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Ministry of Education
and Training

The Ontario Curriculum
Grades 1-8

Science and Technology

1998

Contents

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Preface

The Ministry of Education and Training wishes to acknowledge the contributions of the many individuals, groups, and organizations that participated in the development of *The Ontario Curriculum, Grades 1-8: Science and Technology, 1998*. The document was developed through a collaboration between the Ministry of Education and Training and participants in the Assessment of Science and Technology Achievement Project (ASAP), which was coordinated by the Science Education Group at York University. The following boards of education* participated in the project and contributed to the development of this document with the assistance of a Technology Advisory Group:

- Board of Education for the City of London
- Dufferin-Peel Roman Catholic Separate School Board
- Durham Board of Education
- Halton Board of Education
- Metropolitan Separate School Board
- Metropolitan Toronto School Board
  - Board of Education for the Borough of East York
  - Board of Education for the City of Etobicoke
  - Board of Education for the City of North York
  - Board of Education for the City of Scarborough
  - Board of Education for the City of Toronto
  - Board of Education for the City of York
  - Conseil des écoles françaises de la communauté urbaine de Toronto
- Ottawa Board of Education
- Peel Board of Education
- Simcoe County Board of Education
- Waterloo County Board of Education
- York Region Board of Education

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* The names of the boards of education are the names that were current at the time of the development of this document.

Introduction

The Purpose of *The Ontario Curriculum, Grades 1-8: Science and Technology, 1998*

Students graduating from Ontario schools require the scientific and technological knowledge and skills that will enable them to be productive members of society. They also need to develop attitudes that will motivate them to use their knowledge and skills in a responsible manner. *The Ontario Curriculum, Grades 1-8: Science and Technology, 1998* outlines the knowledge and skills that students must develop in Grades 1 to 8, as well as the levels of achievement at which they are expected to master them. It is these levels that teachers will use to assess students' achievement.

Students must develop a thorough knowledge of basic concepts which they can apply in a wide range of situations. They must also develop the broad-based skills that are so important for effective functioning in the world of work: they must learn to identify and analyse problems and to explore and test solutions in a wide variety of contexts. This firm conceptual base and these essential skills are at the heart of the science and technology curriculum and must be the focus of teaching and learning in the classroom. The knowledge and skills outlined in this document are also consistent with the goals of science education in Canada outlined in the *Common Framework of Science Learning Outcomes, K to 12* (Council of Ministers of Education, Canada, 1997).

This document replaces the sections of *The Common Curriculum: Policies and Outcomes, Grades 1-9, 1995* that relate to science and technology. All science and technology programs for Grades 1 to 8 will be based on the expectations outlined in this document.

What Are Science and Technology?

Science is a form of knowledge that seeks to describe and explain the natural and physical world and its place in the universe. Occasionally, the fundamental theories, concepts, and structures of science change but, for the most part, the basic ideas of science – ideas such as the cellular basis of life, the laws of energy, the particle theory of matter – have proven stable. The curriculum outlined in this document will introduce students to many of these basic ideas. For example, in Grade 7 students are expected to compare the motion of particles in a solid, liquid, and gas using the particle theory.

Technology includes much more than the knowledge and skills related to computers and their applications. 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 solve a specific problem using materials, energy, and tools (including computers). The method of technology consists of inventing or modifying devices, structures, systems, or processes. In Grade 5, for example, students are expected to design devices that can transform one form of energy into another.

Science is not only a body of knowledge but "a way of knowing". Scientific investigation involves exploration, experimentation, observation and measurement, and analysis and dissemination of data. These activities require specific skills and habits of mind; for example, accuracy, discipline, and integrity in the application of scientific principles are fundamental to scientific activity. The science and technology curriculum is designed to develop these skills and habits of mind. In Grade 4, for example, students are expected to describe, using their own observations, the behaviour of light and identify some of the basic characteristics of light.

Technology is also "a way of knowing" and a process of exploration and experimentation. Technological investigation involves the application of methods known as design processes, which in turn involve the use of concepts and procedures such as the identification of a need or problem and the selection of a best solution. In Grade 4, for example, students are expected to design, make, and test an optical device (e.g., a periscope, a kaleidoscope).

Science and technology both exist in a broader social and economic context. They are affected by the values and choices of individuals and governments and in turn have a significant impact on society. 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 body, and of the ways in which living things interact; technology has revolutionized the way we communicate and 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 that they learn to relate their knowledge of science and technology to the world beyond the school. For example, in Grade 6, students are expected to devise a plan for reducing the consumption of electricity at home or at school and to assess how such a plan could affect the use of natural resources and the economy (e.g., jobs).

The Goals of Science and Technology Education

The goals of science and technology education in Grades 1 to 8 follow from the nature of science and technology and from the needs of Ontario's students discussed above. The goals are intended to ensure that all students acquire a basic scientific literacy and technological capability before entering secondary school. The goals for students are:

- to understand the basic concepts of science and technology;
- to develop the skills, strategies, and habits of mind required for scientific inquiry and technological design; and
- to relate scientific and technological knowledge to each other and to the world outside the school.

These goals are equally important. They can be achieved simultaneously through learning activities that combine the acquisition of knowledge with both inquiry and design processes in a concrete, practical context. At the same time, these learning activities must enable students to develop the communication skills that are an essential component of science and technology education.

Features of the New Curriculum for Science and Technology

The science and technology curriculum described in this document differs from previous curricula in several important ways. These are outlined below.

- The knowledge and skills that students are expected to acquire are identified for each grade. Previous curricula focused on outcomes for the end of Grades 3, 6, and 9.
- The subject areas of science and technology are combined. Some of the expectations focus on science, some on technology, while others deal with relating science and technology to each other and to the world outside the school.
- Some concepts and skills are introduced earlier and are given more rigorous treatment. For example, the particle theory and the distinction between heat and temperature, formerly taught in Grade 10, are now introduced in Grade 7.
- A greater number of technology concepts and processes are included and they are introduced earlier. For example, the design process and control systems are introduced in Grade 1.
- There is greater emphasis on earth and space science, in keeping with expectations in other provinces. For example, the curriculum for Grade 6 includes an introduction to astronomy. (Astronomy has been an optional topic in Grade 10 in Ontario since 1987.)
- Greater emphasis is placed in the expectations on relating science and technology to each other and to the world outside the school and on the need for sustainable development. Students' understanding of the concept of sustainability is stressed in a variety of contexts.
- Communication skills and the use of appropriate terminology are given greater emphasis – for example, students are expected to describe what they are doing by using the terminology associated with specific scientific and technological concepts.

The Role of Parents

Studies show that students perform better in school if their parents are involved in their education. Parents therefore have an important role to play in supporting their child's learning. By reading the curriculum, parents can find out what their children are learning in each grade and why they are learning it. This awareness will enable parents to discuss their children's work with them, to communicate with teachers, and to ask relevant questions about their child's progress. Knowledge of the expectations in the various grades will also help parents to interpret their child's report card and to work with the teacher to improve the student's learning. For this reason, parents are urged to read through the expectations for all the grades rather than just the particular grade that their child is in.

There are many other ways in which parents can express their interest in their child's education. Participating in parent conferences, working on the school council, and encouraging children to complete their assignments at home are three obvious examples.

The science and technology curriculum promotes lifelong learning not only for students but also for their parents and all those with an interest in education. In addition to supporting regular hands-on classroom activities, parents are encouraged to promote science fairs, olympiads, and other events that focus on technological skills.

Parents can also provide valuable support for their children's learning by taking an interest in their out-of-school assignments. Such an interest will allow parents to promote safety techniques in the handling of tools and the disposal of harmful substances, as well as the handling of animals and plants. Many home projects demonstrate the close link that exists between science and technology. For example, to decide how to reduce the loss of heat energy from a

home students need to understand first of all how heat energy is transmitted through different materials (science); then they can examine which parts of the home are best insulated, and with what materials (technology).

The Role of Teachers

Teachers and students have complementary responsibilities. Teachers are responsible for developing appropriate instructional strategies. They need to address different student needs and bring enthusiasm and a variety of teaching approaches to the classroom. Teachers know that they must persevere in their efforts and make every reasonable attempt to ensure sound learning for every student.

Teachers will provide as many hands-on activities as possible since the inquiry and design skills emphasized in this curriculum must be taught and learned through experiences with concrete materials. The activities provided should allow students to discover and learn fundamental concepts through investigation, exploration, observation, and experimentation, and to place these concepts in the social, environmental, and economic contexts in which their relevance and application will be most evident. Opportunities to relate knowledge and skills to these wider contexts – to the goals and concerns of the world in which they live – will motivate students to learn in a meaningful way and to learn for life.

The Role of Students

Students also have responsibilities with regard to their learning, which increase as they advance through elementary and secondary school. Students who are willing to make the effort required and who are able to apply themselves will soon learn that there is a direct relationship between achievement and hard work, and will be motivated to work as a result. There will be some students, however, who will find it more difficult to take responsibility for their learning because of the special challenges they face, which may include lack of support and other difficulties in the home or environment in which they are growing up. For these students, the attention, patience, and encouragement of teachers can be extremely important factors for success. However, regardless of their circumstances, learning to take responsibility for one's progress and learning is an important part of education for all students.

It is imperative that students demonstrate a sincere commitment to safety practices and to true team collaboration skills. Demonstration of these attitudes and skills will facilitate the hands-on approach necessary for the mastery of scientific and technological concepts and skills. Students must also actively pursue opportunities outside the classroom to extend and enrich their understanding of scientific and technological concepts and to explore how science and technology are related. For example, they can create their own file on current scientific and technological issues covered in the media.

Curriculum Expectations and Achievement Levels

The Ontario Curriculum, Grades 1-8: Science and Technology, 1998 has two main elements: expectations and achievement levels. The expectations identified for each grade describe the knowledge and skills that students are expected to develop and to demonstrate in their class work and investigations, on tests, and in various other activities on which their achievement is assessed.

Two sets of expectations are listed for each grade in each strand or broad area of the curriculum. The three *Overall Expectations* correspond to the three goals of the science and technology program and describe in general terms the knowledge and skills that students are expected to achieve by the end of each grade. The *Specific Expectations* describe the expected knowledge and skills in greater detail.

The specific expectations are organized under three subheadings: Understanding Basic Concepts; Developing Skills of Inquiry, Design, and Communication; and Relating Science and Technology to the World Outside the School. This organization is not meant to imply that the expectations in any one group are achieved independently of the expectations in the other two groups. The subheadings are used merely to help teachers focus on particular aspects of knowledge and skills as they plan learning activities for their students.

The achievement levels are brief descriptions of four different degrees of achievement of the provincial curriculum expectations for any given grade. These descriptions are among a number of tools that teachers will use to assess students' learning. The achievement levels for science and technology focus on the three goals of science and technology education: understanding the basic concepts of science and technology; developing the skills and strategies required for scientific inquiry and technological design, including the techniques involved in the safe use of appropriate tools and equipment; and developing the ability to relate science and technology to each other and to the world outside the school. Also included are the communication skills that are an essential component of science and technology education. Level 3, which is the "provincial standard", identifies a high level of achievement of the provincial expectations. Parents of students achieving at level 3 in a particular grade can be confident that their children will be prepared for work at the next grade. Level 1 identifies achievement that falls much below the provincial standard. Level 2 identifies achievement that approaches the standard. Level 4 identifies achievement that surpasses the standard. For example, a student who applies some of the required skills of inquiry and design, shows some awareness of safety procedures, and uses tools, equipment, and materials correctly with some assistance would be described as achieving at level 2 in the area of inquiry and design skills.

Strands in the Science and Technology Curriculum

The science and technology expectations are organized into five strands, which are the major areas of knowledge and skills in the science and technology curriculum. The five strands, which combine topics from science and technology, are:

- Life Systems
- Matter and Materials
- Energy and Control
- Structures and Mechanisms
- Earth and Space Systems

The knowledge and skills outlined in the expectations for the science and technology program are mandatory.

Table 1 shows the topics treated in each strand in each grade for Grades 1 to 8.

Table 1. Strands and Topics: Science and Technology, Grades 1-8

Strand	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Life Systems	Characteristics and Needs of Living Things	Growth and Changes in Animals	Growth and Changes in Plants	Habitats and Communities	Human Organ Systems	Diversity of Living Things	Interactions Within Ecosystems	Cells, Tissues, Organs, and Systems
Matter and Materials	Characteristics of Objects and Properties of Materials	Properties of Liquids and Solids	Magnetic and Charged Materials	Materials That Transmit, Reflect, or Absorb Light or Sound	Properties of and Changes in Matter	Properties of Air and Characteristics of Flight	Pure Substances and Mixtures	Fluids
Energy and Control	Energy in Our Lives	Energy From Wind and Moving Water	Forces and Movement	Light and Sound Energy	Conservation of Energy	Electricity	Heat	Optics
Structures and Mechanisms	Everyday Structures	Movement	Stability	Pulleys and Gears	Forces Acting on Structures and Mechanisms	Motion	Structural Strength and Stability	Mechanical Efficiency
Earth and Space Systems	Daily and Seasonal Cycles	Air and Water in the Environment	Soils in the Environment	Rocks, Minerals, and Erosion	Weather	Space	The Earth's Crust	Water Systems

The Importance of Safety

Teachers are responsible for ensuring the safety of students during classroom activities and also for encouraging and motivating students to assume responsibility for safety. They must also teach students the knowledge and skills needed for safe participation in science and technology activities. For these reasons, teachers must model safe practices at all times and communicate safety expectations to students in accordance with school board and Ministry of Education and Training 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; and
- consistently show concern for their safety and that of others.

Specific safety concerns associated with the activities of a particular strand are identified in the introduction to that strand. In addition, skills and practices related to safety are also included in the expectations when knowledge and skills related to safety are part of the learning that students are to acquire in the science and technology program.

Attitudes in Science and Technology

Students need to develop the attitudes or "habits of mind" that are considered essential for meaningful work in science and technology. These include: commitment to accuracy, precision, and integrity in observation, experimentation, and reporting; respect for evidence; concern for the observance of safety procedures; and respect for living things and the environment. These habits of mind have been incorporated into the specific expectations, especially those grouped under the heading Developing Skills of Inquiry, Design, and Communication. Activities that involve students in investigating issues related to science and technology in the world outside the school provide opportunities for them to develop the attitudes and values needed to make informed and responsible decisions.

Students' attitudes towards science, technology, and education can have a significant effect on their achievement of the expectations. Teaching methods and learning activities that encourage students to recognize the value and relevance of what they are learning will go a long way towards motivating students to work and to learn effectively.

The Importance of Communication Skills

Communication is an essential component of the science and technology curriculum since many of the activities and tasks that students undertake involve the use of communication skills, both written and oral. For example, students use language to record their observations, to describe their investigations in both informal and formal contexts, and to present their findings in oral presentations and written reports. Students therefore need to be able to communicate effectively.

The language of science and technology includes special terms that are recognized as belonging to these fields as well as many words that have ordinary meanings but that, in the context of science and technology, are used in new or more specific ways. The study of science and technology will thus encourage students to use language with greater care and precision.

The science and technology curriculum also builds on and reinforces certain aspects of the language and mathematics curricula. For example, it emphasizes the importance of clear, concise communication and involves the use of various charts, tables, and graphs for communicating observations and measurements. It also includes other forms of communication – for example, the use of SI metric units, technical drawing, and experimental reporting. Care has been taken to ensure that expectations involving SI metric units and other communication-related knowledge and skills are consistent with the expectations in language and mathematics for the grade.

The Use of Computers in the Science and Technology Curriculum

The use of computers can extend and enrich students' learning in science and technology in important and unique ways. Whenever possible, therefore, students should be encouraged to use computers for a variety of purposes throughout the science and technology program. For example, students can peruse the World Wide Web to learn about science and technology in the world beyond the school, and they can communicate with students in other schools and in other parts of the world through the Internet to broaden their understanding of global scientific issues. In addition, students can use computer programs to compile, organize, and store data gathered through investigations; to write reports and papers in which they present their findings (using word-processing programs and spreadsheets); and to work with simulations in areas of study in which hands-on activities are not feasible (e.g., in astronomy) or in which there is too great a safety risk (e.g., investigations involving toxic substances).

Planning Student Programs

In planning science and technology programs, teachers will take into account the need to provide students with the fundamental knowledge and skills that will enable them to carry out increasingly complex investigations. Teachers will provide activities and assignments that encourage students to learn the basic concepts of science and technology and to develop the skills required for scientific inquiry and technological design. To ensure that the science and technology program in their school is interesting and relevant, teachers must relate scientific and technological knowledge and skills to issues and problems of the world outside – for example, to the need for sustainable development. Although care must be taken to ensure that the concepts and skills taught are appropriate to students' stage of development, this emphasis on the relationship of science and technology to the world outside the school must be paramount throughout the program if students are to recognize that science and technology are not just school subjects but fields of knowledge that affect their lives, their communities, and the world.

Students in Grades 1 to 6, in particular, will benefit from a program in which science and technology are integrated. An integrated program can help students make connections between the concepts and skills of the two disciplines. For example, students will have opportunities to see the parallels between the processes of inquiry and design. They will also be able to investigate the scientific concepts that underlie and lead to an understanding of technological accomplishments. Schools that have specialist teachers and/or special facilities may teach the two subjects separately, particularly in Grades 7 and 8. In such cases, it is imperative that the two teachers plan their programs collaboratively to ensure that students are able to meet all of the grade expectations.

The development of skills and knowledge in science and technology is often related to learning in other subject areas. When planning programs, teachers should emphasize this cross-curricular learning by:

- *coordinating the teaching of related content in two or more subjects.* For example, in Grade 3 students could be taught data management in mathematics and then asked to use the acquired skills to make a graph of data collected in a science and technology activity. Similarly, students could be taught library skills in language and then asked to use those skills to gather data about a science or technology topic;

- *providing opportunities for students to work towards expectations in two or more subjects within one lesson*. For example, in Grade 7 teachers could develop a unit of study around the building of structures to give students opportunities to learn about the properties of materials (science and technology), the characteristics of geometric shapes (mathematics), and the aesthetics of design (visual art and technology). At the conclusion of the lesson, students could be asked to write a paper (language) assessing the impact of a scientific or technological innovation on the lifestyle of people (science and technology/social studies).

To help teachers plan such integrated units of study, the expectations in science and technology have been carefully aligned with related expectations in language and mathematics.

Science and Technology for Exceptional Students

Recognizing the needs of exceptional students and providing appropriate programs for them are important aspects of implementing the curriculum. For some students, the appropriate choice of instructional methods and settings will suffice to ensure achievement of the expectations. For others, some or all of the expectations will need to be modified. To achieve at the highest possible level, some exceptional students may need to participate in special programs.

The process whereby a student is formally identified as exceptional by an Identification, Placement, and Review Committee (IPRC) is clearly outlined in legislation (Regulation 305). Through this process, parents, teachers, and other support personnel identify the specific needs of a student, create an Individual Education Plan (IEP) that addresses these needs, and review progress according to a predetermined plan. While specific procedures pertaining to the creation of an IEP are not defined in legislation, the majority of boards have established practices and developed appropriate forms pertaining to IEPs.

In the case of students who have been formally identified as exceptional, it is particularly important that school staff work in consultation with parents to support the students' learning. There must be clear and ongoing communication between all parties involved in the students' care to ensure that appropriate support and programs are in place. Assessment and evaluation adaptations for such students need to be discussed with parents and with students at appropriate intervals. Parents need to understand how these adaptations affect the assessment and evaluation of the students' work.

Some students who have not been formally identified as exceptional but who have special short-term learning needs because of medical or other reasons may also require an IEP. The IEP must be discussed with parents when it is introduced into the student's program, and any adaptations in assessment and evaluation must also be discussed at that time.

In science and technology, exceptional students may need a variety of modifications both to the program itself and to the learning environment. These may include the following:

- facilities that allow for the mobility of students with physical impairments;
- modifications to programs for pupils with learning disabilities who may require more hands-on opportunities for learning;
- program adaptations for students who are deemed gifted;
- visual signs related to safety issues; and
- assessment and evaluation strategies that accommodate a variety of learning styles and needs.

Achievement Levels

The chart that follows identifies four areas of achievement in science and technology – understanding of basic concepts, inquiry and design skills, communication of required knowledge, and relating of science and technology to each other and to the world outside the school. For each of these four areas, there are four levels of achievement. These levels contain brief descriptions of degrees of achievement on which teachers will base their assessment of students' work.

The descriptions in the achievement levels are meant to be used to assess each student's achievement of the expectations outlined in this document *in each grade and strand*. Teachers should use the descriptions to identify the level at which a student has achieved a particular expectation, or a group of expectations, in the appropriate category of knowledge or skills. For example, one of the expectations in Life Systems for Grade 7 is that students will "identify and explain the roles of producers, consumers, and decomposers in food chains and their effects on the environment". If the student can give a complete or nearly complete explanation, the student's achievement of that expectation would be at level 3 in the area of understanding of basic concepts. Normally a teacher will apply more than one of the descriptions to a student's achievement of a group of expectations to determine the level that most appropriately describes the student's achievement.

The characteristics given for level 3 represent achievement that is considered to be the standard for the grade. A student's work at level 3 in science and technology in any grade may be described in general terms as follows:

> The student understands most of the basic concepts in science and technology, demonstrates no significant misconceptions, and usually gives complete or nearly complete explanations of them. The student applies most of the required skills of inquiry and design, usually shows awareness of safety procedures, and uses tools, equipment, and materials correctly with only occasional assistance. The student also generally communicates clearly and precisely, using appropriate science and technology terminology and units of measurement. The student shows understanding of connections between science and technology in familiar contexts as well as connections between science and technology and the world outside the school.

Although the chart is intended to be used mainly for assessing student achievement, teachers may wish to use it for other related purposes; for example, they could use it as a guide when collecting samples of student work to show parents what work at different levels is like.

Achievement Levels: Science and Technology, Grades 1-8

Knowledge/Skills	Level 1	Level 2	Level 3	Level 4
Understanding of basic concepts	**The student:**			
	– shows understanding of few of the basic concepts	– shows understanding of some of the basic concepts	– shows understanding of most of the basic concepts	– shows understanding of all of the basic concepts
	– demonstrates significant misconceptions	– demonstrates minor misconceptions	– demonstrates no significant misconceptions	– demonstrates no misconceptions
	– gives explanations showing limited understanding of the concepts	– gives partial explanations	– usually gives complete or nearly complete explanations	– always gives complete explanations
Inquiry and design skills (including skills in the safe use of tools, equipment, and materials)*	**The student:**			
	– applies few of the required skills and strategies	– applies some of the required skills and strategies	– applies most of the required skills and strategies	– applies all (or almost all) of the required skills and strategies
	– shows little awareness of safety procedures	– shows some awareness of safety procedures	– usually shows awareness of safety procedures	– consistently shows awareness of safety procedures
	– uses tools, equipment, and materials correctly only with assistance	– uses tools, equipment, and materials correctly with some assistance	– uses tools, equipment, and materials correctly with only occasional assistance	– uses tools, equipment, and materials correctly with little or no assistance
Communication of required knowledge	**The student:**			
	– communicates with little clarity and precision	– communicates with some clarity and precision	– generally communicates with clarity and precision	– consistently communicates with clarity and precision
	– rarely uses appropriate science and technology terminology and units of measurement	– sometimes uses appropriate science and technology terminology and units of measurement	– usually uses appropriate science and technology terminology and units of measurement	– consistently uses appropriate science and technology terminology and units of measurement
Relating of science and technology to each other and to the world outside the school	**The student:**			
	– shows little understanding of connections between science and technology in familiar contexts	– shows some understanding of connections between science and technology in familiar contexts	– shows understanding of connections between science and technology in familiar contexts	– shows understanding of connections between science and technology in both familiar and unfamiliar contexts
	– shows little understanding of connections between science and technology and the world outside the school	– shows some understanding of connections between science and technology and the world outside the school	– shows understanding of connections between science and technology and the world outside the school	– shows understanding of connections between science and technology and the world outside the school, as well as their implications

* It should be noted that all students, regardless of their level of achievement, receive basic instruction in the safe use of tools, equipment, and materials.

Life Systems

The Life Systems strand combines the study of traditional topics in life science or biology (e.g., animals, plants, ecosystems, and cells) with technology as it relates to basic human needs (e.g., the need for food, shelter, and clothing). Students begin their study of life systems with aspects that are familiar to them (e.g., animals and plants in their environment, their own bodies) and gradually move on to study global or abstract aspects, such as ecosystems, and less readily visible aspects, such as the microscopic world of cells. Of particular importance in the Life Systems strand is the investigation of interactions between living things and their environment.

The topics covered in this strand are:

Grade 1: Characteristics and Needs of Living Things

Grade 2: Growth and Changes in Animals

Grade 3: Growth and Changes in Plants

Grade 4: Habitats and Communities

Grade 5: Human Organ Systems

Grade 6: Diversity of Living Things

Grade 7: Interactions Within Ecosystems

Grade 8: Cells, Tissues, Organs, and Systems

Investigations are a very important part of the Life Systems strand. In the early elementary grades, these take the form of explorations of familiar living things. As students gain the necessary knowledge and skills, their investigations become more complex and more methodical and include laboratory experiments.

It is important that students follow established safety practices in all investigations. These practices include:

– washing one's hands after handling plants, animals, and soils;

– following instructions for touching or smelling any substances under investigation;

– working only with supervision near a pond or other body of water during outdoor activities.

It is also important that students ensure that appropriate school staff are informed of any allergies they may have, and take those allergies into consideration when handling plants, animals, and substances. (In the case of younger students, parents and guardians should ensure that appropriate school staff are informed of any allergies.)

The Life Systems strand includes study of the relationship between science and technology and the role of science and technology in the broader world context, as well as the impact of technological changes on the environment and the need for sustainable development.

In all grades, students will develop the ability to use language to communicate clearly and to use scientific terminology appropriately.

Life Systems: Grade 1 – Characteristics and Needs of Living Things

Overview

The study of Life Systems in Grade 1 focuses on an investigation of the characteristics and basic needs of living things. Students will explore aspects of movement and behaviour in humans and other animals, and will learn about their nutritional requirements. Students will also explore some basic aspects of growth in animals and plants. In all their investigations, students will continually refine their ability to observe, using all five senses, and will attempt to describe their observations as accurately as possible.

Overall Expectations

By the end of Grade 1, students will:

- demonstrate an understanding of the basic needs of animals and plants (e.g., the need for food, air, and water);
- investigate the characteristics and needs of animals and plants;
- demonstrate awareness that animals and plants depend on their environment to meet their basic needs, and describe the requirements for good health for humans.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 1, students will:

– identify major parts of the human body and describe their functions (e.g., arms and legs for movement; lungs and nose for breathing);

– identify the location and function of each sense organ;

– classify characteristics of animals and plants by using the senses (e.g., texture, colour, size, sounds);

– describe the different ways in which animals move (e.g., moles burrow with their large, strong front limbs; fish undulate their bodies) to meet their needs;

– identify and describe common characteristics of humans and other animals that they have observed, and identify variations in these characteristics (e.g., eye and hair colour);

– describe some basic changes in humans as they grow (e.g., growth of feet, hands, arms; loss of baby teeth), and compare changes in humans with changes in other living things;

– describe patterns that they have observed in living things (e.g., sunflower, pine cone, turtle's shell).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 1, students will:

– select and use appropriate tools to increase their capacity to observe (e.g., magnifying glass, stethoscope);

– ask questions about and identify some needs of living things, and explore possible answers to these questions and ways of meeting these needs (e.g., predict how an animal will move on the basis of two or more characteristics that they have observed);

– plan investigations to answer some of these questions or find ways of meeting these needs;

– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use *body*, *legs*, *wings*, and *feelers* in describing an insect);

– record relevant observations, findings, and measurements, using written language, drawings, charts, and concrete materials (e.g., make a drawing of an insect, observing with the unaided eye, and a drawing of the same insect while using a magnifying glass);
– communicate the procedures and results of investigations for specific purposes, using demonstrations, drawings, and oral and written descriptions (e.g., demonstrate how a bird builds a nest).

Relating Science and Technology to the World Outside the School

By the end of Grade 1, students will:

– compare the basic needs of humans with the needs of other living things (e.g., the need for food, air, water, light);
– compare ways in which humans and other animals use their senses to meet their needs (e.g., use of the senses of sight and smell in finding food);
– describe ways in which people adapt to the loss or limitation of sensory or physical ability (e.g., blind people develop more acute hearing; people who cannot walk may use a wheel chair);
– identify a familiar animal or plant from seeing only a part of it (e.g., a feather of a bird, a leaf of a tree);
– describe ways in which the senses can both protect and mislead (e.g., seeing enables us to avoid walking into an obstacle; the sense of smell is not reliable when we have a cold);
– describe a balanced diet using the four basic food groups outlined in Canada's Food Guide to Healthy Eating, and demonstrate awareness of the natural sources of items in the food groups (e.g., bread is made from plant products; meat and milk come from animals);
– identify ways in which individuals can maintain a healthy environment for themselves and for other living things (e.g., practise cleanliness to reduce the spreading of germs; ensure that materials such as toy balloons are not left outdoors since they are harmful to birds if they are ingested).

Life Systems: Grade 2 – Growth and Changes in Animals

Overview

The study of animals in Grade 2 focuses on patterns of growth and change. Since children are interested in the changes that take place in different types of animals, observing these changes can be a powerful learning experience for them. In their exploration of growth, students will also compare patterns of growth in different animals with their own growth, and they will learn about the conditions needed to support healthy development in an animal.

Overall Expectations

By the end of Grade 2, students will:

- demonstrate an understanding of the similarities and differences among various types of animals and the ways in which animals adapt to different environmental conditions;
- investigate physical and behavioural characteristics and the process of growth of different types of animals;
- identify ways in which humans can affect other animals.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 2, students will:

– identify and describe the major physical characteristics of different types of animals (e.g., mammals, reptiles, insects);

– identify and describe behavioural characteristics that enable animals to survive (e.g., migration, dormancy, hibernation);

– classify a variety of animals using observable characteristics (e.g., size, body covering, teeth);

– compare ways in which animals eat their food (e.g., tear flesh, crack shells), move, and use their environment to meet their needs (e.g., gather grass and twigs to build nests);

– describe changes in the appearance and activity of an animal as it goes through a complete life cycle (e.g., mealworm);

– compare the life cycles of some animals that have similar life cycles (e.g., bee and butterfly) and some that have different life cycles (e.g., gerbil and butterfly);

– identify constant traits (e.g., number of legs) and changing traits (e.g., weight) in animals as they grow, and compare the appearance of young and mature animals of the same species;

– describe ways in which animals respond and adapt to their environment (e.g., weasels change colour for camouflage in summer and winter; mammals living in colder climates have longer fur);

– compare ways in which different animals care for their young (e.g., bears, alligators, sea turtles).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 2, students will:

– ask questions about and identify some needs of different animals with which they are familiar, and explore possible answers to these questions and ways of meeting these needs (e.g., examine different kinds of teeth and explain how their shape enables an animal to bite, tear, or grind its food);

– plan investigations to answer some of these questions or find ways of meeting these needs, and describe the steps involved;
– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use the words *egg*, *caterpillar*, *larva*, *chrysalis*, and *adult* in describing the metamorphosis of a butterfly);
– record relevant observations, findings, and measurements, using written language, drawings, and concrete materials (e.g., make accurately labelled drawings showing the life cycle of an animal);
– communicate the procedures and results of investigations for specific purposes, using drawings, demonstrations, and oral and written descriptions (e.g., explain how a caterpillar feeds, using a model constructed of modelling clay and a tree branch).

Relating Science and Technology to the World Outside the School

By the end of Grade 2, students will:

– describe features of the environment that support the growth of familiar animals (e.g., water and insects in a frog's environment);
– identify and compare the effects of the seasons on animals (e.g., some animals grow a thicker coat in cold weather);
– describe ways in which humans can help or harm other living things (e.g., protecting endangered species);
– demonstrate an understanding of the requirements of small animals for survival (e.g., by maintaining an aquarium or a terrarium);
– describe the life processes of an animal that they have observed (e.g., the eating habits, movement, rest patterns, and breathing of a mealworm);
– demonstrate awareness of ways of caring for animals properly (e.g., avoid handling them too much; research nutritional requirements);
– describe how humans produce food by raising livestock (e.g., pigs, chickens, cattle).

Life Systems: Grade 3 – Growth and Changes in Plants

Overview

The study of plants in Grade 3 focuses on the characteristics and requirements of plants and their patterns of growth. Students will observe and investigate a wide variety of local plants, from trees to mosses, in their natural environment. They will also learn about the importance of plants not only as sources of food and shelter for people and animals, but as suppliers of much of the world's oxygen.

Overall Expectations

By the end of Grade 3, students will:

- demonstrate an understanding of the similarities and differences in the physical characteristics of different plant species and the changes that take place in different plants as they grow;
- investigate the requirements of plants and the effects of changes in environmental conditions on plants;
- describe ways in which plants are important to other living things, and the effects of human activities on plants.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 3, students will:

– identify the major parts of plants (e.g., seeds, stem, pistil) and describe their basic functions;

– classify plants according to visible characteristics (e.g., type of tree bark, leaf shape, type of flowers);

– describe, using their observations, the changes that plants undergo in a complete life cycle (e.g., from the germination of a seed to the production of flowers or fruit);

– describe, using their observations, the effects of the seasons on plants (e.g., leaf buds grow into leaves in the spring; leaves turn colour in the fall);

– compare the life cycles of different kinds of plants (e.g., plants that grow from bulbs or from seeds);

– identify traits that remain constant in some plants as they grow (e.g., leaf shape, leaf size, flower colour);

– describe, using their observations, how the growth of plants is affected by changes in environmental conditions (e.g., changes in light, soil);

– explain how different features of plants help them survive (e.g., leaf structure, fibrous or tap root systems).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 3, students will:

– design and conduct a hands-on inquiry into seed germination or plant growth;

– ask questions about and identify some needs of plants, and explore possible answers to these questions and ways of meeting these needs (e.g., predict how long a particular plant could go without water before its leaves started to droop);

– plan investigations to answer some of these questions or find ways of meeting these needs, and explain the steps involved;

– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., *stem*, *pistil*, *stamen*, *flower*);
– record relevant observations, findings, and measurements, using written language, drawings, charts, and graphs (e.g., produce a series of drawings to show a plant at different stages of development);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using drawings, demonstrations, simple media works, and oral and written descriptions (e.g., make a graph that shows the number and kinds of trees found in different yards; design and construct a terrarium or garden that reproduces the conditions that they found to be requirements of specific plants).

Relating Science and Technology to the World Outside the School

By the end of Grade 3, students will:

– describe ways in which humans use plants for food, shelter, and clothing (e.g., trees are used for building houses; cloth is made from cotton);
– describe ways in which humans can protect natural areas to maintain native plant species (e.g., establishing conservation areas, wildlife reserves, wetland sanctuaries);
– identify the parts of a plant that are used to produce specific products for humans (e.g., sugar, dyes, paper, cloth, lumber) and describe the steps in production;
– describe various plants used in food preparation (e.g., vegetables, fruits, spices, herbs) and identify places where they can be grown;
– describe various settings in which plant crops are grown (e.g., farms, orchards, home gardens);
– describe ways in which plants and animals depend on each other (e.g., plants provide food for energy, and animals help distribute pollen and seeds);
– compare the requirements of some plants and animals, and identify the requirements that are common to all living things (e.g., the need for water and minerals);
– demonstrate awareness of ways of caring for plants properly (e.g., ensure that a plant has sufficient light and water);
– identify some functions of different plants in their local area (e.g., trees provide shade; grass binds soil to prevent soil erosion).

Life Systems: Grade 4 – Habitats and Communities

Overview

Students in Grade 4 will be familiar with the basic needs of plants and animals, and will begin to explore and compare ways in which communities of plants and animals satisfy their needs in specific habitats. In their investigations, they will also study some of the factors that affect various habitats, including changes that occur naturally and changes brought about by people.

Overall Expectations

By the end of Grade 4, students will:

- demonstrate an understanding of the concepts of habitat and community, and identify the factors that could affect habitats and communities of plants and animals;
- investigate the dependency of plants and animals on their habitat and the interrelationships of the plants and animals living in a specific habitat;
- describe ways in which humans can change habitats and the effects of these changes on the plants and animals within the habitats.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 4, students will:

– identify, through observation, various factors that affect plants and animals in a specific habitat (e.g., availability of water, food sources, light; ground features; weather conditions);

– classify organisms according to their role in a food chain (e.g., producer, consumer);

– demonstrate an understanding of a food chain as a system in which energy from the sun is transferred eventually to animals, construct food chains of different plant and animal species (e.g., carrot→rabbit→fox), and classify animals as omnivore, carnivore, and herbivore;

– describe structural adaptations of plants and animals that demonstrate a response of the living things to their environment (e.g., the height of a plant depends on the amount of sunlight the plant gets; many animals that live in the Arctic have white fur);

– recognize that animals and plants live in specific habitats because they are dependent on those habitats and have adapted to them (e.g., ducks live in marshes because they need marsh plants for food and shelter and water for movement);

– classify plants and animals that they have observed in local habitats according to similarities and differences (e.g., in shape, location).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 4, students will:

– formulate questions about and identify the needs of animals and plants in a particular habitat, and explore possible answers to these questions and ways of meeting these needs (e.g., predict the structural adaptations, such as webbed feet, that help aquatic animals live in water);

– plan investigations for some of these answers and solutions, identifying variables

that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations, explorations, and observations (e.g., *habitat*, *population*, *ecological niche*, *community*, *food chain*);

– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., display data gathered in a population-simulation exercise, using a labelled graph; classify species of insects in the neighbourhood according to habitat, using a chart or table);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., prepare a poster illustrating the components of a local habitat; trace a food chain in an illustrated chart, using the sun as the starting point).

Relating Science and Technology to the World Outside the School

By the end of Grade 4, students will:

– describe ways in which humans are dependent on plants and animals (e.g., for food products, medicine, clothing, lumber);

– describe ways in which humans can affect the natural world (e.g., urban development forces some species to go elsewhere and enables other species to multiply too rapidly; conservation areas can be established to protect specific habitats);

– construct food chains that include different plant and animal species and humans (e.g., grass→cattle→humans);

– show the effects on plants and animals of the loss of their natural habitat (e.g., nesting sites of ducks may be destroyed when a dam is built);

– investigate ways in which the extinction of a plant or animal species affects the rest of the natural community and humans (e.g., chart the distribution of wolves on a world map and predict the effects if wolves were to become extinct; use a software program that simulates a specific environment to track the effects of the loss of a plant species).

Life Systems: Grade 5 – Human Organ Systems

Overview

In Grade 5, study of the human body focuses on five major organ systems – the respiratory, circulatory, digestive, excretory, and nervous systems. Using models and simulations, students will learn where the major internal organs are located and will explore the functions and interactions of organs within specific systems. In studying the structure of organs, students will learn that all living tissues are composed of different kinds of cells. Students will also develop an understanding of the importance of proper nutrition and exercise to the healthy functioning of organ systems.

Overall Expectations

By the end of Grade 5, students will:

- demonstrate an understanding of the structure and function of the respiratory, circulatory, digestive, excretory, and nervous systems, and the interactions of organs within each system;
- investigate the structure and function of the major organs of the respiratory, circulatory, digestive, excretory, and nervous systems;
- demonstrate understanding of factors that contribute to good health.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 5, students will:

– identify the cell as the basic unit of life;

– describe the basic structure and function of the major organs in the respiratory, circulatory, digestive, excretory, and nervous systems;

– describe, using models and simulations, ways in which the skeletal, muscular, and nervous systems work together to produce movement (e.g., make a model of the structure of the bones and muscles in an arm, using cardboard rolls and elastic bands);

– identify the skin as an organ and explain its purpose;

– explain what happens to excess nutrients not immediately used by the body;

– describe the components of the body's system of defence against infections (e.g., tears, skin, white blood cells).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 5, students will:

– formulate questions about and identify the needs of humans, and explore possible answers to these questions and ways of meeting these needs (e.g., in studying the nervous system, investigate response times by having someone catch a ruler between the thumb and index finger after it is dropped by another person; investigate ways in which orthopaedic devices, such as back rests, have improved the quality of life);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations, explorations, and observations (e.g., use terms

such as *teeth*, *esophagus*, *stomach*, and *gastric juices* in describing the digestive system);

– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., record both qualitative and quantitative data from observations of the nutritional value of foods; produce a graph of the heartbeat rate of someone climbing a specific number of stairs in a given length of time);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., create a comparison chart, grouping foods by major nutrients and by their categories in Canada's Food Guide to Healthy Eating).

Relating Science and Technology to the World Outside the School

By the end of Grade 5, students will:

– describe the types of nutrients in foods (e.g., carbohydrates, fats, proteins, vitamins, minerals) and their function in maintaining a healthy body (e.g., supporting growth);

– identify a balanced diet as one containing carbohydrates, proteins, fats, minerals, vitamins, fibre, and water, and design a diet that contains all of these;

– identify food sources from which people in various societies obtain nutrients (e.g., rice, potatoes, and grains furnish carbohydrates);

– interpret nutritional information to make healthy food choices (e.g., sort commercial cereals into different categories, such as high fat, low fat, high salt, low sugar, and decide which are best);

– demonstrate awareness that some disorders can be affected by diet (e.g., diabetes, heart disease);

– identify types of industries involved in the processing and preserving of foods;

– describe the relationship between eating habits, weight, height, and metabolism;

– describe ways in which various kinds of organisms (e.g., bacteria, fungi) are used to recycle human waste;

– explain the importance of daily physical activity;

– explain how the health of human beings is affected by environmental factors (e.g., smoking, smog, and pollen affect the respiratory system);

– explain the benefits and disadvantages of using some technological innovations (e.g., headsets designed to protect ears from excessive noise are helpful, but headphones used to listen to music can cause hearing impairment);

– describe some types of medical technology (e.g., exercise machines, hearing aids, prosthetics).

Life Systems: Grade 6 – Diversity of Living Things

Overview

The study of living things in Grade 6 focuses on the use of classification systems as ways of learning about the great diversity of species and as ways of organizing the study of species. Particular attention is given to the classification of organisms in the animal kingdom. Classifying animals not only will enable students to learn about many different types of animals, from mammals to microscopic organisms, but will help them to observe and describe similarities and differences among species more precisely. To acquire first-hand experience in studying the diversity of living things, students will examine and classify organisms in a specific habitat – a pond, for example.

Overall Expectations

By the end of Grade 6, students will:

- demonstrate an understanding of ways in which classification systems are used to understand the diversity of living things and the interrelationships among living things;
- investigate classification systems and some of the processes of life common to all animals (e.g., growth, reproduction, movement, response, and adaptation);
- describe ways in which classification systems can be used in everyday life.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 6, students will:

– explain why formal classification systems are usually based on structural characteristics (e.g., type of skeleton, circulatory system, reproductive system) rather than on physical appearance or behavioural characteristics;

– recognize that the essential difference between cold- and warm-blooded animals lies in different means of regulating body temperature;

– identify and describe the characteristics of vertebrates, and use these characteristics to classify vertebrates as mammals, birds, amphibians, reptiles, and fish (the five main classes);

– identify and describe the characteristics of invertebrates, and classify invertebrates into phyla (e.g., sponges, worms, molluscs, arthropods);

– compare the characteristics of vertebrates and invertebrates;

– compare the characteristics of different kinds of arthropods (e.g., crustaceans such as crayfish, shrimp; insects such as grasshoppers, butterflies, mealworms);

– describe microscopic living things using appropriate tools to assist them with their observations (e.g., nets and microscopes for pond study);

– describe ways in which micro-organisms meet their basic needs (e.g., for food, water, air, movement).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 6, students will:

– formulate questions about and identify the needs of different types of animals, and explore possible answers to these questions and ways of meeting these needs (e.g., design an experiment to study whether certain insects will grow larger if given large quantities of food);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *organism*, *species*, *structure*, and *kingdom* in describing classification of animals);
– compile data gathered through investigation in order to record and present results, using charts, tables, labelled graphs, and scatter plots produced by hand or with a computer (e.g., make an inventory of animals found in a specific location);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, charts, graphs, and drawings (e.g., create a clearly labelled chart of organisms observed and identified during a pond study).

Relating Science and Technology to the World Outside the School

By the end of Grade 6, students will:

– identify various kinds of classification systems that are based on specific criteria and used to organize information (e.g., in a telephone system, numbers are classified according to country code, area code, telephone number, extension number);
– identify inherited characteristics (e.g., eye colour, hair colour) and learned or behavioural characteristics (e.g., habits of cleanliness);
– explain why characteristics related to physical appearance (e.g., size, shape, colour, texture) or behaviour are not suitable attributes for classifying living things;
– identify various kinds of plant or animal organisms in a given plot using commercially produced biological or classification keys (e.g., organisms observed in a pond study, in the school yard, in wildlife centres);
– describe specific characteristics or adaptations that enable each group of vertebrates to live in its particular habitat (e.g., fish in water), and explain the importance of maintaining that habitat for the survival of the species;
– explain how fossils provide evidence of changes in animals over geological time;
– compare similarities and differences between fossils and animals of the present.

Life Systems: Grade 7 – Interactions Within Ecosystems

Overview

The study of ecosystems is an introduction to the study of ecology and involves investigation of the complex interactions between all types of organisms and their environment. 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. They will also learn that groups of ecosystems make up biomes, which, in turn, are components of the biosphere. In investigating ecosystems, students will examine the effects of natural factors, such as climate changes, as well as the impact of technological changes on the environment.

Overall Expectations

By the end of Grade 7, students will:

- demonstrate an understanding of the interactions of plants, animals, fungi, and micro-organisms in an ecosystem;
- investigate the interactions in an ecosystem, and identify factors that affect the balance among the components of an ecosystem (e.g., forest fires, parasites);
- demonstrate an understanding of the effects of human activities and technological innovations, as well as the effects of changes that take place naturally, on the sustainability of ecosystems.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 7, students will:

– identify living (biotic) and non-living (abiotic) elements in an ecosystem;

– identify populations of organisms within an ecosystem and the factors that contribute to their survival in that ecosystem;

– identify and explain the roles of producers, consumers, and decomposers in food chains and their effects on the environment (e.g., plants as producers in ponds);

– explain the importance of micro-organisms in recycling organic matter (e.g., as decomposers);

– identify micro-organisms as beneficial (e.g., yeast) and/or harmful (e.g., bacteria or viruses that cause disease);

– interpret food webs that show the transfer of energy among several food chains, and evaluate the effects of the elimination or weakening of any part of the food web;

– describe the process of cycling carbon and water in the biosphere;

– investigate ways in which natural communities within ecosystems can change, and explain how such changes can affect animal and plant populations (e.g., changes affecting their life span, their gestation periods, or their ability to compete successfully);

– identify signs of ecological succession in a local ecosystem (e.g., the presence of blueberries in an area recently devastated by fire; the presence of pioneer organisms that start the process of succession in sand dunes).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 7, students will:

– formulate questions about and identify the needs of various living things in an ecosystem, and explore possible answers to these questions and ways of meeting these

needs (e.g., research the population levels of a species over time and predict its future levels on the basis of past trends and present conditions; determine how the structure of specific plants helps them withstand high winds, live on the surface of water, or compete for sunlight);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use scientific terms such as *biosphere*, *biome*, *ecosystem*, *species*);

– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., use a chart to record the number of producers and consumers in a particular habitat);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, charts, graphs, and drawings (e.g., design a multimedia presentation explaining the interrelationships of biotic and abiotic elements in a specific ecosystem).

Relating Science and Technology to the World Outside the School

By the end of Grade 7, students will:

– investigate the impact of the use of technology on the environment (e.g., the "greenhouse effect"; redirection of water flow for human needs; use of pesticides);

– investigate the bio-economical costs and benefits of the recycling and waste-disposal industries;

– explain the importance of plants as sources of energy (e.g., food, fossil fuels), as producers of carbohydrates and oxygen (e.g., phytoplankton), and as habitats for wildlife;

– describe the conditions in an ecosystem that are essential to the growth and reproduction of plants and micro-organisms, and show the connection between these conditions and various aspects of the food supply for humans;

– identify the importance of plants in the Canadian economy (e.g., in farming, forestry, drug manufacturing, the nursery industry) and describe the impact of the industrial use of plants on the environment;

– explain the long-term effects of the loss of natural habitats and the extinction of species (e.g., loss of diversity of genetic material, both plant and animal);

– identify and explain economic, environmental and social factors that should be considered in the management and preservation of habitats (e.g., the need for recycling; the need for people to have employment).

Life Systems: Grade 8 – Cells, Tissues, Organs, and Systems

Overview

In Grade 5, students were introduced to the cell as the basic unit of life in the study of human organ systems. In Grade 8, students will continue to develop their knowledge of systems in living things, focusing on the structure and function of cells in plants and animals and on the organization of cells into tissues, organs, and organ systems.

Overall Expectations

By the end of Grade 8, students will:

- demonstrate an understanding of the basic structure and function of plant and animal cells, and describe the hierarchical organization of cells in plants and animals;
- investigate basic cellular processes and certain specialized cells in plants;
- describe ways in which study of the structure, function, and interdependence of human organ systems can result in improvements in human health.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 8, students will:

– identify unicellular organisms (e.g., amoebae) and multicellular organisms (e.g., worms, humans);

– investigate ways in which unicellular organisms meet their basic needs (e.g., for food, movement);

– identify organelles in cells through observation (e.g., vacuole, nucleus, chloroplast) and explain their functions;

– describe, using their observations, differences in structure between plant and animal cells;

– describe the organization of cells into tissues, organs, and systems;

– explain the function of selectively permeable membranes in cells;

– describe and explain the structure and function of specialized cells and tissues in different parts of plants (e.g., in roots, stems, leaves);

– recognize that cells in multicellular organisms need to reproduce to make more cells to form and repair tissues;

– explain how the structure of the roots, stem, and leaves of a plant permit the movement of food, water, and gases;

– compare the structure of different plants (e.g., cactus, coniferous tree, moss) and show how their structure enables them to live in specific conditions;

– describe, using their observations, the movement of gases and water into and out of cells during diffusion and osmosis.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 8, students will:

– use a microscope accurately to find, observe, and draw microscopic objects;

– formulate questions about and identify needs related to the functioning of cells, and explore possible answers to these questions and ways of meeting these needs (e.g., design and conduct an experiment to test a hypothesis about the effect of chemicals on a unicellular organism; design and conduct an experiment to test the effectiveness of different substances in preventing cut flowers from wilting);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use scientific terms such as *organelle*, *diffusion*, *osmosis*, *selectively permeable*);
– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., use a diagram to present an estimate of the number of cells in a petri dish);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, charts, graphs, and drawings (e.g., create a simulation illustrating movement of water and nutrients between cells and through various organs and systems).

Relating Science and Technology to the World Outside the School

By the end of Grade 8, students will:

– describe the needs and functions of various cells and organs in relationship to the needs of the human body as a whole;
– describe the basic factors that contribute to the efficient functioning of the human respiratory, circulatory, digestive, excretory, and nervous systems;
– describe some ways in which the various systems in the human body are interdependent;
– describe similarities and differences in the functions of comparable structures in different groups of living things (e.g., compare the food intake and digestion of a unicellular organism, an invertebrate, and a vertebrate);
– describe ways in which research about cells has brought about improvements in human health and nutrition (e.g., development of medicines, immunization procedures, and diets based on the needs of organs such as the heart);
– describe ways in which substances work by altering the way cells function (e.g., insulin);
– describe ways in which various types of cells contribute to the healthy functioning of the human body (e.g., red blood cells transport oxygen throughout the body);
– illustrate how blood is pushed by pressure throughout the body to carry oxygen and nutrients to cells, tissues, and organs.

Matter and Materials

In this strand, the study of matter in science is integrated with the use of materials in technology. In studying matter, students develop an understanding of the properties of substances, which will serve as a foundation for future theoretical studies in science. In designing and making useful objects, students apply their knowledge of the properties of the materials they are using, as well as knowledge of aesthetic and ergonomic principles in the area of technological design.

The topics covered in this strand are:

Grade 1: Characteristics of Objects and Properties of Materials

Grade 2: Properties of Liquids and Solids

Grade 3: Magnetic and Charged Materials

Grade 4: Materials That Transmit, Reflect, or Absorb Light or Sound

Grade 5: Properties of and Changes in Matter

Grade 6: Properties of Air and Characteristics of Flight

Grade 7: Pure Substances and Mixtures

Grade 8: Fluids

In their investigations, students manipulate and observe materials and test them for their properties, and experiment with possible uses of these materials. At first, students report on their findings in qualitative terms, but as they learn to use mathematics, they will be able to express many of their observations in quantitative terms appropriate for their grade. Students also learn to see connections between science and technology and the broader social and economic context – for example, they learn that decisions to make specific products may be based on such factors as economics, environmental and waste considerations, and consumer values and demands.

In all grades, students develop the ability to use language to communicate clearly and to use science and technology terminology appropriately. Many of the terms used in the study of matter and materials are ordinary words, so students will need to learn their specialized meanings.

It is important that students follow established safety practices in all investigations. These practices include:

– following correct procedures when joining and shaping a variety of materials (e.g., always cutting materials away from oneself; firmly holding materials in place; avoiding the application of great force when using a tool as it can lead to loss of control of the tool or material; using scissors to cut masking tape; using a hand drill to make holes in wood; using a paper punch to make holes in paper);
– using tools, materials, and equipment safely (e.g., hacksaw, scissors, hot plate, glue gun, rasp);
– keeping utensils and their work area clean;
– returning materials, tools, utensils, and equipment to their proper places;

- demonstrating concern for one's own safety and the safety of others (e.g., keeping sharp ends of objects such as needles and pins pointed away from oneself and others; tying back long hair and loose garments before approaching a heat source; never leaving a heat source unattended; using pot holders when handling hot utensils or pots; wearing safety goggles; reporting any damage to tools or equipment immediately);
- exercising caution when using the senses to explore substances (e.g., when handling toxic substances).

Matter and Materials: Grade 1 – Characteristics of Objects and Properties of Materials

Overview

In Grade 1, students are introduced to the concept of materials through exploration of various objects in their immediate surroundings. Students will use their senses to identify various materials and objects. In doing this, they will learn to make a clear distinction between objects and materials: they will learn that objects are made from materials and that materials have specific properties. They will also learn to describe these properties clearly and precisely. By making objects out of various materials, they will begin to understand that there is a connection between the properties of materials and the specific purposes for which the materials are used.

Overall Expectations

By the end of Grade 1, students will:

- distinguish between objects and materials (e.g., scissors are objects and they can be made of metal and/or plastic), and identify and describe the properties of some materials (e.g., flexibility of plastic, hardness of wood);
- investigate the properties of materials and make appropriate use of materials when designing and making objects;
- describe the function of specific materials in manufactured objects that they and others use in daily life.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 1, students will:

– identify each of the senses and demonstrate understanding of how they help us recognize and use a variety of materials (e.g., our sense of sight enables us to determine whether a banana is ripe; our sense of hearing tells us whether the washing machine is working properly);

– describe various materials using information gathered by using their senses (e.g., a piece of steel is hard, shiny, and cold, and makes a ringing noise when tapped; a ceramic bowl is hard and rough-textured, and makes a dull sound when tapped);

– identify properties of materials that are important to the purpose and function of the objects that are made from them (e.g., the flexibility of plastic makes plastic wrap useful for covering food in order to keep it fresh);

– describe, using their observations, ways in which materials can be changed to alter their appearance, smell, and texture (e.g., cooking changes the smell and texture of ingredients on a pizza; painting rough wood makes it smoother).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 1, students will:

– sort objects (e.g., students' coats, lunch bags, cooking utensils) and describe the different materials from which those objects are made;

– demonstrate ways in which various materials can be manipulated to produce different sounds (e.g., produce sounds by tapping the sides of glasses that contain different amounts of water) and describe their findings;

– design a usable product that is aesthetically pleasing (e.g., a tote bag, cookie, musical instrument) and construct it by combining and modifying materials that they have selected themselves;
– ask questions about and identify needs and problems related to objects and materials, and explore possible answers and solutions (e.g., test materials to determine which ones insulate more efficiently; test different fabrics to determine which are waterproof);
– plan investigations to answer some of these questions or solve some of these problems;
– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use words such as *soft*, *smooth*, *rough*, and *sticky* when describing textures);
– record relevant observations, findings, and measurements, using written language, drawings, charts, and concrete materials (e.g., make a display board and record the results of their testing of chalk on different materials);
– communicate the procedures and results of investigations for specific purposes, using demonstrations, drawings, and oral and written descriptions (e.g., display examples of materials tested and indicate which ones were best for writing on).

Relating Science and Technology to the World Outside the School

By the end of Grade 1, students will:

– describe how properties of materials (e.g., sounds, textures, lustre) help us learn about natural and human-made objects;
– identify materials that can be used to join and fasten other materials (e.g., tape for paper; thread for buttons);
– demonstrate ways of reusing materials and objects in daily activities (e.g., reuse of plastic containers for storing food);
– recognize that objects made of certain materials can be recycled (e.g., pop cans, plastic jugs, newspapers);
– identify, through observation, the same material in different objects (e.g., cotton in shirts and towels; glass in magnifying glasses and windows; wood in pencils and furniture);
– compare objects constructed for similar purposes (e.g., different types of chairs) and identify the similarities and differences between their corresponding parts and the materials from which they are made (e.g., metal, wood);
– identify materials commonly used in manufactured objects as well as the source of those materials (e.g., wood from trees).

Matter and Materials: Grade 2 – 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 – for example, the way they look, feel, sound, or change. In Grade 2, students will develop their understanding of properties of materials through investigating liquid and solid materials. They will investigate ways in which solids and liquids interact, and will learn that some materials exist in both solid and liquid states. They will also learn that it is important to take into consideration the various properties of solids and liquids when designing and making or building objects for use.

Overall Expectations

By the end of Grade 2, students will:

- demonstrate an understanding of the properties of familiar liquids (e.g., vinegar, detergent, water, oil) and solids (e.g., sugar, salt, sand), and of interactions between liquids and between liquids and solids;
- investigate the properties of and interactions between liquids and between liquids and solids, and identify the types of objects or materials that can be used to contain liquids and solids (e.g., a plastic bowl will hold a liquid or a solid but a paper towel will only hold a dry solid);
- identify and describe ways in which we use our knowledge of liquids and solids in making useful objects and in living in our environment.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 2, students will:

– describe the properties of liquids and solids, using their observations;

– distinguish between solids that dissolve in water (e.g., sugar) and solids that do not (e.g., sand);

– describe, using their observations, the characteristics of the three states of water, and identify the conditions that cause changes from one state to another (e.g., water turns to ice when placed in a freezer);

– recognize that the states of liquids and solids remain constant in some circumstances (e.g., solids remain solid when broken; liquids remain liquid when poured), but may change in other circumstances (e.g., liquids may freeze when the temperature drops; solids may melt when heated);

– identify reversible changes in materials (e.g., the changing of ice to water);

– identify, through observation, various substances that are buoyant (e.g., wood, oil), that can absorb another substance (e.g., paper towel), and that can dissolve another substance (e.g., water);

– evaluate the appropriateness of the materials chosen in the design and used in the construction of a structure that is intended to float (e.g., polystyrene, paper, metal, wood).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 2, students will:

– design and assemble, using given materials, an object that is buoyant and able to support a given mass, and identify and describe the materials and tools they used;

– ask questions about and identify needs and problems related to the use of liquids and solids, and explore possible answers and

solutions (e.g., devise and explain a plan to build a model raft; predict changes that will occur when ice or water is heated or cooled);

– plan investigations to answer some of these questions or solve some of these problems, and describe the steps involved;
– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use such words as *clear*, *runny*, and *greasy* when describing liquids, and *granular*, *hard*, and *opaque* when describing solids);
– record relevant observations, findings, and measurements, using written language, drawings, charts, and concrete materials (e.g., record data from experimentation with liquids and solids on a chart; list characteristics of different liquids that they have observed);
– communicate the procedures and results of investigations for specific purposes, using demonstrations, drawings, and oral and written descriptions (e.g., write a booklet for the school library describing class experiments in investigating liquids and solids).

Relating Science and Technology to the World Outside the School

By the end of Grade 2, students will:

– compare the properties of liquids with those of solids to determine which materials take the shape of their container (e.g., water will fill a margarine container completely but ice cubes will leave spaces);
– compare different materials with respect to their capacity to absorb, and identify ways in which this capacity determines how these materials are used (e.g., bond paper, paper towels, cotton, linen, wood, plastic);
– describe, using their observations, the behaviour of various liquids (e.g., water, oil) when poured on different surfaces (e.g., rough wood, smooth wood, cloth), when combined with solids (e.g., powdered milk), and when combined with other liquids (e.g., vinegar), and explain how the reactions they observe determine the uses of these liquids and solids;
– compare the properties of water with the properties of at least one other liquid (e.g., detergent, oil, molasses);
– identify liquids used in the home and describe how they are used (e.g., milk for drinking and cooking; detergent for cleaning);
– describe, using their observations, some ways in which solids and liquids can be combined to make useful substances (e.g., flour and water make paste);
– identify objects in the immediate environment as solids (e.g., sand, ice, rocks) or liquids (e.g., milk, vinegar, water);
– recognize international symbols that give us information on the safety of substances (e.g., household cleaners, cleansers, bleaches) and Canadian Safety Association signage when working with liquids and solids.

Matter and Materials: Grade 3 – Magnetic and Charged Materials

Overview

In previous grades, students have manipulated, observed, and investigated a wide variety of materials. Now, they will focus on materials that are magnetic or those that can hold an electric charge. Students will investigate the ways in which different materials affect magnetic strength and electric charge. They will learn that every magnet has two poles, and that the strength of a magnet depends on the types and combinations of the various materials from which it is made. Students will also describe their observations of static electricity and the conditions that affect it. Through these investigations, students will increase their knowledge about the properties of materials that make them useful for specific purposes.

Note: Investigations with static electricity best when the air is dry. On humid days, charge on a conductor is reduced by the moisture in the air.

Overall Expectations

By the end of Grade 3, students will:

- demonstrate an understanding of the properties of materials that can be magnetized or charged and of how materials are affected by magnets or static electric charges;
- identify and describe, using their observations, ways in which static electric charges are made in everyday materials, as well as different types of interactions that take place both between charged materials and between magnetized materials;
- identify familiar uses of magnets and give examples of static electric charges that are created in the home or at school.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 3, students will:

– classify, using their observations, materials that are magnetic and not magnetic, and identify materials that can be magnetized (e.g., iron, nickel);

– identify, through observation, the effect of different conditions on the strength of magnets and on static electric charges in materials (e.g., the effect of distance between magnets; the effect of moisture on charged materials);

– compare different materials by measuring their magnetic strength or the strength of their electric charge (e.g., the number of paper clips that can be picked up by a magnetized needle; the number of tissue paper bits that can be picked up by a charged comb);

– identify, through observation, pairs of materials that produce a charge when rubbed together (e.g., glass and silk; wool and hard rubber);

– describe and demonstrate how some materials that have been electrically charged or magnetized may either push or pull similar materials;

– determine, through observation, the polarity of a magnet (e.g., use a magnet of known polarity to test another magnet of unknown polarity);

– identify materials that can be placed between a magnet and an attracted object without diminishing the strength of the attraction (e.g., construction paper);

– predict, verify, and describe the interaction of two objects that are similarly charged (e.g., the interaction of two balloons after rubbing them on hair);
– describe, through observation, changes in the force of attraction at different distances, both for magnetic forces and for static electric forces.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 3, students will:

– design and construct a system that uses magnetic force to move an object (e.g., create a boat that holds paper clips, and move it through water using a magnet);
– ask questions about and identify problems related to magnetic and static electric forces, and explore possible answers or solutions (e.g., investigate ways of producing static electric charges in different materials);
– plan investigations to answer some of these questions or solve some of these problems, and explain the steps involved;
– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use terms such as *north pole*, *south pole*, *attract*, and *repel* when describing magnets, and *charge*, *dry*, *humid*, *conductor*, and *insulator* when describing static electricity);
– record relevant observations, findings, and measurements, using written language, drawings, charts, and graphs (e.g., use a data table to show the number of times a needle can be magnetized and the results of testing magnetic strength);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using demonstrations, drawings, simple media works, and oral and written descriptions (e.g., demonstrate how an object moves through a magnetic maze they have created).

Relating Science and Technology to the World Outside the School

By the end of Grade 3, students will:

– identify uses of magnets in familiar things (e.g., refrigerator magnets, compasses, door seal on a refrigerator, magnetic catches on cupboards);
– describe examples of static electricity encountered in everyday activities (e.g., clothes clinging together after drying in a spin dryer; sparks made by touching objects after shuffling feet on carpets or by sliding down plastic playground slides in nylon snowsuits);
– identify ways in which static electricity can be used safely or avoided (e.g., use a charged sheet of plastic to pick up dust; moisten materials so they do not cling together).

Matter and Materials: Grade 4 – Materials That Transmit, Reflect, or Absorb Light or Sound

Overview

As they explore the properties of sound and light (see the Energy and Control strand for Grade 4), students will also encounter a wide variety of materials that transmit, reflect, or absorb energy. By focusing their investigations on the way these materials affect or are affected by sound and light, students will deepen their knowledge of the types of properties materials can have. They will also learn more about how the different properties of materials can help them to design products that are safe, useful, and creative.

Overall Expectations

By the end of Grade 4, students will:

- demonstrate understanding that certain materials can transmit, reflect, or absorb light or sound;
- investigate materials that transmit, reflect, or absorb light or sound and use their findings in designing objects and choosing materials from which to construct them;
- explain why materials that transmit, reflect, or absorb light and/or sound are used in a variety of consumer products.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 4, students will:

– recognize and describe how different materials affect light (e.g., water and prisms bend light as it passes through them; mirrors and polished metals reflect light);

– classify materials as transparent (e.g., glass, clear acrylic), translucent (e.g., frosted glass, white plastic shopping bags, tissue paper), or opaque (e.g., wood);

– demonstrate how opaque materials absorb light and thereby cast shadows;

– investigate, through explorations, ways in which different properties of materials, including their shape, affect the nature of sound (e.g., compare the sound produced by striking solid and hollow materials);

– identify and describe, using their observations, physical changes in a material that can alter the sound it makes (e.g., the differences in sound when a loose rubber band and a stretched rubber band are plucked);

– identify, using their observations, a variety of materials through which sound can travel (e.g., by ringing bells under water; by sending messages along a string).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 4, students will:

– design and make instruments for a specific purpose or function (e.g., make magnifiers from a glass jar half filled with water; make drums from boxes or margarine containers with lids);

– formulate questions about and identify problems related to the ways in which materials transmit, reflect, or absorb sound or light, and explore possible answers or solutions (e.g., predict and verify the size, shape, and location of shadows from a given light source, or the types of materials that will make ringing sounds when struck);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations, explorations, and observations (e.g., use terms such as *translucent*, *opaque*, *reflection*, *absorption*, and *conductivity* to describe properties of materials in relation to light and sound);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., create a table to show the types of sounds made by hollow objects, such as a coffee can full of air, and by solid objects, such as a coffee can filled with sand);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using oral presentations, written notes and descriptions, drawings, and charts (e.g., create a shade chart of a selected colour; make a spinning colour wheel to demonstrate how "white" light is composed of all the colours).

Relating Science and Technology to the World Outside the School

By the end of Grade 4, students will:

– classify materials that transmit, absorb, or reflect energy as natural or human-made (e.g., wood, metal, clay, plastic, fabric);
– identify transparent, translucent, and opaque materials used in objects in the immediate environment, and evaluate whether the ability of these materials to transmit, reflect, or absorb light enhances the objects' usefulness (e.g., usefulness of translucent white plastic shopping bags versus opaque paper shopping bags; use of coloured glass to preserve food or drink from light);
– describe, using their observations, how substances employed in finishing processes can alter a material's ability to transmit, absorb, or reflect light or sound (e.g., how choice of paint can affect the reflective ability of the surface to be painted);
– describe and demonstrate, using different materials, ways of mixing colours to create new colours (e.g., by overlapping coloured acetates; by mixing paints);
– compare the intensity of light passing through different materials, and identify how the differences might determine the uses of these materials;
– identify different types of light observed in the immediate environment (e.g., neon lights, rainbows, flashlights) and compare them (e.g., with respect to colour, intensity);
– compare materials in terms of the sounds that they can be made to produce (e.g., by plucking a rubber band, beating a drum, tapping glasses filled to different levels with water, shaking a jar of macaroni, blowing air past a blade of grass placed between the thumbs);
– investigate objects in the home and community that are designed and made to produce sounds (e.g., doorbells, sirens, telephones, radios, stereos, smoke detectors, security system alarms);
– describe some ways in which materials that absorb sound are used (e.g., in concert halls, adjacent movie theatres, ear plugs, highway sound barriers);
– describe practices that ensure their safety and that of others (e.g., use of ear plugs in situations involving excessive noise; use of reflective or fluorescent materials on clothes at night).

Matter and Materials: Grade 5 – Properties of and Changes in Matter

Overview

In earlier grades, students have learned about the properties (such as strength, flexibility, buoyancy) of various materials and about how such properties determine what the materials are used for. Students now will begin to explore the underlying concept of matter. They will learn about the three states of matter (solid, liquid, gas) and the characteristics of each. They will also explore changes of state, and investigate the difference between physical changes (which are usually reversible) and chemical changes (which may not be reversible). Students will already know about many of these changes from their previous investigations, but now they will begin to apply their knowledge in a systematic way, using inquiry and design processes to solve problems and to choose appropriate materials for the devices they design and make.

Overall Expectations

By the end of Grade 5, students will:

- demonstrate an understanding of the three states of matter and of changes in state;
- investigate common changes of state (e.g., melting, freezing, condensing, evaporating) and make informed choices about materials when finding solutions to problems in designing and constructing objects;
- identify the properties that make different materials useful in everyday products and discuss the environmental impact of their use.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 5, students will:

– identify and describe some changes to materials that are reversible and some that are not (e.g., freezing and melting are reversible; burning is not);

– describe changes they observe in the properties of materials when the materials interact with each other (e.g., when paints are mixed; when water is combined with gelatine);

– describe examples of interactions between materials that result in the production of a gas (e.g., antacid tablets in water, baking soda in vinegar);

– identify the three different states of matter – solid, liquid, and gas – and give examples of each state (e.g., solid: sugar, rock; liquid: water, oil, gasoline; gas: water vapour, air, oxygen);

– identify the characteristic properties of each of the three states of matter and group materials on the basis of these properties (e.g., solids have definite volume and hold their shape; liquids have definite volume but take the shape of their container; gases have no definite volume and take the volume and shape of their container);

– recognize, on the basis of their observations, that melting and evaporation require heat;

– use a thermometer to measure the temperature of a material;

– identify melting, freezing, condensation, and evaporation as changes of state that can be reversed;

– describe, using their observations, nonreversible changes that occur when some materials are heated (e.g., when paper is burnt; when an egg is cooked);

– investigate and describe the changes in the relative volume, shape, and temperature of materials when pressure is applied to them (e.g., the effects of using a hammer on clay or of sitting on a beach ball with the stopper removed).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 5, students will:

– design and make a device or product that minimizes heat loss (e.g., a coffee mug, a Thermos flask, an insulated lunch bag);
– conduct a fair test to determine the effectiveness of a variety of commercial products designed for the same purpose (e.g., compare the adhesive qualities of different types of glue);
– formulate questions about and identify needs and problems related to the properties and changes in state of familiar materials, and explore possible answers and solutions (e.g., estimate and then measure the length of time certain foods take to melt when heated; design a test to compare the insulating effects of different thicknesses of foam polystyrene);
– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *texture*, *hardness*, *strength*, *buoyancy*, *solubility*, and *flexibility* to describe properties of materials);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., record the reactions of different materials when vinegar is dropped on them, and use a data table to present their findings);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., make accurate and detailed drawings of sugar crystals, as seen both with the unaided eye and through a magnifying glass or microscope).

Relating Science and Technology to the World Outside the School

By the end of Grade 5, students will:

– identify the source of the materials found in a product (e.g., plastic is made from petroleum) and describe the steps required to modify the natural materials to make the product;
– describe how physical and chemical processes change materials found at home and materials used in industry (e.g., cooking, the manufacturing of plastics);
– describe physical changes and chemical reactions that can take place in household products and explain how these reactions affect the use of the products (e.g., the role of baking soda in cooking; the role of heat in cooking an egg);
– measure, in different materials, observable changes that result from such processes as rusting, dissolving, and bleaching, and identify products that are affected by these processes (e.g., metals, powdered foods, fabrics);
– describe chemical changes that can be caused in a substance, and explain how the changes affect the use and function of the

substance (e.g., changes caused by exposing newspaper or construction paper to light, exposing an apple section to air);

- compare the mass of a substance in its liquid and solid states (e.g., compare the mass of ice cubes or chocolate squares with the mass of the liquid that results when they are melted);
- relate the mass of a whole object to the sum of the masses of its parts (e.g., measure the mass of a given amount of salt, the mass of a given amount of water, and the mass of the container for the water, and compare the sum of those masses with the mass of the container and the mixture of salt and water; measure the separate masses of the ingredients for a salad and the salad bowl, and compare the sum of those masses with the mass of the bowl and the salad).

Matter and Materials: Grade 6 – Properties of Air and Characteristics of Flight

Overview

Students will continue to broaden their understanding of the gaseous state of matter by focusing on the properties of air. Through investigations, observations, and experiments, students will discover that gases such as air take up space, have mass, and expand when heated. In addition, students will learn that to a large degree the ability to fly – of both living creatures and aircraft – depends on forces related to air pressure. As students investigate the properties of air, they will begin to understand how it can be a means to achieve lift, movement, and control in flying devices.

Overall Expectations

By the end of Grade 6, students will:

- demonstrate an understanding of the properties of air (e.g., air and other gases have mass) and explain how these can be applied to the principles of flight;
- investigate the principles of flight and determine the effect of the properties of air on materials when designing and constructing flying devices;
- identify design features (of products or structures) that make use of the properties of air, and give examples of technological innovations that have helped inventors to create or improve flying devices.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 6, students will:

– recognize that gravity does not depend on the presence of air;

– demonstrate understanding that gases expand to fill a space;

– demonstrate that air expands when heated (e.g., heat a garbage bag partially filled with air using a blow dryer);

– demonstrate and explain how the shape of a surface over which air flows affects the role of lift (Bernoulli's principle) in overcoming gravity (e.g., changing the shape of airplane wings affects the air flow around them);

– demonstrate and describe methods used to alter drag in flying devices (e.g., flaps on a jet aircraft's wings);

– explain the importance of minimizing the mass of an object when designing devices to overcome the force of the earth's gravity;

– describe the sources of propulsion for flying devices (e.g., moving air, propellers, combustible fuel);

– describe how unbalanced forces are used to steer airplanes and spacecraft (e.g., rocket firings to control docking in space).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 6, students will:

– design, construct, and test a structure that can fly (e.g., a kite, a paper airplane, a hot air balloon);

– design and create a device that uses pneumatic power to move another object;

– formulate questions about and identify needs and problems related to the properties of air and characteristics of flight, and explore possible answers and solutions (e.g., investigate whether the shape of a plane affects its flight path);

– plan investigations for some of these answers and solutions, identifying variables

that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as *lift*, *thrust*, *streamline*, and *aerodynamics* when discussing flight materials);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, labelled graphs, and scatter plots produced by hand or with a computer (e.g., record the flight distances of different styles of paper airplanes, and present their findings in a graph);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., hold an invention convention on things that fly).

Relating Science and Technology to the World Outside the School

By the end of Grade 6, students will:

– identify devices that involve the application of Bernoulli's principle (e.g., paint sprayer, carburetor);
– describe how the properties of air, such as its compressibility and insulating quality, are used in common products (e.g., automobile tires, double-glazed glass, sleeping bags, fire extinguishers);
– describe and justify the differences in design between various types of flying devices (e.g., airplane versus helicopter, spacecraft versus hot-air balloon);
– identify characteristics and adaptations that enable birds and insects to fly;
– compare living things to identify the different features that allow them to be transported by wind (e.g., differences among spores, pollen, seeds);
– describe milestones in the history of air and space travel;
– compare the special features of different transportation methods that enable those methods to meet different needs (e.g., features of bicycles, cars, airplanes, spacecraft);
– assess whether the materials in student-designed projects were used economically and effectively (e.g., decide whether paper was wasted during the construction of paper airplanes);
– describe practices that ensure their safety and that of others (e.g., directing flying objects away from oneself and others).

Matter and Materials: Grade 7 – Pure Substances and Mixtures

Overview

By exploring the distinction between pure substances (e.g., copper, sugar) 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, many medicines, cosmetics, building materials, cleaning agents, and so on. Through experiments, students will learn to distinguish between mixtures and solutions, discover many of their characteristics, and come to understand their uses and importance in daily life. Introduction of a scientific model (the particle theory) used to describe the particulate nature of matter will provide a conceptual basis for students' learning in this area.

Overall Expectations

By the end of Grade 7, students will:

- demonstrate an understanding of the characteristics of mechanical mixtures (heterogeneous) and solutions (homogeneous) and describe these characteristics using a scientific model (the particle theory);
- investigate properties of different kinds of mechanical mixtures and solutions that make them useful in manufacturing products for particular purposes;
- identify human uses of mixtures and solutions in everyday life, and evaluate the environmental impact of some of these uses.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 7, students will:

– distinguish between mechanical mixtures and solutions;

– describe the concentration of a solution in qualitative terms (e.g., dilute, concentrated) and in quantitative terms (e.g., grams of solute per 100 mL);

– recognize that, according to the particle theory, particles have an attraction for each other and that the attraction between the particles of solute and solvent keeps them in solution;

– distinguish between pure substances and mixtures using the particle theory (e.g., pure substances have identical particles whereas mixtures have different particles);

– identify factors that affect solubility and the rate at which substances dissolve (e.g., temperature, type of solute or solvent, particle size, stirring);

– describe, through observation, the difference between saturated and unsaturated solutions;

– identify solutes and solvents in various kinds of solutions (e.g., gold and copper in gold rings; iodine and alcohol in iodine solutions; oxygen and nitrogen in air).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 7, students will:

– formulate questions about and identify needs and problems related to the characteristics of mixtures and solutions, and explore possible answers and ways of meeting these needs (e.g., design a fair test to determine the amount of solute required to form a saturated solution with a fixed amount of solvent whose temperature is varied);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., define the terms *mixture*, *mechanical mixture*, *solution*, *solute*, *solvent*, *mass concentration*, *dissolve*, *soluble*, *insoluble*, *saturated*, *supersaturated*, *unsaturated*, *dilute*);
– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., use a database to record and display results showing the amount of solute used in given amounts of solvent);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use drawings to illustrate the process of manufacturing a product from the collecting of raw materials to the end use of the product and its disposal);
– follow safe work procedures (e.g., wash hands after handling chemicals; seal containers of unused chemicals promptly after use; recognize and take note of WHMIS warning symbols) and use appropriate tools, materials, and equipment.

Relating Science and Technology to the World Outside the School

By the end of Grade 7, students will:

– identify solutions that exist as solids (e.g., alloys such as bronze, brass, gold rings, solder, sterling silver), liquids (e.g., soda pop, nail polish remover), and gases (e.g., air);
– differentiate between raw materials (e.g., wood, coal, natural gas) and processed materials (e.g., plastic, glass, ceramic);
– describe how raw materials are collected and processed to produce different materials (e.g., how iron and coal become steel; how sand, soda ash, and limestone become glass);
– demonstrate different methods of separating the components of mixtures (e.g., evaporation, sifting, filtration, distillation, magnetism) and describe some industrial applications of these methods (e.g., use of evaporation in the production of maple syrup; use of different sizes of sieves to separate wheat grains in the production of white bread; use of filtration in water purification; use of fractional distillation in refining crude oil; use of magnets in scrap metal yards);
– identify a variety of manufactured products made from mixtures or solutions and explain their functions (e.g., medicines, cleaning solutions, salad dressings);
– identify the sources and characteristics of pollutants that result from manufacturing and agricultural systems;
– describe the effects of some solvents on the environment, and identify regulations that are in place to ensure their safe use and disposal;
– demonstrate the use of water as a solvent and as a chemical reactant;

– evaluate and compare the quality of water from different sources by performing simple tests (e.g., for pH, salinity, hardness, temperature, turbidity), and assess whether human use of the environment affected the quality of the water;
– identify different types of waste present in the community (e.g., water, sewage, trash, toxic materials) and the environmental considerations related to their disposal;
– describe practices that ensure their safety and that of others (e.g., read labels on containers of chemical substances to determine whether they are poisonous, flammable, explosive, or corrosive; apply knowledge of WHMIS standards).

Matter and Materials: Grade 8 – Fluids

Overview

The study of fluids, which can be either liquids or gases, introduces students to fluid mechanics, an area of knowledge important in many industries (such as aeronautics, engineering, meteorology, and oceanography). Fluids, including air and water, are essential to many industrial processes and form the basis of hydraulic and pneumatic devices. Students will learn about the properties of fluids by experimenting with and investigating 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. As well, they will learn about the diverse applications of the principles involved in fluid mechanics, including industrial applications such as jet propulsion, and everyday applications such as ensuring that sauces are cooked to the right consistency (degree of viscosity).

Overall Expectations

By the end of Grade 8, students will:

- demonstrate an understanding of the properties (e.g., viscosity) and the buoyant force of fluids;
- investigate the buoyant force and other properties (e.g., viscosity) of fluids, and design and construct pneumatic or hydraulic systems that solve a problem in a given situation;
- describe how knowledge of the properties of fluids can help us to understand and influence organisms in the natural world, and to design and operate technological devices and to evaluate how efficiently different devices make use of these properties.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 8, students will:

– compare various liquids in terms of their viscosity (e.g., water, syrup, oil, detergent, ketchup);

– compare qualitatively the densities of solids, liquids, and gases;

– predict how the flow rate (an indicator of viscosity) of different liquids is affected by temperature;

– describe qualitatively the relationship between mass and weight (e.g., the mass of an object is constant but the weight of an object varies as the pull of gravity on the object changes);

– describe qualitatively the relationship between viscosity and density (e.g., with some exceptions, the greater the viscosity, the greater the density);

– determine, through experimentation, the mass-to-volume ratio of different amounts of the same substance (e.g., copper pennies);

– describe the relationship between the mass, volume, and density of solids, liquids, and gases, using the particle theory;

– compare fluids in terms of their compressibility or incompressibility (e.g., gases versus liquids);

– recognize and state the relationship between gravity and buoyancy (e.g., without gravity there is no buoyancy);

– explain the effects of changes in temperature on the density of solids, liquids, and gases, and relate their findings to the particle model of matter;
– predict the effect of applying external pressure on the behaviour of fluids;
– compare different liquids to determine how they alter the buoyant force on a given object;
– compare liquids and air in terms of their efficiency as transmitters of force in pneumatic and hydraulic devices.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 8, students will:

– design and build devices that use pneumatic or hydraulic systems;
– design, make, and calibrate a hydrometer and use it to compare the density of water with that of another liquid;
– design and construct a model of a common device that uses pneumatic or hydraulic systems (e.g., dentist's chair, automobile hoist);
– formulate questions about and identify needs and problems related to the properties of fluids, and explore possible answers and solutions (e.g., design a fair test to determine whether oil, water, or glycerol has the greatest viscosity);
– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as *flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics*);
– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., accurately measure and record the density of different liquids using a hydrometer);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);
– use the most appropriate items from a selection of tools, equipment, and materials to perform a specific task (e.g., use nuts and bolts to make temporary joints and screws to make permanent joints; use a power sander for shaping and finishing);
– follow safe work procedures (e.g., check the condition of tools and equipment prior to using them).

Relating Science and Technology to the World Outside the School

By the end of Grade 8, students will:

– describe situations in which the density of a substance changes naturally (e.g., molten lava as it cools; air when mirages form) or is intentionally altered (e.g., air in a hot-air balloon; cream when it is churned and cooled);
– identify substances that are useful because of their viscosity (e.g., sauces, vegetable oil, asphalt, hand lotion);
– compare the way fluids function in living things with the way they function in manufactured devices (e.g., compare the human circulatory system and a fuel pump);

- explain how the study of hydraulic systems enhances medical knowledge about vascular systems (e.g., by clarifying how valves control blood flow);
- describe some effects of technological innovations related to hydraulics and pneumatics (e.g., getting water from a tap rather than a well results in a reduced need for manual labour; using automatic transmissions rather than mechanical linkages results in greater efficiency);
- identify some design features (e.g., of aircraft, cars, submarines) and explain how the design makes use of one or more of the properties of fluids;
- identify industries in which the principles of fluid dynamics play a central role (e.g., aeronautics, shipping).

Energy and Control

The Energy and Control strand introduces students to the concept of energy through concrete contexts and investigations, and gradually leads them to a more theoretical consideration of the topic. Some of the aspects of energy examined through concrete experiences include the common forms of energy, its conversions, and its uses. By experimenting with various devices that control the amount of energy dispensed, students will come to understand the relationship between energy consumption and energy conservation.

The topics covered in this strand are:

Grade 1: Energy in Our Lives

Grade 2: Energy From Wind and Moving Water

Grade 3: Forces and Movement

Grade 4: Light and Sound Energy

Grade 5: Conservation of Energy

Grade 6: Electricity

Grade 7: Heat

Grade 8: Optics

As in other strands in the curriculum, investigation of energy begins with an examination of its most common forms, in contexts that are familiar to students, and gradually expands to include more complex forms and global contexts. The exploration of connections with the real world includes such topics as the wise use of energy, energy resources throughout the world, social and economic factors in energy generation, and consumer trends and preferences in energy use.

It is important that students follow established safety practices in all investigations. These practices include:

- operating safely any appliances used in investigations related to energy (e.g., a hairdryer, an electric fan);
- incorporating appropriate safety features in devices or products they design and build, and following safe practices while doing so;
- using all materials (e.g., elastics, springs, light bulbs) in an appropriate and safe manner;
- following the teacher's instructions during investigations that involve observation of the sun (e.g., never looking either at the sun directly or at reflections of its rays in a mirror);
- using safely any device that enables one to study or produce sound (e.g., tapes, microphones, portable cassette players);
- using proper techniques in handling and disposing of glass;
- following safety procedures in investigations involving electricity;
- using appropriate techniques in handling hot materials.

Energy and Control: Grade 1 – Energy in Our Lives

Overview

Energy has many forms and is an integral part of our daily lives. Students need to become aware that they use many different forms of energy every day and to realize that, as the agents who activate and control the source of energy, they are responsible for the amount of energy they consume. This awareness will help students develop a better understanding of the importance of monitoring their energy use. Students should also come to realize that all living things depend on some form of energy for survival.

Overall Expectations

By the end of Grade 1, students will:

- demonstrate an understanding of ways in which energy is used in daily life;
- investigate some common devices and systems that use energy and ways in which these can be controlled manually;
- describe different uses of energy at home, at school, and in the community, and suggest ways in which energy can be conserved.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 1, students will:

– recognize that the sun is the principal source of energy used on the surface of the earth;

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

– identify everyday uses of energy (e.g., gas to heat our homes, electricity to cook our food);

– describe how our senses of touch, hearing, and sight help us to control energy-using devices in the home, school, and community (e.g., our sensitivity to heat and cold (sense of touch) tells us to turn a tap to adjust the water temperature; our sense of hearing tells us to turn off the alarm clock; our sense of sight tells us when to apply the brakes on our bicycle).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 1, students will:

– construct a manually controlled device that performs a specific task (e.g., a folding fan);

– operate a simple device or system and identify the input and output (e.g., a hair dryer: the input is electricity, the output is heat);

– ask questions about and identify needs and problems related to energy production or use in the immediate environment, and explore possible answers and solutions (e.g., discuss how people might cope with a power failure at home – by using candles for light, the barbecue for outdoor cooking, the fireplace for heat);

– plan investigations to answer some of these questions or solve some of these problems;

– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use words such as *electricity, lights, energy*);
– record relevant observations, findings, and measurements using written language, drawings, concrete materials, and charts (e.g., create an energy poster illustrating the various forms of energy used in daily life and how they are controlled);
– communicate the procedures and results of investigations and explorations for specific purposes, using demonstrations, drawings, and oral and written descriptions (e.g., prepare a chart of energy conservation practices at home; prepare a chart illustrating how their senses help them use and control everyday devices).

Relating Science and Technology to the World Outside the School

By the end of Grade 1, students will:

– describe the different forms of energy used in a variety of everyday devices (e.g., coiled springs in wind-up toys, wood in fireplaces);
– identify everyday devices that are controlled manually (e.g., a cassette recorder, lights);
– identify devices they use that consume energy (e.g., lights, computers) and list things they can do to reduce energy consumption (e.g., turn lights out when leaving a room);
– select one of the most common forms of energy used every day and predict the effect on their lives if it were no longer available.

Energy and Control: Grade 2 – Energy From Wind and Moving Water

Overview

The study of wind and water as sources of energy enables students to expand their understanding of different forms of energy and how they can be used. Through exploration and experimentation, students will actively investigate these two forms of energy. By designing their own wind- and water-propelled devices, students will learn to identify factors that affect the motion and control of such devices. The study of wind and moving water should also help students better understand the concept of energy. Integrating this aspect of the course with the Earth and Space Systems expectations for Grade 2 ("Air and Water in the Environment") will help students recognize the importance of air and water as two invaluable resources on earth.

Overall Expectations

By the end of Grade 2, students will:

- demonstrate an understanding of the movement of air and of water as sources of energy;
- design and construct devices that are propelled by moving air or moving water;
- identify wind and moving water as renewable sources of energy and determine the advantages and disadvantages of using them.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 2, students will:

– identify movement as an outcome of energy input (e.g., fuel enables cars, trucks, and buses to move; electricity enables the fan in the kitchen to move; food enables humans to move);

– recognize that it is the *movement* of air and water that produces energy and that air and water are not by themselves sources of energy;

– identify various ways in which moving water is used as a form of energy (e.g., hydroelectricity, tidal energy).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 2, students will:

– design and construct a device propelled by air (e.g., a kite, a pinwheel, a balloon rocket);

– design and construct a system that controls the flow of water and/or air using a variety of mechanisms (e.g., a musical instrument, a fountain, valves, a dam);

– ask questions about and identify needs and problems related to the use of wind and moving water as energy sources, and explore possible answers and solutions (e.g., describe how moving water is used to produce electricity; describe how windmills were used to grind grain into flour);

– plan investigations to answer some of these questions or solve some of these problems, and describe the steps involved;

– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use terms such as *renewable* and *movement* when describing energy);

– record relevant observations, findings, and measurements, using written language, pictures, and charts (e.g., draw a diagram of their device; prepare a chart to present data on the distance travelled by their device over time);

– communicate the procedures and results of investigations and explorations for specific purposes, using drawings, demonstrations, and oral and written descriptions (e.g., prepare a showcase of different devices that are propelled by wind energy; explain the effect of wind direction and speed on the displacement of wind-propelled devices).

Relating Science and Technology to the World Outside the School

By the end of Grade 2, students will:

– identify devices that use moving air and moving water as energy sources (e.g., windmills, water wheels), and describe what happens to these devices when the air or water is still;

– list activities that are affected by moving water and wind (e.g., fishing, sailing, flying a plane);

– recognize that moving air and moving water can be sources of energy for electrical power;

– describe how gravity and the shape of different structures affect the behaviour and use of moving water (e.g., water in waterfalls, taps, fountains).

Energy and Control: Grade 3 – Forces and Movement

Overview

The study of forces introduces students to two types of forces and their effects. The first type involves direct interaction – pushes and pulls between surfaces that are in direct contact. The second type, which includes magnetic and static electric forces, involves interaction at a distance, and students should be aware that these forces also exist. In exploring the effects of forces, students will learn about the ways in which forces create movement in objects – for example, that some movement results from an imbalance between forces, some from the release of stored energy, as with the release of a wound spring. In addition, the study of forces will enable students to expand their understanding of control by designing and making devices that use a form of energy and can apply a force to another object. These activities will help students begin to recognize that all systems share certain characteristics – for example, they are made of component parts that work together to perform a specific task.

The study of the effects of magnetic and static electric forces can be related to the study of materials that can carry a charge or be magnetized. See the Matter and Materials expectations for Grade 3 ("Magnetic and Charged Materials").

Overall Expectations

By the end of Grade 3, students will:

- demonstrate an understanding of how movement is caused by forces and by energy that is stored and then released;
- investigate how different forces affect the operation of everyday devices, and design and construct devices that use a form of energy to create controlled movement;
- identify objects, devices, and systems in everyday life that are affected by forces and movement and explain in what ways they are useful to us.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 3, students will:

– identify force as a push or pull by one body on another;

– investigate the ways in which different forces (e.g., magnetism, static electricity, muscular force, gravitational force) can change the speed or direction of a moving object;

– investigate the effect of magnets and electrically charged objects on the motion of different materials (e.g., iron filings will be moved by a magnet, whereas grains of sugar will not);

– identify, through observation, different forms of energy and suggest how they might be used to provide power to devices and to create movement (e.g., the release of energy from a tightly wound rubber band or spring would create movement in a wind-up toy);

– distinguish between kinds of motion and indicate whether the motion is caused indirectly (e.g., by gravity, static electricity, magnets) or directly (e.g., by applied force);

– investigate the effects of directional forces (e.g., left push for left movement) and how unbalanced forces can cause visible motion in objects that are capable of movement (e.g., an object pushed over a smooth floor).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 3, students will:

- ask questions about and identify needs and problems related to the behaviour of different forces in their immediate environment, and explore possible answers and solutions (e.g., identify everyday situations that produce static electricity and describe ways of removing static electricity from clothes; compare the strength of two magnets in holding layers of paper on a refrigerator door, or in picking up paper clips);
- plan investigations to answer some of these questions or solve some of these problems, and explain the steps involved;
- use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use terms such as *push*, *pull*, *load*, *distance*, *speed* when describing the effect of forces on an object);
- record relevant observations, findings, and measurements, using written language, drawings, charts, and graphs (e.g., track a toy boat moving on water at various speeds, record the distances travelled, and present their findings on a chart);
- communicate the procedures and results of investigations for specific purposes and to specific audiences, using drawings, demonstrations, simple media works, and oral and written descriptions (e.g., give a demonstration showing how a device has been constructed and how it performs; make a drawing showing what alterations would be made to its design in the future; describe in writing the steps they used to build a device);
- design and construct a device that uses a specific form of energy in order to move (e.g., a paper airplane propelled by hand).

Relating Science and Technology to the World Outside the School

By the end of Grade 3, students will:

- describe the visible effects of forces acting on a variety of everyday objects (e.g., a toy car goes forward when pushed; a ball falls down when dropped);
- identify surfaces that affect the movement of objects by increasing or reducing friction (e.g., dry roads, icy roads);
- demonstrate how a magnet works and identify ways in which magnets are useful (e.g., as metal detectors, as a car wrecker's hoist, as a power source for magnetic trains);
- recognize devices that are controlled automatically (e.g., timers, washing machines), at a distance (e.g., a remote-control toy), or by hand (e.g., the flushing mechanism on a toilet);
- identify parts of systems used in everyday life, and explain how the parts work together to perform a specific function (e.g., a subway system, a plant, a wind-up toy).

Energy and Control: Grade 4 – Light and Sound Energy

Overview

Building on their previous learning about different forms of energy and their sources, students now begin to examine in more depth two forms of energy they encounter on a daily basis: light and sound. Students will become familiar with the properties of light by investigating and observing how light interacts with various objects in the environment. From these observations, students will come to realize that light travels in a straight line, and they will begin to use this knowledge in constructing simple optical devices. Similarly, through investigations students will learn how sound is caused (by vibrations), how it travels, and how it can be sensed and measured. As well, by exploring the factors that affect the sounds that are produced, students will begin to discover ways in which sound can be controlled. To help students learn about the properties of light and sound, these expectations should be taught in conjunction with the Matter and Materials expectations for Grade 4 ("Materials That Transmit, Reflect, or Absorb Light or Sound").

Overall Expectations

By the end of Grade 4, students will:

- demonstrate an understanding of the characteristics and properties of light and sound;
- investigate different ways in which light and sound are produced and transmitted, and design and make devices that use these forms of energy;
- identify technological innovations related to light and sound energy and how they are used and controlled at home and in the community, and determine how the quality of life has been affected by these innovations.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 4, students will:

– identify a variety of natural and artificial light sources (e.g., the sun, a candle, a light bulb);

– describe the behaviour of light, using their observations, and identify some of its basic characteristics (e.g., that it travels in a straight path, bends as it passes from one medium to another, and is reflected off shiny surfaces);

– distinguish between objects that produce their own light and those that reflect light from another source (e.g., candles and the sun emit their own light; the moon reflects light from the sun);

– identify, through observation, colour as a property of light (e.g., use prisms to show that white light can be separated into colours);

– predict the location, shape, and size of a shadow when a light source is placed in a given location relative to an object;

– investigate and compare how light interacts with a variety of optical devices (e.g., kaleidoscopes, periscopes, telescopes, magnifying glasses);

– recognize, using their observations, that most objects give off both light and heat (e.g., the sun, a candle, a light bulb), and identify some objects that give off light but produce little or no heat (e.g., light sticks, fireflies);

– recognize, using their observations, that sound can travel through a substance (e.g., place a vibrating tuning fork in a shallow dish of water and describe what happens to the water; place rice on a drum-head and describe what happens to the rice when the drum is tapped);
– group a variety of sounds according to pitch and loudness and demonstrate how the sounds can be modified;
– compare the range of sounds that humans can hear with the range of sounds that other animals can hear (e.g., dogs and cats can hear higher frequencies than humans);
– recognize that sounds are caused by vibrations;
– describe how the human ear is designed to detect vibrations.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 4, students will:

– formulate questions about and identify needs and problems related to their own experiences with light and sound, and explore possible answers and solutions (e.g., identify different sounds and their sources in their environment);
– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *source, artificial, beam of light, reflection* in describing the behaviour of light; or *pitch, loudness, vibrations* in describing sounds);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., create a "sound diary" to record the sounds encountered over a period of time);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., draw diagrams showing the position of the light source and location of the shadow; create a chart showing how devices that rely on or provide light and sound contribute to the user's convenience and comfort);
– design, make, and test an optical device (e.g., a periscope, a kaleidoscope);
– design and make musical instruments, and explain the relationship between the sounds they make and their shapes;
– follow safe work procedures in all investigations (e.g., direct mirrors away from the sun to ensure that the sun's rays are not reflected into their eyes or the eyes of others; avoid producing excessively loud sounds).

Relating Science and Technology to the World Outside the School

By the end of Grade 4, students will:

– identify various uses of sounds encountered daily (e.g., warning sounds such as security alarms, fire sirens, smoke detector alarms);
– describe the harmful effects of high noise levels and identify potential noise hazards at home or in the community (e.g., some leaf-blowing machines);

- describe, using their observations, how sounds are produced in a variety of musical instruments (e.g., wind instruments) and identify those they like listening to best;
- identify sound-related jobs (e.g., tuning pianos) and the role of sound in different jobs (e.g., the beep that warns us a van is backing up; the noise of jackhammers as an occupational hazard);
- describe devices that extend our ability to see and hear (e.g., a telescope, a magnifying glass, an optical microscope, a hearing aid, a microphone or megaphone);
- identify different uses of light at home, at school, or in the community, and explain how their brightness and colour are related to their purpose (e.g., vivid neon lights are used for advertising; blue lights are used to identify snow-removal vehicles; dim lighting is used to create a soothing atmosphere in restaurants);
- describe the effect on the quality of life if light and sound could not be used as forms of energy;
- identify common phenomena related to light and sound (e.g., rainbows, shadows, echoes) and describe the conditions that create them;
- identify systems that use light or sound sensors to detect movement (e.g., motion detectors, check-out scanners, the eye, the ear).

Energy and Control: Grade 5 – Conservation of Energy

Overview

Modern society places large demands on non-renewable sources of energy. It is essential that the energy from these sources be used wisely. In addition, alternative and renewable sources must be developed if we wish to sustain our present standard of living and ensure adequate energy supplies for future generations. Students need to understand the importance of this problem and learn how to conserve energy. Building on their previous learning about mechanisms and systems, students will deepen their understanding of how devices use energy. By designing, constructing, and operating their own devices, they will learn how energy is transferred from one system to another. In addition, students will expand their knowledge of the different sources of energy and classify them as renewable and non-renewable.

Overall Expectations

By the end of Grade 5, students will:

- demonstrate an understanding of the importance of conservation of energy in relation to the wise use of renewable and non-renewable energy sources;
- design and construct devices that use a form of energy to meet a specific need or want, and investigate how the energy is transferred to a specified output;
- evaluate the reasons for conserving natural resources and identify possible ways of conserving energy.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 5, students will:

– distinguish between a renewable and a non-renewable source of energy;

– investigate ways energy can be stored for later use (e.g., mechanical energy is stored in an elastic band or steel spring; chemical energy is stored in a battery);

– describe how energy is stored and transferred in a given device or system (e.g., in an automobile, chemical energy stored in the gasoline is transformed into mechanical energy upon combustion, enabling the vehicle to move and releasing thermal energy as heat);

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

– operate a mechanical device or system that uses a sensory or time-based input (e.g., a timer for lights) and describe how energy is transferred to a specified output.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 5, students will:

– formulate questions about and identify needs and problems related to protection of the natural environment, and explore possible answers and solutions (e.g., investigate how local recycling efforts help conserve energy and natural resources);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *heat, light, sound, electrical, mechanical, magnetic, chemical* when describing forms of energy);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., list the names of some devices used in the home that change energy from one form into another, and record in a table the types of energy transformations for each device);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., use a word processor and graphics program to create a booklet about the design, construction, and effectiveness of a product that meets a specific need; debate the environmental implications of using various sources of energy);
– design devices that can transform one form of energy into another (e.g., an electric bell transforms electrical energy into sound energy).

Relating Science and Technology to the World Outside the School

By the end of Grade 5, students will:

– list various sources of energy and identify them as renewable (e.g., sun, wind, tides, wood) or non-renewable (e.g., coal, natural gas, oil);
– describe the advantages and disadvantages of using renewable energy sources as opposed to non-renewable sources;
– identify the forms of energy (e.g., mechanical, electrical) used in the home, school, and community and identify the energy source for each (e.g., wood, coal, moving water);
– describe how we use different natural resources as sources of energy and evaluate the effect of their use on natural and human-made environments (e.g., in using fossil fuels such as natural gas for heating our homes we deplete natural resources but improve our quality of life);
– explain ways in which technological innovations affect our use of natural resources and increase or decrease our ability to conserve energy (e.g., home insulation allows us to conserve heat and reduce consumption of energy from non-renewable sources);
– identify factors that determine how effectively and economically a device can transform one form of energy into another (e.g., discuss the advantages and disadvantages of using solar panels for heating);
– explain how humans rely on energy transfers from a variety of products and systems to survive (e.g., chemical energy from food becomes muscular energy in humans);
– identify ways humans use energy, evaluate the economic and environmental costs of each, and describe ways to avoid wasting energy (e.g., lowering the thermostat during the night);
– identify design features that improve the energy efficiency of buildings, devices, and systems (e.g., double glazing).

Energy and Control: Grade 6 – Electricity

Overview

Electricity is a versatile form of energy that students encounter every day. Although students will already know about many of the uses of this convenient source of energy, they need to develop a deeper understanding of how it can be used to send signals. It is important for students to learn about this specialized area of study called electronics, which has made a major impact on our lives through many products and devices. Building on previous learning, students will explore devices that use tiny electric currents to switch electric circuits on and off, in order to understand how electronic systems are able to control very complicated processes automatically. As students expand their knowledge of the significant role electricity has in their lives, they should strengthen their awareness that they have control over the amount of electricity they use in the home and at school, as well as their awareness of the potential impact of the over-consumption of energy on our electricity supply.

Overall Expectations

By the end of Grade 6, students will:

- demonstrate understanding that electrical energy can be transformed into other forms of energy;
- design and construct a variety of electrical circuits and investigate ways in which electrical energy is transformed into other forms of energy;
- identify uses of electricity in the home and community and evaluate the impact of these uses on both our quality of life and the environment.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 6, students will:

– investigate ways in which electrical energy can be transformed into other forms of energy (e.g., into light, heat, and sound);

– compare the conductivity of a variety of solids and liquids;

– identify, through experimentation, ways in which chemical energy can be transformed into electrical energy (e.g., build a circuit using a lemon or a potato);

– compare the characteristics of current and static electricity;

– describe the relationship between electricity and magnetism in an electromagnetic device;

– identify, through observation, the effects of using different types of core materials in building an electromagnet;

– identify different types of switches that are used to control electrical devices (e.g., contact, tilt) and explain the key differences among them (e.g., differences in design, use).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 6, students will:

– formulate questions about and identify needs and problems related to the properties or uses of electrical energy, and explore possible answers and solutions (e.g., compare some sources of electrical energy used in the past, such as coal, with sources used today, such as uranium and moving water, and evaluate the advantages and disadvantages of each);

– plan investigations for some of these answers and solutions, identifying variables

that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *current, battery, circuit, conductor, insulator; positive* (plus) and *negative* (minus) *charges* for electrically charged materials; *north pole* and *south pole* for magnetic materials);

– compile data gathered through investigation in order to record and present results, using tally charts, tables, labelled graphs, and scatter plots produced by hand or with a computer (e.g., record in a journal all daily uses of electrical energy for a week, classify the various uses, and present the findings using tables and graphs);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., draw a diagram of an electrical circuit using appropriate symbols; create a brochure outlining safe and unsafe uses of electricity; create a table showing different factors that could lead to a decrease in consumption of electrical energy in the home and at school);

– design and build electrical circuits (e.g., series circuits and parallel circuits) and describe the function of their component parts (e.g., switches, power source);

– build and test an electrical circuit that performs a useful function, and draw a diagram of it using appropriate electrical symbols;

– construct series circuits (e.g., logical AND) and parallel circuits (e.g., logical OR) to control a device, and compare their characteristics;

– design and construct an electrical system that operates a device in a controlled way (e.g., a switch provides a controlled input, and lamps, buzzers, or motors produce the output).

Relating Science and Technology to the World Outside the School

By the end of Grade 6, students will:

– identify sources of electricity and state whether the sources are renewable or non-renewable;

– recognize the use of electromagnets in motors and generators;

– describe the electrical conversions in everyday devices or systems (e.g., electrical energy to heat energy in a toaster; electrical energy to mechanical energy in an electric mixer);

– identify the different ways electricity is produced (e.g., by batteries using chemical energy; by dams using water power; by generating stations using nuclear energy) and evaluate the effect of different production methods on natural resources and living things in the environment;

– describe conditions that could affect the consumption of electrical energy in the home and at school (e.g., seasonal variations in heat and light requirements);

– identify devices that use electricity to send signals (e.g., televisions, telephones, radios, computers);

– describe how electricity was discovered and harnessed for use (e.g., name some inventions) and discuss whether we are more or less dependent on electricity than people in the past;

– develop a plan for reducing electricity consumption at home or at school, and assess how this change could affect the economy (e.g., jobs) and our use of natural resources.

Energy and Control: Grade 7 – Heat

Overview

Students will learn about the causes and effects of heat. They will investigate its properties and how these are related to the measurement of temperature. Students will also be introduced to the particle theory, which can help them to explain their observations and to understand both the relationship between heat and temperature and the concept of heat capacity.

Society's need to maintain its ability to produce heat is another focus of study. Students will consider ideas about recycling excess or waste heat and about how to make better use of alternative, renewable heat sources to replace non-renewable resources that are being depleted.

Overall Expectations

By the end of Grade 7, students will:

- demonstrate understanding that heat is a result of molecular motion;
- identify, through experimentation, ways in which heat changes substances, and describe how heat is transferred;
- explain how the characteristics and properties of heat can be used, and identify the effect of some of these applications on products, systems, and living things in the natural and human-made environments.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 7, students will:

– distinguish between the concept of temperature and the concept of heat (e.g., temperature is a measure of the average kinetic energy of the molecules in a substance; heat is thermal energy that is transferred from one substance to another);

– compare the motions of particles in a solid, a liquid, and a gas using the particle theory;

– explain how heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases (e.g., conduction: a pot heating on a stove; convection: a liquid heating in the pot; radiation: the air being warmed by heat from the element);

– describe how various surfaces absorb radiant heat;

– describe the effect of heating and cooling on the volume of a solid, a liquid, and a gas;

– investigate and identify factors affecting the rate of temperature change (e.g., mass, nature of liquid) using a constant heat source;

– describe the effect of heat on the motion of particles and explain how changes of state occur (e.g., from a liquid into a gas or vapour);

– compare, in qualitative terms, the heat capacities of common materials (e.g., water and aluminum have greater heat capacities than sand and Pyrex);

– identify systems that are controlled by sensory inputs and feedbacks (e.g., a thermostat);

– design and build a device that minimizes energy transfer (e.g., an incubator, a Thermos flask).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 7, students will:

– formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions (e.g., identify the steps that could be followed to test the effectiveness of the heating system in a home that uses solar energy);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms *heat conductor* and *heat insulator*);

– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., plot a graph showing the decrease in temperature of various liquids from identical initial temperatures);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use a diagram to illustrate convection in a liquid or a gas).

Relating Science and Technology to the World Outside the School

By the end of Grade 7, students will:

– recognize heat as a necessity for the survival of plants and animals;

– explain how the heating and cooling of the earth's surface produces air movement that results in all weather effects (e.g., convection currents);

– describe the water cycle as a process of energy transfer involving convection and radiation;

– identify different forms of energy that can be transformed into heat energy (e.g., mechanical, chemical, nuclear, or electrical energy);

– explain how mechanical systems produce heat (e.g., by friction), and describe ways to make these systems more efficient (e.g., by lubrication);

– describe and explain issues related to heat pollution, including both positive and negative aspects (e.g., industrial processes and generation of electricity cause heat pollution of large bodies of water);

– explain why heat energy is considered to be the final or end form of energy transformation;

– identify the purpose of the specialized features of various instruments that are used to measure temperature (e.g., temperature probes provide accurate continuous readings);

– identify and describe steps that can be taken to conserve energy (e.g., using insulation) and the reasons for doing so (e.g., rising fuel costs);

– identify the components of a system that are designed to transfer heat energy (e.g., in a room, a house, or a shopping centre) and describe methods for conserving energy within that system.

Energy and Control: Grade 8 – Optics

Overview

Students will build on previous learning to broaden their understanding of how light is produced, transmitted, and detected. They will further explore the properties of visible light and begin to study other kinds of electromagnetic radiation as different wavelengths of light. In addition, they will investigate how the principles and properties of reflection and refraction are applied in a variety of optical devices that have contributed to scientific progress and enhanced the quality of life (e.g., telescopes, microscopes, contact lenses).

Students will also continue to design and make devices and systems in order to extend their understanding of the transfer and conservation of energy.

Overall Expectations

By the end of Grade 8, students will:

- demonstrate an understanding of the properties of visible light and the properties of other types of electromagnetic radiation, including infrared and ultraviolet rays, X-rays, microwaves, and radio waves;
- investigate the properties of visible light, including the effects of reflection and refraction, and recognize how these properties are used in optical devices;
- describe ways in which different sources of visible light and the properties of light, both natural and artificial, are used by humans for different purposes.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 8, students will:

– identify the properties of visible light through experimentation;

– compare the properties of visible light with the properties of other types of electromagnetic radiation, including infrared and ultraviolet rays, X-rays, microwaves, and radio waves;

– describe how incandescent, fluorescent, and phosphorescent sources produce light;

– identify colours as different wavelengths of light and explain why objects appear to have colour;

– describe qualitatively how visible light is refracted;

– investigate how objects or media refract, transmit, or absorb light (e.g., non-luminous objects are seen when reflected light enters the eye; stars are seen when transmitted light enters the eye);

– identify ways in which the characteristics of mirrors and convex and concave lenses determine their use in optical instruments (e.g., in a camera, a telescope, binoculars, a microscope);

– investigate and describe the laws of reflection of visible light (e.g., using a plane mirror);

– explain colour vision using the additive theory;

– describe the effect of colour filters on white light using the subtractive theory.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 8, students will:

– formulate questions about and identify needs and problems related to the properties and behaviour of light (e.g., interactions between light and different materials), and explore possible answers and solutions (e.g., predict and demonstrate how various liquids will refract a light beam and describe the angle of refraction);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as *incidence*, *reflection*, *refraction*, *wavelength*, *frequency* when describing the properties of light);

– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots by hand or with a computer (e.g., use light sensors to identify and record different light intensities and present the findings in a chart);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a brochure informing the public of the risks of a specific type of electromagnetic radiation).

Relating Science and Technology to the World Outside the School

By the end of Grade 8, students will:

– describe how energy comes to earth as radiation in a range of wavelengths, some of which are visible;

– identify ways in which the properties of reflection are used in everyday situations (e.g., cosmetology, rear-view mirrors in cars, security mirrors, night reflectors on jackets or bicycles);

– explain the function and purpose of combinations of multiple lenses or lenses and mirrors in optical systems (e.g., the source and one or more reflectors or lenses in cameras, periscopes, telescopes);

– compare the automatic functions of the human eye to functions in an automatic camera (e.g., focusing power, adaptation to brightness);

– identify the input, output, feedback, and stability of systems (e.g., stage lights);

– evaluate the effectiveness of energy transfer systems (e.g., compare the amount of heat given off by fluorescent and incandescent bulbs);

– recognize that energy can be a significant cost in the manufacture and use of products or systems and explain how that determines its production (e.g., analyse the costs and benefits of producing and using solar panels).

Structures and Mechanisms

The Structures and Mechanisms strand is largely technological in content. A *structure* is any form that resists forces that would cause it to change shape and size. A *mechanism* uses or creates motion and consists of one or several simple machines (e.g., lever, pulley, wheel) that perform a specific function. With successive grade levels, students gain greater sophistication in their understanding of structures and mechanisms, and skill in their ability to design and construct them. Students also learn that structures and mechanisms can be combined into a *system*, which is a set of connected parts whose action is controlled in specific ways – for example, the brake system on a bicycle or car, or the electrical system in a house.

The topics covered in this strand are:

Grade 1: Everyday Structures

Grade 2: Movement

Grade 3: Stability

Grade 4: Pulleys and Gears

Grade 5: Forces Acting on Structures and Mechanisms

Grade 6: Motion

Grade 7: Structural Strength and Stability

Grade 8: Mechanical Efficiency

Throughout this strand, students pursue many types of investigation that involve them in designing and building structures and mechanisms, and testing the results of their designs. Using their observations, students describe various kinds of forces and motion that affect their designs. In investigating the operation of systems, students identify the parts of a system and understand their function. They then use this knowledge to understand the operation of the system as a whole and to deal with problems and modifications relating to specific parts.

Students make links to the real world when they evaluate real examples of structures and mechanisms using not only performance criteria (e.g., strength) but also other criteria such as aesthetic and ergonomic qualities, cost of production, safety, and reliability. Students can make links to the Matter and Materials strand and the Energy and Control strand, as well as the social studies area of the curriculum (e.g., through consideration of structures designed by people in other cultures). Communication in this strand takes place through graphic design, demonstrations, and media works, as well as written and oral descriptions of structures and mechanisms.

It is important that students follow established safety practices in designing, constructing, and experimenting with structures and mechanisms. These practices include:

- using tools safely to cut, join, and shape objects;
- handling moulding clay correctly and washing one's hands after using it;
- following proper procedures when comparing mechanical systems and their operation;
- using care when observing and working with objects in motion (e.g., objects that are spinning, swinging, bouncing, vibrating; gears and pulleys; elevated objects).

Structures and Mechanisms: Grade 1 – Everyday Structures

Overview

Students are surrounded by a wide variety of objects and structures that have distinctive shapes, patterns, and purposes. What's more, there are also different categories of structures: *solid structures* would include such things as stone walls and dams, *frame structures* would include bridges and bicycles, and *shell structures* would include domes and tents. By observing and manipulating different structures in natural and human-made environments, students in Grade 1 will begin to identify shapes that are repeated in various patterns, and shapes and patterns that are common to most structures.

Students will also be introduced to the concept of a system. In Grade 1, students will observe and use systems that they encounter in daily life and that involve a single *input*, which is the action required to set a system in operation (e.g., flicking a light switch), and a single *output*, which represents the response of the system.

Overall Expectations

By the end of Grade 1, students will:

- demonstrate awareness that structures have distinctive characteristics;
- design and make structures that meet a specific need;
- demonstrate understanding of the characteristics of different structures and of ways in which they are made, and recognize and use some systems in the home or at school.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 1, students will:

– explain the function of different structures (e.g., house, car, bridge, chair, umbrella, television, wheelbarrow);

– identify ways in which various structures are similar to and different from others in form and function (e.g., rooms all have walls but are different in size and are used for different purposes; rubber balls are round and solid whereas balloons are round and hollow);

– classify various structures in their environment (e.g., fences, stairs, ladders, bridges, water towers) according to specific features (e.g., size, materials) and functions;

– identify geometric shapes (e.g., square, triangle, circle) in ordinary structures;

– describe patterns that are produced by the repetition of specific shapes or motifs in various materials and objects (e.g., the pattern formed by triangles in a bridge or by flowers on wallpaper).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 1, students will:

– design and make different structures using concrete materials, and explain the function of the structure (e.g., a toy bridge, a slide for testing a marble);

– ask questions about and identify needs or problems related to structures in their immediate environment, and explore possible answers and solutions (e.g., make a box or a net in which to store a toy that has several pieces);

– plan investigations to answer some of these questions or solve some of these problems;
– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use words such as *triangle, tall,* and *zigzag* in describing shapes; use *input* and *output* in describing the operation of a machine);
– record relevant observations, findings, and measurements, using written language, drawings, charts, and concrete materials (e.g., record the number of different shapes in a playground and draw them);
– communicate the procedures and results of investigations and explorations for specific purposes, using demonstrations, drawings, and oral and written descriptions (e.g., set up a display of different cooking utensils and identify the function of each utensil);
– use appropriate natural and manufactured materials to make structures (e.g., cut paper, mix sand and water, combine pipe cleaners, use moulding clay);
– select appropriate tools and utensils (e.g., pencil, paintbrush, scissors, hacksaw, spoon, measuring cup);
– use tools appropriately when joining and shaping various materials (e.g., nails, glue, sandpaper).

Relating Science and Technology to the World Outside the School

By the end of Grade 1, students will:

– distinguish between structures and devices made by humans (e.g., houses, toys, televisions) and structures found in nature (e.g., bird nests, honeycombs);
– explain the function of a structure that they have made and describe how they made it (e.g., a bridge, a castle);
– identify structures whose function is indicated by their shape (e.g., railway-crossing barrier, stop sign, key);
– examine different kinds of fasteners (e.g., tape, button, zipper) and indicate where they are used;
– use and recognize the effects of different kinds of finishing techniques and processes (e.g., painting, adding decals) on structures they have designed and made;
– recognize that a product is manufactured to meet a need (e.g., scissors for cutting paper; coping saws for cutting wood);
– identify the action (input) required to operate an everyday system (e.g., pressing a button to ring a doorbell), and identify the response (output) of that system (e.g., the ringing of the doorbell);
– describe, using their own experience, how the parts of some systems work together (e.g., wheels and axle; pulley and string).

Structures and Mechanisms: Grade 2 – Movement

Overview

The study of moving things helps children develop a sense of space, as well as an understanding of the relationship between stationary and moving objects, including themselves. Through observation and the use of specific vocabulary, students will develop the ability to describe the position and motion of objects. In exploring motion, students will investigate mechanisms, such as hinges, inclined planes, and wheels and axles, and identify the simple machine(s) within them, such as lever, wedge, and wheel. They will investigate how mechanisms that consist of one or more simple machines can change the type and the direction of the movement of an object; for example, a hinge (mechanism) makes use of a lever (simple machine) to move a door backwards and forwards.

Overall Expectations

By the end of Grade 2, students will:

- describe the position and movement of objects, and demonstrate an understanding of how simple mechanisms enable an object to move;
- design and make simple mechanisms, and investigate their characteristics;
- recognize that different mechanisms and systems move in different ways, and that the different types of movement determine the design and the method of production of these mechanisms and systems.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 2, students will:

– describe different mechanisms through observation and investigation (e.g., hinge, inclined plane), and identify the components that are simple machines (e.g., lever, wedge);

– describe, using their observations, the characteristics and movements of simple mechanisms (e.g., hinge, wheels and axle);

– describe, using their observations, the position of an object in relation to other objects or to a specific area (e.g., use such words as *over, under, beside, behind*);

– identify changes in the position of an object in relation to other objects (e.g., movement upward or to the left);

– describe, using their observations, the pattern of movement of objects (e.g., turning, spinning, swinging, bouncing, vibrating).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 2, students will:

– ask questions about and identify needs or problems related to structures and mechanisms, and explore possible answers and solutions (e.g., investigate the effect of different floor coverings on the motion of a toy car);

– plan investigations to answer some of these questions or solve some of these problems, and describe the steps involved;

– use appropriate vocabulary to describe their investigations, explorations, and observations (e.g., use words such as *rotate, turn, faster,* and *slower* to describe the motion of wheels and axles);

– record relevant observations, findings, and measurements, using written language, drawings, charts, and concrete materials

(e.g., record what happens to the movement of a vehicle released from a ramp if the size of its wheels is changed);

– communicate the procedures and results of investigations and explorations for specific purposes, using drawings, demonstrations, and oral and written descriptions (e.g., draw a sketch of an object they plan to make and another sketch of the object after it is made; tell the class the procedures they followed in making a vehicle or a container with a hinged lid);
– make simple mechanisms and use them in building a device they have designed (e.g., vehicle with wheels and axles);
– select and use appropriate tools, utensils, and equipment (e.g., use a paper punch to make holes for the axle in cardboard wheels);
– use appropriate techniques to make and fasten the components of a model that they have made (e.g., bend cardboard to make hinges; glue various materials together).

Relating Science and Technology to the World Outside the School

By the end of Grade 2, students will:

– identify, through observation, the mechanical parts of objects (e.g., hinges on doors) and describe the motion of these parts;
– compare the motion of objects on different surfaces (e.g., wheels of a toy on carpet, tile, and sand);
– compare the motion of similar objects made with or filled with different materials (e.g., ways in which baseballs and tennis balls bounce; ways in which film canisters containing different materials roll down a slope);
– describe, using their observations, the effect that different surfaces (e.g., wood, tiles, carpet, water) have on the rate at which an object slows down;
– describe, using their observations, the effects of changing the slope of an inclined plane on the motion of an object that is placed on it (e.g., changes in speed, changes in distance travelled);
– predict factors that make a load easier or more difficult to move (e.g., the size of a wheel or hinge, the amount of friction);
– identify different ways in which wheels and axles can be attached to a chassis (e.g., by using an axle-holder, by placing the axle in holes drilled in the frame);
– demonstrate awareness that the wheels of a vehicle rotate clockwise or counterclockwise depending on the direction of movement of the vehicle.

Structures and Mechanisms: Grade 3 – Stability

Overview

Students will develop their understanding of the concept of stability in structures and the function of specific mechanisms. They will design and build structures that are rigid and strong, and will incorporate mechanisms in these structures. Students will also gain some understanding of the concept of balance, which is a necessary foundation for the later study of equilibrium.

Overall Expectations

By the end of Grade 3, students will:

- demonstrate an understanding of the factors that affect the stability of objects;
- design and make structures that include mechanisms and that can support and move a load, and investigate the forces acting on them;
- describe, using their observations, systems involving mechanisms and structures, and explain how these systems meet specific needs and how they have been made.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 3, students will:

– describe, using their observations, ways in which the strength of different materials can be altered (e.g., folding increases the strength of paper);

– describe ways in which forces alter the shape or strength of different structures (e.g., a load may cause a cardboard box to buckle);

– describe ways to improve the strength and stability of a frame structure (e.g., use of triangulation or a cross-member);

– describe, using their observations, the role of struts (e.g., to resist compression) and ties (e.g., to resist tension) in structures under load (e.g., describe the effect of adding a strut to a wooden frame);

– describe, using their observations, the changes in the amount of effort needed to lift a specific load with a lever when the position of the fulcrum is changed;

– describe, using their observations, how simple levers amplify or reduce movement (e.g., in operating the limbs of a puppet);

– describe the effects of different forces on specific structures and mechanisms (e.g., a structure collapses when the load is too heavy; a latch on a gate opens when pressed).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 3, students will:

– ask questions about and identify needs and problems related to structures and mechanisms in their immediate environment, and explore possible answers and solutions (e.g., investigate the effects of folding on the shape and strength of materials);

– plan investigations to answer some of these questions or solve some of these problems, and explain the steps involved;

– use appropriate vocabulary to describe their investigations, explorations, and observations (e.g., use terms such as *fulcrum*, *load*, and *effort* when describing levers);

– record relevant observations, findings, and measurements, using written language, drawings, charts, and graphs (e.g., record

the modifications they have made to increase the stability and strength of their structures);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using demonstrations, drawings, simple media works, and oral and written descriptions (e.g., make a mobile that illustrates their discoveries about balance);
– design and make a stable structure that will support a given mass and perform a specific function (e.g., a bridge, a photo frame);
– use appropriate materials to strengthen and stabilize structures that they have designed and made and that are intended to support a load (e.g., use gussets, struts, ties, buttresses);
– design and make a levered mechanism (e.g., a model of an animal whose legs are moved with a lever);
– design and make a stable structure that contains a mechanism and performs a function that meets a specific need (e.g., a drawbridge, a crane);
– use appropriate equipment and adhesives when making structures that they have designed themselves (e.g., transparent tape for paper; low-temperature glue gun for wood);
– use hand tools (e.g., hand saws, scissors) and equipment (e.g., templates, mitre boxes) appropriately to cut a variety of materials (e.g., wood, paper, cardboard, plastic).

Relating Science and Technology to the World Outside the School

By the end of Grade 3, students will:

– distinguish between the structure of an object (e.g., the chassis of a vehicle) and its mechanical parts (e.g., the wheels and axles);
– recognize that geometrical patterns in a structure contribute to the strength and stability of that structure (e.g., a climbing frame);
– demonstrate awareness that the strength in structures is due to bulk (or mass), number of layers (e.g., layers in particle board), and shape (e.g., triangulation);
– identify a number of common levers (e.g., crowbars, scissors, hammers, pliers, wheelbarrows, tweezers, tongs) and describe how they make work easier;
– identify efficient ways of joining the components of a mechanical structure or system (e.g., construct a right-angled corner; use an axle at a right angle to the frame);
– describe, using their observations, how different balance points of different masses affect the stability of a structure;
– predict which body positions provide the most stability in various circumstances (e.g., standing with legs apart, lying on the ground).

Structures and Mechanisms: Grade 4 – Pulleys and Gears

Overview

In previous grades, students will have investigated and built structures using wheels and axles. In Grade 4, they will broaden their understanding by looking at two special kinds of wheels: pulleys and gears. Pulleys are used singly or in combination to move an object from one place to another. Gears can be used in combination to change speed and direction of movement. Students will design and build pulley systems and gear systems, and will explore the advantages of each type of system. They will also continue to refine their understanding of structures, and will incorporate mechanisms in a structure to meet a specific need.

Overall Expectations

By the end of Grade 4, students will:

- demonstrate an understanding of the characteristics of pulleys and gears;
- design and make pulley systems and gear systems, and investigate how motion is transferred from one system to another;
- identify ways in which different systems function, and identify appropriate criteria to be considered when designing and making such systems.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 4, students will:

– describe, using their observations, the functions of pulley systems and gear systems (e.g., they make changes in direction, speed, and force possible);

– describe, using their observations, how rotary motion in one system (e.g., a system of pulleys of different sizes) is transferred to rotary motion in another (e.g., a system of various gears) in the same structure;

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

– demonstrate an awareness of the concept of mechanical advantage by using a variety of pulleys and gears.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 4, students will:

– formulate questions about and identify needs and problems related to structures and mechanisms in their environment, and explore possible answers and solutions (e.g., test the effort required by different gear systems to lift the same load);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to describe their investigations (e.g., use terms such as *block and tackle* in describing pulley systems and *gear train* in describing gear systems);

– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., create a table recording how the action of a pulley system is altered by changing the tension of the band connecting two pulleys);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, drawings, charts, and oral presentations (e.g., draw a diagram of a proposed object and a diagram of the finished product);
– design, make, and use a pulley system that performs a specific task (e.g., a pulley system that closes a door or carries an object from one place to another);
– design and make a system of pulleys and/or gears for a structure (e.g., a potter's wheel) that moves in a prescribed and controlled way (e.g., fast, straight) and performs a specific function;
– manipulate pliable and rigid materials (e.g., modelling clay, wood) as required by a specific design task.

Relating Science and Technology to the World Outside the School

By the end of Grade 4, students will:

– demonstrate awareness that most mechanical systems are fixed and dependent on structures (e.g., elevators);
– compare in qualitative terms the performance of various mechanical systems (e.g., a block-and-tackle system, a single-pulley system), and describe how they are used;
– identify and make modifications to their own pulley and gear systems to improve the way they move a load (e.g., change the size of pulleys or gears used; use gears that change direction through a right angle);
– evaluate, in general terms (e.g., as more or less effective), the performance of a system that they have made and the performance of another system designed to do the same task;
– explain how various mechanisms on a bicycle function (e.g., levers for braking; gears and chains for changing speed);
– demonstrate awareness that finishing techniques can adversely affect the performance of a mechanical system (e.g., problems result if paint gets into a gear system);
– identify the properties of materials (e.g., pliability, rigidity) that are best suited for use in a structure that contains a mechanical system;
– describe the consequences of having a limited choice of materials when making a device or a structure;
– identify common devices and systems that incorporate pulleys (e.g., clotheslines, flagpoles, cranes) and/or gears (e.g., bicycles, hand drills, wind-up or grandfather clocks).

Structures and Mechanisms: Grade 5 – Forces Acting on Structures and Mechanisms

Overview

As students continue to design and build mechanical devices and structures, they develop a more sophisticated understanding of forces. Students in Grade 5 will identify the forces acting on and within structures, and will give simple quantitative descriptions of these forces. They will focus on ways of making mechanisms accomplish specific tasks with less effort.

Overall Expectations

By the end of Grade 5, students will:

- demonstrate an understanding of the effect of forces acting on different structures and mechanisms;
- design and make load-bearing structures and different mechanisms, and investigate the forces acting on them;
- evaluate the design of systems that include structures and mechanisms, and identify modifications to improve their effectiveness.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 5, students will:

– identify and measure forces acting on a structure (e.g., mass, air pressure), and describe the effects of their application;

– identify the parts of a structure that are under tension and those that are under compression when subjected to a load (e.g., the wires in a suspension bridge are under tension; a ladder bearing a mass is under compression);

– compare the force needed to lift a load manually with the force required to lift the load with a simple machine (e.g., lever, pulley system, gear system);

– describe, using their observations, the advantages and disadvantages of using different types of mechanical systems (e.g., a single-pulley system has no mechanical advantage; a pulley system with two or more pulleys has a mechanical advantage);

– describe the turning force (torque) of different combinations of gears (e.g., the turning force of a higher gear and of a lower gear);

– identify the force required by different pulley systems (systems with one or more pulleys) to move a load, and compare the systems in qualitative terms.

Developing Skills in Inquiry, Design, and Communication

By the end of Grade 5, students will:

– formulate questions about and identify needs and problems related to structures and mechanisms in the outdoor environment, and explore possible answers and solutions (e.g., construct a bridge that must support a given load across a given distance; determine which surface of a cantilever bridge or beam is under tension and which is under compression);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and

observations (e.g., use terms such as *component*, *subsystem*, and *device* when describing systems);

- compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., make a chart to record data on the raising of a load with different pulley systems);
- communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, drawings, charts, and oral presentations (e.g., give a presentation on the process of designing and making a specific structure);
- design and make a frame structure that can support a load (e.g., a bridge);
- make a mechanical system that performs a specific function (e.g., lifting a heavy load; retrieving an object from a position that cannot be reached by hand);
- cut, join, and rearrange pliable and rigid materials to make an object (e.g., cut wood at a 45º angle to make a mitre joint; make a mould for a face mask);
- describe safety measures to be taken to ensure their own safety and that of others (e.g., they need to check that fixed pulleys in pulley systems are secure before testing them).

Relating Science and Technology to the World Outside the School

By the end of Grade 5, students will:

- identify specific considerations in the actual manufacture of a product that they have designed and made (e.g., production time; cost and availability of materials);
- identify problems that arose in the designing and making of a product, and indicate how these could have been avoided or how they were solved;
- describe the consequences of having limited time and materials when making a product;
- identify modifications intended to improve the performance, aesthetic appeal, and impact on the environment of a product they designed;
- identify the aesthetic qualities of a product they made (e.g., form, colour, pattern, type of surface), and explain the usefulness of the product to others;
- assess the effect of modifying a component of a system (e.g., a personal computer system that has a keyboard, floppy disk drive, CD-ROM, hard drive, central processing unit, and monitor);
- assess the effect of modifying a subsystem that interacts with other subsystems within a system to perform a specific function (e.g., changing a pulley system to a lever system);
- describe how different mechanisms (e.g., ratchet and pawl, cam and cam follower) are designed for a specific purpose or function;
- recognize the advantages and disadvantages of using various mechanisms (e.g., levers, wheels and axles, pulleys, gears) with respect to the amount of energy they require to move or lift a given load;
- describe the change in energy transfer that occurs when the number and the size of gears in a gear system are modified.

Structures and Mechanisms: Grade 6 – Motion

Overview

In previous grades, students will have had many experiences observing different kinds of motion. Students in Grade 6 will learn to classify these kinds of motion as *linear* (e.g., a sliding door), *rotational* (e.g., a Ferris wheel or carousel), *reciprocating* (e.g., a self-inking stamp), and *oscillating* (e.g., a swing). They will learn to analyse and predict the motion of objects, devices, and systems by understanding the forces that act on them and that determine the magnitude, speed, and direction of movement. Students will make different mechanisms that move in different ways, and will learn how mechanisms change one type of motion into another.

By observing the effects of motion, students will continue to develop their understanding of stability in systems. Students will also be introduced to the concept of kinetic energy.

Overall Expectations

By the end of Grade 6, students will:

- demonstrate an understanding of different kinds of motion (linear, rotational, reciprocating, oscillating);
- design and make mechanical devices, and investigate how mechanisms change one type of motion into another and transfer energy from one form to another;
- identify modifications to improve the design and method of production of systems that have mechanisms that move in different ways.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 6, students will:

– describe, using their observations, ways in which mechanical devices and systems produce a linear output from a rotary input (e.g., screw, crank and slider, rack and pinion, cam and cam follower);

– describe, using their observations, the purposes or uses of three classes of simple levers (e.g., wheelbarrow, tongs, seesaw);

– demonstrate an understanding of how linkages (systems of levers) transmit motion and force (e.g., by means of a fixed pivot, a moving pivot, and/or a fulcrum);

– demonstrate awareness that a moving mass has kinetic energy that can be transferred to a stationary object (e.g., a car hitting a wheelbarrow will cause the wheelbarrow to move);

– demonstrate awareness that friction (e.g., rubbing hands together) transforms kinetic energy into heat energy;

– investigate ways of reducing friction (e.g., use of ball bearings, lubricants) so that an object can be moved more easily.

Developing Skills in Inquiry, Design, and Communication

By the end of Grade 6, students will:

– design and make mechanical devices that change the direction and speed of an input to produce a desired output and that perform a useful function (e.g., a clothesline);

– formulate questions about and identify needs and problems related to structures and mechanisms in the environment, and explore possible answers and solutions

(e.g., describe how a system, such as a plumbing system, could be modified to meet different needs);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *fulcrum, pivot, rack and pinion, belt*);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, labelled graphs, and scatter plots produced by hand or with a computer (e.g., measure and record the motion of moving objects; manipulate computerized data collected from a moving object);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, drawings, and oral presentations (e.g., describe how a product was created from the first idea to the final model; produce a set of instructions to control the sequence of movements of a mechanical device).

Relating Science and Technology to the World Outside the School

By the end of Grade 6, students will:

– make use of the physical and aesthetic properties of natural and manufactured materials when designing a product;
– show awareness of the effect on a design of the unavailability of specific materials (e.g., the design of a pair of scissors may need to change if only plastic is available instead of metal);
– write a plan outlining the different materials and processes involved in producing a product (e.g., resources, equipment, marketing);
– identify various criteria for selecting a product (e.g., safety, reliability, durability);
– describe modifications that could improve the action of a variety of devices in the home (e.g., can opener, nutcracker, clothesline that uses pulleys);
– show an understanding of the impact of moving mechanisms (e.g., trucks, snowmobiles) on the environment and on living things (e.g., loss of natural habitat);
– compare qualitatively the effort required to move a load a given distance using different devices and systems;
– describe how different devices and systems have been used by different cultures to meet similar needs (e.g., irrigation systems for farms, temporary shelters, bicycles).

Structures and Mechanisms: Grade 7 – Structural Strength and Stability

Overview

In previous grades, students will have investigated, designed, built, and tested a variety of structures. In Grade 7, they will learn more about the effects of forces that act on and within different structural forms. Using increasingly sophisticated techniques, students will continue to investigate how different structural forms support or withstand loads by designing, building, and testing solid (or mass) structures, shell structures, and frame structures.

Overall Expectations

By the end of Grade 7, students will:

- demonstrate an understanding of the relationship between the effectiveness of structural forms and the forces that act on and within them;
- design and make a variety of structures, and investigate the relationship between the design and function of these structures and the forces that act on them;
- demonstrate an understanding of the factors (e.g., availability of resources) that must be considered in the designing and making of products that meet a specific need.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 7, students will:

– classify structures as solid (or mass) structures (e.g., dams), frame structures (e.g., goal posts), or shell structures (e.g., airplane wings);

– demonstrate awareness that the position of the centre of gravity of a structure (e.g., bridge, building, tower) determines whether the structure is stable or unstable;

– describe, using their observations, ways in which different forces can affect the stability of a structure (e.g., certain forces may cause a structure to shear, twist, or buckle);

– demonstrate awareness that the effect of forces acting on a structure under load depends on the magnitude, direction, and point and plane of application of the forces;

– identify forces within a structure that are affected by forces outside the structure (e.g., shear, torsion, tension, and compression within a bridge are affected by external forces such as high wind or ice);

– measure the performance of a structure (e.g., a bridge, a tower) by comparing its mass with the mass of the load it supports.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 7, students will:

– use appropriate techniques and materials (e.g., cutting and joining pieces of wood or plastic) while making structures that have mechanisms;

– formulate questions about and identify needs and problems related to the strength of structures, and explore possible answers and solutions (e.g., determine what caused structural failure and propose ways of supporting a specific load);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as *fields*, *data*, and *cells* when describing databases);
– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., tabulate data from tests of the strength of their own structures; record their evaluations of possible solutions to a design problem);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, drawings, and oral presentations (e.g., create an animated film of the steps taken in designing and making a product).

Relating Science and Technology to the World Outside the School

By the end of Grade 7, students will:

– tell the "story" of a product used every day, identifying the need it meets and describing its production, use, and eventual disposal;
– investigate ways in which research is done on existing products (e.g., basketball shoes, telephones) to generate new ideas for the products;
– recognize the importance of researching needs and opportunities for sale before proposing ways of developing a product;
– recognize that a solution to a problem may result in creating new problems in other areas, and that a solution to a problem may be found while one is working on solving a problem in another area;
– identify energy as a significant cost in the manufacturing and use of products or systems;
– produce a work plan that outlines the possible criteria for choosing resources for manufacturing a product that they have designed (e.g., the properties and availability of the resources; the aesthetic appeal of the product and the impact of its use on the environment);
– describe, using their observations, the function of symmetrical design in structural and mechanical systems (e.g., in bridges);
– use their knowledge of materials in designing and making structures that will stand up to stress;
– demonstrate how information is organized and stored in a computer system (e.g., in a database or a spreadsheet program).

Structures and Mechanisms: Grade 8 – Mechanical Efficiency

Overview

Efficiency is an important consideration in design because some forms of energy or power are costly and need to be used wisely. Students will develop their understanding of the efficient operation of mechanical systems by designing and building devices and systems and investigating their efficiency. Special attention will be given to the use of hydraulic and pneumatic power.

Overall Expectations

By the end of Grade 8, students will:

- demonstrate an understanding of the factors that contribute to the efficient operation of mechanisms and systems;
- design and make systems of structures and mechanisms, and investigate the efficiency of the mechanical devices within them;
- demonstrate understanding of the factors that can affect the manufacturing of a product, including the needs of the consumer.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 8, students will:

– explain how forces are transferred in all directions in fluids (Pascal's law);

– describe in quantitative terms the relationship between force, area, and pressure;

– explain in qualitative terms the relationship between pressure, volume, and temperature when a liquid is compressed or heated and a gas (e.g., air) is compressed or heated;

– compare the effect of pressure on a liquid (e.g., on water in a syringe) with the effect of pressure on a gas (e.g., on air in a syringe);

– explain, using their observations, how the use of appropriate levers and ways of linking the components of fluid systems can improve the performance of the systems (e.g., systems in a steam shovel, in a robot);

– investigate and measure forces that affect the movement of an object (e.g., friction);

– distinguish between velocity and speed (i.e., define velocity as speed in a given direction);

– determine the velocity ratio of devices with pulleys and gears (i.e., divide the distance that a load moves by the distance covered by the force (effort) required to move it);

– predict the mechanical efficiency of using different mechanical systems (e.g., a winch).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 8, students will:

– formulate questions about and identify needs and problems related to the efficient operation of mechanical systems, and explore possible answers and solutions (e.g., test a device at each stage of its development and evaluate its performance in relation to specific criteria);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use such technical terms as *velocity, velocity ratio,* and *efficiency*);
– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., produce and analyse a quotation to complete a job in the home);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., make a display in which they compare the ways in which a closed pneumatic system and a hydraulic system operate the same size of cylinder);
– design and make a mechanical system that is operated by hydraulic or pneumatic power;
– select and use appropriate materials and strategies to make a product;
– produce technical drawings and layout diagrams of a structure or a mechanical system that they are designing, using a variety of resources.

Relating Science and Technology to the World Outside the School

By the end of Grade 8, students will:

– explain how human weight, height, age, sex, and physical capability affect the design of products (e.g., car seats, snowmobiles, zippers);
– analyse the use of symmetry in the ergonomic design of objects and systems (e.g., office furniture, computer equipment);
– describe how the components and subsystems of a product used by humans (e.g., a bicycle, a computer system) enable the product to function;
– identify the kinds of information that assist consumers in making a decision about buying a product (e.g., information on performance, durability, safety, benefits to health);
– identify consumer expectations regarding the function and effectiveness of a product, using information collected in a survey they made, and recognize that expectations may change;
– recognize the importance of unbiased testing of control samples and independent evaluation of the test results before a product is manufactured;
– identify the personal and societal factors that determine whether a product is used;
– evaluate product manuals or help screens (e.g., a manual for a video recorder), focusing on clarity, thoroughness, and general "user-friendliness", and identify ways of making the product easier to use;
– assess the impact on the environment of the use and disposal of various products (e.g., motor oil, Freon);
– explain the economic, social, and environmental factors that can determine whether a product is manufactured (e.g., costs of materials and equipment, availability of skilled labour, potential harmfulness of the product);
– make informed judgements about products designed and made by others;
– evaluate their own designs against the original need, and propose modifications to improve the quality of the products.

Earth and Space Systems

The Earth and Space Systems strand deals with the science and technology of our planet and of space. As with other strands in the curriculum, students begin with aspects of the topic that are most familiar to them – the cycles of the days and seasons, the local soil and rocks, the particular features of their region of the province, the observable constellations in the night sky – and progress towards those with which they are less familiar or that are more complex.

The topics covered in this strand are:

Grade 1: Daily and Seasonal Cycles

Grade 2: Air and Water in the Environment

Grade 3: Soils in the Environment

Grade 4: Rocks, Minerals, and Erosion

Grade 5: Weather

Grade 6: Space

Grade 7: The Earth's Crust

Grade 8: Water Systems

As the above list of topics indicates, the material covered in this strand naturally leads students to observation and exploration. Investigations will be numerous and varied, and should be of particular interest to students since many of the topics deal with things and events that students have often observed and wondered about. Links with the world beyond the classroom also arise naturally since most of the topics studied in the strand relate to the world outside. Students will have many opportunities to explore the environment, the use and abuse of resources, and the impact of space technology on our knowledge of the earth.

It is important that students follow established safety practices in all investigations. These practices include:

– washing one's hands after handling soil samples and other earth materials;
– covering rock samples and wearing safety goggles when chipping;
– waiting for instructions in field work before proceeding;
– following specific instructions during investigations that involve observation of the sun (for example, never looking directly at the sun or through a lens or coloured glass).

Earth and Space Systems: Grade 1 – Daily and Seasonal Cycles

Overview

In observing their environment, students become aware of changes that take place in it, including changes in physical factors such as temperature, wind, and light, and changes in plants and animals. Through observation and investigation, students will learn that changes often occur in cycles, including the relatively short cycle of day and night and the longer cycle of the seasons. Recognizing these cyclical patterns prepares students to discover relationships among events in their environment, and between the environment and themselves.

Overall Expectations

By the end of Grade 1, students will:

- demonstrate an understanding of changes that occur in daily and seasonal cycles and of how these changes affect the characteristics, behaviour, and location of living things;
- investigate changes that occur in a daily cycle and in a seasonal cycle;
- describe how living things, including humans, adapt to and prepare for daily and seasonal changes.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 1, students will:

– identify the sun as a source of heat and light;

– compare the different characteristics of the four seasons (e.g., length of day, type of precipitation);

– use units of time related to the earth's cycles (e.g., days, months, seasons);

– describe, using their observations, changes in heat and light from the sun over a period of time (e.g., measure and describe outdoor temperature changes at different times of the day; observe and describe how the position of the sun influences the length and shape of shadows).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 1, students will:

– design and construct models of structures that would provide protection against local weather conditions (e.g., bus shelters, umbrellas, houses);

– ask questions about and identify needs or problems arising from observable events in the environment, and explore possible answers and solutions (e.g., chart observations of a sunflower over several days and identify a pattern in the movement of the head of the flower; record sunrise times and sunset times and observe a pattern);

– plan investigations to answer some of these questions or solve some of these problems;

– use appropriate vocabulary in describing their explorations, investigations, and observations (e.g., use words such as *buds*, *flowers*, *seeds*, and *leaves* to identify seasonal changes in plants);
– record relevant observations, findings, and measurements, using written language, drawings, concrete materials, and charts (e.g., draw pictures of how animals live and what they do at different times of the year; measure and record changes in temperature);
– communicate the procedures and results of explorations and investigations for specific purposes, using demonstrations, drawings, and oral and written descriptions (e.g., write and illustrate a booklet about their observations of seasonal changes; keep a journal recording and describing the weather for a given period of time).

Relating Science and Technology to the World Outside the School

By the end of Grade 1, students will:

– identify outdoor human activities that are based on the seasons (e.g., swimming, gardening, skating) and examine some of the solutions humans have found to make it possible to engage in these activities out of season (e.g., community and sports centres make it possible to swim and skate in any season; greenhouses make it possible to garden in any season);
– identify characteristics of clothing worn in different seasons and make appropriate decisions about clothing for different environmental conditions;
– identify features of houses that help keep us sheltered and comfortable throughout daily and seasonal cycles (e.g., lights, furnaces);
– describe changes in the characteristics and behaviour of living things that occur on a daily basis (e.g., their own daily routines at school and at home, the behaviour of nocturnal animals, changes in certain plants and flowers);
– describe changes in the characteristics, behaviour, and location of living things that occur in seasonal cycles (e.g., trees shed their leaves, birds migrate);
– describe ways in which humans modify their behaviour to adapt to changes in temperature and sunlight during the day (e.g., they put on extra clothing when it gets colder, they wear sunglasses).

Earth and Space Systems: Grade 2 – Air and Water in the Environment

Overview

Air and water form a major part of the physical environment and are essential materials for life, yet our awareness of them is often limited largely because we recognize them only in their most obvious and observable forms (e.g., water in lakes and rivers, rain, wind). 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. In the process, students will discover the many ways in which air and water contribute to the health and survival of living things, including ourselves.

Overall Expectations

By the end of Grade 2, students will:

- demonstrate an awareness of the forms in which water and air are present in the environment, and describe ways in which living things are affected by water and air;
- investigate the visible effects of air and water in the environment;
- describe ways in which clean air and water are vital for meeting the needs of humans and other living things.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 2, students will:

– demonstrate an awareness of air as a substance that surrounds us and takes up space, and whose movement we feel as wind;

– describe the movement of air relying on their observations of its effects (e.g., tree branches swaying, clouds moving);

– compare characteristics of and changes in observed air conditions, in both indoor and outdoor environments (e.g., cold winter temperatures outdoors and warm temperatures indoors);

– identify ways in which changes in temperature affect living things, including themselves (e.g., decisions concerning activities or transportation; hibernation; dormancy; migration);

– recognize that water exists in three states on earth (e.g., solid – visible as ice; liquid – visible as rain or as water in lakes, streams, etc.; gas – present but invisible as water vapour);

– identify and describe forms of moisture in the environment (e.g., dew, snow, fog, frost, rain);

– identify the factors that cause things to dry quickly or slowly (e.g., air temperature; amount of moisture in the air; amount of wind);

– recognize evidence of the water cycle (e.g., observe water in a closed container and water in an open container; observe puddles evaporating after a rainstorm).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 2, students will:

– ask questions about and identify needs or problems arising from events in the outdoor environment, and explore possible answers and solutions (e.g., observe that there is a relationship between the patterns and movement of clouds and changes in weather; monitor the length of time needed for various materials used for clothing to dry in order to determine which materials are more suitable for wet weather);
– plan investigations to answer some of these questions or solve some of these problems, and describe the steps involved;
– use appropriate vocabulary in describing their explorations, investigations, and observations (e.g., use words such as *solid*, *liquid*, *vapour;* use the correct terms to describe quantities of water in standard (metric) and non-standard units of measure);
– record relevant observations, findings, and measurements, using written language, drawings, concrete materials, and charts (e.g., record and graph weather data gathered over a period of a few weeks);
– communicate the procedures and results of explorations and investigations for specific purposes, using drawings, demonstrations, and oral and written descriptions (e.g., write the instructions for constructing a pinwheel, adding helpful drawings or diagrams).

Relating Science and Technology to the World Outside the School

By the end of Grade 2, students will:

– predict and describe how local weather conditions affect living things, including themselves (e.g., effect of wind on trees in autumn, effect of snowfall on humans' ability to travel);
– describe the different uses of water and identify some that are essential for maintaining our health (e.g., water is used for drinking and washing; clean drinking water is essential for the health of humans);
– identify sources of drinking water (e.g., wells, springs, Great Lakes, rivers);
– recognize that clean water is an increasingly scarce resource in many parts of the world and that the water we use is part of our environment and should be used wisely (e.g., taps should be turned off while brushing teeth; toxic substances such as paint should not be poured down the drain);
– demonstrate awareness of the ways in which the disposal of waste water can affect our health and the health of other living things (e.g., pouring waste water containing chemicals into a lake or river can seriously harm people and the organisms that live in the water).

Earth and Space Systems: Grade 3 – Soils in the Environment

Overview

As children soon discover, soil is not just dirt but a rich source of life and nourishment for many organisms, including humans. Many different kinds of animals and plants live in soil, which provides a base for gardens, forests, fields, and farms. By examining soils, students will discover that soils are made up of living things and different earth materials. Different kinds of soil have different characteristics and combinations of materials, which determine their animal and plant populations as well as their suitability for particular uses. Students' investigations in this strand will involve manipulation as well as observation and other methods of inquiry.

Overall Expectations

By the end of Grade 3, students will:

- demonstrate an understanding of the similarities and differences between various soils and the effects of moving water on soils;
- investigate the components of various soils, and describe the effects of moving water on these soils;
- recognize the dependence of humans and other living things on soil and recognize its importance as a source of materials for making useful objects.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 3, students will:

– describe, using their observations, the various components within a sample of soil (e.g., pebbles, decaying plants);

– describe, using their observations, the differences between sand, clay, humus, and other soil components (e.g., texture, smell, malleability), and compare and describe soil samples from different locations (e.g., school yard, forest, marsh, beach);

– compare the absorption of water by different earth materials, and describe the effects of moisture on characteristics of the materials (e.g., on texture, coherence, ability to hold a shape);

– describe, using their observations, how different earth materials (e.g., rocks, pebbles, sand) are affected by moving water (e.g., the sand on a beach washed by waves; pebbles in a river);

– compare different ways in which plant roots (e.g., fibrous roots, tap roots) grow through the soil;

– describe through experimentation how soil can be separated into its different components (e.g., sieving, sedimentation).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 3, students will:

– ask questions about organisms and events in the outdoor environment and identify needs of organisms that arise from these events, and explore possible answers to these questions and ways of meeting these needs (e.g., investigate the different effects produced when water is sprayed on and poured on exposed soil, asphalt, and grass);

– plan investigations to answer some of these questions or find ways of meeting these needs, and explain the steps involved;

– use appropriate vocabulary in describing their investigations, explorations, and observations (e.g., use terms such as *clay*, *sand*, and *pebbles* to describe the earth materials in soil);
– record relevant observations, findings, and measurements, using written language, charts, and drawings (e.g., create a tally chart to record the water absorption of different earth materials);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using drawings, demonstrations, simple media works, and oral and written descriptions (e.g., record what happens when soil and water are shaken together in a container; prepare a display comparing the composition of soils from different locations).

Relating Science and Technology to the World Outside the School

By the end of Grade 3, students will:

– identify living things found in the soil (e.g., roots, earthworms, larvae);
– demonstrate awareness of the importance of recycling organic materials in soils (e.g., explain the purpose of a compost heap; explain the reason why it is useful to leave grass clippings on the lawn);
– recognize the importance of understanding different types of soil and their characteristics (e.g., enables people to determine which crops can be grown in a particular area; enables gardeners and farmers to improve plant growth);
– describe how the use of different soils affects the growth of indoor plants;
– describe ways of using soil materials to make useful objects, and investigate, through manipulation, ways of shaping clay to make useful objects (e.g., model bricks or beads).

Earth and Space Systems: Grade 4 – Rocks, Minerals, and Erosion

Overview

The study of rocks and minerals introduces students to geology. By examining different types of rocks and minerals found in the earth's crust, students will learn about their characteristics and properties. They will also discover that rocks and minerals are useful for many things and that their characteristics help to determine their use. Through an examination of the processes of erosion, transportation, and deposition, students will develop an understanding of the changing landscape and of the ways in which wind, water, and ice reshape it. The examination of these processes will lead to an exploration of the ways in which humans can both prevent changes to the landscape and adapt to these changes.

Overall Expectations

By the end of Grade 4, students will:

- demonstrate an understanding of the physical properties of rocks and minerals and the effects of erosion on the landscape;
- investigate, test, and compare the physical properties of rocks and minerals and investigate the factors that cause erosion of the landscape;
- describe the effects of human activity (e.g., land development, building of dams, mine development, erosion-preventing measures) on physical features of the landscape, and examine the use of rocks and minerals in making consumer products.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 4, students will:

– describe the difference between minerals (composed of the same substance throughout) and rocks (composed of two or more minerals);

– classify rocks and minerals according to chosen criteria, relying on their observations (e.g., colour, texture, shape);

– recognize that there are three classes of rocks: igneous, sedimentary, and metamorphic;

– compare different rocks and minerals from the local environment with rocks and minerals from other places;

– describe the effects of wind, water, and ice on the landscape (e.g., ice breaking rocks into soil), and identify natural phenomena that cause rapid and significant changes in the landscape (e.g., floods, tornadoes, heavy rainstorms);

– investigate and describe ways in which soil is formed from rocks;

– identify and describe rocks that contain records of the earth's history (e.g., fossils), and explain how they were formed.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 4, students will:

– follow procedures that ensure their safety by covering rock samples with a cloth when chipping and by wearing safety goggles;

– test and compare the physical properties of minerals (e.g., scratch test for hardness, streak test for colour);

– formulate questions about and identify needs and problems related to objects and events in the environment, and explore possible answers and solutions (e.g., create a mould of a fossil and use the mould to

make a replica of the fossil to demonstrate how the fossil was formed; design and carry out an investigation using sand structures to show the relationship between volume of water and erosion);

- plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
- use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *hardness*, *colour*, *lustre*, and *texture* when discussing the physical properties of rocks and minerals);
- compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., use a chart to record findings obtained through a mineral hardness test);
- communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., put together a labelled exhibit of rocks found in the local environment; create a chart of the physical characteristics of different types of rocks and minerals).

Relating Science and Technology to the World Outside the School

By the end of Grade 4, students will:

- distinguish between natural features of the landscape and those that are the result of human activity (e.g., Niagara Escarpment, farm land, vineyards);
- determine positive and negative effects of human alteration of the landscape (e.g., use of farm land for housing developments; use of wilderness areas for cultivation of crops; creation of parks);
- identify ways in which soil erosion can be controlled or minimized (e.g., by planting trees, by building retaining walls), and create a plan for reducing erosion of soil in a local field or plot;
- design, build, and test a system to control the effects of soil erosion;
- identify the many uses of rocks and minerals in manufacturing, and in arts and crafts (e.g., china, iron fences, soapstone carvings, jewellery, coins);
- conduct their investigations of the outdoor environment in a responsible way and with respect for the environment (e.g., leave the site of the investigation as they found it, putting back objects examined where they found them and taking away all equipment brought to the site).

Earth and Space Systems: Grade 5 – Weather

Overview

Weather, the study of which is called meteorology, is an important aspect of daily life. Students will learn that daily weather conditions are not the result of random occurrences, but are, rather, part of larger climatic systems and patterns that can be predicted both on a short-term and on a seasonal basis. Students will study various aspects of weather (temperature, wind speed, cloud formation, precipitation, atmospheric pressure), and examine the role they play in determining weather conditions.

Overall Expectations

By the end of Grade 5, students will:

- demonstrate an understanding of the major climatic factors and patterns associated with weather;
- investigate the major climatic factors associated with weather, and design, construct, and test a variety of instruments for recording various features of the weather;
- examine how weather forecasts influence decisions concerning human activity and how humans have adapted to a variety of weather conditions.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 5, students will:

– explain the difference between weather and climate and the factors that influence both of these systems (e.g., temperature, moisture, wind, air pressure, the sun);

– recognize large-scale and local weather systems (e.g., fronts, air masses, storms);

– predict local weather patterns using data from their own observations of weather and from weather reports;

– explain the formation of clouds and the effects of different cloud formations on weather and climate (e.g., create a model of a cloud in a jar and relate it to the water cycle; describe the relationship between the formation of cumulonimbus clouds and thunderstorms);

– describe the water cycle in terms of evaporation, condensation, and precipitation;

– identify patterns in air movement (e.g., low pressure and high pressure);

– describe the ways in which energy from the sun affects weather conditions (e.g., evaporation of water results in condensation, which in turn results in precipitation);

– identify the effects of air pressure (e.g., low pressure air masses are associated with mild temperature and create conditions that cause storms or clouds; high pressure air masses are cooler and are often associated with clear weather conditions);

– compare outdoor air movement with indoor air movement (e.g., as hot air rises, cold air takes its place; the warmest rooms in a house are usually the upstairs bedrooms).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 5, the student will:

– design, construct, and test a variety of weather instruments (e.g., weather vane, anemometer, rain gauge, wind sock, hygrometer);

– formulate questions about and identify needs and problems related to objects and events in the environment, and explore possible answers and solutions (e.g., test a variety of fabrics for their waterproofing or insulating properties);
– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *temperature*, *precipitation*, *humidity*, *wind chill factor*, *barometric pressure*, and *cloud cover*);
– compile data gathered through investigation in order to record and present results, using tally charts, tables, and labelled graphs produced by hand or with a computer (e.g., record both qualitative and quantitative data from observations of weather over a period of time; accurately use a thermometer to read temperature and record the results);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., draw a labelled diagram of the water cycle).

Relating Science and Technology to the World Outside the School

By the end of Grade 5, the student will:

– describe ways in which weather conditions affect the activities of humans and other animals (e.g., people refrain from strenuous physical activity in extreme heat; farmers plant crops when the soil is moist; animals hibernate in extreme cold);
– explain how climatic and weather conditions influence the choice of materials used for building shelters (e.g., bricks are often used for building in cold climates, stone and marble in warmer climates);
– explain how advances in technology and science have enabled humans to make predictions about the weather (e.g., microwave beams are used to reflect cloud cover; satellite images of the earth allow us to track weather patterns on a larger scale than was previously possible);
– understand and explain the importance of weather forecasts for people in certain occupations (e.g., farmers, pilots);
– recognize how the movement of large-scale air masses affects regional weather in Ontario (e.g., high pressure systems from the Arctic are associated with clear and cool weather; Atlantic systems are associated with cloudy skies; Pacific systems are associated with a variety of different weather conditions);
– explain how weather conditions influence activities and events related to science and technology (e.g., launching the space shuttle).

Earth and Space Systems: Grade 6 – Space

Overview

Space science involves learning about objects in the sky, particularly their form, movements, and interactions. In this strand, students will develop an understanding of earth and space and of the relationship of earth to the other bodies in the solar system. Investigations will involve extensive work with models of the different bodies to allow students to explore their size, position, and motion, as well as relationship to one another. In learning about space, students will come to appreciate that our ability to observe and study objects in space has been greatly enhanced by the use of technological devices.

Overall Expectations

By the end of Grade 6, students will:

- demonstrate an understanding of the patterns of change observable on earth as a result of the movement of the different bodies in the solar system (e.g., solar and lunar eclipses, tides, phases of the moon, position of the constellations) and of the physical characteristics of the different components of the solar system;
- investigate, using models and simulations, the relationship between the sun, earth, and moon, the patterns of change observable on earth that result from the movement of these bodies, and the physical characteristics of the different components of the solar system (e.g., the sun and planets, inner planets and outer planets);
- describe technological and scientific advances that enable humans to study space, and explain how these advances have affected the quality of life on earth.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 6, students will:

– describe the physical characteristics of components of the solar system – the sun, planets, natural satellites, comets, asteroids, and meteoroids (e.g., relative size, surface temperature);

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

– describe, using models or simulations, the features of the moon's surface (e.g., craters, maria, rills);

– identify cycles in nature (e.g., cycle of day and night, cycle of seasons) and describe the changes within the cycles (e.g., observe the phases of the moon over several months to determine the pattern of change, and record these observations);

– describe, using models or simulations, how the earth's rotation causes the cycle of day and night, and how the earth's revolution causes the cycle of the seasons;

– recognize major constellations visible at night and describe the origins of their names (e.g., Orion, Leo);

– describe, using models or simulations, the effects of the relative motion and positions of the earth, moon, and sun (e.g., solar and lunar eclipses, tides, phases of the moon);

– follow safety procedures when observing the sun (e.g., never look at the sun directly or through a lens or coloured glass; look only at a projection of the sun's image; do not use a lens or magnifier to focus the sun's rays to a small area; exercise caution when using mirrors so that they do not reflect the sun's image directly into someone's eyes).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 6, students will:

– construct a device that could have been used to tell time before mechanical clocks were invented (e.g., sundial);

– formulate questions about and identify needs and problems related to objects and events in the environment, and explore possible answers and solutions (e.g., investigate why craters are of different sizes; use print, media, and electronic resources to identify and investigate space technologies and to investigate images of space and identify what they represent; use a computer simulation program to show the relative size of the planets and their distance from the sun);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations (e.g., use terms such as *constellations*, *planets*, *moons*, *comets*, *asteroids*, and *meteors* to describe objects in space);

– compile data gathered through investigation in order to record and present results, using tally charts, tables, labelled graphs, and scatter plots produced by hand or with a computer (e.g., use print and electronic resources to organize information about the solar system);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a multimedia presentation showing Canada's contribution to space exploration).

Relating Science and Technology to the World Outside the School

By the end of Grade 6, students will:

– describe how humans have improved the tools and techniques used in space exploration (e.g., Canadarm, Hubble telescope, Lunar Rover, Sojourner);

– identify Canadians who have contributed to space science and technology (e.g., Marc Garneau, Roberta Bondar, Chris Hadfield, David Levy, Helen Hogg, Bjarni Tryggvason);

– explain how astronauts meet their basic needs in space (e.g., through the use of dehydrated foods, backpacks with an oxygen supply, a hermetically sealed cabin with temperature and air controls);

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

– recognize problems arising from space exploration (e.g., space junk, satellites burning in the atmosphere upon re-entry);

– identify and describe past and present-day contributions of astronomy to the quality of human life (e.g., development of the calendar; prediction of events such as eclipses and seasons; provision of information about space and time);

– identify the ways in which the development of materials and technology for space exploration has led to the use of new technologies and materials on earth (e.g., micro-electronics, medical imaging, remote sensing).

Earth and Space Systems: Grade 7 – The Earth's Crust

Overview

Our knowledge of earth is growing rapidly as a result of new developments in the methods and technologies used to study the components and dynamics of the earth's crust. The study of this strand will involve extensive investigation using models or computer simulations, and will lead students to an understanding of the dynamics of geological systems and events. As a result of this understanding, students will be better able to explain the theories of earth science and to make connections between these theories and their own experiences with local geology.

Overall Expectations

By the end of Grade 7, students will:

- demonstrate an understanding of the composition of the earth's crust, and describe how changes in the earth's crust result from both internal and external processes;
- investigate the formation of the physical features of the earth's crust;
- identify the factors that must be considered in making informed decisions about land use and explain their importance (e.g., environmental impact; properties of soil).

Specific Expectations

Understanding Basic Concepts

By the end of Grade 7, students will:

– describe the composition of the earth's crust;

– classify rocks and minerals, using their observations, according to their characteristics and method of formation;

– distinguish between rocks and minerals and describe the differences in their composition (e.g., minerals, such as the mineral calcite, are components of rocks such as the sedimentary rock limestone, in which calcite is found);

– identify the geological processes involved in rock and mineral formations (e.g., volcanic activity releases lava; the deep cooling of magma produces granite);

– explain the rock cycle (e.g., formation, weathering, sedimentation, and reformation);

– describe the process of soil formation by relating the various meteorological, geological, and biological processes involved;

– describe, using simulations or models, the processes involved in mountain formation and in the folding and faulting of the earth's surface (e.g., plate tectonics);

– analyse, through observation, evidence of geological change (e.g., fossils, strata);

– describe, using simulations or models, the origin and history of natural features of the local landscape (e.g., lakes, river flats);

– explain the causes of some natural events that occur on or near the earth's surface (e.g., earthquakes, volcanic eruptions, landslides) and their effects.

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 7, students will:

– investigate the effect of weathering on rocks and minerals;

– formulate questions about and identify needs and problems arising from events relating to the earth's crust, and explore possible answers and solutions (e.g., search

print and electronic resources to gather and record data on past and current earthquake epicentres and regions of volcanic activity);

– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as *magma*, *crystallization*, *igneous rock*, *weathering*, *transportation*, *sediments*, and *sedimentary rock* when describing the rock cycle);

– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., collect data on the change in turbidity of a river after a rainfall);

– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a model demonstrating volcanic activity; develop a chronological model or time scale of major events in the formation of the earth; design and build models to illustrate different mining techniques).

Relating Science and Technology to the World Outside the School

By the end of Grade 7, students will:

– identify the factors that must be considered in making informed decisions about land use (e.g., environmental impact, jobs, present and future values of natural resources);

– investigate some of the ways in which humans have altered the landscape to meet their needs (e.g., farming, urban development, roads) and assess the environmental and economic consequences;

– identify earth resources used by humans to manufacture products (e.g., iron ore is used to make steel products) and discuss what happens to the products when they are no longer useful;

– explain how the characteristics of soil (e.g., water-holding capacity, size of particles, texture) determine its use (e.g., land that is rich in nutrients and that can hold water is used for crop growing);

– recognize and explain the importance of knowledge of the different types and characteristics of soil in determining its suitability for specific uses (e.g., choosing landfill sites and hazardous-waste disposal sites; developing conservation projects; identifying soils suited to different crops);

– assess the importance of soil conservation (e.g., economically important to the agri-food industry; important for controlling the flow of water; necessary for plant growth);

– describe how humans are affected by natural events and how technology has helped humans adapt to these events (e.g., use of satellites in predicting weather changes; changes in the engineering of buildings in earthquake zones; monitoring of crop growth);

– identify past and present-day applications of technologies that have contributed to the study of geology (e.g., surface observation, core sampling, seismography, magnetometry, satellite technologies);

– recognize that the earth provides us with geothermal energy.

Earth and Space Systems: Grade 8 – Water Systems

Overview

Most 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. In addition, students will come to understand that large bodies of water such as the Great Lakes greatly influence the climate and weather of the region in which they are located, and that both large lakes and oceans interact with the atmosphere through the water cycle. As students develop these understandings, they become aware of the importance of fresh and salt water to the sustainability of life on earth.

Overall Expectations

By the end of Grade 8, students will:

- demonstrate an understanding of how the earth's water systems were formed, the similarities and differences among them, and how they influence the climate and weather of the region in which they are located;
- investigate the major features of the earth's water resources (e.g., oceans, rivers, lakes, glaciers, ice-caps, snowfall, clouds) and the effects of large bodies of water on global climate and ecosystems;
- examine how humans use resources from the earth's different water systems and identify the factors involved in managing these resources for sustainability.

Specific Expectations

Understanding Basic Concepts

By the end of Grade 8, students will:

– identify the various states of water on the earth's surface and the conditions under which they exist (e.g., glaciers, snow on mountains, and polar ice-caps are solid states of water; oceans, lakes, rivers, and groundwater are liquid states of water; the atmosphere contains water in its gaseous state);

– describe the distribution and circulation of water on the earth (e.g., oceans, glaciers, rivers, groundwater, the atmosphere);

– compare the formation of geological features on the ocean floor (e.g., sea mounts, continental shelves, trenches) and the formation of lakes and rivers;

– compare the physical characteristics of salt water with those of fresh water (e.g., movement, density, buoyancy of objects in water);

– explain how salinity differs in bodies of fresh and salt water;

– describe wave formation and the effects of waves on coastal features (e.g., bays, rocky headlands, beaches);

– explain, using simulations or models, how certain geological features affect the height of tides (e.g., Bay of Fundy tides);

– describe, for their geographical area, the direction of water flow and its relationship to the Continental Divide (the watershed boundary for North America);

– investigate, through observation, the effects of changes in temperature on convection currents in water;

– investigate how large bodies of water affect the weather and climate of an area (e.g., lakes affect snow precipitation);

– describe factors that affect glaciers and polar ice-caps, and describe the effects of glaciers and polar ice-caps on the environment (e.g., annual precipitation, temperature);
– investigate, using simulations or models, the movement of ocean currents and their impact on regional climates (e.g., Gulf Stream, Labrador Current, Alaska Current).

Developing Skills of Inquiry, Design, and Communication

By the end of Grade 8, students will:

– formulate questions about and identify needs arising from events relating to the earth's water, and explore possible answers to these questions and ways of meeting these needs (e.g., search print and/or electronic resources for information and prepare a map showing the changes in world ice distribution patterns over several geological time periods; conduct research to explain why fossils of ocean fish are found in places geographically removed from present-day oceans);
– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as *salinity*, *currents*, and *basins* when describing oceans and their characteristics);
– compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., record the results of a comparison of the density of various objects and of their buoyancy in fresh water and salt water);
– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a multimedia presentation on the effects of tides on Canadian shores; create a concept map linking the different stages of the water cycle).

Relating Science and Technology to the World Outside the School

By the end of Grade 8, students will:

– evaluate human use of water and the economic and environmental effects of that use (e.g., filtration plants, tourism, industrial applications, control of water flow);
– explain the different stages involved in processing water for use by humans (e.g., obtaining water from its source, treatment, distribution, disposal);
– evaluate the positive and negative effects on the earth's water supply of the development of natural resources (e.g., use of oil rigs, pulp and paper mills);
– describe technological innovations that have facilitated and improved scientific research into oceans (e.g., sonar mapping, core sampling, satellite imaging, underwater photography and videography, tracking devices, submersibles);
– analyse factors that affect the productivity and distribution of animal species in marine and fresh water environments (e.g., water released from a nuclear power plant, oil spills);

- compare the diversity of living organisms in salt water with that in fresh water (e.g., construct marine and freshwater food webs and compare them);
- explain how the geological features of the ocean floor interact with ocean currents to influence the productivity of the oceans and affect marine life (e.g., Grand Banks);
- identify ways in which humans have tried to contain damage caused by water (e.g., flood control, dune vegetation, coastline reconfiguration);
- explain how changes in the water table (e.g., changes in the water level in wells) relate to the water cycle;
- discuss the technologies used to extract and secure oil and natural gas from the ocean floor and the possible economic and environmental costs and benefits.

Explanatory Notes

The following definitions of terms are intended to help teachers and parents use this document.

Achievement levels. Brief descriptions of four different degrees of achievement of the provincial curriculum expectations for any given grade. Level 3, which is the "provincial standard", identifies a high level of achievement of the provincial expectations. Parents of students achieving at level 3 in a particular grade can be confident that their children will be prepared for work at the next grade. Level 1 identifies achievement that falls much below the provincial standard. Level 2 identifies achievement that approaches the standard. Level 4 identifies achievement that surpasses the standard.

Bernoulli's principle. A law that states that, for a fluid that is flowing steadily, its pressure is low when its velocity is high and its pressure is high when its velocity is low.

Biogeochemical cycle. The cycling of matter within the biosphere (e.g., the water cycle).

Biome. An area with a characteristic geographic and climatic pattern that supports characteristic animal and plant populations (e.g., boreal forest).

Biosphere. The portion of the planet that supports life and the living organisms within it.

Buoyant force. The upward force on objects submerged in fluids. For some objects it can be sufficient to overcome completely the force of gravity and cause the object to float.

Cam and cam follower. A mechanism that changes rotary (circular) motion into linear motion (motion in a straight line).

Capacity. The greatest amount that a container can hold. Capacity is usually measured in litres or millilitres.

Chemical change. A process in which new substances with new properties are formed.

Classification (or biological) key. A list of alternatives (e.g., *backbone or no backbone*) used by scientists as an aid in identifying an unknown plant or animal. (There are other kinds of classification keys but this is the most common.)

Community. A group of all the interdependent plant and animal species found in a habitat.

Computer spreadsheet. Software that helps to organize information, using rows and columns.

Concept map. A diagram that shows various relationships among concepts. A concept map can also contain references to events, objects, laws, themes, classroom activities, or other items related to the concepts.

Concrete materials. Objects and materials that can be handled. Students make use of these in their explorations and investigations.

Conductivity. The ability of a substance to transmit electricity or heat.

Conductor. A substance that can transmit electricity or heat.

Conservation of energy. The principle that energy can neither be created nor destroyed, but can only be changed from one form into another.

Cumulonimbus cloud. A principal cloud type, exceptionally dense and vertically developed, occurring either as isolated clouds or as a line or wall of clouds with separated upper portions.

Data. Facts or information.

Database. An organized or sorted list of facts or information, usually generated by a computer.

Decomposer. An organism that breaks down dead organic matter.

Density. The mass per unit volume of a substance (density = mass ÷ volume).

Diffusion. The net movement of molecules from an area of higher concentration of molecules to an area of lower concentration of molecules.

Displacement. The amount of fluid displaced by an object that is put into the fluid.

Dissolve. Mix a solute completely with a solvent to form a solution.

Ecological niche. The pattern of relationships between a species and all the living and non-living things within its habitat.

Ecology. The study of all the interactions that occur within the biosphere.

Ecosystem. A group of living organisms that, along with their abiotic environment, form a self-regulating system through which energy and materials are transferred.

Efficiency. The comparison of the useful work or energy provided by a machine or system with the actual work or energy supplied to the machine or system. Efficiency is usually stated as a percentage. The formula is as follows:

$$\text{per cent efficiency} = \frac{\text{energy output}}{\text{energy input}} \times 100\%$$

Effort. The force supplied to a machine in order to produce an action.

Expectations. The knowledge and skills that students are expected to develop and to demonstrate in their class work, on tests, and in various other activities on which their achievement is assessed. The new Ontario curriculum for Science and Technology identifies expectations for each grade from Grade 1 to Grade 8.

Fair test. Investigation carried out under strictly controlled conditions to ensure accuracy and reliability of results. In a fair test, all variables are controlled except the one under investigation.

Food chain. A sequence of feeding relationships between organisms in an ecosystem.

Food web. A network of feeding relationships in an ecosystem that develops because few organisms confine themselves to a single source of food.

Fossil fuel. A fuel formed from the partially decomposed remains of plants and animals buried in the earth over an extremely long period of time (e.g., coal, oil, natural gas).

Frequency. The number of cycles completed by a periodic quantity (e.g., a vibrating object) in a unit of time. Frequency is usually expressed as cycles per second.

Fulcrum. The point of rotation of a lever. The fulcrum is also called the *pivot*.

Gear. A rotating wheel-like object with teeth around its rim. A gear is used to transmit force to another gear with matching teeth.

Gear train. A group of two or more gears.

Geothermal energy. An energy source derived from the heat of the earth.

Graph. A representation of data in a pictorial form. Some types of graphs are:

- bar graph. A diagram consisting of horizontal or vertical bars that represent data.
- coordinate graph. A grid that has data points named as ordered pairs of numbers, for example, (4,3).
- histogram. A type of bar graph in which each bar represents a range of values and in which the data are continuous.

Gusset. A plate that is used to strengthen truss joints.

Habitat. The area in which a species lives.

Hydraulic power. Power that comes from the pressure of a liquid, usually oil. The liquid is forced through hoses to the area where the force is needed.

Hydraulics. The study of pressure in liquids.

Input. Anything that is put into a system. Sources of input include people, materials, and energy.

Insulation. Material that does not conduct heat or electricity very well.

Lift. Upward force on a forward-moving object that results when the air flow around the top of the object is faster than the air flow beneath it.

Linkage. A system of levers used to transmit motion.

Load. The weight of an object that is moved by a machine, or the resistance to movement that a machine has to overcome.

Mass. The amount of matter in an object. Mass is usually measured in grams or kilograms.

Mass concentration. The mass of solute dissolved in a given volume of solution. Mass concentration may be expressed in grams per millilitre or grams per litre.

Mechanical advantage. The ratio of the force produced by a machine or system (sometimes called the *load*) to the force applied to the machine or system (sometimes called the *effort force*). The formula is as follows:

$$\text{mechanical advantage} = \frac{\text{force produced by the machine}}{\text{force applied to the machine}}$$

Mechanical mixture. A mixture made up of two or more easily identifiable parts that can be easily separated, for example, a mixture of sand and iron filings.

Media works. Forms of communication that include written or spoken words, sound, and/or pictures, such as brochures, posters, magazines, newspapers, documentary films, videos, advertisements, cartoons, commercials, news reports, nature programs, and travelogues. Audio elements include speech, music, background sounds, sound effects, volume, silence, narration, pace, and sequence of sounds. Compositional elements include form (structure), theme, setting, atmosphere, and point of view. Visual elements include lighting, colour, images, size and type of lettering, size of images, sequence of images, symbols, graphics, camera angles, logos, speed of presentation, shape of design, credits, details of sponsorship, animation, and live action.

Multi-media. A variety of different media, such as written text, sound, graphics, and video.

Non-renewable energy sources. Energy sources that are limited and that cannot be replaced once they are used up (e.g., coal, oil, natural gas).

Nucleus. The control organelle of a living cell.

Organelle. A structure within a cell that has a specific function.

Osmosis. Diffusion of a solvent, usually water, through a selectively permeable membrane.

Output. The actual result obtained from a system (e.g., the light that comes on when the light switch on an electrical system is pressed).

Pascal's law or principle. A law that states that pressure exerted on a contained fluid is transmitted undiminished in all directions throughout the fluid and perpendicular to the walls of the container.

Physical change. A change of properties that does not change the type of substance.

Pitch. The quality of a sound that is determined by the frequency of the wave. The term *pitch* is often substituted for the term *frequency of vibration* in reference to sound waves (e.g., in musical instruments).

Pneumatics. The study of pressure in gases.

Population. All of the members of one species found in a particular area at a particular time.

Pressure. The force acting perpendicular to a unit area (pressure = force ÷ area).

Producer. An organism that produces its own food. In an ecosystem, a producer is an organism that is capable of carrying out photosynthesis.

Qualitative data. Information gathered in observations in which no measurement takes place.

Qualitative property. A characteristic of a substance that can be described but not measured.

Quantitative data. Data that consist of numbers and/or units of measurement. Quantitative data are obtained through measurement and through mathematical calculations.

Quantitative property. A characteristic of a substance that can be measured.

Renewable energy sources. Natural energy sources that can be replaced. For example, when trees are cut down for lumber, new trees can be planted in their place.

Saturated solution. A solution in which no more solute can be dissolved at a particular temperature.

Scatter plot. A graph that attempts to show a relationship between two variables by means of points plotted on a coordinate grid. Also called *scatter diagram*.

Scientific notation. The writing of a number as the product of a number between 1 and 10 and a power of 10 (e.g., in scientific notation, 58 000 000 is written 5.8×10^7).

Shear. Two forces that act on an object in opposite directions along the same line or plane (e.g., the movement of the two blades of a pair of scissors).

SI. The international system of measurement units, including such terms as *centimetre* and *kilogram*. (From the French *Système international d'unités*).

Solubility. The property of being able to dissolve. More specifically, it refers to the mass of a solute that can dissolve in a given amount of solvent to form a saturated solution at a particular temperature.

Solute. The substance that dissolves in a solvent to form a solution.

Solvent. The substance that dissolves a solute to form a solution.

Stem-and-leaf plot. An organization of data into categories based on place values.

Strands. The five major areas of knowledge and skills into which the curriculum for Science and Technology is organized. The strands for Science and Technology are: Life Systems, Matter and Materials, Energy and Control, Structures and Mechanisms, and Earth and Space Systems.

Stress. Forces created inside a material or an object by other forces acting on it from the outside.

Structure. A supporting framework (e.g., a bridge or building that is built to sustain a load).

Strut. A part of a structure whose function is to resist compressive forces. It may also be said that a strut is "under compression".

Succession. The slow, orderly, progressive replacement of one community by another during the development of vegetation in an area.

Survey. A sampling of information, often compiled by asking people questions or interviewing them.

Sustainable development. Development that meets the needs of the present generation without compromising the ability of future generations to meet their needs.

Table. An orderly arrangement of facts set out for easy reference (e.g., an arrangement of numerical values in vertical or horizontal columns).

Tally chart. A chart that uses tally marks to count data and record frequencies.

Tension. A force that stretches an object.

Thrust. Pushing power that is based on the principle that for every action there is an equal and opposite reaction.

Tie. A part of a structure that is under tension.

Torque. The product of a force and the perpendicular distance to a turning axis.

Torsion. A force that causes an object to twist along its axis.

Triangulation. A means of strengthening a structure that involves the use of the triangle as a strong, rigid shape.

Truss. A structural element made up of a series of triangular frames.

Variable. A factor that affects the results of an investigation. Variables are things that could change during an investigation or experiment (e.g., the amount of sunlight received by a plant).

Volume. The amount of space occupied by an object. Volume is measured in cubic units such as cubic centimetres.

Wavelength. The distance between the crests of a wave of light as it travels through space.

Weight. The pull of gravity on an object. Unlike mass, weight changes with location.

WHMIS. Acronym that stands for Workplace Hazardous Materials Information System. This is a system in use across Canada through which employers and workers can obtain information about hazardous materials in their workplace so that they can protect their health and ensure their safety.

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