Québec Education Program

Progression of Learning

Science and Technology

Secondary III

2021-2022 School Year

Learning to Be Prioritized for the 2021-2022 School Year
in the Context of the Pandemic

This document is identical to the one
produced for the 2020-2021 school year.

Votre gouvernement

Québec

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Progression of Learning in Secondary School

The progression of learning in secondary school constitutes a complement to each school subject, providing further information on the knowledge that the students must acquire and be able to use in each year of secondary school. This tool is intended to assist teachers in planning both their teaching and the learning that their students are to acquire.

The role of knowledge in learning

The knowledge that young people acquire enables them to better understand the world in which they live. From a very early age, within their families and through contact with the media and with friends, they accumulate and learn to use an increasingly greater body of knowledge. The role of the school should be to progressively broaden, deepen and structure this knowledge.

Knowledge and competencies must mutually reinforce each other. On the one hand, knowledge becomes consolidated when it is used and, on the other hand, the exercise of competencies entails the acquisition of new knowledge. Helping young people acquire knowledge raises the challenging question of how to make this knowledge useful and durable, and thus evokes the notion of competency. For example, we can never be really assured that a grammar rule has been assimilated until it is used appropriately in a variety of texts and contexts that go beyond the confines of a repetitive, targeted exercise.

Intervention by the teacher

The role of the teacher in knowledge acquisition and competency development is essential, and he or she must intervene throughout the learning process. In effect, the *Education Act* confers on the teacher the right to "select methods of instruction corresponding to the requirements and objectives fixed for each group or for each student entrusted to his care." It is therefore the teacher's responsibility to adapt his or her instruction and to base it on a variety of strategies, whether this involves lecture-based teaching for the entire class, individualized instruction for a student or a small group of students, a series of exercises to be done, a team activity or a particular project to be carried out.

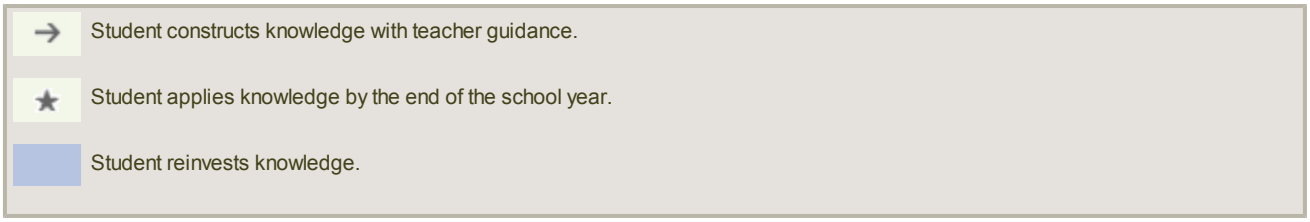
In order to meet the needs of students with learning difficulties, teachers should encourage their participation in the activities designed for the whole class, although support measures should also be provided, when necessary. These might involve more targeted teaching of certain key elements of knowledge, or they might take the form of other specialized interventions.

As for the evaluation of learning, it serves two essential functions. Firstly, it enables us to look at the students' learning in order to guide and support them effectively. Secondly, it enables us to verify the extent to which the students have acquired the expected learning. Whatever its function, in accordance with the *Policy on the Evaluation of Learning*, evaluation should focus on the acquisition of knowledge and the students' ability to use this knowledge effectively in contexts that draw upon their competencies.

Structure

The progression of learning is presented in the form of tables that organize the elements of knowledge similarly to the way they are organized in the subject-specific programs. In mathematics, for example, learning is presented in fields: arithmetic, geometry, etc. For subjects that continue on from elementary school, the *Progression of Learning in Secondary School* has been harmonized with the *Progression of Learning in Elementary School*. Every element of learning indicated is associated with one or more years of secondary school during which it is formally taught.

A uniform legend is used for all subjects. The legend employs three symbols: an arrow, a star and a shaded box. What is expected of the student is described as follows:



An **arrow** indicates that teaching must be planned in a way that enables students to begin acquiring knowledge during the school year and continue or conclude this process in the following year, with ongoing systematic intervention from the teacher.

A **star** indicates that the teacher must plan for the majority of students to have acquired this knowledge by the end of the school year.

A **shaded box** indicates that the teacher must plan to ensure that this knowledge will be applied during the school year.

Science and Technology

General Education Path

Introduction

This document provides additional information about the learning prescribed in the compulsory secondary-level Science and Technology programs and its progression from year to year and from cycle to cycle. This document is intended to help teachers with their lesson planning.

To progress in their learning, students need to do more than merely acquire knowledge. They must also learn to apply their knowledge in a variety of increasingly complex situations. By appropriately using the knowledge, techniques and strategies listed in this document, they will develop the competencies outlined in the Science and Technology programs. By applying these competencies, they will acquire new knowledge which, in turn, will help them further develop their competencies.

In order to seek answers or solutions to scientific and technological problems (Competency 1), students must become familiar with strategies and acquire conceptual and technical knowledge that will enable them to define a problem, explore it and then justify their methodological choices and results. Similarly, the appropriate scientific or technological concepts and principles can help them understand phenomena, explain the operation of objects or form an opinion and, consequently, make the most of their scientific and technological knowledge (Competency 2). Finally, in order to communicate in the languages used in science and technology (Competency 3), they must have knowledge that will enable them to interpret and convey messages using the languages and types of representation associated with science and technology.

In elementary school, students became familiar with science and technology and explored knowledge involving simple and usually observable phenomena in their immediate environment. In secondary school, they further develop their scientific and technological literacy and continue to do so throughout their lives. In Cycle One, students learn about natural phenomena and man-made objects that interest them. In Cycle Two, the compulsory concepts are organized around two themes: *The Human Organism* in Secondary III and *The Environment* in Secondary IV. In the optional Environmental Science and Technology program, the knowledge to be acquired is organized around three environmental issues, two of which are new. Successful completion of this program will make it easier to enroll in the optional Physics and Chemistry programs offered in Secondary V.

The tables in this document outline the knowledge related to each of the four areas of the programs: The Material World, The Living World, The Earth and Space, and The Technological World. Each table is preceded by a text explaining how this knowledge contributes to students' learning in science and technology. Each section begins with a short text describing the related knowledge that was acquired at the elementary level.[1] Two other tables provide information about the appropriate techniques and strategies for students to use.

The concepts are further clarified by a list of statements indicating the degree of complexity of the subject matter targeted and explanations of the progression of learning from one year to the next. In some cases, specifications about the extent of the knowledge to be addressed appear in parentheses.

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1. Elementary school teachers can choose themes from among those listed in the program. It is therefore possible that some students may not have studied certain concepts, even though the concepts mentioned here should have been addressed at the elementary level. The table of strategies includes a column devoted to learning acquired in elementary school.

Science and Technology

General Education Path

The Material World

In The Material World, students acquire scientific and technological knowledge pertaining to the organization of the world around us, the elements that compose it and the forces that govern it.

In secondary school, students explore increasingly complex phenomena and technical objects and seek answers and solutions to a variety of problems. They acquire scientific knowledge about The Material World that helps them understand and explain the factors at play in different scientific issues and in the operation of technological objects, systems and processes. This knowledge, along with the knowledge they acquire in other areas of the program, enables them to understand scientific models, theories and laws. Students refine their understanding of the concepts related to The Material World by using the experimental method, technological analysis and the technological design process.

In Secondary III, knowledge in this area is organized around the problem-solving process and the analysis and design of technical objects pertaining to the human organism, which enables students to make connections with knowledge from The Living World. In Secondary IV, students continue to construct their scientific and technological knowledge by exploring laws and models related to environmental issues.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge. Statements preceded by the symbol ♦ indicate knowledge specific to the compulsory Science and Technology program. Most of these statements are, however, found in the progression of learning for the optional Science and the Environment program.	Secondary				
	ST Cycle One		ST Cycle Two		EST Cycle Two
A. Properties	1	2	3	4	4
Elementary school Students recognize and describe the external characteristics of an object and the materials of which it is made. They compare the mass and volume of solids and liquids. They use a thermometer and associate temperature changes with different contexts. They can tell the difference between three states of matter (solid, liquid, gas) and describe the operations required to move from one to the other (heating, cooling).					
Secondary school					
1. Properties of matter	ST		ST		EST
a. Mass					
i. Defines the concept of mass	→	★			
ii. Compares the mass of different substances with the same volume	→	★			
b. Volume					
i. Defines the concept of volume	→	★			
ii. Chooses the appropriate unit of measurement to express volume (e.g. 120 mL or 0.12 L or 120 cm^3)	→	★			
iii. Compares the volume of different substances with the same mass	→	★			
c. Temperature					
i. Describes the effect of heat on the degree of agitation of particles	→	★			
ii. Defines temperature as a measurement of the degree of agitation of particles	→	★			
iii. Explains the thermal expansion of bodies	→	★			

d. States of matter					
i. Names the different phase changes of matter (vaporization, condensation, freezing, melting, deposition, sublimation)[1]	→	★			
ii. Interprets the phase change diagram for a pure substance	→	★			
e. Acidity/alkalinity					
i. Determines the observable properties of acidic, basic or neutral solutions (e.g. reaction to litmus, reactivity with metals)	→	★			
ii. Determines the acidity or alkalinity of common substances (e.g. water, lemon juice, vinegar, soft drinks, milk of magnesia, cleaners)	→	★			
f. Characteristic properties					
i. Defines a characteristic property as a property that aids in the identification of a substance or group of substances	→	★			
ii. Identifies groups of substances based on their common characteristic properties (e.g. acids turn litmus red)	→	★			
iii. Associates a characteristic property of a substance or material with its use (e.g. metal is used to make pots because it is a good conductor of heat)	→	★			
2. Characteristic physical properties	ST		ST		EST
a. Melting point					
i. Identifies a substance by its melting point using a reference document			★		
b. Boiling point					
i. Identifies a substance by its boiling point using a reference document			★		
c. Density					
i. Explains the concept of density			★		
ii. Determines the density of different substances			★		
iii. Identifies liquid and solid substances by their density using a reference document			★		
d. Solubility					
♦ i. Defines the concept of solubility			★		
♦ ii. Describes the effect of variations in temperature on the solubility of a substance			★		
3. Properties of solutions	ST		ST		EST
a. Solutions[2]					
i. Describes the properties of an aqueous solution (e.g. only one visible phase, translucent)	→	★			
b. Solute					
♦ i. Recognizes the solute in a given aqueous solution			★		
c. Solvent					
♦ i. Recognizes the solvent in a given aqueous solution (e.g. lymph, tears, cell plasma, urine)			★		
d. Concentration					
♦ i. Defines the concept of the concentration of a solution			★		

	ii. Describes the effect of variations in the quantity of solute or solvent on a solution's concentration			★		
	iii. Determines the concentration of an aqueous solution (g/L or percentage)			★		
♦	iv. Determines the concentration of an aqueous solution (g/L, percentage or ppm)				★	
	v. Determines the concentration of an aqueous solution (g/L, percentage, ppm, mol/L)					★
	e. Electrolytes					
♦	i. Defines the concept of electrolyte				★	
	f. Strength of electrolytes					
	i. Qualitatively speaking, associates the strength of an electrolyte with its degree of dissociation					★
	g. pH scale[3]					
♦	i. Describes the pH scale (acidity, alkalinity, neutrality, increasing and decreasing values)				★	
♦	ii. Determines the pH of a few common substances (e.g. distilled water, rainwater, saliva, lemon juice, cleaners)				★	
	h. Electrolytic dissociation					
♦	i. Describes electrolytic dissociation				★	
	i. Ions					
♦	i. Defines the concept of ion				★	
	j. Electrical conductivity					
♦	i. Describes the mechanism that allows aqueous solutions to conduct electricity (electrolytic dissolution of a solute, formation of mobile ions)				★	
4. Characteristic chemical properties		ST		ST		EST
	a. Reaction to indicators					
	i. Recognizes a substance by its characteristic chemical properties (e.g. starch turns blue in the presence of an iodine solution, acidic solutions turn bromothymol blue yellow)			★		
B. Changes		**1**	**2**	**3**	**4**	**4**

Elementary school
Students demonstrate that the properties of matter do not change during physical changes (e.g. distortion, breaking, crushing), but that they do change during chemical changes (e.g. cooking, combustion). They recognize that the quantity of matter is conserved during physical changes (e.g. mass of a piece of chalk whether whole or crushed). They become familiar with how certain household products are made (e.g. soap, paper, maple syrup).

Secondary school

1. Changes in matter		ST		ST		EST
	a. Conservation of matter					
	i. Demonstrates that matter is conserved during a chemical change (e.g. conservation of mass in a precipitation reaction)	→	★			
	b. Mixtures					
	i. Describes the properties of a mixture (e.g. made up of several substances, one or more phases)	→	★			
	ii. Distinguishes between a solution or homogenous mixture (e.g. drinking water, air, alloy) and a heterogeneous mixture (e.g. tomato juice, smog, rock)	→	★			

c. Solutions[4]					
d. Separation of mixtures					
i. Associates a separation technique with the type of mixture to be separated[5]	→	★			
ii. Describes the steps involved in separating a complex mixture (e.g. sedimentation, decantation and evaporation to separate salt water and sand)	→	★			
e. Particle model					
i. Defines the particle model as a means of representing the behaviour of matter			★		
ii. Describes the particle model in terms of the qualities and limitations of a scientific model			★		
2. Physical changes	**ST**		**ST**		**EST**
a. Physical changes					
i. Describes the characteristics of a physical change (e.g. substance retains its properties, molecules remain intact)	→	★			
ii. Recognizes different physical changes (e.g. phase changes, preparation or separation of a mixture)	→	★			
b. Dissolution					
♦ i. Explains dissolution using the particle model			★		
c. Dilution					
♦ i. Explains dilution in terms of concentration and volume			★		
♦ ii. Determines the final volume or concentration of an aqueous solution after dilution (e.g. when the volume of solvent is doubled, the concentration of the solution decreases by half)			★		
d. Phase changes					
♦ i. Compares the arrangement of particles in a substance in a solid, liquid or gaseous form			★		
♦ ii. Explains phase changes using the particle model			★		
3. Chemical changes	**ST**		**ST**		**EST**
a. Chemical changes					
i. Describes the indicators of a chemical change (formation of a precipitate, effervescence, colour change, heat, light)	→	★			
ii. Explains a chemical change based on the changes in the properties of the substances involved	→	★			
iii. Names different types of chemical changes (e.g. decomposition, oxidation)	→	★			
iv. Names chemical changes that occur in the human body (e.g. respiration, digestion)			★		
b. Decomposition and synthesis					
♦ i. Represents a decomposition or synthesis reaction using the particle model			★		
♦ ii. Associates known chemical reactions with decomposition or synthesis reactions (e.g. respiration, photosynthesis, combustion, digestion)			★		
c. Oxidation					
i. Represents an oxidation reaction using the particle model			★		

ii. Associates known chemical reactions with oxidation reactions (e.g. combustion, corrosion)			★		
iii. Associates a chemical equation in which oxygen is one of the reactants with one of the possible cases of an oxidation reaction					★
d. Precipitation					
♦ i. Describes the visible manifestation of precipitation (formation of a solid deposit when two aqueous solutions are mixed)			★		
♦ ii. Represents a precipitation reaction using the particle model			★		
e. Combustion					
i. Describes the perceivable manifestations of rapid combustion (e.g. heat, light)				★	
ii. Explains a combustion reaction using the fire triangle				★	
f. Photosynthesis and respiration[6]					
g. Acid-base neutralization reaction					
♦ i. Gives examples of acid-base neutralization reactions (e.g. adding lime to neutralize the acidity of a lake)				★	
♦ ii. Names the products formed during acid-base neutralization (salt and water)				★	
♦ iii. Recognizes an acid-base neutralization from its equation				★	
h. Salts					
i. Determines the molecular formula of the salt produced by the neutralization of a given acid and a given base					★
i. Types of bonds					
i. Covalent					
– Defines a covalent bond as a bond resulting from a sharing of electrons					★
– Makes a schematic representation of a covalent bond					★
– Identifies molecules that feature a covalent bond (e.g. N_2, CO_2)					★
ii. Ionic					
– Defines an ionic bond as a bond resulting from the gain or loss of electrons					★
– Makes a schematic representation of an ionic bond					★
– Identifies molecules that feature an ionic bond (e.g. NaCl, NH_4OH)					★
– Associates an ionic bond with an electrolytic substance					★
j. Law of conservation of mass					
♦ i. Explains the law of conservation of mass during a chemical reaction				★	
♦ ii. Represents the conservation of mass using the particle model				★	
k. Balancing chemical equations					
♦ i. Balances chemical equations				★	
l. Stoichiometry					
i. Determines the quantities of reactants or products using stoichiometric calculations (gram or mole)					★

m. Endothermic and exothermic reactions					
i. Distinguishes an endothermic reaction from an exothermic reaction according to perceptible signs (e.g. temperature variations, emission of light)					★
ii. Distinguishes an endothermic reaction from an exothermic reaction according to the position of the energy term in the chemical equation					★
4. Nuclear changes[7]	**ST**		**ST**		**EST**
a. Nuclear stability					
i. Explains nuclear stability as the case where the nucleus of the atom is held together by an optimal number of neutrons					★
b. Radioactivity					
i. Defines radioactivity as the emission of particles or energy by the nuclei of atoms following nuclear transformations					★
ii. Associates the use of radioactivity with technological applications (e.g. radiotherapy, dating)					★
c. Fission and fusion					
i. Distinguishes nuclear fission from nuclear fusion					★
5. Transformation of energy[8]	**ST**		**ST**		**EST**
a. Forms of energy					
i. Describes different forms of energy (chemical, thermal, mechanical, radiation)			★		
ii. Identifies the forms of energy involved in a transformation (e.g. electrical to thermal in a toaster, electrical to radiation in an infrared lamp)			★		
♦ iii. Defines joule as the unit of measurement for energy			★		
b. Law of conservation of energy					
i. Explains qualitatively the law of conservation of energy				★	
ii. Applies the law of conservation of energy in different contexts				★	
c. Energy efficiency					
i. Defines the energy efficiency of a device or system as the proportion of energy consumed that is transformed into effective work (amount of useful energy / amount of energy consumed x100)				★	
ii. Explains how to improve the energy efficiency of an electrical appliance				★	
d. Distinction between heat and temperature[9]					
i. Describes heat as a manifestation of energy				★	
ii. Describes the relationship between heat and temperature				★	
e. Relationship between thermal energy, specific heat capacity, mass and temperature variation					
i. Describes qualitatively the relationship between the change in thermal energy (quantity of heat) of a substance, its mass, its specific heat capacity and the variations in temperature to which it is exposed					★
ii. Applies the mathematical relationship between thermal energy, mass, specific heat capacity and temperature variation ($\Delta E = Q = mc\Delta T$)					★
f. Effective force					
i. Defines effective force as the component of the applied force parallel to the direction of travel					★

ii. Determines graphically the magnitude of the effective force in a given situation					★
g. Relationship between work, force and distance travelled					
i. Describes qualitatively the relationship between the work done, the force applied on a body and the distance travelled by the body					★
ii. Applies the mathematical relationship between work, effective force and distance travelled ($W = F\Delta d$)					★
h. Relationship between mass and weight					
i. Describes qualitatively the relationship between mass and weight					★
ii. Applies the mathematical relationship between mass and weight ($F_g = mg$)					★
i. Relationship between potential energy, mass, acceleration and distance travelled					
i. Describes qualitatively the relationship between the potential energy of a body, its mass, its gravitational acceleration and the distance it travels					★
ii. Applies the mathematical relationship between potential energy, mass, gravitational acceleration and the distance travelled ($E_p = mgh$)					★
j. Relationship between kinetic energy, mass and speed					
i. Describes qualitatively the relationship between the kinetic energy of a body, its mass and its speed					★
ii. Applies the mathematical relationship between kinetic energy, mass and speed ($E_k = ½mv^2$)					★
k. Relationship between work and energy[10]					
i. Describes qualitatively the relationship between the work done on a body and the variation in energy within that body					★
ii. Applies the mathematical relationship between work and energy ($W = \Delta E$)					★
C. Organization	**1**	**2**	**3**	**4**	**4**
Elementary school Students classify objects or substances based on their properties, and living organisms based on their physical characteristics. They use the common names for certain substances (e.g. water, carbon dioxide, oxygen) when studying photosynthesis and respiration.					
Secondary school					
1. Structure of matter	**ST**		**ST**		**EST**
a. Atom					
i. Describes Dalton's atomic model	→	★			
ii. Defines the atom as the basic unit of the molecule	→	★			
b. Molecule					
i. Describes a molecule using Dalton's atomic model (combination of atoms linked by chemical bonds)	→	★			
ii. Represents the formation of a molecule using Dalton's atomic model	→	★			
c. Element					
i. Defines an element as a pure substance made of a single type of atom (e.g. Fe, N_2)	→	★			
d. Periodic table					
i. Describes the periodic table as a structured classification of elements	→	★			

e. Pure substance					
i. Defines a pure substance as a substance made up of a single type of atom or molecule			★		
ii. Distinguishes between elements (e.g. iron, dioxygen, sodium) and compounds (e.g. water, carbon dioxide, glucose)			★		
f. Homogeneous and heterogeneous mixtures[11]					
i. Describes homogeneous and heterogeneous mixtures in the human body (e.g. lymph, blood, urine)			★		
g. Groups and periods					
♦ i. Locates the groups and periods in the periodic table				★	
♦ ii. Describes the common characteristics of a group (e.g. number of valence electrons, chemical reactivity)				★	
♦ iii. Associates the number of electron shells in an element with the number of its period				★	
h. Rutherford-Bohr atomic model					
♦ i. Describes the Rutherford-Bohr atomic model				★	
♦ ii. Represents atoms using the Rutherford-Bohr model				★	
i. Neutron					
i. Describes the position and electrical charge of the neutron in an atom					★
j. Simplified atomic model					
i. Represents an atom of a given element using the simplified atomic model					★
k. Lewis notation					
♦ i. Determines the number of valence electrons in an element				★	
♦ ii. Represents atoms using Lewis notation				★	
l. Nomenclature and notation rules					
i. Applies nomenclature and notation rules to name the molecule or write the molecular formula of binary compounds					★
m. Polyatomic ions					
i. Recognizes the common polyatomic ions (e.g. NH_4^+, OH^-, NO_3^-, CO_3^{2-}, SO_4^{2-}, PO_4^{3-}) by their name, their formula or their composition					★
n. Concept of the mole					
i. Defines the mole as the unit of measure of the amount of a substance					★
ii. Expresses an amount of a substance in moles					★
o. Avogadro's number					
i. Expresses a quantity of particles using Avogadro's number					★
2. Periodic classification	**ST**		**ST**		**EST**
a. Atomic number					
i. Associates the atomic number of an element with the number of protons it has					★

b. Isotopes[12]					
i. Defines isotopes as atoms of the same element whose nuclei have different numbers of neutrons and therefore different atomic masses					★
ii. Defines a radioactive isotope as an isotope whose atomic nucleus is unstable					★
c. Relative atomic mass					
i. Explains qualitatively the concept of relative atomic mass					★
d. Periodicity of properties					
i. Describes the periodicity of certain properties of elements (e.g. chemical reactivity, atomic radius, electronegativity)					★
D. Fluids	**1**	**2**	**3**	**4**	**4**
Elementary school Students distinguish between three states of matter: solid, liquid and gas.					
Secondary school					
a. Pressure					
i. Defines pressure as the force exerted by particles when they collide with a constricting surface			★		
ii. Describes qualitatively the main factors that affect the pressure exerted by a fluid			★		
b. Compressible and incompressible fluids					
i. Distinguishes between compressible and incompressible fluids			★		
ii. Names compressible fluids (e.g. air) and incompressible fluids (e.g. blood) in the human body			★		
iii. Explains how fluids move around in the human body, using the concept of pressure			★		
c. Relationship between pressure and volume					
i. Qualitatively describes the relationship between the pressure and volume of a gas (e.g. inhaling and exhaling, bicycle pump)			★		
E. Waves	**1**	**2**	**3**	**4**	**4**
Elementary school Students associate sunlight with a source of energy.					
Secondary school					
a. Frequency					
i. Defines the frequency of a wave as the number of cycles per second (Hz)			★		
ii. Associates the frequency of a sound wave with the pitch of the sound (e.g. a low-frequency wave produces a low-pitched sound)			★		
b. Wavelength					
i. Defines wavelength as the distance between two identical points on a wave at a given time (e.g. distance between crests)			★		
ii. Describes the relationship between wavelength and energy (e.g. X-rays, which are high-energy waves, have a short wavelength)			★		
c. Amplitude					
i. Defines the amplitude of a sound wave as the loudness of the sound			★		
d. Decibel scale					

i. Locates on the decibel scale levels dangerous to the human ear based on duration or frequency of exposure			★		
e. Electromagnetic spectrum						
i. Locates different areas on the electromagnetic spectrum (e.g. radio waves, visible light, X-rays)			★		
ii. Describes different applications of electromagnetic waves in the health care sector (e.g. X-rays, infrared optical imaging)			★		
f. Deviation of light waves						
i. Describes how light rays are deviated by a plane reflective surface			★		
ii. Determines the angle of reflection of a light ray on the surface of a plane mirror			★		
iii. Describes how light rays are deviated when they pass through the surface of a translucent substance			★		
g. Focal point of a lens						
i. Determines the focal point of concave and convex lenses			★		
ii. Describes the relationship between the focal point of a lens and the degree of deviation of light rays in different situations (e.g. accommodation of the crystalline lens, choice of corrective lenses)			★		
F. Electricity and electromagnetism	**1**	**2**	**3**	**4**	**4**
Elementary school Students name the components of a simple electrical circuit (wire, power source, bulb, switch) and describe their function. They recognize the effects of magnetism in magnets (attraction and repulsion).					
Secondary school					
1. Electricity	**ST**		**ST**		**EST**
a. Electrical charge					
i. Associates elementary particles with their electrical charge				★	
ii. Describes the behaviour of electrical charges of opposite signs or of the same sign when close together				★	
b. Static electricity					
i. Describes static electricity as the transfer of electrons from one body to another				★	
c. Ohm's law					
i. Describes qualitatively the relationship between voltage, resistance and current intensity in an electrical circuit				★	
ii. Applies the mathematical relationship between voltage, resistance and current intensity in an electrical circuit (V = RI)				★	
d. Electrical circuits					
i. Describes the function of different elements of an electrical circuit (e.g. the wires transmit electrons along the circuit, resistors transform electrical energy into another form of energy)[13]				★	
ii. Describes the two types of connections in electrical circuits (series, parallel)				★	
iii. Distinguishes between alternating and direct current				★	
iv. Represents a simple electrical circuit using a diagram				★	
e. Relationship between power and electrical energy					
i. Applies the mathematical relationship between power, voltage and current intensity in an electrical circuit (P = VI)				★	

ii. Describes qualitatively the relationship between the power of an electrical appliance, the electrical energy it consumes and the amount of time it is in operation				★		
iii. Applies the mathematical relationship between electrical energy consumed, the power of an electrical appliance and the amount of time it is in operation ($E = P\Delta t$)				★		
f. Kirchhoff's laws						
i. Describes the distribution of current in various components of an electrical circuit					★	
ii. Determines the value of the current flowing in various components of a series or parallel circuit					★	
iii. Describes the distribution of the voltage across various components of an electrical circuit					★	
iv. Determines the value of the voltage across various components of a series or parallel circuit					★	
v. Determines the value of the equivalent resistance of a series or parallel circuit using Ohm's law and Kirchhoff's laws					★	
g. Electrical field						
i. Describes qualitatively the effect of an electrical field on electrically charged particles					★	
h. Coulomb's law						
i. Applies the mathematical relationship between the electrical force, the magnitude of the electrical charges and the distance separating these charges ($F = kq_1q_2/r^2$)					★	
2. Electromagnetism	**ST**		**ST**		**EST**	
a. Magnetic field of a live wire						
i. Describes the magnetic field produced by a current-carrying wire (right-hand rule or left-hand rule)				★		
ii. Names ways of modifying the intensity of the magnetic field produced by a current-carrying wire (type of wire, current intensity)				★		
b. Forces of attraction and repulsion						
i. Compares the behaviour of a compass in the magnetic field of a magnet with the magnetic field created by a current-carrying wire				★		
c. Magnetic field of a solenoid						
i. Describes the magnetic field produced by a solenoid (right-hand rule or left-hand rule)					★	
ii. Names ways of changing the intensity of the magnetic field produced by a solenoid (nature of the core, intensity of the current, number of turns)					★	
iii. Explains the use of solenoids in technological applications (e.g. earphones, electric motor, magnetic crane)					★	

1. See *The Material World, Changes, Physical changes, Phase changes* (MW, B, 2, d).
2. In Cycle One, this concept appears under *Changes.*
3. See *The Material World, Properties, Properties of matter, Acidity/alkalinity* (MW, A, 1, e).
4. See *The Material World, Properties, Properties of solutions* (MW, A, 3).
5. See *Techniques, Science, Separating mixtures* (Techniques, Science, b).
6. See *The Living World, Life-sustaining processes, Photosynthesis and respiration* (LW, B, f).
7. See *Organisation, Isotopes* (MW, C, 2, b).
8. See *The Technological World, Mechanical engineering, Technological systems, Energy transformations* (TW, B, 2, c).

9. The definition of temperature was covered in Cycle One. See *Properties* above (MW, A, 1 c).
10. See *Law of conservation of energy* (MW, B, 5, b).
11. See *The Material World, Changes, Changes in matter, Mixtures* (MW, B, 1, b).
12. See *The Material World*, *Nuclear changes* (MW, B, 4).
13. See *The Technological World, Electrical engineering* (TW, C).

Science and Technology

General Education Path

The Living World

In The Living World, students acquire scientific and technological knowledge pertaining to life as it relates to molecules, cells, organisms and ecosystems.

In secondary school, students explore increasingly complex phenomena and technical objects and seek answers and solutions to a variety of problems. They acquire scientific knowledge about The Living World that helps them understand and explain the factors at play in different scientific issues. This knowledge, along with the knowledge they acquire in other areas of the program, particularly The Earth and Space, enables them to understand the complexity of the relationships between living organisms and their planet. Students refine their understanding of the concepts related to The Living World by using the experimental method, the observation method and modelling.

In Secondary III, the theme *The Human Organism* places The Living World at the heart of the program. In Secondary IV, students continue constructing their knowledge in this area by exploring environmental issues. They examine the influence of living organisms on their environment and discover how the knowledge they acquired can help them understand and improve the world around them.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge. Statements preceded by the symbol ♦ indicate knowledge specific to the compulsory Science and Technology program. Most of these statements are, however, found in the progression of learning for the optional Science and the Environment program.	Secondary				
	ST Cycle One		ST Cycle Two		EST Cycle Two
A. Diversity of life forms	**1**	**2**	**3**	**4**	**4**
Elementary school Students classify animals by kingdom and, in the case of vertebrates, by class (mammals, reptiles, birds, fish, amphibians). They describe the physical and behavioural characteristics that demonstrate that an animal has adapted to its environment (e.g. fins, claws, colour, ability to burrow into the ocean floor, migration).					
Secondary school					
1. Ecology	**ST**		**ST**		**EST**
a. Habitat					
i. Names the characteristics that define a habitat (e.g. geographic location, climate, flora, fauna, proximity of man-made constructions)	→	★			
ii. Describes the habitat of certain species	→	★			
b. Ecological niche					
i. Names the characteristics that define an ecological niche (e.g. habitat, diet, daily rhythms)	→	★			
ii. Describes the ecological niche of an animal species	→	★			
c. Species					
i. Names the characteristics that define a species (common physical characteristics; natural, viable and fertile reproduction)	→	★			
d. Population					
i. Distinguishes between a population and a species	→	★			
ii. Calculates the number of individuals of a species in a given territory	→	★			
e. Study of populations					

♦	i. Describes a given population (density, distribution, biological cycles)				★	
♦	ii. Describes the influence of biotic or abiotic factors on the biological cycles of a population (natality, mortality, immigration, emigration)				★	
♦	iii. Explains how the availability of resources in the environment affects reproduction and survival				★	
♦	iv. Defines a community as a group of populations that interact				★	
	v. Defines an ecosystem as the relationships between the individuals in a community and abiotic factors in the environment				★	
	f. Dynamics of communities					
	i. Biodiversity					
♦	– Defines the biodiversity of a community as the relative abundance of species it comprises				★	
♦	– Explains factors that affect the biodiversity of a given community				★	
	ii. Disturbances					
	– Defines a disturbance in a community				★	
	– Explains the effects of certain factors that disturb the ecological balance (e.g. human activity, natural disasters)				★	
	g. Dynamics of ecosystems					
	i. Trophic relationships					
	– Describes the trophic levels (producers, consumers, decomposers)				★	
	– Explains the relationships between the trophic levels of a food web				★	
	ii. Primary productivity					
	– Defines primary productivity as the quantity of organic matter produced by plants in a given territory				★	
	– Explains the effects of certain factors on primary productivity (e.g. bees help pollinate fruit trees, pathogenic microorganisms hinder plant growth)				★	
	iii. Material and energy flow					
	– Describes material and energy flow in an ecosystem				★	
	iv. Chemical recycling					
	– Describes certain processes underlying chemical recycling (e.g. action of microorganisms and decomposers, erosion)				★	
	h. Ecological footprint					
	i. Explains the concept of ecological footprint					★
	i. Ecotoxicology					
	i. Contaminant[1]					
	– Defines a contaminant as an agent that causes changes in the physical, chemical or biological properties of an environment or an organism					★
	ii. Bioaccumulation					
	– Defines bioaccumulation as the process by which a contaminant from the environment or food supply accumulates in an organism					★
	– Explains bioaccumulation in food chains (biomagnification)					★

iii. Bioconcentration					
– Defines bioconcentration as a special case of bioaccumulation by which an organism accumulates a contaminant through direct contact with its envirommment (from sources other than food)					★
iv. Toxicity threshold					
– Defines the toxicity threshold of a substance as the minimum concentration of a substance that produces a significant harmful effect in an organism (mg/kg of the organism's mass)					★
– Describes factors that influence the toxicity of a contaminant (e.g. concentration, characteristics of the environment into which it is released, nature of the organisms with which it is in contact, duration of exposure)					★
2. Diversity of life forms	**ST**		**ST**		**EST**
a. Physical and behavioural adaptation					
i. Describes physical adaptations that enable animals and plants to improve their chances of survival (e.g. coat colour matched to the environment, shape of leaves)	→	★			
ii. Describes behavioural adaptations that enable animals and plants to improve their chances of survival (e.g. movement in groups, phototropism)	→	★			
b. Evolution					
i. Describes the stages in the evolution of living organisms	→	★			
ii. Explains the natural selection process	→	★			
c. Taxonomy					
i. Defines taxonomy as a system for classifying living organisms based for the most part on their anatomical and genetic characteristics	→	★			
ii. Identifies a species using a taxonomic key	→	★			
d. Genes and chromosomes[2]					
i. Locates chromosomes in the cell	→	★			
ii. Defines a gene as part of a chromosome	→	★			
iii. Describes the role of genes (transmission of hereditary characteristics)	→	★			
3. Genetics	**ST**		**ST**		**EST**
a. Heredity					
i. Defines heredity					★
b. Gene					
i. Defines a gene as being, in most cases, a DNA segment that carries the code for synthesizing one or more proteins					★
ii. Describes the composition (nitrogen bases, sugar, phosphate) and the overall structure (bonding of bases on the double helix) of a DNA molecule					★
c. Character trait					
i. Defines what an hereditary trait is					★
ii. Names hereditary traits in an individual or population					★

d. Allele					
i. Defines an allele as a possible form of a gene					★
e. Homozygotes and heterozygotes					
i. Defines a homozygote as an individual with two identical alleles for a particular character trait					★
ii. Defines a heterozygote as an individual with two different alleles for a particular character trait					★
f. Dominant and recessive					
i. Describes the phenomena of dominant and recessive character traits					★
g. Genotype and phenotype					
i. Defines genotype					★
ii. Defines phenotype					★
iii. Describes an individual's genotype and phenotype for a character trait (e.g. a bean with a Yellow phenotype may have a Yellow-Yellow genotype or a Yellow-Green genotype)					★
h. Protein synthesis					
i. Describes the role of DNA in protein synthesis					★
ii. Explains the phenomena of transcription and translation of a strand of DNA					★
i. Crossbreeding					
i. Explains the relationship between the crossbreeding carried out by humans on animals and plants and the desired traits obtained					★
B. Life-sustaining processes	**1**	**2**	**3**	**4**	**4**
Elementary school Students explain the essential needs of living organisms (e.g. food, respiration) and describe metabolic activity (transformation of energy, growth, maintenance of systems and body temperature). They describe the function of photosynthesis, which they distinguish from respiration.					
Secondary school					
a. Characteristics of living things					
i. Describes certain characteristics common to all living things (nutrition, relationships, adaptation, reproduction)	→	★			
b. Plant and animal cells					
i. Defines the cell as the structural unit of life	→	★			
ii. Names vital functions carried out by cells	→	★			
iii. Distinguishes between animal and plant cells	→	★			
c. Cellular components visible under a microscope					
i. Identifies the main cellular components visible under a microscope (cell membrane, cytoplasm, nucleus, vacuoles)	→	★			
ii. Describes the role of the main cellular components visible under a microscope	→	★			
d. Inputs and outputs (energy, nutrients, waste)					
i. Names cellular inputs	→	★			
ii. Names cellular outputs	→	★			

e. Osmosis and diffusion					
i. Distinguishes between osmosis and diffusion	→	★			
f. Photosynthesis and respiration[3]					
i. Names the inputs and outputs involved in photosynthesis	→	★			
♦ ii. Represents the photosynthesis reaction in a balanced equation				★	
iii. Names the inputs and outputs involved in respiration	→	★			
♦ iv. Represents the respiration reaction in a balanced equation				★	
C. Tissues, organs and systems	**1**	**2**	**3**	**4**	**4**
Elementary school Students associate parts of animal anatomy and systems with their main function.					
Secondary school					
a. Tissues					
♦ i. Defines a tissue as a set of identical or different cells that work together to perform a common function in an organism			★		
b. Organs					
♦ i. Defines an organ as a differentiated part of an organism that performs one or more specific functions			★		
c. Systems					
♦ i. Defines a biological system as a set of cells, tissues or organs that perform one or more common functions			★		
♦ ii. Describes the main functions performed by the human body (nutrition, relationships, reproduction)			★		
D. Systems	**1**	**2**	**3**	**4**	
Elementary school Students describe the functions of certain parts of their anatomy (limbs, head). They associate parts of animal anatomy and systems with their main functions.					
Secondary school					
Nutrition					
1. Digestive system	**ST**		**ST**		**EST**
a. Digestive tract					
i. Names the main parts of the digestive tract (mouth, esophagus, stomach, small intestine, large intestine, anus)			★		
ii. Explains the role of the digestive tract (decomposition of food, absorption of nutrients and water, elimination of waste)			★		
iii. Describes the functions of the main organs that make up the digestive tract (mouth, stomach, small intestine, large intestine)			★		
b. Digestive glands					
i. Names the main digestive glands (salivary glands, gastric glands, pancreas, liver, intestinal glands)			★		
ii. Describes the function of the main digestive glands (e.g. secretion of saliva, gastric enzymes, digestive juices, bile)			★		

c. Types of foods					
i. Describes the main biological functions of the different food constituents (water, proteins, carbohydrates, fats, vitamins, minerals)			★		
ii. Associates food constituents with their main sources (e.g. proteins with meat and meat substitutes)			★		
d. Energy value of different foods					
i. Evaluates the energy and nutritional value of different foods			★		
e. Transformation of food					
i. Describes the two types of transformation of food that take place in the digestive system (mechanical, chemical)			★		
ii. Associates the organs in the digestive tract with the type of transformation they perform (e.g. mechanical action of teeth, chemical action of glands)			★		
2. Respiratory and circulatory systems	**ST**		**ST**		**EST**
a. Respiratory system					
i. Names the main parts of the respiratory system (nasal cavity, pharynx, trachea, bronchi, lungs)			★		
ii. Explains the role of the respiratory system (gaseous exchanges between the blood and the surrounding air)			★		
iii. Describes the function of the nasal cavity and lungs			★		
b. Functions of blood constituents					
i. Describes the main function of plasma (transportation of the blood's soluble and formed elements)			★		
ii. Names the formed elements of the blood (red blood cells, white blood cells, platelets)			★		
iii. Describes the main function of the formed elements of the blood			★		
c. Compatibility of blood types					
i. Determines the compatibility or incompatibility of blood types (e.g. an individual with type A- blood can only receive type O- or type A- blood)			★		
d. Circulatory system					
i. Names the main parts of the circulatory system (heart, types of blood vessels, pulmonary and systemic circulation)			★		
ii. Explains the role of the circulatory system (transportation and exchange of gases, nutrients and waste)			★		
iii. Describes the function of the main parts of the circulatory system (heart, arteries and veins, capillaries)			★		
e. Lymphatic system					
i. Names the main parts of the lymphatic system (lymph, antibodies)			★		
ii. Explains the role of the lymphatic system (circulation of antibodies outside the blood vessels)			★		
iii. Describes two ways of acquiring active immunity (production of antibodies, vaccination)			★		
3. Excretory system	**ST**		**ST**		**EST**
a. Urinary system					
i. Names the main parts of the urinary system (kidneys, ureters, bladder, urethra)			★		
ii. Explains the role of the excretory system (filtration of the blood, elimination of cellular waste)			★		

iii. Describes the function of the kidneys and bladder			★		
b. Components of urine					
i. Names the main components of urine (water, mineral salts, urea)			★		
c. Maintaining a balanced metabolism					
i. Explains the role of the kidneys, lungs and sweat glands in maintaining a balanced metabolism			★		
Relationships					
1. Nervous and musculoskeletal systems	**ST**		**ST**		**EST**
a. Central nervous system					
i. Identifies the parts of the central nervous system (brain, spinal cord)			★		
ii. Explains the role of the central nervous system (e.g. to manage complex behaviours and process sensory information and the related responses)			★		
iii. Describes the functions of the brain and the spinal cord			★		
b. Peripheral nervous system					
i. Neuron					
– Names the main parts of a neuron (synapse, axon, dendrites)			★		
– Explains the role of the peripheral nervous system (transportation of nerve impulses from the senses to the brain and from the brain to the muscles)			★		
ii. Neural inflow					
– Associates nerves with the transmission of nerve impulses			★		
– Distinguishes between voluntary acts and reflex arcs			★		
c. Sensory receptors					
i. Eye					
– Names the parts of the eye involved in vision (iris, cornea, crystalline lens, retina)			★		
– Describes the function of the main parts of the eye			★		
ii. Ear					
– Names the main parts of the ear involved in hearing and balance (auditory canal, ear drum, ossicles, cochlea, semicircular canals)			★		
– Describes the function of the main parts of the ear involved in hearing			★		
– Describes the role of the semicircular canals in maintaining balance			★		
iii. Tongue					
– Describes the function of the taste buds on the tongue (transformation and transmission of flavours: sweet, salty, sour, bitter, umami)			★		
iv. Nose					
– Names the parts of the nose involved in smelling (nasal cavity, olfactory bulb)			★		
– Describes the function of the olfactory bulb			★		
v. Skin					

– Describes the function of the skin's sensory receptors (transformation and transmission of feelings of pressure, temperature and pain)			★		
d. Musculoskeletal system						
i. Function of bones, joints and muscles						
– Names the main parts of the skeleton (head, thorax, spinal column, upper and lower limbs)			★		
– Describes the functions of the main parts of the skeleton (e.g. the spinal column protects the spinal cord and allows the trunk to move)			★		
– Explains the role of the musculoskeletal system			★		
– Describes how pairs of antagonistic muscles work (e.g. biceps, triceps)			★		
– Describes how joints work (linking bone to bone, mobility)			★		
ii. Types of muscles						
– Associates the different types of muscles (smooth, skeletal, heart) with the tissues in which they are found			★		
iii. Types of joint movement						
– Describes types of joint movement (e.g. flexion, rotation)			★		
E. Survival of species	**1**	**2**	**3**	**4**	**4**
Elementary school Students describe the growth and reproduction of flowering plants and different animals.					
Secondary school					
1. Reproduction	**ST**		**ST**		**EST**
a. Asexual and sexual reproduction					
i. Distinguishes between asexual and sexual reproduction (e.g. sexual reproduction involves gametes)	→	★			
b. Reproductive mechanisms in plants					
i. Describes asexual reproductive mechanisms in plants (e.g. cutting, layering)	→	★			
ii. Describes the sexual reproductive mechanism in plants (flowering plants)	→	★			
c. Reproductive mechanisms in animals					
i. Describes the roles of the male and female in the reproduction of certain types of animals (e.g. birds, fish, mammals)	→	★			
d. Reproductive organs					
i. Names the main male and female reproductive organs (penis, testicles, vagina, ovaries, Fallopian tubes, uterus)	→	★			
e. Gametes					
i. Names the male and female gametes	→	★			
ii. Describes the role of gametes in reproduction	→	★			
f. Fertilization					
i. Describes fertilization in humans	→	★			
g. Pregnancy					
i. Names the stages of human development during pregnancy (zygote, embryo, fetus)	→	★			

h. Stages of human development					
i. Describes the stages of human development (childhood, adolescence, adulthood)	→	★			
i. Contraception					
i. Describes contraceptive methods (e.g. condom, ovulation suppression agents)	→	★			
ii. Describes the advantages and disadvantages of different contraceptive methods	→	★			
j. Methods of preventing the implantation of the zygote in the uterus					
i. Names methods of preventing the implantation of the zygote in the uterus (intrauterine device, day-after pill)	→	★			
k. Sexually transmitted and blood-borne diseases[4]					
i. Names sexually transmitted and blood-borne diseases	→	★			
ii. Describes behaviours to prevent contracting sexually transmitted and blood-borne diseases (e.g. wearing a condom)	→	★			
iii. Describes responsible behaviours to adopt after being diagnosed with a sexually transmitted or blood-borne disease (e.g. informing one's partner)	→	★			
2. Cell division[5]	ST		ST		EST
a. DNA					
i. Describes the shape of DNA (double helix)			★		
ii. Explains the role of DNA (a molecule bearing the organism's genetic code)			★		
b. Mitosis					
i. Describes the functions of mitosis (reproduction, growth, regeneration)			★		
c. Meiosis and sexual development (meiosis, fertilization)					
i. Describes the function of meiosis (production of gametes)			★		
ii. Indicates the advantages of sexual development (e.g. blending of genes from both parents, difference between descendants and their parents)			★		
d. Functions of cell division					
i. Distinguishes between mitosis and meiosis based on their functions			★		
e. Genetic diversity					
i. Associates genetic diversity with sexual reproduction			★		
Reproduction					
1. Reproductive system	ST		ST		EST
a. Puberty (male and female)					
i. Describes physical and psychological changes that occur at puberty (e.g. appearance of body hair, voice change, ability to procreate, need for independence)			★		
b. Hormone regulation in men					
i. Spermatogenesis					
– Names the hormones responsible for the formation of spermatozoa (follicle stimulating hormone [FSH], luteinizing hormone [LH], testosterone)			★		

ii. Erection					
– Describes the physiology of erection			★		
iii. Ejaculation					
– Explains the function of ejaculation in reproduction			★		
c. Hormone regulation in women					
i. Oogenesis					
– Names the hormones responsible for the maturation of the ovarian follicle (FSH, LH, estrogen, progesterone)			★		
ii. Ovarian cycle					
– Describes the hormone changes that occur during the menstrual cycle			★		
iii. Menstrual cycle					
– Describes the main stages in the menstrual cycle (e.g. menstruation, endometrium development, ovulation)			★		

1. See *The Earth and Space*, *Characteristics of the Earth*, *Contamination* (ES, A, 2, o; ES, A, 3, f; ES, A, 4, f).
2. See *The Living World, Survival of species, Cell division* (LW, E, 2).
3. The Secondary IV concepts related to photosynthesis and respiration are presented in the program under *The Material World, Changes*, Chemichal changes.
4. This replaces the term "sexually transmitted diseases" used in the program.
5. For concepts related to *Genes and chromosomes* addressed in Cycle One, see *The Living World, Diversity of life forms* above (LW, A, 2, d).

Science and Technology

General Education Path

The Earth and Space

In The Earth and Space, students acquire scientific and technological knowledge pertaining to space and interactions in the biosphere.

In secondary school, students explore different phenomena that occur on Earth and in space and related technical objects. They seek answers and solutions to a variety of problems. They acquire knowledge about The Earth and Space that helps them explain the factors at play in different scientific issues. This knowledge, along with the knowledge they acquire in other areas of the program, enables them to understand scientific models, theories and laws. Students refine their understanding of the concepts related to The Earth and Space by using the experimental method, technological analysis and modelling.

In Secondary III, analyzing geological and geophysical phenomena and studying related technical objects enable students to locate living organisms on the geological time scale. In Secondary IV, students continue constructing their knowledge by exploring environmental issues. They do a more in-depth study of the impact of certain natural phenomena and human activities on the biosphere.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge. Statements preceded by the symbol ♦ indicate knowledge specific to the compulsory Science and Technology program. Most of these statements are, however, found in the progression of learning for the optional Science and the Environment program.	Secondary				
	ST Cycle One		ST Cycle Two		EST Cycle Two
A. Characteristics of the Earth	1	2	3	4	4
Elementary school Students recognize visible structures on the surface of the Earth (e.g. continents, oceans, ice caps, mountains, volcanoes). They describe the effects of the quality of air, water and soil on living beings (e.g. illnesses, increase or decrease in population). They compare the properties of different types of soil (e.g. composition, capacity to retain water and heat).					
Secondary school					
1. General characteristics of the Earth	ST		ST		EST
a. Internal structure of the Earth					
i. Describes the main characteristics of the three parts of the internal structure of the Earth (crust, mantle, core)	→	★			
2. Lithosphere	ST		ST		EST
a. General characteristics of the lithosphere					
i. Defines the lithosphere as the outer shell of the Earth comprising the crust and the upper mantle	→	★			
ii. Describes the main relationships between the lithosphere and human activity (e.g. survival, agriculture, mining, land-use planning)	→	★			
b. Relief					
i. Describes relationships between relief (topology) and geological and geophysical phenomena[1] (e.g. the retreat of a glacier causes the formation of a plain)	→	★			
ii. Describes the effect of relief on human activities (e.g. transportation, construction, sports, agriculture)	→	★			
c. Stratigraphic layers					
♦ i. Explains the formation of strata in terms of the layering of sediment (e.g. recent layers are deposited on older layers)			★		

d. Geological time scale[2]						
i. Places in order the main divisions of the geological time scale (Precambrian, Paleozoic, Mesozoic, Cenozoic)			★			
ii. Describes events associated with the main divisions of the geological time scale (e.g. formation of oceans in the Precambrian Era, reign of the reptiles and dinosaurs in the Mesozoic Era)			★			
e. Major stages in the history of life on Earth						
i. Locates the appearance or evolution of living organisms (e.g. bacteria, plants, fish, hominids) on the geological time scale			★			
f. Extinctions						
i. Locates periods of mass extinction of certain species on the geological time scale (e.g. disappearance of a large portion of marine life in the Paleozoic Era)			★			
g. Fossils						
i. Defines fossils as traces of organisms preserved for the most part in sedimentary rock			★			
ii. Explains the usefulness of fossils in dating stratigraphic layers			★			
h. Types of rocks						
i. Describes the formation of three types of rock: igneous, metamorphic, sedimentary	→	★				
ii. Classifies rocks by method of formation (e.g. granite is an igneous rock, lime is a sedimentary rock, slate is a metamorphic rock)	→	★				
iii. Distinguishes between rocks and minerals	→	★				
i. Minerals						
i. Names basic minerals based on their properties (e.g. colour, hardness, magnetism)	→	★				
ii. Distinguishes between minerals and ore				★		
iii. Describes some of the environmental impacts of mining or of the transformation of minerals				★		
j. Types of soil						
i. Classifies soils based on their composition (e.g. sand, clay, organic material)	→	★				
k. Soil profile (horizons)						
i. Describes the structure of a soil (superimposition of layers of different compositions and thicknesses)				★		
ii. Explains the chemical and biological reactivity of a soil based on its composition (e.g. oxidation, acid-base neutralization, decomposition)				★		
l. Permafrost						
i. Defines the permafrost as a layer of permanently frozen soil				★		
ii. Explains some of the consequences of a rise in temperature in the permafrost (e.g. landslides, methane emissions)				★		
m. Soil depletion						
i. Explains how human activities contribute to soil depletion					★	
n. Buffering capacity of the soil						
i. Defines the buffering capacity of a soil as its ability to limit pH variations					★	

ii. Explains the advantages of a good soil buffering capacity					★
o. Contamination					
i. Names soil contaminants[3]					★
p. Biogeochemical cycles					
i. Carbon cycle					
♦ – Describes transformations related to the circulation of carbon (e.g. photosynthesis, plant decomposition, dissolution in water, combustion of fossil fuels)				★	
ii. Nitrogen cycle					
♦ – Describes transformations related to the circulation of nitrogen (e.g. nitrogen fixation, nitrification, denitrification)				★	
iii. Phosphorous cycle					
– Describes transformations related to the circulation of phosphorous (e.g. erosion of rocks, breakdown of fertilizers, metabolism of algae)					★
3. Hydrosphere	**ST**		**ST**		**EST**
a. General characteristics of the hydrosphere					
i. Describes the distribution of fresh water and salt water on the Earth's surface (e.g. glaciers contain inaccessible fresh water)	→	★			
ii. Describes the main interactions between the hydrosphere and the atmosphere (e.g. heat exchanges, climate regulation, meteorological phenomena)	→	★			
b. Catchment area					
i. Defines a catchment area as a territory surrounding a waterway				★	
ii. Describes some of the impacts of human activity on the waterways in a catchment area				★	
c. Salinity					
♦ i. Defines salinity as a measure of the quantity of salt in a solution				★	
♦ ii. Describes the influence of salinity on the density of a solution				★	
d. Oceanic circulation					
♦ i. Describes factors that affect the circulation of surface currents and deep currents (e.g. wind, the Earth's rotation, temperature, salinity, density)				★	
♦ ii. Describes the role of thermohaline circulation on global climate regulation (e.g. effect of the Gulf Stream on the climate of the east coast of North America)				★	
e. Glacier and ice floe					
♦ i. Distinguishes between glaciers and ice floes				★	
♦ ii. Describes some of the impacts of the melting of glaciers and ice floes (e.g. increase in sea level, disturbance of thermohaline circulation)				★	
f. Contamination					
i. Names water contaminants[4]					★
g. Eutrophication					
i. Explains the natural process of eutrophication of a body of natural water					★

ii. Explains how human activities accelerate the eutrophication of a body of natural water					★
4. Atmosphere	ST		ST		EST
a. General characteristics of the atmosphere					
i. Locates the main layers of the atmosphere (troposphere, stratosphere, mesosphere, thermosphere)	→	★			
ii. Describes the composition of pure air at sea level (nitrogen, oxygen, carbon dioxide, water vapour)	→	★			
iii. Describes the relationships between the atmosphere and certain human activities (e.g. recreation, transportation, energy consumption)	→	★			
b. Greenhouse effect					
♦ i. Describes the greenhouse effect				★	
♦ ii. Explains some of the consequences of a higher concentration of greenhouse gases (e.g. global warming that could result in higher sea levels, disturbances in ecosystems or the melting of glaciers)				★	
c. Air mass					
i. Describes the properties of an air mass (temperature, humidity, pressure)				★	
ii. Explains the formation of clouds when two different air masses meet				★	
d. Atmospheric circulation					
♦ i. Describes the main factors responsible for atmospheric circulation (e.g. pressure variations, uneven heating of the Earth's surface)				★	
ii. Describes the effect of prevailing winds on the dispersal of air pollutants in a given region					★
e. Cyclone and anticyclone					
i. Explains the formation of cyclones (low-pressure areas) and anticyclones (high-pressure areas)				★	
f. Contamination					
i. Names air contaminants[5]					★
5. Climate zone	ST		ST		EST
a. Factors that influence the distribution of biomes					
i. Describes the geographical and climatic factors that affect the distribution of biomes (e.g. latitude, humidity, temperature, salinity)				★	
b. Terrestrial biomes					
♦ i. Describes different terrestrial biomes (e.g. fauna, flora, climate, type of soil)				★	
c. Marine biomes					
♦ i. Describes different marine biomes (e.g. fauna, flora, temperature, salinity)				★	
B. Geological and geophysical phenomena	**1**	**2**	**3**	**4**	**4**
Elementary school Students explain the water cycle (evaporation, condensation, precipitation, runoff, infiltration) and describe different types of precipitation (rain, snow, hail, freezing rain). Concepts related to energy play an important role in the elementary school program. Students explain that sunlight, moving water and wind are renewable energy resources. They differentiate them from nonrenewable energy resources such as fossil fuels (e.g. gasoline, propane, butane, oil, natural gas). They describe technologies used to convert renewable energy into electricity (hydroelectric dams, wind turbines, solar panels).					

Secondary school					
a. Tectonic plate					
i. Describes the main elements of the theory of tectonic plates (e.g. plate, subduction zone, mid-oceanic ridge)	→	★			
b. Orogenesis					
i. Describes the formation of mountains, folding and breaks (tectonic plate movements)	→	★			
c. Volcano					
i. Describes a volcanic eruption	→	★			
ii. Describes the geographical distribution of volcanoes	→	★			
d. Earthquake					
i. Describes the processes that cause earthquakes (e.g. tectonic plate movements, slides)	→	★			
e. Erosion					
i. Describes different types of erosion (e.g. soils dried by the wind, fragmentation of rocks caused by water freezing and thawing)	→	★			
f. Winds					
i. Names the main factors responsible for wind (e.g. convection movements, movement of air masses)	→	★			
g. Water cycle					
i. Explains the water cycle (phase changes, energy exchanges)	→	★			
h. Natural energy sources					
i. Describes the role of solar energy as a natural energy source (e.g. wind, tornadoes, hurricanes, storms)	→	★			
i. Renewable and nonrenewable energy resources					
i. Distinguishes between renewable and nonrenewable energy resources (e.g. Sun, molten rock, moving water, oil)	→	★			
ii. Describes technologies used to produce electricity using the energy resources in the lithosphere, hydrosphere and atmosphere				★	
iii. Describes the main impact of the use of energy resources in the lithosphere, hydrosphere and atmosphere				★	
C. Astronomical phenomena	**1**	**2**	**3**	**4**	**4**
Elementary school Students learn that the cycle of day and night is related to the Earth's rotation. They distinguish between stars, planets and moons in our solar system. They describe seasonal changes (e.g. temperature variations, luminosity, types of precipitation), in particular the apparent position of the Sun and its influence on the length of shadows.					
Secondary school					
1. Concepts related to astronomy	**ST**		**ST**		**EST**
a. Universal Gravitation					
i. Defines gravitation as a force of mutual attraction between bodies	→	★			
b. Earth-Moon system					
i. Describes the tides in terms of the gravitational effect of the Earth-Moon system				★	

c. Light					
i. Defines light as a form of radiant energy[6]	→	★			
ii. Describes properties of light (propagation in a straight line, diffuse reflection by surfaces)	→	★			
iii. Explains different phenomena using the properties of light (cycles of day and night, seasons, phases of the Moon, eclipses)	→	★			
d. Solar energy flow					
i. Describes the main factors that affect the quantity of solar energy that reaches the Earth's surface (e.g. reflection and absorption of solar energy by the atmosphere or surfaces)				★	
2. Solar system	**ST**		**ST**		**EST**
a. Characteristics of the solar system					
i. Compares some of the characteristics of the planets in our solar system (e.g. distances, relative size, composition)	→	★			
b. Cycles of day and night					
i. Explains the alternation of day and night in terms of the Earth's rotation	→	★			
c. Phases of the Moon					
i. Explains the phases of the lunar cycle	→	★			
d. Eclipses					
i. Explains a lunar or solar eclipse	→	★			
e. Seasons					
i. Explains the phenomenon of seasons in terms of the position of the Earth with respect to the Sun (tilt, revolution)	→	★			
f. Comets					
i. Describes the main parts of a comet (core of ice and rock, tail of gas, and tail of dust)	→	★			
g. Aurora borealis (northern lights)					
i. Locates the geographic regions where the aurora borealis occurs (polar regions)	→	★			
ii. Identifies the atmospheric layer in which the aurora borealis occurs	→	★			
h. Meteoroid impact					
i. Identifies traces left by meteoroid impacts in Québec (e.g. craters, astroblemes)	→	★			
3. Space	**ST**		**ST**		**EST**
a. Scale of the universe					
i. Astronomical unit					
– Defines an astronomical unit as the unit of length corresponding to the average distance between the Earth and the Sun			★		
ii. Light year					
– Defines light year as a unit of length corresponding to the distance travelled by light in one Earth year			★		

iii. Location of the Earth in the universe						
♦ – Compares the relative distance between different celestial bodies (e.g. stars, nebulae, galaxies)			★			
b. Conditions conducive to the development of life						
♦ i. Describes conditions conducive to the development or maintenance of life (e.g. presence of a gaseous atmosphere, water, energy source)			★			

1. See *The Earth and Space, Geological and geophysical phenomena* below (ES, B).
2. According to the scale established by the International Commission on Stratigraphy (2009).
3. See *Living World*, *Ecotoxicology*, *Contaminant* (LW, A, 1, i, i).
4. See *Living World*, *Ecotoxicology*, *Contaminant* (LW, A, 1, i, i).
5. See *Living World*, *Ecotoxicology*, *Contaminant* (LW, A, 1, i, i).
6. See *The Material World, Changes, Transformation of energy, Forms of energy* (MW, B, 5, a).

Science and Technology

General Education Path

The Technological World

In The Technological World, students acquire and apply scientific and technological knowledge.

In secondary school, students analyze and design increasingly complex technical objects and seek solutions to increasingly sophisticated technological problems. The technical and technological knowledge they acquire helps them understand the objects and factors at play in different scientific issues as well as evaluate possible technological solutions. It also helps them apply knowledge they acquire in other areas of the program, in particular The Material World.

In Secondary III, analyzing and designing technical objects, processes and technological systems associated with the human organism allow students to integrate knowledge associated with The Living World. In Secondary IV, students continue constructing their knowledge by exploring environmental issues. They study the influence of technology with respect to these issues and discover how it can help them understand and improve the world around them.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge. Statements preceded by the symbol ♦ indicate knowledge specific to the compulsory Science and Technology program. Most of these statements are, however, found in the progression of learning for the optional Science and the Environment program.	Secondary				
	ST Cycle One		ST Cycle Two		EST Cycle Two
A. Graphical language[1]	1	2	3	4	4
Elementary school Students learn symbols associated with motion and parts and use them to produce or interpret diagrams or drawings.					
Secondary school					
a. Diagram of principles (design plan)					
i. Defines a diagram of principles as a representation used to effectively explain the operation of a technical object	→	★			
ii. Associates the functional elements of a technical object with the appropriate diagram of principles	→	★			
iii. Explains the operation of a simple technical object by drawing a diagram illustrating the active forces and the resulting motion	→	★			
iv. Names the subassemblies and parts essential to the operation of a technical object	→	★			
v. Indicates certain principles of simple machines illustrated in a technical object (e.g. a lever in a wheelbarrow, a wedge in an axe)	→	★			
b. Construction diagram (technical diagram)					
i. Defines a construction diagram as a representation used to effectively explain the construction and assembly of a technical object	→	★			
ii. Associates the shape and arrangement of parts of technical objects with the appropriate construction diagram	→	★			
iii. Explains the construction of a simple technical object by drawing a diagram illustrating the assembly and arrangement of parts	→	★			
iv. Names the components of a simple technical object	→	★			
v. Indicates the links and guiding controls on a construction diagram	→	★			
c. Standards and representations					
i. Chooses the appropriate type of diagram for a given representation (e.g. uses a construction diagram to represent assembly solutions, a diagram of principles to represent the operation of an object)			★		

ii. Represents different types of motion related to the operation of an object using the appropriate symbols (rectilinear translation, rotation, helical)			★			
d. Geometric lines						
i. Associates a drawing with a combination of geometric lines (e.g. the drawing of a rounded corner of a table is an arc joined to two sides of a right angle)			★			
e. Basic lines						
i. Names basic lines in a drawing (visible contour, hidden contour, centre, extension, dimension lines)			★			
ii. Associates the basic lines in a drawing with the contours and details of a simple part			★			
f. Orthogonal projections						
i. Associates the types of projection with their use (multiview and isometric projections)			★			
ii. Interprets drawings representing parts in multiview orthogonal projection			★			
iii. Represents simple shapes in multiview orthogonal projection			★			
iv. Represents simple shapes in isometric projection			★			
v. Interprets assembly drawings of technical objects consisting of a small number of parts					★	
g. Scales[2]						
i. Associates scales with their use (actual-size representation, reduction or enlargement of an object)			★			
ii. Chooses a simple scale for a drawing (e.g. 1 : 1, 1 : 2, 5 : 1)			★			
iii. Takes the scale into account when interpreting drawings			★			
h. Forms of representation						
i. Defines perspective drawing, oblique projection and axonometric projection			★			
ii. Sketches simple objects freehand using different forms of representation			★			
i. Axonometric projection: exploded view (reading)						
i. Names the characteristics of an exploded view					★	
ii. Explains the purpose of exploded views (projection accompanying the assembly instructions or specifications for an object)					★	
j. Cross-sectional views						
i. Describes the purpose of cross-sectional views in technical drafting			★			
ii. Interprets a technical drawing with cross-sectional views			★			
iii. Represents a simple shape in a cross-sectional view			★			
k. Dimensioning						
i. Describes the main dimensioning rules (e.g. to make a drawing easy to read, avoid crossing dimensioning lines)			★			
ii. Interprets technical drawings including the dimensions required for manufacturing purposes			★			
l. Dimensional tolerances						
i. Defines tolerance as the required manufacturing precision (dimensions indicated on the drawing, along with allowances)					★	

B. Mechanical engineering	1	2	3	4	4
Elementary school Students describe the characteristics of motion (direction, speed). They describe the effect of a force on an object and on certain materials or structures. They become familiar with simple machines. They identify mechanical parts (e.g. gear assemblies, cams, springs), distinguish between translation and rotation and describe a simple sequence of mechanical parts in motion (e.g. in a door lock, the lever rotates and the motion of the bolt is rectilinear translation).					
Secondary school					
1. Forces and motion	**ST**		**ST**		**EST**
a. Types of motion					
i. Identifies parts that move in a specific way in a technical object (rectilinear translation, rotation, helical)	→	★			
b. Effects of a force					
i. Explains the effects of a force in a technical object (change in the motion of an object, distortion of a material)	→	★			
c. Simple machines					
i. Identifies wheels, inclined planes and levers in simple technical objects (e.g. a wheelbarrow is made up of a second-class lever and a wheel)	→	★			
ii. Describes qualitatively the mechanical advantages of different types of levers (first-class, second-class, third-class) in different applications	→	★			
2. Technological systems	**ST**		**ST**		**EST**
a. System					
i. Identifies a system (set of connected elements that interact with each other) in a technical object or technological application	→	★			
ii. Describes the overall function of a technological system	→	★			
iii. Names the inputs and outputs of a technological system	→	★			
iv. Names the processes and control elements of a technological system	→	★			
b. Components of a system					
i. Describes the role of the components of a technological system (e.g. explains the role of the parts of a lighting system)	→	★			
c. Energy transformations[3]					
i. Associates energy with radiation, heat or motion	→	★			
ii. Defines energy transformations	→	★			
iii. Identifies energy transformations in a technical object or technological system	→	★			
3. Engineering	**ST**		**ST**		**EST**
a. Basic mechanical functions (links, guiding control)					
i. Describes the role of links and guiding controls in a technical object	→	★			
ii. Identifies a guiding control in a technical object, as well as the related links (e.g. a pizza wheel is guided by a pivot, which links it to the handle)	→	★			
b. Typical mechanical links					
i. Describes the advantages and disadvantages of different types of links			★		
ii. Names the types of links used in a technical object (e.g. the spiral link between a jar and its lid)			★		

c. Linking of mechanical parts					
i. Describes the characteristics of the links in a technical object (direct or indirect, rigid or flexible, removable or permanent, partial or complete)				★	
ii. Determines the desirable characteristics of links in the design of a technical object				★	
iii. Judges the choice of assembly solutions in a technical object				★	
d. Degree of freedom of a part					
i. Explains the purpose of limiting motion (degree of freedom) in a technical object (e.g. some hinges limit how far a cupboard door can open, preventing it from hitting the wall)					★
e. Typical functions					
i. Defines the typical functions (linking, guiding, sealing, lubricating)			★		
ii. Associates a typical function with certain parts of a technical object			★		
iii. Explains the choice of a type of link in a technical object (e.g. using a screw makes it possible to attach and remove a battery case)			→	★	
f. Guiding controls					
i. Explains the choice of a type of guiding control in a technical object (e.g. the slide guides a drawer and reduces friction)				★	
g. Adhesion and friction of parts					
i. Describes the advantages and disadvantages of the adhesion and friction of parts in a technical object					★
h. Motion transmission systems					
i. Identifies motion transmission systems in technical objects	→	★			
i. Function, components and use of motion transmission systems					
i. Names motion transmission systems in technical objects (friction gears, pulleys and belt, gear assembly, sprocket wheels and chain, wheel and worm gear)			★		
ii. Describes the functions of the components of a motion transmission system (e.g. in a bicycle, the gear assembly on the crankset is the driving unit, the sprocket wheel on the rear wheel is the receiving unit, and the chain is the intermediate unit)			★		
iii. Describes the speed changes or reversibility of a motion transmission system (e.g. a sprocket wheel that is replaced by a smaller wheel or a wheel with fewer teeth increases rotation speed)			★		
j. Construction and characteristics of motion transmission systems					
i. Explains the choice of a motion transmission system in a technical object (e.g. using a gear assembly rather than friction gears to get better engine torque and avoid slipping)				★	
k. Motion transformation systems					
i. Identifies motion transformation systems in technical objects	→	★			
l. Function, components and use of motion transformation systems					
i. Names motion transformation systems in technical objects (e.g. screw gear system, cam and roller, connecting rod and crank, rack and pinion)			★		
ii. Describes the functions of the components of a motion transformation system (e.g. in a double-lever corkscrew, the pinion is the driving unit and the rack is the receiving unit)			★		

iii. Describes speed changes or the reversibility of a motion transformation system (e.g. the cam and roller is a nonreversible motion transformation system)			★		
m. Construction and characteristics of motion transformation systems					
i. Explains the choice of a motion transformation system (screw gear system, cams, connecting rods, cranks, slides, rotating slider crank mechanisms, rack-and-pinion drive) in a technical object (e.g. most car jacks use a screw gear system rather than a rack-and-pinion system, because the force of the arm on the small crank provides more thrust and because, given that it is nonreversible, the system is safer)				★	
ii. Explains the choice of a motion transformation system (screw gear, cams, connecting rods, cranks, slider-crank mechanism, rack-and-pinion drive, eccentric) in a technical object					★
n. Speed changes					
i. Uses systems that allow for speed changes in the design of technical objects				★	
C. Electrical engineering	**1**	**2**	**3**	**4**	**4**
Elementary school Students describe energy transformations and recognize them in different devices. They describe ways of transforming energy resources into electricity (e.g. wind turbines transform wind energy into electricity).					
Secondary school					
a. Power supply					
i. Defines power supply as the ability to generate electrical current				★	
ii. Determines the source of current in technical objects with an electrical circuit (e.g. chemical battery, solar cell, alternator, thermocouple, piezoelectric)				★	
b. Conduction, insulation and protection					
i. Defines conduction as the ability to conduct electricity				★	
ii. Distinguishes between electrical conductors and insulators in a technical object				★	
iii. Describes the role of a protective device in a circuit (fuse, breaker)				★	
iv. Analyzes the factors that affect electrical conductivity (section, length, nature, temperature of conductor)				★	
v. Uses the colour code to determine the electrical resistance of a resistor					★
vi. Describes the operation of a printed circuit					★
c. Control					
i. Defines control as the ability to control the travel of electrical current				★	
ii. Describes different types of switches (lever, pushbutton, flip-flop, magnetic control)				★	
iii. Distinguishes between unipolar and bipolar switches					★
iv. Distinguishes between unidirectional and bidirectional switches					★
d. Transformation of energy (electricity and light, heat, vibration, magnetism)					
i. Associates the transformation of energy with different components of a circuit (e.g. bulbs transform electrical energy into light and heat)				★	
ii. Describes the energy transformations that take place in electrical or electronic appliances (e.g. in a cell phone, electricity is transformed into light for the display and vibrations for the sound)				★	

e. Other functions					
i. Describes the function of certain electronic components (condenser, diode)					★
D. Materials	**1**	**2**	**3**	**4**	**4**
Elementary school Students describe the physical properties of certain materials.					
Secondary school					
1. Material resources	**ST**		**ST**		**EST**
a. Raw materials					
i. Associates raw materials with the unprocessed materials used in an industry (e.g. bauxite is the raw material used in aluminum smelters)	→	★			
b. Materials					
i. Names the materials present in a technical object (e.g. a cooking pot is composed of two materials: a metal used to make the container and plastic used to coat the handle)	→	★			
ii. Determines the origins of the materials present in a technical object (animal, plant, mineral, wood)	→	★			
c. Equipment					
i. Defines tools and equipment as the elements needed to manufacture an object (machining, control, assembly)	→	★			
2. Mechanical properties of materials	**ST**		**ST**		**EST**
a. Constraints					
i. Describes the constraints to which different technical objects are subject: tension, compression, torsion (e.g. the top of a beam is subject to compression)			★		
ii. Describes the constraints to which different technical objects are subject: tension, compression, torsion, deflection, shearing (e.g. a diving board is subject to deflection)				★	
b. Mechanical properties					
i. Describes the mechanical properties of different materials (hardness, ductility, elasticity, malleability, corrosion resistance)			★		
c. Characteristics of mechanical properties					
i. Explains the choice of a material based on its properties (e.g. the malleability of aluminum makes it useful for making thin-walled containers)				★	
d. Types and properties					
i. Associates the use of different types of materials with their respective properties					
– Ferrous alloys (cast iron is harder than steel)			★		
– Nonferrous metals and alloys (the wire used in a dental appliance can be made of a nickel and titanium alloy, which has shape memory)			★		
– Wood and modified wood (e.g. oak is used for flooring because it is a hard wood that is shock and wear resistant)			★		
– Plastics: thermoplastics and thermosetting plastics (e.g. thermoplastics are used for prostheses because of their corrosion resistance and lightness; Bakelite, a thermosetting plastic, is used to mould electrical parts because it is a good electrical insulator)				★	
– Ceramics (e.g. ceramics are used in ovens because they are very hard and heat and wear resistant)				★	

– Composites (e.g. carbon fibre is used for hockey sticks because of its hardness, resilience and lightness)				★	
e. Modification of properties					
i. Describes different treatments to prevent degradation of materials (e.g. metal plating, antirust treatments, painting)				★	
f. Heat treatments					
i. Defines heat treatments as ways of changing the properties of materials (e.g. quenching increases hardness but fragility as well)					★
E. Manufacturing	**1**	**2**	**3**	**4**	**4**
Elementary school Students are introduced to the design and construction of instruments, tools, machines, structures (e.g. bridges, towers), systems (e.g. water filtration), models (e.g. glider) and simple electrical circuits. They trace parts and cut them out of different materials using the appropriate tools. They use a variety of assembly methods (e.g. screws, glue, nails, round-head fasteners, nuts) and tools to obtain an aesthetic finish.					
Secondary school					
a. Specifications					
i. Defines specifications as a set of constraints associated with the design of a technical object	→	★			
ii. Evaluates a prototype or technical object based on the environments described in the specifications (human, technical, industrial, economic, physical, environmental)	→	★			
b. Manufacturing process sheet					
i. Defines a manufacturing process sheet as a set of steps to follow to machine the parts that make up a technical object	→	★			
ii. Follows a process and assembly sheet to construct an object consisting of few components or to construct part of that object	→	★			
c. Shaping					
i. Machines and tools					
– Associates shaping processes with the types of materials used (e.g. injection blow moulding is used to shape plastics)					★
– Determines the appropriate shaping techniques based on direct observation of technical objects (e.g. some table legs are turned on a lathe)					★
d. Manufacturing					
i. Characteristics of laying out, drilling, tapping and threading					
– Associates laying out (marking) with saving materials, shaping techniques and the types of materials to be shaped					★
– Describes the characteristics of the tools needed to shape a material to be machined (e.g. the tip of a metal drill is conical, while that of a wood drill is double fluted)					★
e. Measurement					
i. Direct measurement					
– Explains the purpose of direct measurement (using a ruler) to control the machining of a part					★
– Explains the choice of the direct measurement instrument used (a vernier caliper is more precise than a ruler)					★

F. Biotechnology	1	2	3	4	4
Elementary school Students do not address any concepts associated with biotechnology.					
Secondary school					
a. Processes					
i. Pasteurization					
– Describes the pasteurization process			★		
– Describes the purpose of pasteurization (preservation of food and its nutritional properties)			★		
ii. Manufacture of vaccines					
– Describes the process for manufacturing vaccines			★		
iii. Assisted reproduction					
– Describes different assisted-reproduction processes			★		
– Describes the purpose of artificial insemination (animal reproduction, an answer to human infertility, preservation of the gene pool)			★		
iv. Cell cultures					
– Names parameters to be controlled in the case of cultured cells (sources of mother cells, growth, preservation, characteristics of cell media, ethical standards)			★		
v. Genetic transformation (genetically modified organisms)					
– Names the main advantages and disadvantages of genetic transformation			★		
vi. Cloning					
– Defines cloning as a reproductive process that results in an identical copy of an organism, a tissue or a cell, whether genetically modified or not					★
– Describes the main advantages and disadvantages of cloning					★
vii. Wastewater treatment					
– Describes treatments used to decontaminate wastewater					★
viii. Biodegradation of pollutants					
– Describes ways to promote biodegradation of pollutants (e.g. phytoremediation)					★

1. See *Techniques, Technology, Graphic communication* (Techniques - Technology, 1).
2. See *Techniques, Technology, Graphic communication, Using scales* (Techniques - Technology, 1, d).
3. For Cycle Two concepts related to *Energy transformations,* see *The Material World, Changes, Transformation of energy* (MW, B, 5).

Science and Technology

General Education Path

Techniques

The techniques listed below are divided into three categories, depending on whether they apply to science or technology or both. Many of them require the use of instruments and tools or chemicals. Safety in the workshop and laboratory should be a constant concern.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge. Statements preceded by the symbol ♦ indicate knowledge specific to the compulsory Science and Technology program. Most of these statements are, however, found in the progression of learning for the optional Science and the Environment program.	Secondary				
	ST Cycle One		ST Cycle Two		EST Cycle Two
A. Technology	1	2	3	4	4
Elementary school Students use some symbols associated with motion and electrical and mechanical parts. They interpret diagrams or simple drawings containing symbols. By designing technical objects, they become familiar with the use of simple machines (e.g. lever, inclined plane, pulley, wheel). They trace parts and cut them out of different materials. They are introduced to the safe use of tools (e.g. pliers, screwdriver, hammer, wrench, template) and different assembly methods (e.g. screws, glue, nails, round-head fasteners, nuts). They pay attention to finishing.					
Secondary school					
1. Graphic communication[1]	ST		ST		EST
a. Doing a technical drawing					
i. Chooses the best view for an elevation drawing of a technical object	→	★			
ii. Represents the visible edges using solid lines	→	★			
iii. Represents the hidden edges using dotted lines	→	★			
iv. Indicates the overall external dimensions of an object on a drawing	→	★			
b. Reading plans					
i. Associates views with the sides of a technical object	→	★			
ii. Associates lines with the edges of a technical object	→	★			
c. Drawing diagrams[2]					
i. Chooses the best view to describe a technical object	→	→	→	★	
ii. Uses different colours for each part of a technical object	→	★			
iii. Indicates all the information needed to explain the operation or construction of an object	→	→	→	★	
d. Using scales[3]					
i. Associates real measurements with each of the dimensions in a drawing	→	★			
ii. Reduces or multiplies the dimensions of a technical object based on the scale	→	★			
iii. Dimensions multiview orthogonal projections in accordance with the main dimensioning rules			★		

e. Using drawing instruments					
i. Uses drawing instruments (e.g. ruler, square) to make diagrams	→	★			
f. Constructing a graph using instruments					
i. Uses instruments to construct a graph (e.g. multiview orthogonal projection, isometric representation, perspective drawing)			→	★	
2. Manufacturing	**ST**		**ST**		**EST**
a. Safely using machines and tools[4]					
i. Uses tools safely (e.g. retractable utility knife, hammer, screwdriver, pliers)	→	★			
ii. Uses machine tools safely (band saw, drill, sander)			→	★	
b. Measuring and laying out					
i. Identifies the unit of measurement on the instrument	→	★			
ii. Positions the measuring instrument to obtain reliable reference points	→	★			
iii. Adopts the appropriate position for reading an instrument	→	★			
iv. Marks the materials to be shaped using a pencil or punch	→	★			
c. Machining and forming					
i. Chooses the appropriate materials, tools, techniques and processes	→	★			
ii. Draws the necessary reference lines	→	★			
iii. Immobilizes the part to be formed	→	★			
iv. Forms the part in accordance with the steps in the following machining processes: sawing, drilling, sanding, filing	→	★			
v. Forms the part in accordance with the steps in the following machining processes: stripping, splicing, soldering			→	★	
d. Finishing					
i. Sands the sides or deburrs the edges of each part after forming	→	★			
ii. Uses the appropriate finish (stain, paint)	→	★			
iii. Grinds, polishes, hammers or chisels metal parts			→	★	
e. Assembling					
i. Marks the references (holes, points or guidelines)	→	★			
ii. Immobilizes parts during gluing	→	★			
iii. Drills to the diameter of the screws, nails or rivets used	→	★			
iv. Countersinks the openings for countersunk screws	→	★			
f. Assembling and disassembling					
i. Identifies and gathers the parts and hardware	→	★			
ii. Chooses the appropriate tools	→	★			
iii. For disassembly, numbers and records the location of the parts	→	★			
iv. In the case of electrical circuits, identifies and gathers the electrical components				★	

v. In the case of electronic circuits, identifies and gathers the electronic components					★
vi. Chooses and places the electrical components in sequence based on the circuit diagram				★	
vii. Chooses and arranges the electronic components based on the circuit diagram					★
viii. Connects the components using wire, connectors or solders				★	
g. Performing verification and control tasks					
i. Evaluates the dimensions of a part during and after construction using a ruler			→	★	
ii. Compares the real dimensions of a part with the specifications (e.g. draft, drawing, technical sheet)			→	★	
iii. Uses a template to verify the conformity of a part			→	★	
iv. Evaluates the dimensions of a part during and after construction using vernier callipers				★	
h. Making a part					
i. Makes a part using the appropriate techniques			→	★	
B. Science	**1**	**2**	**3**	**4**	**4**
Elementary school Students become familiar with the use of observational instruments (magnifying glass, stereomicroscope, binoculars) and simple measuring instruments (ruler, eyedropper, graduated cylinder, balance, thermometer, chronometer).					
Secondary school					
a. Safely using laboratory materials and equipment[5]					
i. Uses laboratory materials and equipment safely (e.g. allows hotplate to cool, uses beaker tongs)	→	→	→	→	★
ii. Handles chemicals safely (e.g. uses a spatula and pipette filler)	→	→	→	→	★
b. Separating mixtures					
i. Separates heterogeneous mixtures using sedimentation and decantation	→	★			
ii. Separates heterogeneous mixtures using filtration	→	★			
iii. Separates different aqueous solutions using evaporation or distillation	→	★			
c. Designing and creating an environment					
i. Uses environmental design and construction techniques that respect the characteristics of the habitat (e.g. terrarium, aquarium, composting medium)	→	★			
d. Using measuring instruments					
i. Adopts the appropriate position for reading an instrument	→	★			
ii. Measures the mass of a substance using a balance	→	★			
iii. Measures the volume of a liquid using the appropriate graduated cylinder	→	★			
iv. Measures the volume of an insoluble solid using water displacement	→	★			
v. Measures temperature using a graduated thermometer	→	★			
vi. Uses measuring instruments appropriately (e.g. ammeter, volumetric flask)			→	★	
vii. Uses vernier calipers appropriately					★

e. Using observational instruments					
i. Uses observational instruments appropriately (e.g. magnifying glass, stereomicroscope, binoculars, microscope)	→	★			
f. Preparing solutions					
i. Prepares an aqueous solution of a specific concentration given a solid solute			★		
ii. Prepares an aqueous solution of a specific concentration given a concentrated aqueous solution			★		
g. Collecting samples					
i. Collects samples appropriately (e.g. sterilizes the container, uses a spatula, refrigerates the sample)			→	★	
C. Techniques common to Science and Technology	**1**	**2**	**3**	**4**	**4**
a. Verifying the repeatability, accuracy and sensitivity of measuring instruments					
i. Takes the same measurement several times to check the repeatability of the instrument used					★
ii. Carries out the required operations to ensure the accuracy of a measuring instrument (e.g. cleans and calibrates a balance, dries out a graduated cylinder, rinses and calibrates a pH-meter)					★
iii. Chooses a measuring instrument by taking into account the sensitivity of the instrument (e.g. uses a 25-mL graduated cylinder rather than a 100-mL one to measure 18 mL of water)					★
b. Interpreting the results of measurement					
i. Determines the error attributable to a measuring instrument (e.g. the error in a measurement made using a graduated cylinder is provided by the manufacturer or corresponds to half of the smallest division on the scale					★
ii. Estimates the errors associated with the user and the environment when taking a measurement					★
iii. Expresses a result with a significant number of digits that takes into account the errors related to the measure (e.g. a measurement of 10.35 cm taken with a ruler graduated in millimetres should be expressed as 10.4 cm or 104 mm)					★

1. See *The Technological World, Graphical language* (TW, A).
2. The progression of learning associated with these techniques is characterized by the increasing complexity of the objects to be represented.
3. See *The Technological World, Graphical language, Scales* (TW, A, g).
4. When the teacher introduces a new technique, he or she should explain the related safety rules and repeat them often. After several practice sessions, students should apply the rules without being reminded.
5. When the teacher introduces a new technique, he or she should explain the related safety rules and repeat them often. After several practice sessions, students should apply the rules without being reminded.

Science and Technology

General Education Path

Strategies

The strategies listed below are fundamental to the approaches used in science and technology. They can be applied in a variety of increasingly complex contexts and are therefore inclusive. Thus, students build on the strategies they learned in elementary school. New strategies are added, including analytical strategies, which are adapted to students' level of cognitive development.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge. **E** : The letter **E** indicates that students were introduced to this strategy in elementary school.	Elementary	Secondary				
		ST Cycle One		ST Cycle Two		EST Cycle Two
A. Exploration strategies		1	2	3	4	4
1. Studying a problem or a phenomenon from different points of view (e.g. social, environmental, historical, economic)	E					
2. Distinguishing between the different types of information useful for solving the problem	E					
3. Referring to similar problems that have already been solved	E					
4. Becoming aware of his or her previous representations	E					
5. Drawing a diagram for the problem or illustrating it	E					
6. Formulating questions	E					
7. Putting forward hypotheses (e.g. individually, in teams, as a class)	E					
8. Exploring various ways of solving the problem	E					
9. Anticipating the results of his or her approach	E					
10. Imagining solutions to a problem in light of his or her explanations	E					
11. Taking into account the constraints involved in solving a problem or making an object (e.g. specifications, available resources, time allotted)	E					
12. Examining his or her mistakes in order to identify their source	E					
13. Using different types of reasoning (e.g. induction, deduction, inference, comparison, classification)	E					
14. Using empirical approaches (e.g. trial and error, analysis, exploration using one's senses)	E					
15. Ensuring that the procedure is appropriate and safe and making the necessary adjustments		→	★			
16. Collecting as much scientific, technological and contextual information as possible to define a problem or predict patterns				→	★	
17. Generalizing on the basis of several structurally similar cases				→	★	
18. Developing various scenarios				→	★	
19. Considering various points of view on scientific or technological issues				→	★	

B. Instrumentation strategies		1	2	3	4	4
1. Using different sources of information (e.g. books, newspapers, Web sites, magazines, experts)	E					
2. Validating sources of information	E					
3. Using technical design to illustrate a solution (e.g. diagrams, sketches, technical drawings)	E					
4. Using different tools for recording information (e.g. diagrams, notes, graphs, procedures, logbook)	E					
5. Using a variety of observational techniques and tools	E					
6. Selecting suitable techniques or tools for observation		→	★			
C. Analytical strategies		**1**	**2**	**3**	**4**	**4**
1. Identifying the constraints and important elements related to the problem-solving situation		→	★			
2. Dividing a complex problem into simpler subproblems		→	★			
3. Using different types of reasoning (e.g. inductive and deductive reasoning, comparison, classification, prioritization) in order to process information		→	★			
4. Reasoning by analogy in order to process information and adapt scientific and technological knowledge				→	★	
5. Selecting relevant criteria to help him or her determine where he or she stands on a scientific or technological issue				→	★	
D. Communication strategies		**1**	**2**	**3**	**4**	**4**
1. Using different means of communication to propose explanations or solutions (e.g. oral presentation, written presentation, procedure)	E					
2. Organizing information for a presentation (e.g. tables, diagrams, graphs)	E					
3. Exchanging information	E					
4. Comparing different possible explanations for or solutions to a problem in order to assess their relevance (e.g. full-group discussion)	E					
5. Using tools to display information in various formats (e.g. data tables, graphs, diagrams)		→	★			