identify ways in which the position of an object can be changed *(e.g., by pushing, by pulling, by dropping)*

3.3 identify the six basic types of simple machines – lever; inclined plane; pulley; wheel and axle, including gear; screw; and wedge – and give examples of ways in which each is used in daily life to make tasks easier

3.4 describe how each type of simple machine allows humans to move objects with less force than otherwise would be needed *(e.g., an inclined plane allows a heavy object to be moved upwards more easily than if it were lifted and carried up stairs; a wheel and axle allow an object to roll, which creates less friction than if it were dragged; a lever activated by a piano key strikes [pushes] a string, which vibrates to make a sound)*

3.5 identify simple machines used in devices that move people *(e.g., the wheel and axle on a bicycle or a car; the pulleys on an elevator; the inclined planes of moving ramps in parking garages and malls)*

GRADE 2 | UNDERSTANDING MATTER AND ENERGY
PROPERTIES OF LIQUIDS AND SOLIDS

OVERVIEW

When students examine materials in the world around them, they become aware of a wide variety of similarities and differences in the properties of those materials, including how they look, feel, and change. Students will develop their understanding of the properties of materials through investigating familiar liquid and solid materials, including the different ways in which liquids and solids interact and the various uses of liquid and solid materials.

When working with liquids and solids, it is important that students do so in a manner that ensures their personal safety and the safety of others. This includes understanding why they should never put any materials in their mouths unless told to do so by the teacher. Students should also understand why they should wash their hands after handling any materials.

Connections can also be made with the topic in the following strand – Air and Water in the Environment.

Fundamental Concepts	Big Ideas
Energy Matter	Materials that exist as liquids and solids have specific properties. *(Overall expectations 2 and 3)* Liquids and solids interact in different ways. *(Overall expectations 2 and 3)* Some liquids and solids can be harmful to us and the environment. *(Overall expectations 1 and 2)*

OVERALL EXPECTATIONS

By the end of Grade 2, students will:

1. assess ways in which the uses of liquids and solids can have an impact on society and the environment;
2. investigate the properties of and interactions among liquids and solids;
3. demonstrate an understanding of the properties of liquids and solids.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 2, students will:

1.1 assess the ways in which liquids and solids in the home are used, stored, and disposed of in terms of the effect on personal safety and the health of the environment, and suggest responsible actions to replace inappropriate practices

Sample prompts: Directions for the use of medicines and cleaning products should be followed carefully. Medicines should be used only by the person for whom they are prescribed. Cleaning products should be stored in the original container and kept out of reach of young children. Old paint and pesticides should be taken to an appropriate waste disposal depot.

1.2 assess the impacts of changes in state of solids and liquids on individuals and society

Sample prompts: Rain turns to sleet or freezing rain when the temperature near the ground is cold enough. Freezing rain makes walking and driving dangerous. If layers of ice build up on power lines, the lines can fall, leaving people without power to their homes. Tree branches coated with this ice can also fall.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 2, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., clean up spills as soon as they happen)*

2.2 investigate the properties of liquids *(e.g., conduct experiments to compare the rate at which different liquids flow)* and solids *(e.g., conduct experiments to find out ways in which solids can be changed)*

2.3 investigate, through experimentation, interactions that occur as a result of mixing and/or dissolving liquids and solids *(e.g., salt and water, sand and water)*, liquids and liquids *(e.g., oil and water)*, and solids and solids *(e.g., salt and sand)*

2.4 use scientific inquiry/experimentation skills (see page 12) to investigate liquids and solids in terms of their capacity for buoyancy *(e.g., wood floats, coins sink)* and/or absorption *(e.g., paper towel absorbs liquid, plastic wrap repels liquid)*

Sample guiding questions: What question are you trying to answer about buoyancy or absorption? What steps did you follow to carry out your experiment? What did you predict will happen? What did you find out? What conclusions can you make from this information? How might you share the things that you learned? How might someone use the information that you gathered from your experiments?

2.5 use technological problem-solving skills (see page 16), and knowledge acquired from previous investigations, to design, build, and test a structure that involves interactions between liquids and solids *(e.g., an object that floats)*

Sample guiding questions: What did you build? How does it use the properties of liquids and solids? What changes might you make based on the testing that you did on your object? Who might find this information useful?

2.6 use appropriate science and technology vocabulary, including *clear, opaque, runny, hard, greasy,* and *granular,* in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use a simple drawing program to write a booklet for the school library describing class experiments in investigating liquids and solids)*

3. Understanding Basic Concepts

By the end of Grade 2, students will:

3.1 identify objects in the natural and built environment as solids *(e.g., sand, ice, rocks, tables, sidewalks, walls)* or liquids *(e.g., water, tree sap, milk, gasoline)*

3.2 describe the properties of solids *(e.g., they maintain their shape and cannot be poured)* and liquids *(e.g., they take the shape of the container they are in and can be poured)*

3.3 describe the characteristics of liquid water *(e.g., it takes the shape of the container it is in)* and solid water *(e.g., ice floats)*, and identify the conditions that cause changes from one to the other *(e.g., water turns to ice when the temperature goes below zero; ice turns to water when heated)*

3.4 identify conditions in which the states of liquids and solids remain constant *(e.g., solids remain solid when broken; liquids remain liquid when poured)* and conditions that can cause their states to change *(e.g., liquids may freeze when the temperature drops; solids may melt when heated)*

3.5 describe some ways in which solids and liquids can be combined to make useful substances *(e.g., flour and water make paste; milk and chocolate powder make chocolate milk)*

3.6 explain the meaning of international symbols that give us information on the safety of substances *(e.g., a skull-and-crossbones symbol means that the substance is poisonous; a flame inside a hexagon means that the substance is flammable)*

GRADE 2 | UNDERSTANDING EARTH AND SPACE SYSTEMS
AIR AND WATER IN THE ENVIRONMENT

OVERVIEW

Air and water form a major part of the environment and are essential materials for life. Through investigations, students will learn about the characteristics of air and the various forms of water in the environment, about changes in and interactions between air and water when they are heated and cooled, and about their movement through the environment. Students will also learn about the impact of human actions on the quality of air and water and about their responsibility for keeping air and water clean.

It is important that students investigate air and water in a manner that ensures their personal safety and the safety of others. This includes understanding why demonstrations involving heat (e.g., using a kettle) must always be done by the teacher, and why any objects that are propelled by air should always be directed away from other students.

Connections can also be made with the topic in the preceding strand – Properties of Liquids and Solids.

Fundamental Concepts	Big Ideas
Change and Continuity Sustainability and Stewardship	Air and water are a major part of the environment. *(Overall expectations 1, 2, and 3)* Living things need air and water to survive. *(Overall expectations 1 and 3)* Changes to air and water affect living things and the environment. *(Overall expectations 1 and 3)* Our actions affect the quality of air and water, and its ability to sustain life. *(Overall expectations 1, 2, and 3)*

OVERALL EXPECTATIONS

By the end of Grade 2, students will:

1. assess ways in which the actions of humans have an impact on the quality of air and water, and ways in which the quality of air and water has an impact on living things;
2. investigate the characteristics of air and water and the visible/invisible effects of and changes to air and/or water in the environment;
3. demonstrate an understanding of the ways in which air and water are used by living things to help them meet their basic needs.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 2, students will:

1.1 assess the impact of human activities on air and water in the environment, taking different points of view into consideration *(e.g., the point of view of parents, children, other community members)*, and plan a course of action to help keep the air and water in the local community clean

Sample prompts: "On the weekend, after my mom and I washed the car, we poured the soapy water down the drain at the corner of our street." "I wanted to walk with my dad to the library, but he wanted to drive because it is faster."

1.2 assess personal and family uses of water as responsible/efficient or wasteful, and create a plan to reduce the amount of water used, where possible

Sample prompts: Many people do not realize how much water they use, because it seems so easy to get water. We shouldn't waste water, for the same reasons that we shouldn't waste food – for example, because others don't have enough and it costs money. In what ways do you and your family use water at home (e.g., flushing the toilet, drinking, bathing, washing dishes, watering the lawn)? What does it mean to use water excessively? How might your use of water change if you had to carry it from a central source into your house or apartment? What responsible/efficient water-use practices does your family use already (e.g., fixing leaky faucets or toilets quickly; turning off the water while you brush your teeth or soap up your hands and face; watering the lawn early in the morning to reduce evaporation; running the dishwasher only with a full load)? What are some other strategies that you and your family might implement in the future (e.g., installing low-flow shower heads and a water-saver flush kit in the toilet; not splashing lots of water out of swimming pools; keeping a bottle of drinking water in the refrigerator rather than letting your tap run to get cold water when you want a drink)?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 2, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., use caution around hot kettles and the steam they produce; clean up water spills as soon as they happen)*

2.2 investigate, through experimentation, the characteristics of air *(e.g., air takes up space, has mass)* and its uses *(e.g., living things breathe air to stay alive; air makes certain activities possible: helps keep a kite flying and a sailboat moving)*

2.3 investigate, through experimentation, the characteristics of water *(e.g., water takes up space, flows or moves when not contained, has mass)* and its uses *(e.g., living things need water to stay alive; water makes things move: spins a water wheel; water makes certain activities possible: keeps a white-water raft afloat)*

2.4 investigate the stages of the water cycle, including evaporation *(e.g., heat water in a kettle)*, condensation *(e.g., collect the water vapour from the kettle on an overturned mirror)*, precipitation *(e.g., allow the water vapour on the overturned mirror to collect, cool, and drop)*, and collection *(e.g., let the dripping water accumulate in a container)*

2.5 investigate water in the natural environment *(e.g., observe and measure precipitation; observe and record cloud formations; observe water flow and describe where it goes; observe a puddle over time and record observations)*

Sample guiding questions: Where does the water come from? Where does it go? What happens to snow when it disappears? What do you notice about the sky when it is raining/snowing? How does fog feel?

2.6 use appropriate science and technology vocabulary, including *solid, liquid, vapour, evaporation, condensation,* and *precipitation*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., create posters or media ads that encourage care and concern for water and air in the community)*

3. Understanding Basic Concepts

By the end of Grade 2, students will:

3.1 identify air as a gaseous substance that surrounds us and whose movement we feel as wind

3.2 identify water as a clear, colourless, odourless, tasteless liquid that exists in three states and that is necessary for the life of most animals and plants

3.3 describe ways in which living things, including humans, depend on air and water *(e.g., most animals, including humans breathe air to stay alive; wind generates energy, disperses seeds; all living things need to drink or absorb water to stay alive; water is used for washing and bathing, transportation, energy generation)*

3.4 identify sources of water in the natural and built environment *(e.g., natural: oceans, lakes, ponds, streams, springs, water tables; human-made: wells, sewers, water-supply systems, reservoirs, water towers)*

3.5 identify the three states of water in the environment, give examples of each *(e.g., solid – visible as ice, snow, sleet, hail, frost; liquid – visible as rain, dew; gas – visible as fog, water vapour)*, and show how they fit into the water cycle when the temperature of the surrounding environment changes *(e.g., heat – evaporation; cooling – condensation and precipitation)*

3.6 state reasons why clean water is an increasingly scarce resource in many parts of the world

GRADE **3**

GRADE 3 | UNDERSTANDING LIFE SYSTEMS
GROWTH AND CHANGES IN PLANTS

OVERVIEW

Growth and Changes in Plants focuses on the characteristics and requirements of plants and the ways in which plants grow. Students will observe and investigate a wide variety of local plants, from trees and mosses in their natural environment to flowers and vegetables grown at school or on farms, and will consider the impact of human activity on plants and their habitats. Students will also learn about the importance of plants as sources of oxygen, food, and shelter, and the need for humans to protect plants and their habitats.

In preparation for working with plants, it is important that students be able to identify practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why they should not taste any part of a plant unless directed to do so by a teacher, and why they should wash their hands after handling plants or parts of plants.

This topic also provides opportunities for connecting to the Grade 3 social studies topic Canada and World Connections: Urban and Rural Communities. As students look at similarities and differences between regions, they can consider the kinds of plants that help to make a location unique. They can also consider the need to protect farmlands as plant habitats and as producers of food for living things. Connections can also be made with the Grade 3 social studies topic Heritage and Citizenship: Early Settlements in Upper Canada, as students look at the types of plants that were used both by Aboriginal people and the settlers, plants that were native to the area, and plants that were introduced by the settlers. Connections can also be made with another Grade 3 science and technology topic, Understanding Earth and Space Systems: Soils in the Environment.

Fundamental Concepts	Big Ideas
Systems and Interactions Sustainability and Stewardship	Plants have distinct characteristics. *(Overall expectations 2 and 3)* There are similarities and differences among various types of plants. *(Overall expectation 2)* Plants are the primary source of food for humans. *(Overall expectation 1)* Humans need to protect plants and their habitats. *(Overall expectation 1)* Plants are important to the planet. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 3, students will:

1. assess ways in which plants have an impact on society and the environment, and ways in which human activity has an impact on plants and plant habitats;
2. investigate similarities and differences in the characteristics of various plants, and ways in which the characteristics of plants relate to the environment in which they grow;
3. demonstrate an understanding that plants grow and change and have distinct characteristics.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 3, students will:

1.1 assess ways in which plants are important to humans and other living things, taking different points of view into consideration *(e.g., the point of view of home builders, gardeners, nursery owners, vegetarians)*, and suggest ways in which humans can protect plants

Sample prompts: Plants provide oxygen and food that other living things need to survive. Plants use and store carbon dioxide, helping reduce the amount of this greenhouse gas in the atmosphere. Trees reduce humans' energy use in summer by providing cooling shade. Leaves, twigs, and branches of trees and shrubs block erosion-causing rainfall. Grass and shrubs prevent soil from washing away. Roots, leaves, and trunks provide homes for wildlife. Aboriginal people use plants for many medicines.

1.2 assess the impact of different human activities on plants, and list personal action they can take to minimize harmful effects and enhance good effects

Sample prompts: When humans provide common house plants and blooming potted plants with an appropriate environment, they help fight pollution indoors. When humans plant trees, they benefit the environment in many different ways. When humans fill in wetlands to build houses, they destroy an important habitat that supports many plants. When humans pick wildflowers or dig them up to replant in their home gardens, they harm a natural habitat that supports many living things. When humans plant non-native plants and trees that need pesticides and/or a lot of water to survive, they drive out native plants and trees that are adapted to our climate and that provide habitat and food for native birds, butterflies, and mammals.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 3, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., avoid touching eyes when handling plants; never taste any part of a plant unless instructed to do so by the teacher)*

2.2 observe and compare the parts of a variety of plants *(e.g., roots of grass, carrot, dandelion; stem of cactus, carnation, tree; leaves of geranium, spider plant, pine tree)*

2.3 germinate seeds and record similarities and differences as seedlings develop *(e.g., plant quick-growing seeds – nasturtium, morning glory, sunflower, tomato, beet, or radish seeds – in peat pellets to observe growth)*

2.4 investigate ways in which a variety of plants adapt and/or react to their environment, including changes in their environment, using a variety of methods *(e.g., read a variety of non-fiction texts; interview plant experts; view DVDs or CD-ROMs)*

2.5 use scientific inquiry/experimentation skills (see page 12), and knowledge acquired from previous investigations, to investigate a variety of ways in which plants meet their basic needs

Sample guiding questions: How do plants meet their need for air, water, light, warmth, and space? What are different ways in which we can help plants meet their needs?

2.6 use appropriate science and technology vocabulary, including *stem*, *leaf*, *root*, *pistil*, *stamen*, *flower*, *adaptation*, and *germination*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., make illustrated entries in a personal science journal to describe plant characteristics and adaptations to harsh environments)*

3. Understanding Basic Concepts

By the end of Grade 3, students will:

3.1 describe the basic needs of plants, including air, water, light, warmth, and space

3.2 identify the major parts of plants, including root, stem, flower, stamen, pistil, leaf, seed, and fruit, and describe how each contributes to the plant's survival within the plant's environment *(e.g., the roots soak up food and water for the plant; the stem carries water and food to the rest of the plant; the leaves make food for the plant with help from the sun; the flowers grow fruit and seeds for new plants)*

3.3 describe the changes that different plants undergo in their life cycles *(e.g., some plants grow from bulbs to flowers, and when the flowers die off the bulb produces little bulbs that will bloom the next year; some plants grow from germination of a seed to the production of a fruit containing seeds that are then scattered by humans, animals, or the wind so that new plants can grow)*

3.4 describe how most plants get energy to live directly from the sun *(e.g., plants turn the energy from the sun into food for themselves)* and how plants help other living things to get energy from the sun *(e.g., Other living things, which cannot "eat" sunshine, eat the plants to get the energy. They also get energy when they eat the animals that eat the plants.)*

3.5 describe ways in which humans from various cultures, including Aboriginal people, use plants for food, shelter, medicine, and clothing *(e.g., food – from rice plants; houses for shelter – from the wood of trees; medicines – from herbs; clothing – from cotton plants)*

3.6 describe ways in which plants and animals depend on each other *(e.g., plants provide food for energy; animals help disperse pollen and seeds, and provide manure that fertilizes the soil in which plants grow; plants need the carbon dioxide that animals breathe out, and animals need the oxygen that plants release into the air)*

3.7 describe the different ways in which plants are grown for food *(e.g., on farms, in orchards, greenhouses, home gardens)*, and explain the advantages and disadvantages of locally grown and organically produced food, including environmental benefits

3.8 identify examples of environmental conditions that may threaten plant and animal survival *(e.g., extreme heat and cold; floods and/or droughts; changes in habitat because of human activities such as construction, use of gas-powered personal watercraft on lakes)*

GRADE 3 | UNDERSTANDING STRUCTURES AND MECHANISMS
STRONG AND STABLE STRUCTURES

OVERVIEW

Both people and animals build structures, and both people and animals need their structures to be strong and stable and to last a long time. Students need to understand the important distinction between strength (the capacity to withstand forces that tend to break an object or change its shape) and stability (the capacity to maintain balance and stay fixed in one position), and the ways in which these two properties affect the usefulness of a structure. Students will investigate the factors that affect a structure's strength and stability, such as its shape and centre of gravity, and apply their learning as they design and build their own strong and stable structures.

Students in Grade 3 will encounter very few hazards in their designing and building activities. However, it is important that they be able to identify general practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why work spaces should be kept tidy and uncluttered, and why it is important to follow instructions carefully.

Fundamental Concepts	Big Ideas
Structure and Function Matter	A structure has both form and function. *(Overall expectations 1, 2, and 3)* Structures are affected by forces acting on them. *(Overall expectations 1 and 3)* Structures need to be strong and stable to be useful. *(Overall expectations 1, 2, and 3)*

OVERALL EXPECTATIONS

By the end of Grade 3, students will:

1. assess the importance of form, function, strength, and stability in structures through time;
2. investigate strong and stable structures to determine how their design and materials enable them to perform their load-bearing function;
3. demonstrate an understanding of the concepts of *structure*, *strength*, and *stability* and the factors that affect them.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 3, students will:

1.1 assess effects of strong and stable structures on society and the environment *(e.g., reliable load-bearing structures are essential in all areas of life for shelter, transportation, and many other everyday purposes; strong and stable structures can endure for long periods of time and provide a historical record of other societies and cultures; strong and stable structures can be hard to dispose of when their usefulness is ended and may then have a negative effect on the environment)*

Sample guiding questions: What are some structures that we see or use every day that we depend on to be strong and stable (e.g., bicycle, table, airplane, bridge, tractor, skyscraper)? What features of structures such as old covered bridges, heritage homes, the Pyramids, and the Parthenon have enabled them to still be standing today? What can we learn about strength, stability, form, and function from studying these structures?

1.2 assess the environmental impact of structures built by various animals and those built by humans

Sample guiding questions: What kinds of materials are used in human constructions (e.g., bricks, cement, wood, adobe, clay/mud, ice/snow)? In animal constructions? How do the purposes of animal structures compare to those of humans? What is the impact on the environment of a dam built by a beaver? Of a nest built by a tent caterpillar in a tree? Of an anthill built in a backyard? What is the impact of homes, shopping plazas, playgrounds, and bridges built by humans? What effects do traditional Aboriginal homes have on the environment?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 3, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., carry scissors and other cutting tools in a safe manner)*

2.2 investigate, through experimentation, how various materials *(e.g., paper and wood)* and construction techniques *(e.g., folding, adding layers, twisting/braiding, changing shapes)* can be used to add strength to structures

2.3 investigate, through experimentation, the effects of pushing, pulling, and other forces on the shape and stability of simple structures *(e.g., the effect of adding one or more struts on the strength of a tower; the effect of adding ties on the strength of a bridge; the effect of adding weight to the base of a tower on the stability of the tower)*

2.4 use technological problem-solving skills (see page 16), and knowledge acquired from previous investigations, to design and build a strong and stable structure that serves a purpose *(e.g., a place to store lunch bags, a place to put wet boots)*

2.5 use appropriate science and technology vocabulary, including *compression*, *tension*, *strut*, *ties*, *strength*, and *stability*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., an oral report to the class on the results of experiments to strengthen materials)*

3. Understanding Basic Concepts

By the end of Grade 3, students will:

3.1 define a structure as a supporting framework, with a definite size, shape, and purpose, that holds a load *(e.g., a running shoe, a tepee, a bicycle, an igloo)*

3.2 identify structures in the natural environment *(e.g., a tree, a bees' nest/hive)* and in the built environment *(e.g., a totem pole, a fence, a pyramid, the CN Tower)*

3.3 identify the strength of a structure as its ability to support a load

3.4 identify the stability of a structure as its ability to maintain balance and stay fixed in one spot

3.5 identify properties of materials *(e.g., strength, flexibility, durability)* that need to be considered when building structures

3.6 describe ways in which the strength of different materials can be altered *(e.g., by folding, adding layers, twisting/braiding, changing their shape)*

3.7 describe ways to improve a structure's strength *(e.g., by using triangulation or cross-members)* and stability *(e.g., by lowering the centre of gravity)*

3.8 explain how strength and stability enable a structure *(e.g., bridge, tent)* to perform a specific function

3.9 describe ways in which different forces can affect the shape, balance, or position of structures *(e.g., a load may cause a cardboard box to buckle)*

3.10 identify the role of struts and ties in structures under load *(e.g., a strut is added to a wooden frame to resist compression that might cause its collapse; a tie is added to a roof truss to resist tension that might cause the roof to collapse from the weight of the shingles)*

GRADE 3 | UNDERSTANDING MATTER AND ENERGY
FORCES CAUSING MOVEMENT

OVERVIEW

There are two basic types of forces that cause movement. Contact forces involve direct interaction (pushes and pulls between surfaces that are in direct contact). Non-contact forces include magnetic and gravitational forces and involve interaction at a distance. In exploring the effects of forces, students will learn about ways in which forces, including forces in nature, cause objects to move. In addition, students will expand their understanding of control by designing and building devices that can use forces to create controlled movement. Opportunities must be provided for all students, including students with special education needs, to participate in these or comparable activities.

Explorations involving forces and movement may require students to manipulate materials (e.g., twist an elastic, bend paperclips). When working with materials in this manner, it is important that students are able to identify practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why it is important to protect their eyes and faces from stretched or twisted materials, and their feet from loads that might drop.

Fundamental Concepts	Big Ideas
Energy Change and Continuity	There are several types of forces that cause movement. *(Overall expectations 1, 2, and 3)* Forces cause objects to speed up, slow down, or change direction through direct contact or through interaction at a distance. *(Overall expectations 2 and 3)* Forces in nature, such as high winds or water, can have a significant impact on humans and the environment, and need to be regarded with respect. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 3, students will:

1. assess the impact of various forces on society and the environment;
2. investigate devices that use forces to create controlled movement;
3. demonstrate an understanding of how forces cause movement and changes in movement.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 3, students will:

1.1 assess the effects of the action of forces in nature (natural phenomena) on the natural and built environment, and identify ways in which human activities can reduce or enhance this impact

Sample prompts: Erosion: Heavy rains and water run-off naturally erode soil. Humans make erosion happen faster by cutting down trees, removing shrubs and plants, and having too many animals on farmland. When soil is lost through erosion, it pollutes rivers, lakes, and other water systems. When soil is lost on farmlands, farmers cannot grow as many crops. Depleted soil produces crops that provide less nourishment to people. What action can humans take to help prevent erosion? *Landslides:* Landslides can happen anywhere and are triggered by rains, floods, earthquakes, and other natural events. Humans contribute to landslides when they change the land to put in lawns, gardens, roads, and houses. Landslides can destroy houses, transportation routes, and utilities. They can cause flooding and pollute water. They can carry trees and plants away with them. What action can humans take to help prevent landslides?

1.2 assess the impact of safety devices that minimize the effects of forces in various human activities

Sample prompts: What are the costs and benefits of using seatbelts in cars, knee and elbow pads and wrist guards for roller blading, helmets for cycling and hockey, sport shoes designed for high impact sports like aerobics and basketball?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 3, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., use eye protection when twisting, bending, compressing, or stretching materials)*

2.2 investigate forces that cause an object to start moving, stop moving, or change direction *(e.g., release a wound-up elastic band to propel a toy vehicle; pull on a leash to stop a dog; hit a ball with a bat; hold papers on a refrigerator door using magnets)*

2.3 conduct investigations to determine the effects of increasing or decreasing the amount of force applied to an object *(e.g., using two magnets instead of one to pick up pins; changing the number of people on one side of a tug of war; rubbing a balloon ten times instead of five times on a wool sweater to create a static charge)*

2.4 use technological problem-solving skills (see page 16), and knowledge acquired from previous investigations, to design and build devices that use forces to create controlled movement *(e.g., an airplane propelled by hand or by an elastic band; a boat that holds paper clips and moves through water using magnets; a crane that lifts a load; a timed marble run)*

Sample guiding questions: What is the purpose of your device? What force(s) are being used? How does your device move? How do the force(s) control the movement? How might your device be improved?

2.5 use appropriate science and technology vocabulary, including *push*, *pull*, *load*, *distance*, and *speed*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., give a demonstration to show how a device was constructed and how it performs; use a drawing to illustrate the design alterations needed to improve a device; describe with pictures and/or in writing the steps required to build a device)*

3. Understanding Basic Concepts

By the end of Grade 3, students will:

3.1 identify a force as a push or a pull that causes an object to move

3.2 identify different kinds of forces *(e.g., gravity – the force that pulls objects towards the earth; electrostatic force – the push or pull that happens with charged objects; magnetic force – the force of a magnet that attracts objects containing iron or nickel)*

3.3 describe how different forces *(e.g., magnetism, muscular force, gravitational force, friction)* applied to an object at rest can cause the object to start, stop, attract, repel, or change direction

3.4 explain how forces are exerted through direct contact *(e.g., pushing a door, pulling a toy)* or through interaction at a distance *(e.g., magnetism, gravity)*

3.5 identify ways in which forces are used in their daily lives *(e.g., magnetism – fridge magnet; gravity – a falling ball; friction – bicycle brakes)*

GRADE 3 | UNDERSTANDING EARTH AND SPACE SYSTEMS
SOILS IN THE ENVIRONMENT

OVERVIEW

Soil is not just dirt but an essential source of life and nutrients for many organisms, including humans. Soil provides a base for forests, fields, farms, and gardens and is necessary to many different kinds of animals and plants. Through investigations, students will learn that soils are composed of a variety of living and non-living things and earth materials; that there are different kinds of soil; and that the unique characteristics, composition, and condition of each soil type determine its capacity to sustain life. As they learn about the importance of soils, students will also learn about ways to maintain healthy soil conditions, including the process of composting.

When exploring different kinds of soils, students should able to identify practices that ensure their personal safety and the safety of others and to demonstrate an understanding of the importance of these practices. This includes knowing why they should check collected soils for unsafe objects before beginning their investigations, and why they should always wash their hands after completing soil explorations.

Connections can be made with another Grade 3 science and technology topic, Understanding Life Systems: Growth and Change in Plants, as well as with the social studies topics for Grade 3 – Heritage and Citizenship: Early Settlements in Upper Canada, and Canada and World Connections: Urban and Rural Communities.

Fundamental Concepts	Big Ideas
Systems and Interactions	Soil is made up of living and non-living things. *(Overall expectations 1, 2, and 3)*
Change and Continuity	The composition, characteristics, and condition of soil determine its capacity to sustain life. *(Overall expectations 1, 2, and 3)*
Sustainability and Stewardship	Soil is an essential source of life and nutrients for many living things. *(Overall expectation 3)*
	Living things, including humans, interact with soils and can cause positive or negative changes. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 3, students will:

1. assess the impact of soils on society and the environment, and of society and the environment on soils;
2. investigate the composition and characteristics of different soils;
3. demonstrate an understanding of the composition of soils, the types of soils, and the relationship between soils and other living things.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 3, students will:

1.1 assess the impact of soils on society and the environment, and suggest ways in which humans can enhance positive effects and/or lessen or prevent harmful effects

Sample prompts: Poor soil affects both a plant's ability to take up the nutrients it needs and the quality of the nutrients that are passed from the plant to humans. Some soils do not provide any of the nutrients that are needed to support plant life (e.g., sand in the desert). Landslides can be caused in part by soil conditions and the type of soil in a particular area.

1.2 assess the impact of human action on soils, and suggest ways in which humans can affect soils positively and/or lessen or prevent harmful effects on soils

Sample prompts: Erosion caused by natural events such as heavy rain or waves and erosion caused by human actions affect soil conditions and cause water pollution. When houses and other buildings are constructed, trees and plants and the top or best layer of soil are often removed from the building site.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 3, students will:

2.1 follow established safety procedures during science and technology investigations *(e.g., wash hands after working with soil samples)*

2.2 investigate the components of soil *(e.g., non-living things such as pebbles and decaying matter; living things such as organic matter, bacteria, earthworms, and insects)*, the condition of soil *(e.g., wet, dry)*, and additives found in soil *(e.g., pesticides, fertilizers, salt)*, using a variety of soil samples *(e.g., sand, clay, loam)* from different local environments, and explain how the different amounts of these components in a soil sample determine how the soil can be used

2.3 use scientific inquiry/experimentation skills (see page 12), and knowledge and skills acquired from previous investigations, to determine which type(s) of soil *(e.g., sandy soil, clay soil, loam)* will sustain life

Sample guiding questions: What question(s) are you trying to answer with your experiment? What do you predict will happen in your experiment? In what ways will you control the light and/or water? In what ways will you record your observations? What conclusions can you make from your observations? How would this information help someone else (e.g., a gardener)?

2.4 investigate the process of composting, and explain some advantages and disadvantages of composting *(e.g., set up a pop-bottle composter in the classroom, and observe what happens over time)*

Sample guiding questions: What is composting? Where does composting happen naturally? What are some good things about composting? Why might people not be able to or want to compost? What "ingredients" do we need to start a classroom composter? What things should not go into the composter? As the compost "cooks", what changes do you notice? What happens to the things that we put into the classroom composter? How will we use our compost?)

2.5 use appropriate science and technology vocabulary, including *clay*, *sand*, *loam*, *pebbles*, *earth materials*, and *soil*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., record in words and pictures what happens when soil and water are shaken together in a container; prepare a display comparing the composition of soils from different locations)*

3. Understanding Basic Concepts

By the end of Grade 3, students will:

3.1 identify and describe the different types of soils *(e.g., Sandy soil is made up of minerals and tiny pieces of rock that have come from the erosion and weathering of rocks. It feels gritty and does not stick together well. Sandy soil drains easily and quickly after a rain and warms up quickly in the spring, but does not hold water and nutrients as well as clay soil, and is eroded more easily. Loamy soil is made up of sand, silt,*

and clay in relatively equal amounts. It sticks together better than sand but not as well as clay. Loamy soil holds water and nutrients well, and also drains well so that sufficient air can reach the roots. Clay soil is a very fine-grained soil that is plastic when wet but hard when dried. It feels slick and smooth. Clay soils have poor drainage and aeration.)

3.2 identify additives that might be in soil but that cannot always be seen *(e.g., pesticides, fertilizers, salt)*

3.3 describe the interdependence between the living and non-living things that make up soil *(e.g., earthworms ingest the soil and absorb the nutrients, then their castings return the nutrients to the soil; the roots of plants use the soil as an anchor to keep the plants from blowing away)*

3.4 describe ways in which the components of various soils enable the soil to provide shelter/homes and/or nutrients for different kinds of living things *(e.g., microscopic bacteria and micro-organisms feed on decaying matter in the soil; roots of plants absorb minerals from the soil)*

GRADE **4**

GRADE 4 | UNDERSTANDING LIFE SYSTEMS
HABITATS AND COMMUNITIES

OVERVIEW

This strand focuses on habitats, the natural communities that depend on them, and the impacts that changes to habitats can have on interrelationships among plants and animals within these communities. Students will learn that living things (including humans) rely on other living things for the energy and resources they need to live. They will also investigate factors that alter various habitats and communities, including those factors that occur naturally and those that result from human action. Care must be taken to ensure that all students, including students with special education needs, have comparable opportunities to explore the natural world.

When assessing human impacts on habitats and communities, students must be given opportunities to consider human actions from a variety of viewpoints: for example, from the perspective of the developer who wants to build low-cost housing on a woodlot, people who are concerned about the destruction of a natural habitat, families who will benefit from affordable housing, and people in the community who have used the woodlot carefully for leisure activities. Thoughtful consideration of various viewpoints, as well as the scientific evidence of the environmental costs and risks, will enable students not only to look for ways in which people might come to agreement on how to minimize the negative impacts of their actions, but also to make more informed decisions about personal choices.

Caring for living things in the classroom helps students to learn about their habitats. It is important that students be able to identify practices that ensure their own personal safety and the safety of others and to demonstrate an understanding of these practices. This includes knowing why it is important to wash their hands before and after handling animals, and to properly clean and maintain the environment for any plants and animals kept in the classroom.

This topic provides opportunities for making connections to the Grade 4 social studies topic Canada and World Connections: Canada's Provinces, Territories, and Regions.

Fundamental Concepts	Big Ideas
Systems and Interactions Sustainability and Stewardship	Plants and animals are interdependent and are adapted to meet their needs from the resources available in their particular habitats. *(Overall expectations 1, 2, and 3)* Changes to habitats (whether caused by natural or human means) can affect plants and animals and the relationships between them. *(Overall expectations 2 and 3)* Society relies on plants and animals. *(Overall expectations 1 and 2)*

OVERALL EXPECTATIONS

By the end of Grade 4, students will:

1. analyse the effects of human activities on habitats and communities;
2. investigate the interdependence of plants and animals within specific habitats and communities;
3. demonstrate an understanding of habitats and communities and the relationships among the plants and animals that live in them.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 4, students will:

1.1 analyse the positive and negative impacts of human interactions with natural habitats and communities *(e.g., human dependence on natural materials)*, taking different perspectives into account *(e.g., the perspectives of a housing developer, a family in need of housing, an ecologist)*, and evaluate ways of minimizing the negative impacts

Sample issues: (a) Humans depend on natural habitats and communities for many things, including food, building materials, clothing, and medicine. Natural habitats also help to purify our air and water. In spite of this dependency, however, we are destroying some of the habitats and communities that we depend on. How can we continue to draw benefits from the natural environment and still ensure that it is there to benefit future generations? (b) Urban development provides housing for an expanding population, but it also destroys natural habitats, causing some species to die off locally or go elsewhere and enabling other species to multiply rapidly. When scarce farmland is used for development, we lose family farms and a way of life, as well as local sources of fresh food and important open spaces. To lessen such impacts, we need to think of alternative ways of meeting our needs. Some cities work with developers to conserve green spaces. Others are starting to concentrate expansion within their existing boundaries instead of spreading beyond them. How is development affecting natural habitats in your community, and what is being done to protect them?

1.2 identify reasons for the depletion or extinction of a plant or animal species *(e.g., hunting, disease, invasive species, changes in or destruction of its habitat)*, evaluate the impacts on the rest of the natural community, and propose possible actions for preventing such depletions or extinctions from happening

Sample issues: (a) Deforestation for land development, as well as hunting, trapping, and increased tourism, have had an impact on the wolf population in Ontario. Despite recent laws designed to protect them, wolves in Ontario still face many threats. What other animals and plants would be affected by their destruction, and what can we do to help them survive? (b) A plant called American ginseng has commonly been used as a traditional medicine and may be useful in preventing colds and treating diabetes and other diseases. Because of harvesting, timber extraction, and the clearing of land for agriculture and development, American ginseng is on the endangered species list in Ontario. It is a long-lived perennial herb, but slow-growing, so replenishing its population will take time. How can we protect the wild plant? What might be some alternative ways of getting the plant without taking it from the wild?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 4, students will:

2.1 follow established safety procedures for working with soils and natural materials *(e.g., wear gloves when handling soils to set up a working terrarium)*

2.2 build food chains consisting of different plants and animals, including humans

2.3 use scientific inquiry/research skills (see page 15) to investigate ways in which plants and animals in a community depend on features of their habitat to meet important needs *(e.g., beavers use water for shelter [they build their lodges so the entrance is under water], food*

[cattails, water lilies, and other aquatic plants], and protection [they slap their tails on the water to warn of danger])

2.4 use scientific inquiry/research skills (see page 15) to create a living habitat containing a community, and describe and record changes in the community over time

Sample guiding questions: What factors need to be considered when setting up your habitat (e.g., location for container; creating the right climate, light, and humidity)? What equipment and materials (e.g., a container of the correct size, appropriate plant material and/or animals) will you need to create a habitat that meets the needs of the community it supports? What did you learn from your initial observations about meeting the needs of living things? What modifications, based on your observations, need to be made to keep the habitat healthy?

2.5 use appropriate science and technology vocabulary, including *habitat, population, community, adaptation*, and *food chain*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use presentation software to show the steps one might follow to set up and maintain a terrarium)*

3. Understanding Basic Concepts

By the end of Grade 4, students will:

3.1 demonstrate an understanding of habitats as areas that provide plants and animals with the necessities of life *(e.g., food, water, air, space, and light)*

3.2 demonstrate an understanding of food chains as systems in which energy from the sun is transferred to producers (plants) and then to consumers (animals)

3.3 identify factors *(e.g., availability of water or food, amount of light, type of weather)* that affect the ability of plants and animals to survive in a specific habitat

3.4 demonstrate an understanding of a community as a group of interacting species sharing a common habitat *(e.g., the life in a meadow or in a patch of forest)*

3.5 classify organisms, including humans, according to their role in a food chain *(e.g., producer, consumer, decomposer)*

3.6 identify animals that are carnivores, herbivores, or omnivores

3.7 describe structural adaptations that allow plants and animals to survive in specific habitats *(e.g., the thick stem of a cactus stores water for the plant; a duck's webbed feet allow it to move quickly and efficiently in water)*

3.8 explain why changes in the environment have a greater impact on specialized species than on generalized species *(e.g., diminishing ice cover hampers the ability of polar bears to hunt seals, their main food source, and so the polar bear population in some areas is becoming less healthy and may begin to decrease; black bear habitat has been heavily disrupted by human encroachment, but because black bears are highly adaptable omnivores that eat everything from insects to garbage generated by humans, their numbers have been increasing)*

3.9 demonstrate an understanding of why all habitats have limits to the number of plants and animals they can support

3.10 describe ways in which humans are dependent on natural habitats and communities *(e.g., for water, medicine, flood control in wetlands, leisure activities)*

GRADE 4 | UNDERSTANDING STRUCTURES AND MECHANISMS
PULLEYS AND GEARS

OVERVIEW

This strand helps students broaden their understanding of simple machines by looking at two special kinds of wheels: pulleys and gears. Students will learn that pulleys and gears can transfer motion from one object to another, transform one kind of motion into another, change the speed and direction of an object's motion, and change the amount of force needed to move an object. They will identify how these devices are used to improve everyday life, learn about mechanical advantage, and apply what they have learned through investigations of their own design.

Pulleys and gears are so much a part of daily life that it would be easy to overlook their impact. As students learn about the mechanics of these simple machines, consideration should also be given to how different groups might view these devices. A physically challenged person who gains some freedom and independence by using elevators, for example, may have a different perspective from the person who is able to use stairs. When students consider issues from perspectives other than their own, they begin to see how biases develop and, in turn, learn to form their own opinions on relevant issues.

It is important that students be able to identify and demonstrate an understanding of practices that ensure their own personal safety and the safety of others when designing, building, and testing devices that use pulleys and gears. This includes knowing why long hair should be tied back and loose jewellery removed when working with pulleys and gears, and why pulleys and gears need to be securely fastened before testing them with a load.

Connections can be made to the Grade 4 social studies topic Heritage and Citizenship: Medieval Times. Students can see that simple machines have been in use for a very long time, and can compare the forms of energy used to operate machines today with those used to operate machines in the past.

Fundamental Concepts	Big Ideas
Systems and Interactions Energy	Pulleys and gears change the speed, direction, and motion of, and force exerted on, moving objects. *(Overall expectations 2 and 3)* Pulleys and gears make it possible for a small input force to generate a large output force. (*Note*: Grade 4 students need to understand mechanical advantage only in its qualitative sense). *(Overall expectation 1)* Gears are specialized wheels and axles that are used daily in many machines. *(Overall expectations 1, 2, and 3)*

OVERALL EXPECTATIONS

By the end of Grade 4, students will:

1. evaluate the impact of pulleys and gears on society and the environment;
2. investigate ways in which pulleys and gears modify the speed and direction of, and the force exerted on, moving objects;
3. demonstrate an understanding of the basic principles and functions of pulley systems and gear systems.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 4, students will:

1.1 assess the impact of pulley systems and gear systems on daily life

Sample issues: Elevators and other lifting devices use pulley and gear systems; they allow people with physical challenges to have equal access to all floors of a building. Bicycles use gears; they provide us with transportation and exercise. Snowmobiles, VCRs, and joysticks use pulleys and/or gears; they provide us with leisure activities. Clothes dryers and clotheslines, sewing machines, and windshield wipers on cars and trucks use pulleys and/or gears. However, many of these mechanisms require power to operate.

1.2 assess the environmental impact of using machines with pulleys and gears, taking different perspectives into account *(e.g., the perspective of a car driver or cyclist, someone who is physically challenged, the owner of a multi-floor building)*, and suggest ways to minimize negative impacts and maximize positive impacts

Sample issues: (a) Escalators run all the time, using large amounts of electrical energy. (b) A clothesline and a clothes dryer, which use pulleys or gears, are both used to dry clothes. Using a clothes dryer is faster than drying clothes on a line, but the environmental impact of the dryer is greater because it uses electricity or natural gas. (c) Gears reduce the effort needed to pedal a bicycle, but riding a bicycle still requires more effort and takes longer than driving a car to the same destination. However, the bicycle is more environmentally friendly because it does not use fossil fuel.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 4, students will:

2.1 follow established safety procedures for working with machinery *(e.g., check to ensure that pulley systems are firmly attached to a secure support before operating them; be aware that changing a larger gear wheel to a smaller one will change the speed at which the mechanism moves)*

2.2 use scientific inquiry/experimentation skills (see page 12) to investigate changes in force, distance, speed, and direction in pulley and gear systems

Sample guiding questions: What happens when the number of pulleys in a system is increased? When the number is decreased? How does the force required to raise a load change when the number of pulleys is changed? How does the distance over which the force is exerted change? What happens when you change the size of one of the wheels in a gear system? What gear system will you use to change the direction of the motion?

2.3 use technological problem-solving skills (see page 16) to design, build, and test a pulley or gear system that performs a specific task

Sample problems: Design, build, and test a mechanism that will raise and lower a flag. Design, build, and test a changing billboard. Design, build, and test a model elevator that could be used in a barn. Design, build, and test a model drawbridge for a castle.

2.4 use appropriate science and technology vocabulary, including *pulley*, *gear*, *force*, and *speed*, in oral and written communication

2.5 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., write a set of instructions for setting up a pulley system)*

3. Understanding Basic Concepts

By the end of Grade 4, students will:

3.1 describe the purposes of pulley systems and gear systems *(e.g., to facilitate changes in direction, speed, or force)*

3.2 describe how rotary motion in one system or its components *(e.g., a system of pulleys of different sizes)* is transferred to another system or component *(e.g., a system of various gears)* in the same structure

3.3 describe how one type of motion can be transformed into another type of motion using pulleys or gears *(e.g., rotary to linear in a rack and pinion system, rotary to oscillating in a clock pendulum)*

3.4 describe, using their observations, how gears operate in one plane *(e.g., spur gears, idler gears)* and in two planes *(e.g., crown, bevel, or worm gears)*

3.5 distinguish between pulley systems and gear systems that increase force and those that increase speed

3.6 identify pulley systems *(e.g., clotheslines, flagpoles, cranes, elevators, farm machinery)* and gear systems *(e.g., bicycles, hand drills, can openers)* that are used in daily life, and explain the purpose and basic operation of each

3.7 explain how the gear system on a bicycle works *(e.g., by using the largest gear on the front chain ring and the smallest gear on the rear wheel, we can move quickly along a flat surface)*

3.8 identify the input components that drive a mechanism and the output components that are driven by it *(e.g., the pedals on a bike are the input component; the rear wheel is the output component)*

GRADE 4 | UNDERSTANDING MATTER AND ENERGY
LIGHT AND SOUND

OVERVIEW

Students will become familiar with the properties of light and sound by investigating and observing how these forms of energy interact with various objects in the environment. Materials can be used to transmit, reflect, or absorb light and sound. By exploring the factors that affect sound and light, students will discover ways in which they can be controlled. Students will begin to apply this knowledge by constructing simple auditory and optical devices and by examining the impact of technologies related to sound and light on our everyday lives, including their use of energy. It is necessary to provide opportunities for students with special education needs to participate in these or comparable activities.

When gathering information to make informed choices, students must be encouraged to look beyond their own place in the world and consider the opinions and feelings of others. As they study innovations related to light and sound, students should consider, for example, how their use of personal music players affects those around them. By considering the feelings and well-being of others, students will begin to make personal choices that are fair and equitable.

It is important that students be able to identify and demonstrate an understanding of practices that ensure their own personal safety and the safety of others. For example, when conducting experiments with sound and sound-producing devices, students need to know why safe volume levels must be observed. When conducting experiments with light and light-producing devices, students need to know why sunlight reflected from a mirror should be aimed away from people's eyes and from materials that might be ignited.

Fundamental Concepts	Big Ideas
Energy	Light and sound are forms of energy with specific properties. *(Overall expectations 2 and 3)* Sound is created by vibrations. *(Overall expectations 2 and 3)* Light is required to see. *(Overall expectation 3)* Technological innovations involving light and sound have an impact on the environment. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 4, students will:

1. assess the impact on society and the environment of technological innovations related to light and sound;
2. investigate the characteristics and properties of light and sound;
3. demonstrate an understanding of light and sound as forms of energy that have specific characteristics and properties.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 4, students will:

1.1 assess the impacts on personal safety of devices that apply the properties of light and/or sound *(e.g., UV-coated lenses in sunglasses, safety eyes on garage door openers, reflective material on clothing, ear plugs, backup signals on trucks and cars, MP3 players, cellphones)*, and propose ways of using these devices to make our daily activities safer

Sample prompts: (a) It is important to be physically active in our daily lives. Walking, skateboarding, rollerblading, and bicycling are all good forms of exercise that take place outside. When taking part in these activities we should be sure to wear sunglasses that protect our eyes from the sun and wear clothing marked with reflective material so we can be seen by motorists. (b) Using MP3 players or cellphones while walking, riding, or driving can prevent us from hearing warning noises or divert our attention from approaching dangers. (c) Ear plugs can protect our ears from excessive noise from lawn mowers and power tools.

1.2 assess the impacts on society and the environment of light and/or sound energy produced by different technologies, taking different perspectives into account *(e.g., the perspectives of someone who has to walk on the street late at night, a cottage owner, a person who is hearing impaired, manufacturers of and merchants who sell MP3 players)*

Sample issues: (a) Streetlights increase visibility and make areas safer for people to move about in the city at night. However, they use large amounts of electrical energy and contribute to light pollution that obscures the features of the night sky. Also, birds may be disoriented by lights from tall buildings and may be killed when they hit the buildings. (b) Items like gasoline-powered lawn mowers and leaf blowers make work easier, and items like jet skis provide enjoyment to the user. However, these technologies also create noise pollution. (c) Advances in electronic technology have allowed us to develop hearing aids for people who might never have been able to hear well without them. However, these same advances have allowed us to create powerful sound systems and devices like personal music players that can be played at volume levels that annoy others and are potentially damaging to human hearing.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 4, students will:

2.1 follow established safety procedures for protecting eyes and ears *(e.g., use proper eye and ear protection when working with tools)*

2.2 investigate the basic properties of light *(e.g., conduct experiments to show that light travels in a straight path, that light reflects off of shiny surfaces, that light refracts [bends] when passing from one medium to another, that white light is made up of many colours, that light diffracts [bends and spreads out] when passing through an opening)*

2.3 investigate the basic properties of sound *(e.g., conduct experiments to show that sound travels, that sound can be absorbed or reflected, that sound can be modified [pitch, volume], that there is a relationship between vibrations and sound)*

2.4 use technological problem-solving skills (see page 16) to design, build, and test a device that makes use of the properties of light *(e.g., a periscope, a kaleidoscope)* or sound *(e.g., a musical instrument, a sound amplification device)*

Sample guiding questions: How might you use what you know about sound or about light and mirrors in your device? Which properties of light or sound will be most useful to you in your device? What challenges might you encounter, and how can you overcome them?

2.5 use scientific inquiry/research skills (see page 15) to investigate applications of the properties of light or sound *(e.g., careers where knowledge of the properties of light and/or sound play an important role [photography, audio engineering]; ways in which light and/or sound are used at home, at school, and in the community; ways in which animals use sound)*

2.6 use appropriate science and technology vocabulary, including *natural*, *artificial*, *beam of light*, *pitch*, *loudness*, and *vibration*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., create a song or short drama presentation for younger students that will alert them to the dangers of exposure to intense light and sound)*

3. Understanding Basic Concepts

By the end of Grade 4, students will:

3.1 identify a variety of natural light sources *(e.g., the sun, a firefly)* and artificial light sources *(e.g., a candle, fireworks, a light bulb)*

3.2 distinguish between objects that emit their own light *(e.g., stars, candles, light bulbs)* and those that reflect light from other sources *(e.g., the moon, safety reflectors, minerals)*

3.3 describe properties of light, including the following: light travels in a straight path; light can be absorbed, reflected, and refracted

3.4 describe properties of sound, including the following: sound travels; sound can be absorbed or reflected and can be modified *(e.g., pitch, loudness)*

3.5 explain how vibrations cause sound

3.6 describe how different objects and materials interact with light and sound energy *(e.g., prisms separate light into colours; voices echo off mountains; some light penetrates through wax paper; sound travels further in water than air)*

3.7 distinguish between sources of light that give off both light and heat *(e.g., the sun, a candle, an incandescent light bulb)* and those that give off light but little or no heat *(e.g., an LED, a firefly, a compact fluorescent bulb, a glow stick)*

3.8 identify devices that make use of the properties of light and sound *(e.g., a telescope, a microscope, and a motion detector make use of the properties of light; a microphone, a hearing aid, and a telephone handset make use of the properties of sound)*

GRADE 4 | UNDERSTANDING EARTH AND SPACE SYSTEMS
ROCKS AND MINERALS

OVERVIEW

The study of rocks and minerals introduces students to the science of geology. By examining different types of rocks and minerals found in the earth's crust, students will learn that the unique characteristics and properties of rocks and minerals are a result of how they were formed. Such properties determine possible uses. It is important that students become aware of how human uses of rocks and minerals not only alter the landscape but also affect the environment in various other ways.

Because rocks and minerals are such an integral part of our lives, it may be hard for students in Grade 4 to see the issues clearly. It would be very easy for their viewpoint to be skewed as they come to realize the impacts associated with just one person's yearly use of these natural resources (including impacts from mining, production, use, and disposal). Therefore, it is critical that they be given opportunities to look at the issues from the standpoint of all stakeholders: mining companies, communities where the mines are located, manufacturers, those who are dependent on the natural environment, and people who benefit from the use of the products – the students and their families. In communities where mining or related manufacturing processes provide the livelihood for parents of many students, teachers must be sensitive to the feelings of all students when discussing the costs and benefits of using everyday objects and products made from rocks and minerals.

It is important that students be able to identify and demonstrate an understanding of practices that ensure their own personal safety and the safety of others. For example, students need to know that some places might be unsafe for collecting their rock samples (e.g., a construction site) and that they need to wear eye protection when conducting investigations (e.g., when chipping samples).

Fundamental Concepts	Big Ideas
Change and Continuity	Rocks and minerals have unique characteristics and properties that are a result of how they were formed. *(Overall expectations 2 and 3)*
Sustainability and Stewardship	The properties of rocks and minerals determine society's possible uses for them. *(Overall expectations 1 and 2)*
Structure and Function	Our use of rocks and minerals affects the environment. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 4, students will:

1. assess the social and environmental impacts of human uses of rocks and minerals;
2. investigate, test, and compare the physical properties of rocks and minerals;
3. demonstrate an understanding of the physical properties of rocks and minerals.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 4, students will:

1.1 assess the social and environmental costs and benefits of using objects in the built environment that are made from rocks and minerals

Sample issues: (a) Quarried stone, sand, and gravel are used to make concrete. We need the strength and long life that concrete gives to roads and buildings, but making concrete uses a lot of natural resources and energy. (b) Aluminum is used to make soft drink containers and trash cans. It can be recycled many times, and recycling uses much less energy than making aluminum from ore. (c) One person uses 5.4 kilograms of salt per year on food and another 180 kilograms a year for other things, such as de-icing roads and sidewalks in winter. We need salt in our diet, but when we use it on our roads and sidewalks, it causes damage to cars, water, and plants. (d) Clay is used to make plates and mugs, bricks for buildings, and kitty litter, but clay is strip-mined and the products made from it are persistent in the environment.

1.2 analyse the impact on society and the environment of extracting and refining rocks and minerals for human use, taking different perspectives into account *(e.g., the perspectives of mine owners, the families of the miners, Aboriginal communities, the refinery workers, manufacturers of items who need the refined rocks and minerals to make their products, residents who live in communities located near refineries and manufacturing facilities and who are concerned about the environment)*

Sample issues: (a) Strip mining (or close surface extraction) is used to extract rocks and minerals for eventual human use. It is less dangerous for humans than underground mining, but it has a greater impact on the surface landscape, including the loss of significant amounts of rich topsoil. Efforts are being made by mining companies to reclaim land where mines and quarries have been closed. Abandoned quarries can be filled with water and used for recreational purposes. When a mine is closed, topsoil can be replaced and native species replanted. (b) The smelting process is necessary to extract ores and minerals that can be made into products for human use. But the process produces waste materials, including gases that cause climate change, acid rain, and smog.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 4, students will:

2.1 follow established safety procedures for outdoor activities and for working with tools, materials, and equipment *(e.g., use scratch and streak test materials for the purposes for which they are intended; when working outdoors, leave the site as it was found)*

2.2 use a variety of tests to identify the physical properties of minerals *(e.g., hardness [scratch test], colour [streak test], magnetism)*

2.3 use a variety of criteria *(e.g., colour, texture, lustre)* to classify common rocks and minerals according to their characteristics

2.4 use scientific inquiry/research skills (see page 15) to investigate how rocks and minerals are used and disposed of in everyday life *(e.g., nickel and copper are made into coins; old coins can be melted down and the metal can be used for making other things; calcium [from limestone], silicon [from sand or clay], aluminum [from bauxite and iron ore], and iron [from bauxite and iron ore] are made into cement that is used for roads and buildings; cement can be returned to cement and concrete production facilities and recycled; rocks from quarries are used for garden landscaping, and these rocks can be reused; marble is used for countertops and statues; old and worn pieces of marble can be repolished and recut to be made to look like new)*

Sample guiding questions: Where might we find products made from rocks and minerals in our daily life? How might you find out other ways in which rocks and minerals are used in everyday items? Why might some people and groups have concerns about the use of some of these rocks and minerals? What might be some alternative materials that could be used instead of the rocks and minerals? How are some of the items made from rocks and/or minerals disposed of when they are no longer useful? Which minerals can be recycled or reused in other products?

2.5 use appropriate science and technology vocabulary, including *hardness*, *colour*, *lustre*, and *texture*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use a graphic organizer to show how rocks and minerals are used in daily life)*

3. Understanding Basic Concepts

By the end of Grade 4, students will:

3.1 describe the difference between rocks (composed of two or more minerals) and minerals (composed of the same substance throughout), and explain how these differences make them suitable for human use

3.2 describe the properties *(e.g., colour, lustre, streak, transparency, hardness)* that are used to identify minerals

3.3 describe how igneous, sedimentary, and metamorphic rocks are formed *(e.g., igneous rocks form when hot, liquid rock from deep below the earth's surface rises towards the surface, cools, and solidifies; sedimentary rocks form when small pieces of the earth that have been worn away by wind and water accumulate at the bottom of rivers, lakes, and oceans and are eventually compressed into rock; metamorphic rocks form when igneous or sedimentary rocks are changed by heat and pressure)*

3.4 describe the characteristics of the three classes of rocks *(e.g., sedimentary rocks often have flat or curved layers, are composed of pieces that are roughly the same size with pores between the pieces, and often contain fossils; igneous rocks have no layers, are usually made up of two or more minerals whose crystals are different sizes, and normally do not contain fossils; metamorphic rocks may have alternating bands of light and dark minerals, may be composed of only one mineral, such as marble or quartzite, and rarely contain fossils)*, and explain how their characteristics are related to their origin

GRADE *5*

GRADE 5 | UNDERSTANDING LIFE SYSTEMS
HUMAN ORGAN SYSTEMS

OVERVIEW

As students continue to make choices in their lives, they need to know that choices they make about their bodies may have lifelong effects. This topic, Human Organ Systems, helps students understand that the body is made up of a number of organs and that these organs are parts of systems that can be affected by a variety of factors. Using models and simulations, students will learn the location, structure, and function of the major organs of the respiratory, circulatory, and digestive systems. Students will also develop an understanding of the importance of proper nutrition and exercise to the healthy functioning of organ systems.

When faced with choices that may have long-term consequences for their health, students need to have skills and attitudes that will help them make reasoned, informed decisions. They need to consider issues from many perspectives and to look for bias in the information they receive. Is it really the latest style of running shoe that makes a person a better runner or basketball player, or is it the physical health, dedication, and determination of the player? Does the latest fad diet really work? What other side effects might it have that could be less desirable? As students learn to look at things from different points of view and not just accept them at face value, they will become more skilled at making good and thoughtful decisions.

Fundamental Concepts	Big Ideas
Systems and Interactions	Organ systems are components of a larger system (the body) and, as such, work together and affect one another. *(Overall expectations 2 and 3)*
Structure and Function	Organ structures are linked to their functions. *(Overall expectations 2 and 3)*
	Systems in the human body work together to meet our basic needs. *(Overall expectations 2 and 3)*
	Choices we make affect our organ systems and, in turn, our overall health. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 5, students will:

1. analyse the impact of human activities and technological innovations on human health;
2. investigate the structure and function of the major organs of various human body systems;
3. demonstrate an understanding of the structure and function of human body systems and interactions within and between systems.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 5, students will:

1.1 assess the effects of social and environmental factors on human health, and propose ways in which individuals can reduce the harmful effects of these factors and take advantage of those that are beneficial

Sample problems: (a) Each year, about 90 000 children in Ontario try smoking. Smoking kills almost 12 000 people in Ontario each year. Ad campaigns about the dangers of smoking can encourage young people to stay away from tobacco products. But the media still often portray smoking as glamorous. Develop a personal plan of action to find the information you need to make good decisions about smoking (e.g., where you might find reliable information and data; whom you might ask for help and support). (b) Overexposure to the sun in childhood can cause skin cancer in adults. But the vitamin D that we create using sunlight during "safe" hours helps to build strong bones and increases our resistance to many kinds of diseases. Make a personal plan to get the recommended one hour a week of sunlight, taking into account the safety concerns about exposure to the sun.

1.2 evaluate the effects, both beneficial and harmful, of various technologies on human body systems, taking different perspectives into account *(e.g., the perspectives of the developers of the technologies, advertisers, children and young people, parents)*

Sample issue: Industrial technology (e.g., manufacturing and communication processes) has both helped and harmed human health. For example, new running shoe designs provide better body protection, but manufacturing them may involve social (e.g., unsafe working conditions, child labour) and environmental costs and marketing them increases social pressure to wear the latest shoes. Indoor and outdoor video technology can bring us messages that promote healthy living (e.g., the importance of drinking milk or getting lots of exercise), but it can also bring messages that encourage unhealthy choices (e.g., that drinking alcohol is "cool"; that driving fast is fun), and it exposes people to constant bombardment with sound and light).

Sample guiding questions: What effects might playing video games, watching TV, or using Internet chat lines and e-mail have on human body systems? How can the increased ease of air travel affect individual and public health?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 5, students will:

2.1 follow established safety procedures for physical activities *(e.g., make the teacher aware of any physical limitations that might affect ability to perform activities)*

2.2 use scientific inquiry/experimentation skills (see page 12) to investigate changes in body systems *(e.g., heart rate, breathing, body temperature)* as a result of physical activity *(e.g., exercise, resting, eating)*

Sample guiding questions: What observations did you make about the effect of exercise on your heart rate? What happened to your breathing as your heart rate changed? How long did it take for your heart rate and breathing to return to normal after physical exertion? How did your body temperature change? What other changes did you notice (e.g., sweating)? What conclusions can you make as a result of your investigations?

2.3 design and build a model to demonstrate how organs or components of body systems in the human body work and interact with other components *(e.g., build a model that shows how muscles, bones, and joints in the human body work together as a system to allow movement of the arms or legs; build a model to show how the lungs and heart work as a system)*

2.4 use appropriate science and technology vocabulary, including *circulation*, *respiration*, *digestion*, *organs*, and *nutrients*, in oral and written communication

2.5 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., create labelled charts or graphs to show changes in heart rate and breathing as a result of exercising)*

3. Understanding Basic Concepts

By the end of Grade 5, students will:

3.1 identify major systems in the human body *(e.g., musculoskeletal system, digestive system, nervous system, circulatory system)* and describe their roles and interrelationships

3.2 describe the basic structure and function of major organs in the respiratory, circulatory, and digestive systems *(e.g., we have two lungs; each one is about 25–30 cm long and cone-shaped; the right lung is slightly bigger because it has three lobes and the left lung has only two; our lungs are responsible for gas exchanges)*

3.3 identify interrelationships between body systems *(e.g., the respiratory system provides oxygen and removes carbon dioxide for the circulatory system)*

3.4 identify common diseases and the organs and/or body systems that they affect *(e.g., epilepsy affects the brain [central nervous system]; appendicitis affects the appendix [digestive system]; asthma and emphysema affect the lungs [respiratory system])*

GRADE 5 | UNDERSTANDING STRUCTURES AND MECHANISMS

FORCES ACTING ON STRUCTURES AND MECHANISMS

OVERVIEW

In this strand, students will identify and describe forces acting on and within structures. As they measure and compare external forces (natural or human) acting on structures and their effects on different materials, they will develop a more sophisticated understanding of the concept of force and of ways in which structures respond to forces acting upon them. Students will have an opportunity to apply their learning as they design and build structures or mechanisms.

By examining the effects of forces from natural phenomena on society and the environment, students will gain respect for the power behind these forces and appreciation for the devastating effects that they have on the natural and built environment, and they will be able to develop strategies for keeping themselves and others safe during these events.

Connections can be made between this topic and the Grade 5 social studies topic Canada and World Connections: Aspects of Citizenship and Government in Canada, as students discuss planning decisions and the construction of structures within their community.

Fundamental Concepts	Big Ideas
Structure and Function	Structures and mechanisms throughout our environment have forces that act on and within them. *(Overall expectations 1 and 3)* We can measure forces in order to determine how they affect structures and mechanisms. This information can be used to guide the design of new structures and mechanisms. *(Overall expectations 1 and 2)* Forces that result from natural phenomena have an effect on society and the environment. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 5, students will:

1. analyse social and environmental impacts of forces acting on structures and mechanisms;
2. investigate forces that act on structures and mechanisms;
3. identify forces that act on and within structures and mechanisms, and describe the effects of these forces on structures and mechanisms.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 5, students will:

1.1 analyse the effects of forces from natural phenomena *(e.g., tornadoes, hurricanes, earthquakes, tsunamis)* on the natural and built environment

Sample guiding questions: (a) What is a tornado? Where does the force of a tornado come from? What kinds of damage does a tornado inflict on the built environment (e.g., on structures such as houses and shopping malls)? What is the impact of a tornado on the natural environment (e.g., on trees, on animals such as fish and birds)? How can humans protect themselves from the force of a tornado? (b) What is an earthquake? Where does the force of an earthquake come from? How is the damage from an earthquake different from that of a tornado? What is the impact of an earthquake on the natural environment? What can humans do to protect themselves from the forces of an earthquake?

1.2 evaluate the impact of society and the environment on structures and mechanisms, taking different perspectives into account *(e.g., the perspectives of golfers, local bird-watching groups, families, a school board)*, and suggest ways in which structures and mechanisms can be modified to best achieve social and environmental objectives

Sample issues: (a) The local golf course wants to expand into an area where bald eagles are known to winter. (b) People in the Far North have to construct buildings on ground that is permanently frozen just below the surface. If their buildings have normal foundations, the heat loss from them would melt the frozen ground and unsettle the structure.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 5, students will:

2.1 follow established safety procedures for working with tools and materials *(e.g., wear protective eyewear when testing structures to the breaking point)*

2.2 measure and compare, quantitatively and/or qualitatively, the force required to move a load *(e.g., to lift a book, to open a drawer)* using different mechanical systems *(e.g., different pulley systems, a lever, a gear system)*, and describe the relationship between the force required and the distance over which the force moves

2.3 use scientific inquiry/research skills (see page 15) to investigate how structures are built to withstand forces

Sample guiding questions: What different materials and construction techniques are used to build structures that may be subjected to forces from natural phenomena such as earthquakes? In what ways are structures modified to allow them to stand up to forces from natural phenomena such as tornadoes and hurricanes? What standard building techniques are used to ensure that structures can withstand forces placed upon them (e.g., the force from the weight of snow on a roof)?

2.4 use technological problem-solving skills (see page 16) to design, build, and test a frame structure *(e.g., a bridge, a tower)* that will withstand the application of an external force *(e.g., a strong wind or simulated vibrations from a train)* or a mechanical system that performs a specific function *(e.g., a building crane)*

Sample guiding questions: What strategies will you use to ensure that you build a structure capable of withstanding an external force? What function is your device intended to perform? How will you test your structure or device? What safety measures do you need to consider when building and testing it? How will you know if your structure or device was successful? What changes might you suggest to improve its efficiency, functionality, or performance?

2.5 use appropriate science and technology vocabulary, including *tension*, *compression*, *torque*, *system*, and *load*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., make an oral presentation explaining the techniques they used to build a model of a bridge that can withstand vibrations from a train)*

3. Understanding Basic Concepts

By the end of Grade 5, students will:

3.1 identify internal forces acting on a structure *(e.g., compression [squeezing], tension [stretching])*, and describe their effects on the structure

3.2 identify external forces acting on a structure *(e.g., the weight of people and furniture in a house, wind blowing on a tent, the movement caused by a passing train)*, and describe their effects on the structure, using diagrams

3.3 explain the advantages and disadvantages of different types of mechanical systems *(e.g., a hoist in a lifting system that comprises four pulleys will decrease the amount of force needed by four times, but the force will have to move four times as fast)*

3.4 describe forces resulting from natural phenomena that can have severe consequences for structures in the environment *(e.g., a house loses its roof in a wind storm)*, and identify structural features that help overcome some of these forces *(e.g., cross supports for roofs, steel beams in bridges)*

3.5 describe how protective sports equipment protects the body from the impact of forces *(e.g., helmets reduce the intensity of the force of the impact, spreading the impact over a larger area and preventing direct impact to the skull; knee and shin pads spread the impact over a larger area and protect against cuts and scrapes)*

GRADE 5 | UNDERSTANDING MATTER AND ENERGY

PROPERTIES OF AND CHANGES IN MATTER

OVERVIEW

In earlier grades, students learned how the properties of various materials, such as strength, flexibility, and buoyancy, determine what the materials are used for. In Grade 5, students will continue those studies and also examine the environmental impact associated with the production, use, and disposal of such materials. In addition, students will explore the concept of matter. They will learn about commonly found states of matter (solids, liquids, and gases) and the characteristics of each. They will also explore changes of state and investigate the difference between physical changes (which are reversible) and chemical changes (which are not reversible). Concepts learned in this strand about the use of heat to effect changes in matter will be relevant to the study of energy conservation in the next strand. It is necessary to provide opportunities for all students, including students with special education needs, to participate in these or comparable activities.

As governments deal with ongoing concerns about growing landfill sites, problems with waste disposal, and the potential of recycling processes, it is often our students who are our best environmental stewards. The habits of mind, attitudes, and values they form now will remain with them throughout their adult lives. Therefore, we need to ensure that they learn to form their own opinions after they have fully explored the issues. This means looking at issues such as recycling not only from the perspective of recycling plant operators but also from that of providers of raw materials, manufacturers, people concerned about the environment, and consumers. By helping students get a balanced view of the issues, we help them to consider the values and perspectives of others.

When exploring changes of state, it is important that students be able to identify and demonstrate an understanding of practices that ensure their personal safety and the safety of others. This includes knowing how to heat samples safely, and why any flaws in glassware should be reported to the teacher.

Fundamental Concepts	Big Ideas
Matter Energy Sustainability and Stewardship	There are three states of matter. *(Overall expectations 2 and 3)* Matter that changes state is still the same matter. *(Overall expectations 2 and 3)* Physical change refers to the fact that a substance can be changed from one form to another. *(Overall expectations 2 and 3)* Chemical change implies the formation of a new substance. *(Overall expectations 2 and 3)* The properties of materials determine their use and may have an effect on society and the environment. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 5, students will:

1. evaluate the social and environmental impacts of processes used to make everyday products;
2. conduct investigations that explore the properties of matter and changes in matter;
3. demonstrate an understanding of the properties of matter, changes of state, and physical and chemical change.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 5, students will:

1.1 evaluate the environmental impacts of processes that change one product into another product through physical or chemical changes

Sample issues: Consider the impacts on the environment of changing grains such as wheat, corn, and rice into flours, and the flours into breads, pasta, crackers, or wallpaper paste; changing new trees, lumberyard scraps, and recycled paper products into pulp, and pulp into paper and paper products; changing petroleum into plastic, and plastic into everyday items such as rulers and soft drink bottles, some of which end up in landfills and some of which are recycled into clothing or rugs.

1.2 assess the social and environmental impact of using processes that rely on chemical changes to produce consumer products, taking different perspectives into account *(e.g., the perspectives of food manufacturers, consumers, landfill operators, people concerned about the environment)*, and make a case for maintaining the current level of use of the product or for reducing it

Sample issues: The use of chemical preservatives makes foods last longer, but the preservatives may have an impact on human health. Recycling paper, cardboard, plastics, and organics can keep materials out of landfills for a longer period of time, but the processes involved may have their own impacts.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 5, students will:

2.1 follow established safety procedures for working with heating appliances and hot materials *(e.g., switch hot plates off immediately after use)*

2.2 measure temperature and mass, using appropriate instruments *(e.g., a thermometer, a single-pan balance)*

2.3 use scientific inquiry/experimentation skills (see page 12) to investigate changes of state and changes in matter

Sample guiding questions: What change of state happens during condensation? During solidification? Do the changes of state you are observing take place because of a release of heat or an absorption of heat? Explain. What physical changes in matter did you observe? What caused those changes to take place? What would have to happen to reverse those changes? What chemical changes in matter did you observe? What caused those changes to take place? What conclusions did you make about changes in matter?

2.4 use scientific inquiry/experimentation skills (see page 12) to determine how the physical properties of materials make them useful for particular tasks *(e.g., when cleaning up a liquid spill in the kitchen, which material is best suited to do the job: a piece of sponge, a piece of terry cloth, a paper towel?)*

Sample guiding questions: How will you ensure that your test of the materials is fair? What properties of the materials make them useful for the task? What is the environmental impact of using each of the materials? Which of their properties might hamper the task? How might you improve one of these products to make it better suited to the task?

2.5 use appropriate science and technology vocabulary, including *mass*, *volume*, *properties*, *matter*, *physical/reversible changes*, and *chemical/irreversible changes*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., create a labelled chart or graph to show the time required for an ice cube to melt completely)*

3. Understanding Basic Concepts

By the end of Grade 5, students will:

3.1 identify matter as everything that has mass and occupies space

3.2 identify properties of solids, liquids, and gases *(e.g., solids have definite volume and hold their shape; liquids have definite volume but take the shape of their container or spread when they are not contained; gases have no definite volume and take the volume and shape of their container or spread when they are not contained)*, and state examples of each

3.3 explain changes of state in matter *(e.g., evaporation, condensation, solidification or freezing, fusion or melting, sublimation)*, and give examples of each *(e.g., water from wet clothes evaporates; steam from a boiling kettle condenses on a cold window; water in ponds and lakes solidifies or freezes in winter; a frozen treat melts on a warm summer day; a moth ball sublimates in the closet)*

3.4 describe physical changes in matter as changes that are reversible *(e.g., a melted ice cube can be refrozen; a bottle of frozen water can be thawed to a liquid state again; water vapour that has condensed on a cold window can evaporate into a vaporous state again; water from a puddle that has evaporated will fall to the ground as rain)*

3.5 describe chemical changes in matter as changes that are irreversible *(e.g., when the chrome on a bicycle rusts, it can never go back to being chrome; when an egg is boiled it can never go back to being a raw egg)*

3.6 explain how changes of state involve the release of heat *(e.g., when water freezes it releases heat)* or the absorption of heat *(e.g., when an ice cube melts, it absorbs heat)*

3.7 identify indicators of a chemical change *(e.g., production of a gas, change in colour, formation of precipitate)*

3.8 distinguish between a physical change and a chemical change *(e.g., a physical change can be reversed [ice to water to ice], whereas a chemical change creates new substance[s] [wood to smoke and ash])*

GRADE 5 | UNDERSTANDING EARTH AND SPACE SYSTEMS
CONSERVATION OF ENERGY AND RESOURCES

OVERVIEW

Energy choices are becoming increasingly important. Making greater use of renewable and alternative sources and conserving energy are options that students need to know about if we are to sustain our present standard of living and ensure adequate energy supplies for future generations. Students must also recognize that there are immediate and long-term impacts and costs associated with every choice.

Never has it been more important for our students to be creative and critical thinkers. More than ever, they need to know how to understand situations and to respond to them in new ways. They need to be able to recognize the choices made by others, while being able to question the ideas behind the choices. They need to be able to think critically, to see things from many different perspectives, and to use all of the information available to make informed and reasoned personal choices about energy use and conservation.

By designing, constructing, and operating their own devices, students will learn how energy is transferred from one system to another. When building devices, it is important that students be able to identify and demonstrate an understanding of practices that ensure their personal safety and the safety of others. This includes knowing why it is important to keep work spaces neat and tidy and why batteries should be recharged only under adult supervision.

Fundamental Concepts	Big Ideas
Energy Sustainability and Stewardship	Energy sources are either renewable or non-renewable. *(Overall expectation 3)* Energy can neither be created nor destroyed, but it can be transformed. *(Overall expectations 2 and 3)* Choices about using energy and resources have both immediate and long-term impacts. *(Overall expectation 1)* Conservation (reducing our use of energy and resources) is one way of reducing the impacts of using energy and resources. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 5, students will:

1. analyse the immediate and long-term effects of energy and resource use on society and the environment, and evaluate options for conserving energy and resources;
2. investigate energy transformation and conservation;
3. demonstrate an understanding of the various forms and sources of energy and the ways in which energy can be transformed and conserved.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 5, students will:

1.1 analyse the long-term impacts on society and the environment of human uses of energy and natural resources, and suggest ways to reduce these impacts *(e.g., turning off the faucet while brushing teeth or washing and rinsing dishes conserves water; reusing or recycling products, or using fewer products, conserves natural resources and energy)*

Sample issue: Natural gas is a clean, reliable, and safe fuel for heating our homes, but it is non-renewable and its use contributes to climate change (although not as much as other fossil fuels). Alternative forms of energy such as solar energy or wind energy do not deplete natural resources or contribute to climate change, but they may have other drawbacks (such as being more expensive and less reliable).

1.2 evaluate the effects of various technologies on energy consumption *(e.g., improving our home's insulation allows us to conserve heat and reduce energy consumption; aerodynamic design can improve the energy efficiency of cars and buses; household appliances designed to make our lives easier use large amounts of energy; some cars and recreational vehicles use energy less efficiently than others)*, and propose ways in which individuals can improve energy conservation

Sample problem: Conduct an energy audit of your home (e.g., look for places where there are drafts; check the wattage of light bulbs; with the help of an adult, estimate the standard of insulation; check the energy efficiency ratings of heating and cooling equipment and large appliances), and create a plan for how your family could improve their energy conservation efforts.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 5, students will:

2.1 follow established safety procedures for using tools and materials *(e.g., use hand drills correctly when making holes in wood)*

2.2 use scientific inquiry/research skills (see page 15) to investigate issues related to energy and resource conservation *(e.g., interview an Aboriginal person about his or her traditional teachings on conservation)*

Sample guiding questions: Why did you choose this issue to research? Where will you find information about it? How will you determine if the source of information is a good one (e.g., unbiased, current, knowledgeable)? Why might some of the sources be biased one way or another on the issue? What are some of the concerns that were raised in your research? How might this issue be relevant to our local community? Who can take action on this issue? How might you as an individual influence the outcome of the issue?

2.3 use technological problem-solving skills (see page 16) to design, build, and test a device that transforms one form of energy into another *(e.g., create a child's toy that uses the electrical energy from a battery or solar cell to move across the floor [kinetic energy] and make a noise [sound energy])*, and examine ways in which energy is being "lost" in the device

Sample guiding questions: Describe the energy transformations that are taking place in your device. What challenges did you encounter in making these transformations take place? As one form of energy is being transformed into another, where is energy being lost in your device? How might you minimize that loss?

2.4 use appropriate science and technology vocabulary, including *energy*, *heat*, *light*, *sound*, *electrical*, *mechanical*, and *chemical*, in oral and written communication

2.5 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., in a small group, discuss ways in which technological innovations increase and/or decrease our ability to conserve energy)*

3. Understanding Basic Concepts

By the end of Grade 5, students will:

3.1 identify a variety of forms of energy *(e.g., electrical, chemical, mechanical, heat, light, kinetic)* and give examples from everyday life of how that energy is used *(e.g., electrical energy for cooking; chemical/electrical energy to run our cars; mechanical energy to hit a*

baseball; light energy for managing traffic on the roads; heat energy to warm homes and schools)

3.2 identify renewable and non-renewable sources of energy *(e.g., renewable: sun, wind, ocean waves and tides, wood; non-renewable: fossil fuels such as coal and natural gas)*

3.3 describe how energy is stored and transformed in a given device or system *(e.g., in a portable electric device, chemical energy stored in a battery is transformed into electrical energy and then into other forms of energy such as mechanical, sound, and/or light energy)*

3.4 recognize that energy cannot be created or destroyed but can only be changed from one form to another *(e.g., chemical energy in a battery becomes electrical energy)*

3.5 explain that energy that is apparently "lost" from a system has been transformed into other energy forms (usually heat or sound) that are not useful to the system *(e.g., sound from a car's engine does not help the car move)*

GRADE **6**

GRADE 6 | UNDERSTANDING LIFE SYSTEMS
BIODIVERSITY

OVERVIEW

Because all living things (including humans) are connected, maintaining biodiversity is critical to the health of the planet. Students will learn that biodiversity includes diversity among individuals, species, and ecosystems. Through observations of a specific habitat and the classification of organisms, students will have a first-hand opportunity to appreciate the diversity of living things while recognizing the roles and interactions of individual species within the whole. Care must be taken to ensure that all students, including students with special education needs, have comparable opportunities to explore the natural world.

When assessing human impacts on species and ecosystems, especially at a local level, students must be given opportunities to look at a variety of points of view. They should consider how and why the perspectives of developers, people concerned about the environment, and residents of the local community might be similar or different. Through thoughtful consideration of various viewpoints and biases, students not only can look for ways in which people might come to agreement on how to minimize the negative impact of their actions, but also will be able to make more informed decisions about their own positions and about action they can take.

In preparation for working outside the school, it is important that students be able to identify and demonstrate an understanding of practices that ensure their personal safety and the safety of others. This includes making the teacher aware of any potential personal dangers of being outside (e.g., allergic reactions to bee stings), knowing why it is important to wear clothing and footwear appropriate for the conditions, and staying within the area of study.

Fundamental Concepts	Big Ideas
Systems and Interactions Sustainability and Stewardship	Biodiversity includes diversity of individuals, species, and ecosystems. *(Overall expectations 2 and 3)* Classification of the components within a diverse system is a beginning point for understanding the interrelationships among the components. *(Overall expectations 2 and 3)* Because all living things are connected, maintaining diversity is critical to the health of the planet. *(Overall expectations 1 and 3)* Humans make choices that can have an impact on biodiversity. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 6, students will:

1. assess human impacts on biodiversity, and identify ways of preserving biodiversity;
2. investigate the characteristics of living things, and classify diverse organisms according to specific characteristics;
3. demonstrate an understanding of biodiversity, its contributions to the stability of natural systems, and its benefits to humans.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 6, students will:

1.1 analyse a local issue related to biodiversity *(e.g., the effects of human activities on urban biodiversity, flooding of traditional Aboriginal hunting and gathering areas as a result of dam construction)*, taking different points of view into consideration *(e.g., the points of view of members of the local community, business owners, people concerned about the environment, mine owners, local First Nations, Métis, Inuit)*, propose action that can be taken to preserve biodiversity, and act on the proposal

Sample issue: A local forest is slated to be cut down to make room for a new shopping plaza.

Sample guiding questions: What are the positive and negative aspects of the issue (e.g., a community will have access to goods and services in the new shopping plaza that were not there before; getting the land for the shopping plaza means losing a local forest)? Who might have differing opinions on this issue? Why? What are some things that you might do as an individual, or that we might do as a class, to make others aware of the issues and concerns (e.g., write a letter to the local newspaper, the mayor, or the Member of Parliament; design and hang awareness posters in the community)?

1.2 assess the benefits that human societies derive from biodiversity *(e.g., thousands of products such as food, clothing, medicine, and building materials come from plants and animals)* and the problems that occur when biodiversity is diminished *(e.g., monocultures are more vulnerable to pests and diseases)*

Sample issue: Monoculture systems on farms allow crops to be grown in the soil that is best for them. But monoculture systems reduce diversity, and so more soil and pest problems result. In turn, farmers apply more chemical fertilizers and pesticides, which pollute the land, the water, and the food they are producing.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 6, students will:

2.1 follow established safety procedures for outdoor activities and field work *(e.g., stay with a partner when exploring habitats; wash hands after exploring a habitat)*

2.2 investigate the organisms found in a specific habitat and classify them according to a classification system

2.3 use scientific inquiry/research skills (see page 15) to compare the characteristics of organisms within the plant or animal kingdoms *(e.g., compare the characteristics of a fish and a mammal, of coniferous and deciduous trees, of ferns and flowering plants)*

Sample guiding questions: What are the criteria you will use to compare organisms? Why are these good criteria to use to compare the organisms? How might the criteria change if you picked two different organisms? Why is it important to be able to compare organisms in some organized way?

2.4 use appropriate science and technology vocabulary, including *classification*, *biodiversity*, *natural community*, *interrelationships*, *vertebrate*, *invertebrate*, *stability*, *characteristics*, and *organism*, in oral and written communication

2.5 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use a graphic organizer to show comparisons between organisms in various communities)*

3. Understanding Basic Concepts

By the end of Grade 6, students will:

3.1 identify and describe the distinguishing characteristics of different groups of plants and animals *(e.g., invertebrates have no spinal column; insects have three basic body parts; flowering plants produce flowers and fruits)*, and use these characteristics to further classify various kinds of plants and animals *(e.g., invertebrates – arthropods – insects; vertebrates – mammals – primates; seed plants – flowering plants – grasses)*

3.2 demonstrate an understanding of biodiversity as the variety of life on earth, including variety

within each species of plant and animal, among species of plants and animals in communities, and among communities and the physical landscapes that support them

3.3 describe ways in which biodiversity within species is important for maintaining the resilience of those species *(e.g., because of genetic differences, not all squirrels are affected equally by infectious diseases such as mange; some species of bacteria have become resistant to antibiotics because resistant individuals have survived and reproduced)*

3.4 describe ways in which biodiversity within and among communities is important for maintaining the resilience of these communities *(e.g., having a variety of species of wheat allows for some part of the crop to survive adverse conditions)*

3.5 describe interrelationships within species *(e.g., wolves travel in packs to defend their territory, raise their cubs, and hunt large prey)*, between species *(e.g., the brightly-coloured anemone fish protects its eggs by laying them among the poisonous tentacles of the sea anemone, and in return the fish's bright colours attract prey for the anemone to eat; birds and bees take sustenance from plants and carry pollen between plants)*, and between species and their environment *(e.g., algae and water lilies compete for sunlight in a pond)*, and explain how these interrelationships sustain biodiversity

3.6 identify everyday products that come from a diversity of organisms *(e.g., traditional pain relievers are derived from the bark of the white willow tree; tofu is made from soybeans; silk is made from silkworm cocoons; nutritional supplements, shampoos, toothpastes, and deodorants contain pollen collected by bees)*

3.7 explain how invasive species *(e.g., zebra mussel, Asian longhorned beetle, purple loosestrife)* reduce biodiversity in local environments

GRADE 6 | UNDERSTANDING STRUCTURES AND MECHANISMS
ELECTRICITY AND ELECTRICAL DEVICES

OVERVIEW

Electricity is a form of energy that students encounter every day. Students will already be familiar with many of the uses of this convenient source of energy. Building on their prior learning, students will explore devices that convert electricity to other forms of energy. The building of circuits should further strengthen students' understanding of how electrical systems work.

We live in an age when everyone is concerned about how we use electrical energy and how we will continue to meet the demand for it. Students need opportunities to think about how electrical energy can be conserved both at home and at school and about alternative ways of producing energy. They must learn to think critically about the information and ideas they encounter. Throughout their investigations, they should also be encouraged to examine the opinions of others and to question those opinions as they form their own opinions and plans of action.

It is important that students be able to identify and demonstrate an understanding of practices that ensure their personal safety and the safety of others when working with and around electricity. This includes knowing why hands should be dry when handling alternating current (AC) equipment and why equipment with frayed plugs should be reported to the teacher.

Fundamental Concepts	Big Ideas
Energy Systems and Interactions Sustainability and Stewardship	Electrical energy can be transformed into other forms of energy. *(Overall expectations 2 and 3)* Other forms of energy can be transformed into electrical energy. *(Overall expectations 2 and 3)* Electrical energy plays a significant role in society, and its production has an impact on the environment. *(Overall expectation 1)* Society must find ways to minimize the impact of energy production on the environment. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 6, students will:

1. evaluate the impact of the use of electricity on both the way we live and the environment;
2. investigate the characteristics of static and current electricity, and construct simple circuits;
3. demonstrate an understanding of the principles of electrical energy and its transformation into and from other forms of energy.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 6, students will:

1.1 assess the short- and long-term environmental effects of the different ways in which electricity is generated in Canada *(e.g., hydro, thermal, nuclear, wind, solar)*, including the effect of each method on natural resources and living things in the environment

Sample problems: (a) Electricity in Ontario is generated by nuclear plants, hydroelectric plants, coal-fired plants, and natural gas plants, and a small percentage is obtained through alternative energy sources. Choose an electricity-generating plant that supplies electricity in your community, and compare the environmental effects of the generating method it uses with a method used in another part of the province. (b) The James Bay Hydroelectric Project was one of the biggest hydroelectric developments of the past century, but it has also had a serious impact on the environment and the James Bay Cree people. Investigate both sides of this issue, and suggest how things might be approached differently today.

1.2 assess opportunities for reducing electricity consumption at home or at school that could affect the use of non-renewable resources in a positive way or reduce the impact of electricity generation on the environment

Sample issue: Peak demand times for electricity are morning and early evening. Because electricity cannot be stored in a cost-effective way, it must be supplied as it is being used. This means that almost all of a utility's available power plants must run to meet the demand and prevent system outages. Some utility companies are considering a plan to pay consumers to reduce their electricity consumption, especially during peak hours. This plan would not only reduce demand but would also reduce the cost of electricity for all customers and the impact of electricity production on the environment.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 6, students will:

2.1 follow established safety procedures for working with electricity *(e.g., ensure hands are completely dry when working with electricity; be aware of electrical hazards at home, at school, and in the community)*

2.2 design and build series and parallel circuits, draw labelled diagrams identifying the components used in each, and describe the role of each component in the circuit

2.3 use scientific inquiry/experimentation skills (see page 12) to investigate the characteristics of static electricity

Sample guiding questions: Is static electricity really static? Explain. What causes static electricity? Is it easier to generate static electricity in a dry room or a humid room? Why? Which materials accept a charge better than others? Where would you find static electricity in action?

2.4 design, build, and test a device that produces electricity *(e.g., a battery built from a lemon or potato; a wind turbine)*

Sample guiding questions: How can you find the positive and negative ends of your battery? How much voltage does your battery produce? How can you increase the voltage? What would happen if you exchanged the lemon for an apple? For a potato or a carrot? For other fruits or vegetables? How does a wind turbine produce electricity? Is this a good method of producing electricity? Why? Why not?

2.5 use technological problem-solving skills (see page 16) to design, build, and test a device that transforms electrical energy into another form of energy in order to perform a function *(e.g., a device that makes a sound, that moves, that lights up)*

Sample guiding questions: What function will your device perform? What does your device transform the electrical energy into? How does your device work?

2.6 use appropriate science and technology vocabulary, including *current*, *battery*, *circuit*, *transform*, *static*, *electrostatic*, and *energy*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using scientific and technological conventions, create a labelled diagram showing the component parts of the device they created to transform electrical energy into another form of energy and perform a function)*

3. Understanding Basic Concepts

By the end of Grade 6, students will:

3.1 distinguish between current and static electricity

3.2 use the principles of static electricity to explain common electrostatic phenomena *(e.g., the attraction of hairs to a comb that has been rubbed on a piece of wool; the attraction of small pieces of paper to a plastic ruler that has been rubbed with a rag; the attraction of pieces of clothing to each other when they come out of a clothes dryer)*

3.3 identify materials that are good conductors of electricity *(e.g., copper, gold, silver, aluminum, water [when it has a high mineral content])* and good insulators *(e.g., glass, plastic, rubber, ceramics)*

3.4 describe how various forms of energy can be transformed into electrical energy *(e.g., batteries use chemical energy; hydroelectric plants use water power; nuclear generating stations use nuclear energy; wind turbines use wind power; solar panels use energy from the sun; wave power stations use energy from ocean waves)*

3.5 identify ways in which electrical energy is transformed into other forms of energy *(e.g., electrical energy is transformed into heat energy in a toaster, light and sound energy in a television, mechanical energy in a blender)*

3.6 explain the functions of the components of a simple electrical circuit *(e.g., a battery is the power source; a length of wire is the conductor that carries the electrical current to the load; a light bulb or motor is the load)*

3.7 describe series circuits (components connected in a daisy chain) and parallel circuits (components connected side by side like the rungs of a ladder), and identify where each is used *(e.g., some strings of patio lights are in series circuits – when one light burns out, the whole string goes out; parallel circuits are used for wiring lighting and electrical outlets in your house – when one light burns out, the others keep burning)*

3.8 describe ways in which the use of electricity by society, including the amount of electrical energy used, has changed over time *(e.g., drying clothes in a dryer instead of using a clothesline; playing video games instead of playing board games; using electric lights instead of candles)*

GRADE 6 | UNDERSTANDING MATTER AND ENERGY
PROPERTIES OF AIR AND PRINCIPLES OF FLIGHT

OVERVIEW

Air has many properties that can be used for different purposes, including flight. The use of flight technologies has substantial effects on both society and the environment. Through investigations, observations, and experiments, students will discover that flight occurs when the characteristics of structures take advantage of certain properties of air. Students will learn that air takes up space, has mass, expands, and can exert a force when compressed. They will apply their newly acquired knowledge to design and test a flying device.

It is important that students be able to identify practices that ensure their personal safety and the safety of others and demonstrate an understanding of these practices. As students explore flying things, it is important that they understand why projectiles of any kind should always be aimed away from spectators, and why buildings, trees, and overhead wires present hazards to anyone flying kites or airplanes.

Fundamental Concepts	Big Ideas
Matter Structure and Function	Air has many properties that can be used for different purposes, including flight. *(Overall expectations 2 and 3)* Many technological innovations and consumer products utilize the properties of air. *(Overall expectation 1)* Flight occurs when the characteristics of structures take advantage of certain properties of air. *(Overall expectations 2 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 6, students will:

1. assess the societal and environmental impacts of devices that make use of the properties of air;
2. investigate the properties of air, and apply these properties when designing flying devices;
3. demonstrate an understanding of the properties of air, and explain ways in which they can be applied to the principles of flight and flying devices.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 6, students will:

1.1 assess the benefits and costs of aviation technology for society and the environment, taking different social and economic perspectives into account *(e.g., the perspectives of farmers, airline workers, doctors, home owners, tour operators)*

Sample issues: (a) Crop dusting from planes allows the chemicals to spread quickly over large crop areas, which is critical to pest control and crop protection. However, the planes cannot direct the chemicals onto the target crop with precision, so the chemicals spread where they are not wanted. (b) The speed and ease of air travel allow quick transportation of organs for lifesaving transplants, quick transportation of injured patients to hospitals, and trips for business and pleasure. However, air travel also increases the risk of spreading infectious diseases and creates noise and air pollution.

1.2 assess the environmental impact of everyday products that use the properties of air

Sample issue: Air-filled tires give a smooth ride and good traction, but present disposal problems. Recycled tires can become raw material for runner mats, playground surfaces, soaker hoses, and loading-dock bumpers, but eventually even these products may end up in a landfill and create environmental and health hazards.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 6, students will:

2.1 follow established safety procedures for using tools and materials and operating flying devices *(e.g., aim flying devices away from each other when launching them; fly kites and airplanes a safe distance from overhead hydro wires)*

2.2 use scientific inquiry/experimentation skills (see page 12) to investigate the properties of air *(e.g., air takes up space, has mass, can be compressed)*

Sample guiding questions: How do we know that air is there? When have you felt the force or pressure of air? Where might you see some of these principles applied in daily life?

2.3 investigate characteristics and adaptations that enable living things to fly *(e.g., a bat's wings are made up of long, thin bones covered with a very light membrane that forms an airfoil surface; insects can twist and turn their wings, which helps them to hover in the air or even fly backwards; some seeds, such as the keys of a maple tree or dandelion seeds, have parachutes or wings like a glider that allow them to be carried by the wind)*

2.4 use technological problem-solving skills (see page 16) to design, build, and test a flying device *(e.g., a kite, a paper airplane, a hot air balloon)*

Sample guiding questions: How does your device use the principles of flight? What were some challenges in getting your device off the ground? How might you change your device to make it fly better?

2.5 use appropriate science and technology vocabulary, including *aerodynamics*, *compress*, *flight*, *glide*, *propel*, *drag*, *thrust*, and *lift*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using technological conventions, make a drawing of the flying device they constructed)*

3. Understanding Basic Concepts

By the end of Grade 6, students will:

3.1 identify the properties of air that make flight possible *(e.g., air takes up space, has mass, expands, can exert a force when compressed)*

3.2 identify common applications of the properties of air, such as its compressibility and insulating qualities *(e.g., home insulation, tires, sleeping bags, layered clothing)*

3.3 identify and describe the four forces of flight – lift, weight, drag, and thrust

3.4 describe, in qualitative terms, the relationships between the forces of lift, weight, thrust, and drag that are required for flight *(e.g., lift must be greater than weight for a plane to take off; thrust must be greater than drag for a plane to take off; lift must be less than weight for a plane to land; thrust must be less than drag for a plane to land)*

3.5 describe ways in which flying devices or living things use unbalanced forces to control their flight *(e.g., a plane can be steered up or down by tilting the elevators on the tail; when a bird flaps its wings, the wings develop lift as well as forward and upward force, thus causing it to take off)*

3.6 describe ways in which the four forces of flight can be altered *(e.g., increasing the angle of attack increases the lift; lightweight materials help to keep the overall mass of the plane down, so that it can fly with smaller lift force; jet engines can vary the amount of thrust, which enables the plane to move forward; using the flaps on airplane wings changes the amount of drag, which reduces the speed of the plane)*

GRADE 6 | UNDERSTANDING EARTH AND SPACE SYSTEMS
SPACE

OVERVIEW

Our ability to observe and study objects in space has been greatly enhanced by the use of technological devices. The application of these technologies affects our lives in many ways. Space science involves learning about objects in the sky, particularly their form, movements, and interactions. In learning about space, students will focus on past and present-day contributions of space science to the quality of human life while developing an understanding of the phenomena that result from the movement of different bodies in space. Investigations will involve working with models of the different bodies to allow students to explore their size, position, and motion and help them gain an understanding of Earth as a component of larger systems.

It is important that students be able to identify and demonstrate an understanding of practices that ensure their personal safety and the safety of others. As students design, build, and test models, for example, it is important that they understand why Styrofoam needs to be cut in a well-ventilated space and how to use equipment safely and correctly.

Fundamental Concepts	Big Ideas
Systems and Interactions	Earth is a part of a large interrelated system. *(Overall expectations 2 and 3)* Technological and scientific advances that enable humans to study space affect our lives. *(Overall expectations 1 and 2)*

OVERALL EXPECTATIONS

By the end of Grade 6, students will:

1. assess the impact of space exploration on society and the environment;
2. investigate characteristics of the systems of which the earth is a part and the relationship between the earth, the sun, and the moon;
3. demonstrate an understanding of components of the systems of which the earth is a part, and explain the phenomena that result from the movement of different bodies in space.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 6, students will:

1.1 assess the contributions of Canadians *(e.g., astronauts Marc Garneau and Roberta Bondar; astronomers Richard Bond, David Levy, and Helen Hogg; Spar Aerospace Limited's development of the Canadarm; the University of British Columbia's development of the "Humble" space telescope)* to the exploration and scientific understanding of space

1.2 evaluate the social and environmental costs and benefits of space exploration, taking different points of view into account *(e.g., the point of view of health care workers and workers in other agencies that compete with space programs for public money; astronauts and their families; the general public; scientists)*

Sample issue: Space exploration has brought many benefits to society. High-quality radio and television signals are now relayed around the globe by satellite. Biological experiments in space, such as the growing of insulin crystals, are contributing to our ability to fight disease. The technology used for space shuttle fuel pumps is now being used to make better artificial hearts. Geographical data obtained by satellites have improved the quality of maps and made navigation safer. But space exploration is also very expensive, involves risks to the lives of astronauts and others, produces pollution, and creates space junk that may eventually fall back to Earth. Are the benefits worth the costs and risks?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 6, students will:

2.1 follow established safety procedures for handling tools and materials and observing the sun *(e.g., use appropriate eye protection when testing a sundial)*

2.2 use technological problem-solving skills (see page 16) to design, build, and test devices *(e.g., a sundial, a model of the earth's rotation around the sun)* for investigating the motions of different bodies in the solar system

Sample guiding questions: In what direction does your sundial fin need to point? Why? In what direction might you expect the shadow to move? How would daylight saving time affect the accuracy of your sundial? How might your model of the earth and sun best be used to explain the reason for day and night? What impact does the tilt of the earth's axis have on cycles on earth? What does the earth do to cause the day and night cycle?

2.3 use scientific inquiry/research skills (see page 15) to investigate scientific and technological advances that allow humans to adapt to life in space

Sample guiding questions: Why is life in space a challenge for humans? How might some of those challenges be overcome? What technologies exist now to allow us to overcome the challenges? In what ways does the International Space Station mimic conditions on Earth? What technologies create conditions similar to Earth's on the space station, and what differences remain? How might robotics play a role in human adaptation to space life? Under what circumstances might robots replace humans in space exploration?

2.4 use appropriate science and technology vocabulary, including *axis*, *tilt*, *rotation*, *revolution*, *planets*, *moons*, *comets*, and *asteroids*, in oral and written communication

2.5 use a variety of forms (*e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use a graphic organizer to identify and order main ideas and supporting details for a report about how science and technology can help humans adapt to life in space)*

3. Understanding Basic Concepts

By the end of Grade 6, students will:

3.1 identify components of the solar system, including the sun, the earth, and other planets, natural satellites, comets, asteroids, and meteoroids, and describe their physical characteristics in qualitative terms *(e.g., The earth's surface is very young; much of it is covered with water. The moon is the earth's only natural satellite. Comets are the largest objects in our solar system; their centres contain rock particles trapped in frozen liquid; their tails are made up of gas and dust.)*

3.2 identify the bodies in space that emit light *(e.g., stars)* and those that reflect light *(e.g., moons and planets)*

3.3 explain how humans meet their basic biological needs in space *(e.g., obtaining air, water, and food and managing bodily functions)*

3.4 identify the technological tools and devices needed for space exploration *(e.g., telescopes, spectroscopes, spacecraft, life-support systems)*

3.5 describe the effects of the relative positions and motions of the earth, moon, and sun *(e.g., use models or simulations to show solar and lunar eclipses, phases of the moon, tides)*

GRADE **7**

GRADE 7 | UNDERSTANDING LIFE SYSTEMS
INTERACTIONS IN THE ENVIRONMENT

OVERVIEW

By Grade 7, students realize that humans have many impacts on the environment. In the study of this topic, they will analyse some of these impacts and their consequences, while reflecting upon their personal responsibility to protect the environment. During investigations, the students will observe existing ecosystems and investigate factors that may affect balances within the system. Students will learn that ecosystems consist of communities of plants and animals that are dependent on each other as well as on the non-living parts of the environment. Care must be taken to ensure that all students, including students with special education needs, have comparable opportunities to explore the natural world.

In preparation for working outside the school, it is important that students be able to identify and explain the importance of practices that ensure their personal safety and the safety of others. This includes understanding why it is important to make the teacher aware of any potential allergic reactions (e.g., to bee stings), to wear the clothing and footwear appropriate for the conditions, and to stay within the area of study.

Fundamental Concepts	Big Ideas
Systems and Interactions Sustainability and Stewardship	Ecosystems are made up of biotic (living) and abiotic (non-living) elements, which depend on each other to survive. *(Overall expectations 2 and 3)* Ecosystems are in a constant state of change. The changes may be caused by nature or by human intervention. *(Overall expectations 1 and 2)* Human activities have the potential to alter the environment. Humans must be aware of these impacts and try to control them. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 7, students will:

1. assess the impacts of human activities and technologies on the environment, and evaluate ways of controlling these impacts;
2. investigate interactions within the environment, and identify factors that affect the balance between different components of an ecosystem;
3. demonstrate an understanding of interactions between and among biotic and abiotic elements in the environment.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 7, students will:

1.1 assess the impact of selected technologies on the environment

Sample issue: The use of technologies such as cars and computers has many impacts on the environment. What are some of these impacts and how do they affect the ability of the environment to support life?

1.2 analyse the costs and benefits of selected strategies for protecting the environment

Sample issues: (a) Many people recycle because it makes them feel that they are doing something good for the environment. But the focus on recycling takes the emphasis away from strategies like reducing or reusing. (b) Integrated Pest Management (IPM) is a pest management strategy that uses a variety of methods to prevent or control pest problems. But some of the methods can be as much of a problem as the pests themselves. (c) Some groups consider widening highways to reduce traffic congestion to be preferable to improving public transit systems. In some cases, however, highway expansion increases the problems that already existed, and other unexpected problems also arise. (d) Controlling the water flow in natural systems has a domino effect on the environmental integrity of the water system.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 7, students will:

2.1 follow established safety procedures for investigating ecosystems *(e.g., stay with a partner, wash hands after investigating an ecosystem)*

2.2 design and construct a model ecosystem *(e.g., a composter, a classroom terrarium, a greenhouse)*, and use it to investigate interactions between the biotic and abiotic components in an ecosystem

Sample guiding questions: What are some biotic components of this ecosystem? What are some abiotic components? How do these components affect each other (abiotic and abiotic; biotic and biotic; abiotic and biotic)? What are some of the interactions that are occurring in the model ecosystem?

2.3 use scientific inquiry/research skills (see page 15) to investigate occurrences *(e.g., a forest fire, a drought, an infestation of invasive species such as zebra mussels in a local lake or purple loosestrife in a wetland habitat)* that affect the balance within a local ecosystem

Sample guiding questions: Should naturally caused fires in national parks be allowed to burn to their natural end? How do human activities and natural occurrences contribute to droughts? What happens in a drought? What is the impact of invasive species such as zebra mussels, spiny water fleas, round gobies, and sea lampreys on Ontario lakes, and what can be done to lessen the impact?

2.4 use appropriate science and technology vocabulary, including *sustainability*, *biotic*, *ecosystem*, *community*, *population*, and *producer*, in oral and written communication

2.5 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., design a multimedia presentation explaining the interrelationships between biotic and abiotic components in a specific ecosystem)*

3. Understanding Basic Concepts

By the end of Grade 7, students will:

3.1 demonstrate an understanding of an ecosystem *(e.g., a log, a pond, a forest)* as a system of interactions between living organisms and their environment

3.2 identify biotic and abiotic elements in an ecosystem, and describe the interactions between them *(e.g., between hours of sunlight and the growth of plants in a pond; between a termite colony and a decaying log; between the soil, plants, and animals in a forest)*

3.3 describe the roles and interactions of producers, consumers, and decomposers within an ecosystem *(e.g., Plants are producers in ponds. They take energy from the sun and produce food, oxygen, and shelter for the other pond life. Black bears are consumers in forests. They eat fruits, berries, and other consumers. By eating other consumers, they help to keep a balance in the forest community. Earthworms are decomposers in soil. They ingest decaying matter in soils and take needed nutrients from it, then return those nutrients to the soil through their castings.)*

3.4 describe the transfer of energy in a food chain and explain the effects of the elimination of any part of the chain

3.5 describe how matter is cycled within the environment and explain how it promotes sustainability *(e.g., bears carry salmon into the forest, where the remains decompose and add nutrients to the soil, thus supporting plant growth; through crop rotation, nutrients for future crops are created from the decomposition of the waste matter of previous crops)*

3.6 distinguish between primary succession *(e.g., the growth of native grasses on a sand dune)* and secondary succession *(e.g., the growth of grasses and shrubs in a ploughed field)* within an ecosystem

3.7 explain why an ecosystem is limited in the number of living things *(e.g., plants and animals, including humans)* that it can support

3.8 describe ways in which human activities and technologies alter balances and interactions in the environment *(e.g., clear-cutting a forest, overusing motorized water vehicles, managing wolf-killings in Yukon)*

3.9 describe Aboriginal perspectives on sustainability and describe ways in which they can be used in habitat and wildlife management *(e.g., the partnership between the Anishinabek Nation and the Ministry of Natural Resources for managing natural resources in Ontario)*

GRADE 7 | UNDERSTANDING STRUCTURES AND MECHANISMS
FORM AND FUNCTION

OVERVIEW

Humans build structures to meet specific needs. In doing so, they must consider many factors, including not only the functions the structures must perform but also the resources available to build them, the intended lifetime of the structures, and the impact of the structures on the environment. In Grade 7, students will continue to learn about the effects of forces that act on and within different structural forms. They will investigate how different structural forms support or withstand loads by designing, building, and testing structures, using increasingly sophisticated techniques. Other factors that affect a structure's functioning, such as type of structure and centre of gravity, will also be explored. It is necessary to provide opportunities for students with special education needs to participate in these or comparable activities.

As students design, build, and test their structures to determine what loads they can support, it is important that they do it in a manner that ensures their personal safety and the safety of others. This includes understanding why it is important to properly dispose of the remains of broken structures and to protect faces and feet from falling objects.

Fundamental Concepts	Big Ideas
Structure and Function Energy	Structures have a purpose. *(Overall expectation 1)* The form of a structure is dependent on its function. *(Overall expectations 1, 2, and 3)* The interaction between structures and forces is predictable. *(Overall expectations 2 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 7, students will:

1. analyse personal, social, economic, and environmental factors that need to be considered in designing and building structures and devices;
2. design and construct a variety of structures, and investigate the relationship between the design and function of these structures and the forces that act on them;
3. demonstrate an understanding of the relationship between structural forms and the forces that act on and within them.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 7, students will:

1.1 evaluate the importance for individuals, society, the economy, and the environment of factors that should be considered in designing and building structures and devices to meet specific needs *(e.g., function; efficiency; ease of use; user preferences; aesthetics; cost; intended lifespan; effect on the environment; safety, health, legal requirements)*

Sample guiding questions: Why is it important for companies to find out what consumers want now and what they might want and/or need in the future? How might this information influence the design and appearance of a structure, the materials it is made from, and so on? What things might a company need to take into account when considering the construction of a new structure that consumers might not consider (e.g., the environmental impact of using certain resources to make the structure, the eventual disposal of the structure)?

1.2 evaluate the impact of ergonomic design on the safety and efficiency of workplaces, tools, and everyday objects *(e.g., furniture, computer equipment, home tools and equipment)*, and describe changes that could be made in personal spaces and activities on the basis of this information *(e.g., use computer keyboards and mice that are ergonomically designed; use kitchen tools such as knives with ergonomic handles; use equipment for household jobs that is designed to ease strain on the body, such as ergonomically designed snow shovels and garden tools)*

Sample guiding questions: What is ergonomics? Why is it important that tools, equipment, and furniture be ergonomically designed? What are some ways in which traditional designs of tools, equipment, and furniture can be changed to be more ergonomic? How might different populations benefit from ergonomic designs (e.g., the elderly, people with physical challenges, students, etc.)?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 7, students will:

2.1 follow established safety procedures for using tools and handling materials *(e.g., wear safety glasses when cutting or drilling)*

2.2 design, construct, and use physical models to investigate the effects of various forces on structures *(e.g., the struts of a roof experience compression forces from shingles; the support cables of a suspension bridge are in tension; a twisted ruler has torsion forces; the pin that holds the two parts of a pair of scissors together has shear forces acting on it)*

2.3 investigate the factors that determine the ability of a structure to support a load *(e.g., the weight of the structure itself; the magnitude of the external loads it will need to support; the strength of the materials used to build it)*

2.4 use technological problem-solving skills (see page 16) to determine the most efficient way for a structure *(e.g., a chair, a shelf, a bridge)* to support a given load

Sample problem: Using the least amount of material (by mass), construct a bridge to support a specific load (e.g., minimum of 4 kilograms).

2.5 investigate methods used by engineers to ensure structural safety *(e.g., incorporating sensors in structures to detect unusual stresses and give early warning of failure; designing structures to carry much heavier loads than they will actually have to bear)*

2.6 use appropriate science and technology vocabulary, including *truss, beam, ergonomics, shear,* and *torsion)*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., use a graphic organizer to show the steps taken in designing and making a product)*

3. Understanding Basic Concepts

By the end of Grade 7, students will:

3.1 classify structures as solid structures *(e.g., dams)*, frame structures *(e.g., goal posts)*, or shell structures *(e.g., airplane wings)*

3.2 describe ways in which the centre of gravity of a structure *(e.g., a child's high chair, a tower)* affects the structure's stability

3.3 identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure

3.4 distinguish between external forces *(e.g., wind, gravity, earthquakes)* and internal forces (tension, compression, shear, and torsion) acting on a structure

3.5 describe the role of symmetry in structures *(e.g., aesthetic appeal, structural stability)*

3.6 identify and describe factors that can cause a structure to fail *(e.g., bad design, faulty construction, foundation failure, extraordinary loads)*

3.7 identify the factors *(e.g., properties of the material as they relate to the product, availability, costs of shipping, aesthetic appeal, disposal)* that determine the suitability of materials for use in manufacturing a product *(e.g., a running shoe)*

GRADE 7 | UNDERSTANDING MATTER AND ENERGY
PURE SUBSTANCES AND MIXTURES

OVERVIEW

By exploring the distinction between pure substances and mechanical mixtures and solutions, students will come to recognize that most matter is either a solution or a mechanical mixture – including most foods and drinks and many medicines, cosmetics, building materials, and cleaning agents. Students will use this information to weigh the social and environmental consequences of the use of various consumer products. The introduction of a scientific model (the particle theory) to describe the particulate nature of matter will provide students with a conceptual basis for learning in this area.

When experimenting with pure substances and mixtures, it is important that students be able to identify and explain the importance of practices that ensure their personal safety and the safety of others. This includes knowing why it is important to handle glassware safely (when using plastic containers is not suitable), to choose and safely use an appropriate heat source, and to use safety goggles or face shields to protect their eyes.

Fundamental Concepts	Big Ideas
Matter Systems and Interactions	Matter can be classified according to its physical characteristics. *(Overall expectations 2 and 3)* The particle theory of matter helps to explain the physical characteristics of matter. *(Overall expectations 2 and 3)* Pure substances and mixtures have an impact on society and the environment. *(Overall expectation 1)* Understanding the characteristics of matter allows us to make informed choices about how we use it. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 7, students will:

1. evaluate the social and environmental impacts of the use and disposal of pure substances and mixtures;
2. investigate the properties and applications of pure substances and mixtures;
3. demonstrate an understanding of the properties of pure substances and mixtures, and describe these characteristics using the particle theory.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 7, students will:

1.1 assess positive and negative environmental impacts related to the disposal of pure substances *(e.g., uranium)* and mixtures *(e.g., paint, sewage)*

Sample issues: (a) Pure substances that are harmful to people or the environment must be disposed of very carefully. That usually means burying them in special landfills or underground chambers that will keep them from getting back into the environment or, if possible, recycling them or converting them into a substance that is not harmful. If these solutions are not possible, then we have to reduce our use of the substance or not use it all. (b) Mixtures that have harmful components must be treated in the same way. Lead-based paint is a mixture that has to be disposed of in special landfills because the lead in it is harmful. Latex paint, which has no harmful components, does not require special treatment. Sometimes, harmful components can be separated from the rest of the mixture, leaving less material for special disposal. Sewage is an example. Solid materials can be removed and decomposed by bacteria, leaving water that can be returned to lakes and rivers. The leftover sludge can be buried or, if it does not contain toxic materials, converted into fertilizer. (c) Nuclear power stations produce no air pollutants, but the used uranium fuel rods remain dangerously radioactive for thousands of years. What options have been proposed for disposing of this waste? How safe are they? How would these concerns affect your decision about whether to heat your home by using electricity that is provided by nuclear energy?

1.2 assess the impact on society and the environment of different industrial methods of separating mixtures and solutions

Sample guiding questions: Why might oil refineries be located away from populated areas? How do air purification systems make air healthier for people to breathe? What are the impacts on the environment of the evaporation process used in making maple syrup?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 7, students will:

2.1 follow established safety procedures for handling chemicals and apparatus *(e.g., wash hands after handling chemicals, take note of universal warning symbols)*

2.2 use scientific inquiry/experimentation skills (see page 12) to investigate factors *(e.g., temperature, type of solute or solvent, particle size, stirring)* that affect the solubility of a substance and the rate at which substances dissolve

2.3 investigate processes *(e.g., filtration, distillation, settling, magnetism)* used for separating different mixtures

Sample problem: Use filtration and magnetism to separate a mixture of water, sand, and paperclips. Use filtration to separate marbles of different sizes. Use evaporation to separate dissolved salt from water.

2.4 use scientific inquiry/experimentation skills (see page 12) to investigate the properties of mixtures and solutions *(e.g., the amount of solute required to form a saturated solution; differences between pure substances and mixtures)*

Sample guiding questions: How does changing the amount of solute or solvent affect the solution? What factors affect the amount of solute that can dissolve in a solvent? What factors affect the speed at which a solute dissolves?

2.5 use appropriate science and technology vocabulary, including *mechanical mixture, solution, solute, insoluble, saturated, unsaturated,* and *dilute*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using appropriate mathematical conventions, make a scatter plot to show the relationship between solute, solvent, and temperature)*

3. Understanding Basic Concepts

By the end of Grade 7, students will:

3.1 distinguish between pure substances *(e.g., distilled water, salt, copper pipe)* and mixtures *(e.g., salad dressing, chocolate chip cookies)*

3.2 state the postulates of the particle theory of matter (all matter is made up of particles; all particles are in constant motion; all particles of one substance are identical; temperature affects the speed at which particles move; in a gas, there are spaces between the particles; in liquids and solids, the particles are close together and have strong forces of attraction between them)

3.3 use the particle theory to describe the difference between pure substances (which have identical particles) and mixtures (which have different particles)

3.4 distinguish between solutions and mechanical mixtures

3.5 describe the processes *(e.g., evaporation, sifting, filtration, distillation, magnetism)* used to separate mixtures or solutions into their components, and identify some industrial applications of these processes *(e.g., use of cheesecloth to separate seeds and skins from juice and pulp to make fruit jellies; use of evaporation in maple syrup production; use of different sizes of sieves to separate wheat grains in white bread production; use of strainers in industries to separate slurry into solids and liquids)*

3.6 identify the components of a solution *(e.g., solvent, solute)*

3.7 identify solutes and solvents in various kinds of solutions *(e.g., copper and tin in bronze; iodine and alcohol in iodine solution)*

3.8 describe the concentration of a solution in qualitative terms *(e.g., dilute, concentrated)* and in quantitative terms *(e.g., 5 grams of salt in 1000 ml of water)*

3.9 describe the difference between saturated and unsaturated solutions

3.10 explain why water is referred to as the universal solvent

GRADE 7 | UNDERSTANDING EARTH AND SPACE SYSTEMS
HEAT IN THE ENVIRONMENT

OVERVIEW

Heat energy plays a critical role in natural processes and in human life. Global warming has also focused considerable attention on the processes that control temperatures at the earth's surface. By acquiring a working understanding of the nature of heat, students in Grade 7 will gain new insights into the ways that heat affects our world. Students will learn about the causes and effects of heat, investigate its properties, relate it to geological and meteorological processes, and use their new-found knowledge to design a device to minimize heat transfer. They will also use the particle theory to help them explain their observations.

Experiments with heat require that students identify and explain the importance of practices that ensure their personal safety and the safety of others. This includes knowing why very hot water should always be carried in a closed container (e.g., an insulated flask) and why they should stand when heating things and hold objects that are being heated well away from themselves.

Fundamental Concepts	Big Ideas
Energy Sustainability and Stewardship Systems and Interactions	Heat is a form of energy that can be transformed and transferred. These processes can be explained using the particle theory of matter. *(Overall expectations 2 and 3)* There are many sources of heat. *(Overall expectation 3)* Heat has both positive and negative effects on the environment. *(Overall expectation 1)*

OVERALL EXPECTATIONS

By the end of Grade 7, students will:

1. assess the costs and benefits of technologies that reduce heat loss or heat-related impacts on the environment;
2. investigate ways in which heat changes substances, and describe how heat is transferred;
3. demonstrate an understanding of heat as a form of energy that is associated with the movement of particles and is essential to many processes within the earth's systems.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 7, students will:

1.1 assess the social and environmental benefits of technologies that reduce heat loss or transfer *(e.g., insulated clothing, building insulation, green roofs, energy-efficient buildings)*

Sample guiding questions: (a) Insulated clothing protects our bodies and increases our ability to enjoy outdoor activities in winter. What science and technology concepts are at work in coats designed for use in cold weather? Who might be interested in such designs? (b) A well-insulated home is more comfortable and costs less to heat. Reducing heat loss saves energy, and saving energy reduces the environmental impact of energy production. What are some areas of your home where heat might be lost? How can this heat loss be counteracted? What are the benefits of doing so? (c) Green roofs save on heating and cooling costs and reduce the amount of insulation that is needed. But they have not gained wide acceptance in Ontario. What might be some deterrents to having a green roof? How might these deterrents be overcome? (d) Energy-efficient buildings are extremely airtight compared to conventionally constructed buildings. This minimizes the amount of warm (or cool) air that can pass through the structure. What are some of the disadvantages to having airtight buildings (e.g., lack of fresh air, moisture buildup)? How can these problems be solved (e.g., through mechanical ventilation systems with heat recovery and humidity control), and how effective are the solutions?

1.2 assess the environmental and economic impacts of using conventional *(e.g., fossil fuel, nuclear)* and alternative forms of energy *(e.g., geothermal, solar, wind, wave, biofuel)*

Sample issues: (a) Your family is building a new home. Present a case for installing a geothermal heat pump. In your discussion, be sure to include the benefits and costs from both an environmental perspective and an economic perspective. (b) Make a case for (or against) using rural land or marginal land-use areas for wind turbine farms.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 7, students will:

2.1 follow established safety procedures for using heating appliances and handling hot materials *(e.g., use protective gloves when removing items from hot plates)*

2.2 investigate the effects of heating and cooling on the volume of a solid, a liquid, and a gas

2.3 use technological problem-solving skills (see page 16) to identify ways to minimize heat loss

Sample problem: Use the materials provided to create a product (e.g., a model of a piece of winter clothing, a model of a wet suit, a model travel mug for a hot beverage or food item) that will minimize heat loss

2.4 use scientific inquiry/experimentation skills (see page 12) to investigate heat transfer through conduction, convection, and radiation

Sample problem (conduction): After letting spoons made of different materials sit partially submerged in a container of hot water, measure the temperature of the parts sticking out of the water. What conclusions can you draw from your findings?

2.5 use appropriate science and technology vocabulary, including *heat, temperature, conduction, convection,* and *radiation,* in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using the conventions of science, create a labelled diagram to illustrate convection in a liquid or a gas)*

3. Understanding Basic Concepts

By the end of Grade 7, students will:

3.1 use the particle theory to compare how heat affects the motion of particles in a solid, a liquid, and a gas

3.2 identify ways in which heat is produced *(e.g., burning fossil and renewable fuels, electrical resistance, physical activity)*

3.3 use the particle theory to explain the effects of heat on volume in solids *(e.g., rails, sidewalks, and bridge segments expand in hot weather)*, liquids *(e.g., sea levels are rising partly because global warming is making the oceans warmer and the water in them is expanding)*, and gases *(e.g., the air in car tires expands on hot pavement)*

3.4 explain how heat is transmitted through conduction *(e.g., the transmission of heat from a stove burner to a pot and from the pot to the pot handle)*, and describe natural processes that are affected by conduction *(e.g., the formation of igneous and metamorphic rocks and diamonds)*

3.5 explain how heat is transmitted through convection, and describe natural processes that depend on convection *(e.g., thunderstorms, land and sea breezes)*

3.6 explain how heat is transmitted through radiation, and describe the effects of radiation from the sun on different kinds of surfaces *(e.g., an ice-covered lake, a forest, an ocean, an asphalt road)*

3.7 describe the role of radiation in heating and cooling the earth, and explain how greenhouse gases affect the transmission of radiated heat through the atmosphere *(e.g., The earth is warmed by absorbing radiation from the sun. It cools by radiating thermal energy back to space. Greenhouse gases absorb some of the radiation that the earth emits to space and reradiate it back to the earth's surface. If the quantity of greenhouse gases in the atmosphere increases, they absorb more outgoing radiation, and the earth becomes warmer.)*

3.8 identify common sources of greenhouse gases *(e.g., carbon dioxide comes from plant and animal respiration and the burning of fossil fuels; methane comes from wetlands, grazing livestock, termites, fossil fuel extraction, and landfills; nitrous oxide comes from soils and nitrogen fertilizers)*, and describe ways of reducing emissions of these gases

GRADE **8**

GRADE 8 | UNDERSTANDING LIFE SYSTEMS
CELLS

OVERVIEW

Cells are the smallest unit of life, and each cell is a system nested within a system. In Grade 8, students will continue to develop their knowledge of organisms by focusing on the structure and function of cells in plants and animals. Our knowledge of cells has increased enormously since the middle of the twentieth century, and students will examine the implications of this knowledge for individuals, society, and the environment.

Students will also be introduced to the use of microscopes. These are invaluable tools for scientists and provide students with opportunities to explore objects in amazing detail. Microscopes are precision instruments and must be handled with great care. It is important that students be able to identify and explain the importance of practices for handling and using microscopes that not only respect the fragility of the tool but also ensure their personal safety and the safety of others.

Fundamental Concepts	Big Ideas
Systems and Interactions Structure and Function	Cells are the basis of life. *(Overall expectations 2 and 3)* Cells organize into tissues, tissues into organs, organs into organ systems, and organ systems into organisms. *(Overall expectations 2 and 3)* Healthy cells contribute to healthy organisms. *(Overall expectations 1 and 2)* Systems are interdependent. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 8, students will:

1. assess the impact of cell biology on individuals, society, and the environment;
2. investigate functions and processes of plant and animal cells;
3. demonstrate an understanding of the basic structure and function of plant and animal cells and cell processes.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 8, students will:

1.1 assess the role of selected technologies *(e.g., the development of the electron microscope, the ability to infuse dyes into cells, in vitro fertilization)* in enhancing our understanding of cells and cellular processes

Sample guiding questions: How have electron microscopes helped our understanding of cells and cell processes? What are some disadvantages of using this technology that might affect its availability or effectiveness? How might infusing dye into cells be a useful tool for diagnosing and/or treating diseases, or for understanding how cells work? How might the understanding of cells and cell processes help in treating disease?

1.2 assess the potential that our understanding of cells and cell processes has for both beneficial and harmful effects on human health and the environment, taking different perspectives into account *(e.g., the perspectives of farmers, pesticide manufacturers, people with life-threatening illnesses)*

Sample issues: (a) Medical scientists can identify changes in a cell or in chromosomes that signal the development of medical problems. But because of the cost of the procedure, this service may not be available to everyone. (b) Scientists can develop pest-resistant crops that reduce the need for chemical pesticides. But there are some concerns that these crops may cross-breed with native plants and disrupt natural populations and balances.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 8, students will:

2.1 follow established safety procedures for handling apparatus and materials *(e.g., wash hands after preparing materials for slides)* and use microscopes correctly and safely *(e.g., carry the microscope with both hands, place it near the centre of the desk, ensure that the sun cannot be directly focused through the instrument when sunlight is used for illumination, keep both eyes open when viewing to avoid eye strain)*

2.2 use a microscope correctly and safely to find and observe components of plant and animal cells *(e.g., using an onion slice or a prepared slide of a protist)* and make accurate drawings of their observations

2.3 prepare dry- and wet-mount slides of a variety of objects for use with a microscope *(e.g., a piece of newspaper, a hair)*

2.4 use scientific inquiry/experimentation skills (see page 12) to investigate the processes of osmosis and diffusion

Sample guiding questions: What question will your experiments try to answer? What do you predict might happen in your experiment? What variables might you need to consider? What conclusions might you draw from the results of your experiment? How closely do your predictions compare with what you actually observed in your experiments? How might what you have learned about osmosis and diffusion be useful in daily life (e.g., how might this help you to keep your houseplants from wilting?)

2.5 use appropriate science and technology vocabulary, including *organelle, diffusion, osmosis, cell theory, selective permeability, membrane, stage,* and *eyepiece*, in oral and written communication

2.6 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using the conventions of science, make a labelled drawing of a cell; create a slide show to explain the results of investigations into the processes of osmosis and diffusion)*

3. Understanding Basic Concepts

By the end of Grade 8, students will:

3.1 demonstrate an understanding of the postulates of the cell theory *(e.g., the cell is the basic unit of life; all cells come from pre-existing cells; all living things are made up of one or more cells)*

3.2 identify structures and organelles in cells, including the nucleus, cell membrane, cell wall, chloroplasts, vacuole, mitochondria, and cytoplasm, and explain the basic functions of each *(e.g., the nucleus holds all the information needed to make every cell in the body)*

3.3 compare the structure and function of plant and animal cells

3.4 explain the processes of diffusion and osmosis and their roles within a cell

3.5 identify unicellular organisms *(e.g., amoebae)* and multicellular organisms *(e.g., hydra, invertebrates [worms], vertebrates [frogs])*, and compare ways in which they meet their basic needs *(e.g., nutrition, movement, gas exchange)*

3.6 describe the organization of cells into tissues, organs, and systems *(e.g., groups of cells with similar functions combine to make up tissues; groups of tissues with similar functions combine to make organs; groups of organs work together as organ systems)*

GRADE 8 | UNDERSTANDING STRUCTURES AND MECHANISMS
SYSTEMS IN ACTION

OVERVIEW

The smooth functioning of society depends on a great number and variety of systems. The needs of society can influence the evolution of established systems or demand the introduction of new ones. Whether large or small, human, mechanical, or natural, all systems consist of many components that can be studied and improved. Students will learn to calculate the mechanical advantage of mechanical systems, and will learn about the overall safety, efficiency, and effectiveness of a variety of systems. It is necessary to provide opportunities for students with disabilities to participate in these or comparable activities.

When making and/or experimenting with and testing devices or structures, it is important that students be able to identify and explain the importance of practices that ensure their personal safety and the safety of others. This includes knowing the correct way to use tools and equipment, knowing when and how to use protective eyewear, and knowing how to operate electricity and electrical systems safely.

Fundamental Concepts	Big Ideas
Systems and Interactions Continuity and Change	Systems are designed to accomplish tasks. *(Overall expectations 1, 2, and 3)* All systems include an input and an output. *(Overall expectations 2 and 3)* Systems are designed to optimize human and natural resources. *(Overall expectations 1 and 3)*

OVERALL EXPECTATIONS

By the end of Grade 8, students will:

1. assess the personal, social, and/or environmental impacts of a system, and evaluate improvements to a system and/or alternative ways of meeting the same needs;
2. investigate a working system and the ways in which components of the system contribute to its desired function;
3. demonstrate an understanding of different types of systems and the factors that contribute to their safe and efficient operation.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 8, students will:

1.1 assess the social, economic, and environmental impacts of automating systems

Sample issues: (a) Automation was feared by some people who believed that replacing humans with automated systems would lead to high unemployment. However, others argued that automation would actually lead to higher employment, because it freed some of the labour force to enter higher-skilled, higher-paying jobs. (b) Although automation is often viewed as a way to minimize human error in systems, as the degree and sophistication of automation increase so do the chances of more serious errors and their consequences. (c) The effects of automation can be environmentally disastrous. Serious pollution coincided with the development of factories and the widespread use of coal to run their machinery. Although factories and automation continue to exist, we are more aware of what these systems can do to the environment. (d) Mass-produced furniture is made of low-quality materials, lacks durability, and involves minimal original craftsmanship, and it therefore can be purchased at a reasonable price. However, many consumers tend to discard it readily, and it often is sent to landfills, thus creating environmental problems.

1.2 assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration

Sample issues: (a) A large city decides that it will put in more bicycle lanes and bikeways instead of expanding its existing public transit system. (b) A school system decides to have students and teachers in school year-round, instead of having everyone on vacation in July and August.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 8, students will:

2.1 follow established safety procedures for working with apparatus, tools, materials, and electrical systems *(e.g., tie hair back before working with drills, saws, and sanders)*

2.2 investigate the work done in a variety of everyday activities and record the findings quantitatively *(e.g., calculate the work done when lifting dumbbells by measuring the force required to move the dumbbell and multiplying by the distance the dumbbell moves)*

2.3 use scientific inquiry/experimentation skills (see page 12) to investigate mechanical advantage in a variety of mechanisms and simple machines

Sample problems: Conduct experiments to determine what happens when the length of the effort arm and/or the load arm in a lever are changed, and note qualitative or quantitative changes in mechanical advantage. Conduct experiments to determine what happens when the diameter of the piston in a hydraulic system is changed, and note qualitative or quantitative changes in mechanical advantage. Conduct experiments to determine what happens when the number of pulleys that support a load is changed, and note qualitative or quantitative changes in mechanical advantage.

2.4 use technological problem-solving skills (see page 16) to investigate a system *(e.g., an optical system, a mechanical system, an electrical system)* that performs a function or meets a need

Sample problem: Create a device that will carry a snack from one place to another. Describe the function of each component part, and examine the effects of making a change to one or more of the components.

Sample guiding questions: What purpose or need does your device fulfil? When you tested your device, which component or components worked as intended? Which did not? Why do you think the problem occurred? Predict what will happen if you remove or change the size or direction of one or more of the components.

2.5 investigate the information *(e.g., owner's manual for a car, weather advisories for a region, pest forecasts/warnings for a crop/region)* and support *(e.g., a technical support line for computers)* provided to consumers/clients to ensure that a system functions safely and effectively

Sample guiding questions: What are the criteria for a good owner's manual (for a car, an MP3 player, etc.) or for an effective help or support service? Why is it important to have this kind of information? What other information might have been included to make the manual more helpful? How might the help or support service be improved? What might be some consequences of not having this kind of help and support?

2.6 use appropriate science and technology vocabulary, including *mechanical advantage, input, output, friction, gravity, forces,* and *efficiency*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using appropriate mathematical conventions, create a graph to represent changes in mechanical advantage when certain factors in a mechanism are manipulated)*

3. Understanding Basic Concepts

By the end of Grade 8, students will:

3.1 identify various types of systems *(e.g., mechanical systems, body systems, optical systems, mass transit systems, Aboriginal clan systems, health care systems)*

3.2 identify the purpose, inputs, and outputs of various systems *(e.g., a garden – purpose: to grow things; input: seeds, water, fertilizer; output: flowers, food)*

3.3 identify the various processes and components of a system *(e.g., robot, front-end loader/backhoe, heating system, transportation system, health care system)* that allow it to perform its function efficiently and safely

3.4 compare, using examples, the scientific definition with the everyday use of the terms *work*, *force*, *energy*, and *efficiency*

3.5 understand and use the formula work = force × distance ($W = F \times d$) to establish the relationship between work, force, and distance moved parallel to the force in simple systems

3.6 calculate the mechanical advantage (MA = force needed without a simple machine divided by force needed with a simple machine) of various mechanical systems *(e.g., a wheelbarrow allows a smaller force to lift a larger weight, a hockey stick allows a short movement of hands to move the blade a larger distance, a simple fixed pulley system redirects the effort force)*

3.7 explain ways in which mechanical systems produce heat, and describe ways to make these systems more efficient *(e.g., friction produces heat, which can be reduced by lubrication)*

3.8 describe systems that have improved the productivity of various industries *(e.g., robotic systems have increased the rate of production in factories that assemble the fine parts of wrist watches)*

3.9 identify social factors that influence the evolution of a system *(e.g., growing concern over the amount of waste creates a need for recycling centres, and the recycling centres must grow as population and waste increase; the desire to make tasks easier creates a need for pulley systems, gear systems, and hydraulic and pneumatic systems; changes in traditional work hours created by technological advances can influence changes in a child care system)*

GRADE 8 | UNDERSTANDING MATTER AND ENERGY
FLUIDS

OVERVIEW

Fluids are essential to many industrial processes and form the basis of hydraulic and pneumatic devices. Any substance that flows is considered to be a fluid. This includes such things as water, shampoo, sunscreen, and honey. Even gases, such as air, can be classified as fluids. Students will learn about the diverse applications of the principles involved in fluid mechanics, the impacts of technological innovations based on the properties of fluids, and the industries and jobs related to fluids. To learn about the properties of fluids, students will experiment with and investigate the viscosity and density of different liquids and ways in which these properties affect objects placed in those liquids. Students will explore the implications of Archimedes' principle by investigating and measuring the buoyant forces on different objects.

When designing, building, and testing devices, it is important that students be able to identify and explain the importance of practices that ensure their personal safety and the safety of others. This includes being able to recognize and remedy possible safety hazards in testing situations and knowing how to use joining equipment and materials properly and safely.

Fundamental Concepts	Big Ideas
Matter Systems and Interactions	Fluids are an important component of many systems. *(Overall expectations 1, 2, and 3)* Fluids have different properties that determine how they can be used. *(Overall expectations 1, 2, and 3)* Fluids are essential to life. *(Overall expectation 3)*

OVERALL EXPECTATIONS

By the end of Grade 8, students will:

1. analyse how the properties of fluids are used in various technologies, and assess the impact of these technologies on society and the environment;
2. investigate the properties of fluids;
3. demonstrate an understanding of the properties and uses of fluids.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 8, students will:

1.1 assess the social, economic, and environmental impacts of selected technologies that are based on the properties of fluids

Sample issues: (a) The use of heavy hydraulic equipment on construction sites increases productivity. It also reduces the need for manual labourers. (b) Dialysis and blood-separation techniques have decreased mortality rates. But the costs of the equipment can mean that the service is not available to everyone who needs it.

1.2 assess the impact of fluid spills on society and the environment, including the cost of the cleanup and the effort involved

Sample issues: An oil tanker spills its load in B.C.'s inside coastal waters. A fuel truck jackknifes and is leaking gasoline onto a major highway and into local groundwater. A farm truck moving down a country road is leaking liquid fertilizer. The family car is in need of repair – there is brake fluid running down the driveway.

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 8, students will:

2.1 follow established safety practices for using apparatus, tools, and materials *(e.g., use syringes and tubing for the purposes for which they were designed)*

2.2 determine the mass-to-volume ratio of different amounts of the same substance *(e.g., water, corn syrup, copper pennies)*

2.3 investigate and compare the density of a variety of liquids *(e.g., water, salt water, corn syrup, liquid soap)*

Sample problem: Construct and calibrate a hydrometer and use it to find the density of a variety of liquids.

2.4 investigate applications of the principles of fluid mechanics *(e.g., in aeronautical research, shipping, food services, plumbing, hydrodynamic engineering)*

2.5 use scientific inquiry/experimentation skills (see page 12) to identify factors that affect the flow rates of various fluids

Sample problem: Devise an experiment to find out how the flow rate of a fluid is affected by changing its temperature; by changing the angle or tilt at which it is poured; by changing the diameter of the tube through which it is poured.

2.6 use technological problem-solving skills (see page 16) to design, build, and test devices that use pneumatic or hydraulic systems

Sample problem: Use your knowledge of Pascal's law to design, construct, and test a working model of a device (e.g., a dentist's chair, an automobile hoist, a hydraulic brake, a backhoe) that operates using hydraulics and/or pneumatics.

2.7 use appropriate science and technology vocabulary, including *viscosity, density, particle theory of matter, hydraulic,* and *pneumatic,* in oral and written communication

2.8 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g., using appropriate scientific and/or technological conventions, create a technical drawing of a pneumatic/hydraulic device; create a brochure or a multimedia presentation outlining safe and unsafe uses of the device that was modelled)*

3. Understanding Basic Concepts

By the end of Grade 8, students will:

3.1 demonstrate an understanding of viscosity and compare the viscosity of various liquids *(e.g., water, syrup, oil, shampoo, ketchup)*

3.2 describe the relationship between mass, volume, and density as a property of matter

3.3 explain the difference between solids, liquids, and gases in terms of density, using the particle theory of matter *(e.g., in general, solids are more dense than liquids, which are more dense than gases)*

3.4 explain the difference between liquids and gases in terms of their compressibility *(e.g., gases are more compressible than liquids)* and how their compressibility affects their usage *(e.g., pneumatic devices are used to operate bus doors because they work over a larger temperature range and are safer for this purpose than hydraulic devices)*

3.5 determine the buoyancy of an object, given its density, in a variety of fluids *(e.g., less dense objects float, more dense objects sink)*

3.6 explain in qualitative terms the relationship between pressure, volume, and temperature when a liquid *(e.g., water)* or a gas *(e.g., air)* is compressed or heated

3.7 explain how forces are transferred in all directions in fluids (Pascal's law)

3.8 compare the ways in which fluids are used and controlled in living things to the ways in which they are used and controlled in manufactured devices *(e.g., compare the role of valves in the circulatory system to the role of valves in an internal combustion engine; compare the role of a fish's swim bladder to the role of the ballast tanks in a submarine)*

GRADE 8 | UNDERSTANDING EARTH AND SPACE SYSTEMS
WATER SYSTEMS

OVERVIEW

More than 70 per cent of the earth's surface is covered with water, and most of this water is found in the oceans. In learning about the earth's water systems, students will develop an understanding of the important role that water systems play in global ecosystems. They will evaluate the role media play in portraying controversial water issues and research recent technological innovations related to Earth's water systems. Students will gain a basic understanding of Earth's water systems and come to a better understanding of their own role in caring for this precious resource.

It is important that students be able to identify and explain the importance of practices that ensure their personal safety and the safety of others. This includes making the teacher aware of any potential allergic reactions (e.g., to bee stings), wearing the clothing and footwear appropriate for the conditions they are working in, and staying within the area of study.

Fundamental Concepts	Big Ideas
Sustainability and Stewardship Systems and Interactions Change and Continuity	Water is crucial to life on Earth. *(Overall expectations 1 and 2)* Water systems influence climate and weather patterns. *(Overall expectation 3)* Water is an important resource that needs to be managed sustainably. *(Overall expectations 1 and 2)*

OVERALL EXPECTATIONS

By the end of Grade 8, students will:

1. assess the impact of human activities and technologies on the sustainability of water resources;
2. investigate factors that affect local water quality;
3. demonstrate an understanding of the characteristics of the earth's water systems and the influence of water systems on a specific region.

SPECIFIC EXPECTATIONS

1. Relating Science and Technology to Society and the Environment

By the end of Grade 8, students will:

1.1 evaluate personal water consumption, compare it with personal water consumption in other countries, and propose a plan of action to reduce personal water consumption to help address water sustainability issues

1.2 assess how various media sources (*e.g., Canadian Geographic; the science section in newspapers; Internet websites; local, national, and international news on television and radio)* address issues related to the impact of human activities on the long-term sustainability of local, national, or international water systems

Sample issues: (a) You are doing research on the implications of exporting water from Canada to other countries. Your sources are a national newspaper, a scientific magazine, and some selected Internet sites. Each has a slightly different opinion on the issue. (b) A farmer wants to ensure that her nutrient management strategies are not adversely affecting the local water system. She consults the agriculture section of a local newspaper, a Canadian magazine with an environmental focus, and local farm reports. She finds conflicting information. (c) The Protocol for Safe Drinking Water in First Nations Communities addresses drinking water concerns in First Nations communities. Various government agencies, news agencies, and interest groups have different perspectives on its development and release.

Sample guiding questions: How does each of these texts address the purpose and the intended audience for the piece? Are there implied messages in the text, and if so, what are they? How does the information in each of the texts compare? Why might they take different positions? What different groups are represented in the texts? How does each text capture and maintain the interest of the reader? Why might different people or groups of people react differently to these texts?

1.3 assess the impact on local and global water systems of a scientific discovery or technological innovation *(e.g., enhancing the efficiency of naturally occurring bacteria that consume hydrocarbons from oil spills and convert them to carbon dioxide and water; development of desalination techniques to provide fresh water from sea water)*

Sample issues: (a) Bioremediation (e.g., the use of microorganisms to clean up contaminated soil or water) can eliminate contamination in many environments with a speed and thoroughness much greater than traditional methods and at significantly lower costs. However, it is effective on a limited number of contaminants; in some cases, the time involved is relatively long; and considerable knowledge and experience are needed to design and implement a successful bioremediation program. (b) Desalination is a method that allows sea water to be made into fresh water. The cost to do this is declining, while extracting water from rivers and lakes is becoming more expensive as well as ecologically harmful, and groundwater in many locations is depleted. However, not every area that needs a supply of fresh water is on a coastline.

Sample guiding questions: What scientific discoveries or technologies are currently affecting Earth's water systems? What kind of an impact are these advances having on water systems? What discoveries or technologies are available (or in development) that can help clean our water systems?

2. Developing Skills of Scientific Investigation and Technological Problem Solving

By the end of Grade 8, students will:

2.1 follow established safety procedures for the use of apparatus and chemicals *(e.g., when using water-testing equipment and water-testing chemicals)*

2.2 investigate how municipalities process water *(e.g., obtain it, test it, and treat it)* and manage water *(e.g., distribute it, measure consumption, and dispose of waste water)*

2.3 test water samples for a variety of chemical characteristics *(e.g., pH, salinity, chlorine)*

Sample problem: Test the pH, salinity, and chlorine content of tap water, rain water, bottled water, filtered water, and water from a variety of other sources such as streams, rivers, ponds, or lakes. Record and compare the findings and draw conclusions from them.

2.4 use scientific inquiry/research skills (see page 15) to investigate local water issues

Sample guiding questions: Where does your local water supply come from? How is water used in the area where you live? How does the use of water in your community affect the local water supply? How might you find out? What are some local issues regarding the water supply for your area? Why have these become issues? How are they currently being addressed by your city, town, or region? How might you and your family have become aware of the issue? What are some things that you think others should know about their local water supply and how it is managed?

2.5 use technological problem-solving skills (see page 16) to design, build, and test a water system device that performs a practical function or meets a need

Sample problem: Design, build, and test a filtration device that makes unclean water clean; build a working model of an irrigation system.

2.6 use appropriate science and technology vocabulary, including *water table, aquifer, polar ice-cap,* and *salinity*, in oral and written communication

2.7 use a variety of forms *(e.g., oral, written, graphic, multimedia)* to communicate with different audiences and for a variety of purposes *(e.g. using appropriate scientific conventions, draw a labelled diagram of a water treatment facility; create a brochure about the safe use of wells and septic tanks)*

3. Understanding Basic Concepts

By the end of Grade 8, students will:

3.1 identify the various states of water on the earth's surface, their distribution, relative amounts, and circulation, and the conditions under which they exist *(e.g., water is a solid in glaciers, snow, and polar ice-caps; a liquid in oceans, lakes, rivers, and aquifers; and a gas in the atmosphere)*

3.2 demonstrate an understanding of the watershed as a fundamental geographic unit, and explain how it relates to water management and planning

3.3 explain how human and natural factors cause changes in the water table *(e.g., lawn watering, inefficient showers and toilets, drought, floods, overuse of wells, extraction by bottled water industry)*

3.4 identify factors *(e.g., annual precipitation, temperature, climate change)* that affect the size of glaciers and polar ice-caps, and describe the effects of these changes on local and global water systems

3.5 explain changes in atmospheric conditions caused by the presence of bodies of water *(e.g., differences in temperature near large bodies of water; microclimates; storms off coastal areas)*

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