Éducation, Loisir et Sport Québec

Progression of Learning in Secondary School

Physics
Secondary V Optional Program

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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.

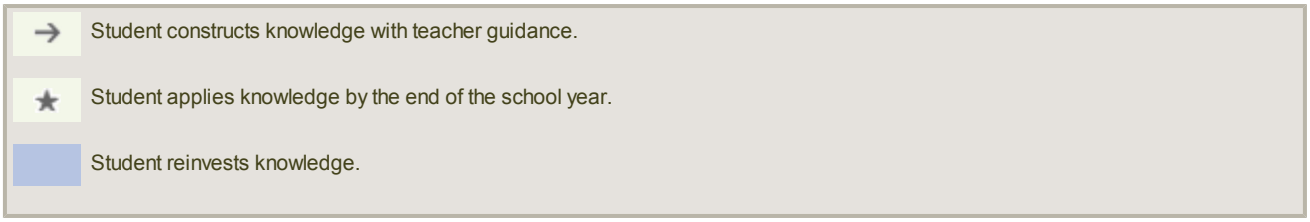
In order to meet the needs of students with learning difficulties, teachers should encourage their participation in the activities designed for the whole class, although support measures should also be provided, when necessary. These might involve more targeted teaching of certain key elements of knowledge,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

Physics - Secondary V Optional Program

Introduction

This document provides additional information about the learning prescribed in the optional Secondary V Physics program. It 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 Physics program. 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 physics 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 concepts and principles can help them explain phenomena or understand the operation of objects and, consequently, make use of their scientific and technological knowledge (Competency 2). Finally, in order to communicate ideas relating to questions involving physics (Competency 3), they must acquire and apply knowledge that will enable them to interpret or produce messages using the languages and types of representations specific to science and technology.

In Secondary Cycle One, students learn about natural phenomena and man-made objects that interest them. In Cycle Two, the concepts are organized around applications connected to seven technological fields, in the Applied Science and Technology General Education Path, or environmental issues in the General Education Path or in the optional programs in Secondary IV.

The four tables in this document outline the knowledge related to the general concepts presented in the Physics program: kinematics, dynamics, transformation of energy and geometric optics. Each table is preceded by a text explaining how knowledge of the general concept contributes to the students' learning in physics. This is followed by a list of the main concepts studied in Secondary Cycle One and related to this general concept. Lastly, the table itself lists a certain number of statements that refer to subject matter covered during Secondary Cycle Two and that is relevant to the study of concepts in the Physics program.[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. Only those concepts specific to the Physics program are identified by a number.

Physics - Secondary V Optional Program

Kinematics

Studying kinematics gives students the opportunity to acquire scientific and technical knowledge of phenomena and applications[1] that involve bodies in motion.

Over the course of their secondary school education, students have explored increasingly complex phenomena, problems and applications. They have acquired knowledge related to The Material World, The Living World, The Earth and Space and the Technological World. By using the experimental method, modelling and carrying out analysis, they are able to describe, understand and explain the laws and models governing kinematics. Students learn to apply this new knowledge in a variety of contexts to explain phenomena or make predictions. In this way, they acquire a better understanding of the motion of bodies in the world around us and of the related applications.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge.	Secondary				
	AST	AST – SE	ST	ST – EST	PHY
	3	4	3	4	5
Secondary Cycle One Types of motion Identifies parts that move in a specific way in a technical object (rectilinear translation, rotation, helical) Effects of a force Explains the effects of a force in a technical object (change in the motion of an object, distortion of a material)					
Secondary Cycle Two Only those concepts specific to the Physics program are identified by a number. Light blue shading indicates that the student acquired this knowledge in Secondary III or IV.					
Relationship between constant speed, distance and time					
Describes qualitatively the relationship between speed, distance and time		★			
Applies the mathematical relationship between constant speed, distance and time ($v = d/\Delta t$)		★			
1. Reference systems					
i. Chooses a reference system suited to the situation					★
2. Uniform rectilinear motion					
a. Relationship among position with respect to the point of origin, velocity and time					
i. Provides a qualitative explanation and uses a graph to illustrate the relationship between the position of an object with respect to its point of origin (displacement), its velocity and the time during which it is in motion					★
ii. Applies the mathematical relationship between position with respect to the point of origin (displacement), velocity and time ($\Delta d = v\Delta t$) in a given situation					★
b. Displacement and distance travelled					
i. Distinguishes displacement from distance travelled					★
Speed changes					
Uses systems that allow for speed changes in the design of technical objects		★		★	
3. Uniformly accelerated rectilinear motion					
a. Relationship among acceleration, change in velocity and time					
i. Provides a qualitative explanation and uses a graph to illustrate the relationship between the acceleration of a body, the change in its velocity and the time during which this change occurs					★

ii. Applies the mathematical relationship between acceleration, change in velocity and time ($a = \Delta v/\Delta t$) in a given situation						★
b. Relationship among acceleration, distance and time						
i. Provides a qualitative explanation and uses a graph to illustrate the relationship between the acceleration of a body, the distance it travelled and the time interval						★
ii. Applies the mathematical relationship between acceleration, the distance travelled and the time ($\Delta d = v_i\Delta t + \frac{1}{2}a\Delta t^2$) in a given situation						★
c. Average velocity and instantaneous velocity						
i. Determines the average velocity of an object						★
ii. Determines the instantaneous velocity of an object						★
iii. Explains the distinction between average velocity and instantaneous velocity						★
d. Free fall						
i. Provides a qualitative explanation and uses a graph to illustrate the motion of a free-falling body (position, displacement, average velocity, instantaneous velocity, acceleration)						★
ii. Determines the position, displacement, average velocity, instantaneous velocity or acceleration of a free-falling body						★
e. Motion of a body on an inclined plane						
i. Provides a qualitative explanation and uses a graph to illustrate the motion of a body on an inclined plane (position, displacement, average velocity, instantaneous velocity, acceleration)						★
ii. Determines the position, displacement, average velocity, instantaneous velocity or acceleration of a body on an inclined plane						★
4. Motion of projectiles						
a. Explains the motion of a projectile (combination of uniform rectilinear motion and uniformly accelerated rectilinear motion)						★
b. Determines the position, displacement or instantaneous velocity of a projectile, or the time elapsed						★

1. “Application” is understood to mean a technical object, a system, a product or a process.

Physics - Secondary V Optional Program

Dynamics

Studying dynamics gives students the opportunity to acquire scientific and technical knowledge of phenomena and applications[1] that involve forces acting on bodies.

Over the course of their secondary school education, students have explored increasingly complex phenomena, problems and applications. They have acquired knowledge related to The Material World, The Living World, The Earth and Space and the Technological World. By using the experimental method, modeling and carrying out analysis, they are able to describe, understand and explain the laws and models governing dynamics. Students learn to apply this new knowledge in a variety of contexts to explain phenomena or make predictions. In this way, they acquire a better understanding of the effects of forces on bodies in the world around us and of the related applications.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge.	Secondary				
	AST	AST – SE	ST	ST – EST	PHY
	3	4	3	4	5
Secondary Cycle One Mass Defines the concept of mass Effects of a force Explains the effects of a force in a technical object (change in the motion of an object, distortion of a material) Simples machines 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) Describes qualitatively the mechanical advantages of different types of levers (first-class, second-class, third-class) in different applications					
Secondary Cycle Two Only those concepts specific to the Physics program are identified by a number. Light blue shading indicates that the student acquired this knowledge in Secondary III or IV.					
Relationship between work, force and distance travelled					
Describes qualitatively the relationship between the work done, the force applied on a body and the distance travelled by the body		★		★	
Applies the mathematical relationship between work, effective force and distance travelled ($W = F\Delta d$)		★		★	
Relationship between mass and weight					
Describes qualitatively the relationship between mass and weight		★		★	
Applies the mathematical relationship between mass and weight ($F_g = mg$)		★		★	
Effective force					
Defines effective force as the component of the applied force parallel to the direction of travel		★		★	
Determines graphically the magnitude of the effective force in a given situation		★		★	
1. Gravitational acceleration					
a. Compares the average values of gravitational acceleration on Earth and on the Moon (9,8 m/s^2 on Earth, 1,6 m/s^2 on the Moon)					★
2. Gravitational force					
a. Associates the free fall of a body with the effect of gravitational force					★
b. Associates the gravitational force of a body with its weight					★
c. Determines the component of gravitational force parallel to the displacement of a body (e.g. inclined plane)					★

3. Newton's Laws					
a. Describes qualitatively the law of inertia (Newton's First Law)					★
b. Describes qualitatively the relationship between the force acting on a body, its mass and its acceleration (Newton's Second Law)					★
c. Applies the mathematical relationship between the force acting on a body, mass and acceleration (F = ma)					★
d. Describes qualitatively the law of action-reaction (Newton's Third Law)					★
e. Explains a phenomenon or how a technical object works, using Newton's Laws					★
Pressure					
Defines pressure as the force exerted by particles when they collide with a constricting surface	★		★		
Adhesion and friction of parts					
Describes the advantages and disadvantages of the adhesion and friction of parts in a technical object		★		★	
4. Force of friction					
a. Explains the possible effects of a frictional force (slows down, stops or impedes the motion of a body)					★
b. Names the factors that can affect the force of friction in a given situation (e.g. nature of the surfaces that are in contact, shape of a body that is moving in a fluid)					★
c. Determines the value of the force of friction in a given situation[2] (force of friction = applied force - net force)					★
Constraints					
Describes the constraints to which different technical objects are subject: tension, compression, torsion (e.g. the top of a beam is subject to compression)	★		★		
Describes the constraints to which different technical objects are subject: tension, compression, torsion, deflection, shearing (e.g. a diving board is subject to deflection)		★		★	
5. Centripetal force					
a. Explains qualitatively the effect of centripetal force on a body in motion					★
6. Free-body diagram					
a. Uses vectors to represent the forces that act on a body					★
7. Equilibrium and resultant of several forces					
a. Determines the magnitude and direction of the vector associated with the resultant force of a system of forces					★
b. Determines the magnitude and direction of the vector associated with the balancing force of a system of forces					★

1. "Application" is understood to mean a technical object, a system, a product or a process.
2. Calculations using the coefficients of friction are not required.

Physics - Secondary V Optional Program

Transformation of energy

Studying the transformation of energy gives students the opportunity to acquire scientific and technical knowledge of phenomena and applications[1] in which energy is transformed.

Over the course of their secondary school education, students have explored increasingly complex phenomena, problems and applications. They have acquired knowledge related to The Material World, The Living World, The Earth and Space and the Technological World. By using the experimental method, modelling and carrying out analysis, they are able to describe, understand and explain the laws and models governing the transformation of energy. Students learn to apply this new knowledge in a variety of contexts to explain phenomena or make predictions. In this way, they acquire a better understanding of the transformations of energy in the world around us and of the related applications.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge.	Secondary				
	AST	AST – SE	ST	ST – EST	PHY
	3	4	3	4	5
Secondary Cycle One Light Defines light as a form of radiant energy Energy transformations Associates energy with radiation, heat or motion Defines energy transformations Identifies energy transformations in a technical object or technological system					
Secondary Cycle Two Only those concepts specific to the Physics program are identified by a number. Light blue shading indicates that the student acquired this knowledge in Secondary III or IV.					
Forms of energy					
Describes different forms of energy (chemical, thermal, mechanical, radiation)	★		★		
Defines joule as the unit of measurement for energy			★		
Law of conservation of energy					
Explains qualitatively the law of conservation of energy		★		★	
Applies the law of conservation of energy in different contexts		★		★	
Energy efficiency					
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 x 100)		★		★	
Relationship between work, force and distance travelled		★		★	
Describes qualitatively the relationship between the work done, the force applied on a body and the distance travelled by the body		★		★	
Applies the mathematical relationship between work, effective force and distance travelled ($W = F\Delta d$)		★		★	
Relationship between potential energy, mass, acceleration and distance travelled					
Describes qualitatively the relationship between the potential energy of a body, its mass, its gravitational acceleration and the distance it travels		★		★	
Applies the mathematical relationship between potential energy, mass, gravitational acceleration and the distance travelled ($E_p = mgh$)		★		★	
Relationship between kinetic energy, mass and speed					
Describes qualitatively the relationship between the kinetic energy of a body, its mass and its speed		★		★	

Applies the mathematical relationship between kinetic energy, mass and speed ($E_k = ½mv^2$)		★		★	
Relationship between work and energy					
Describes qualitatively the relationship between the work done on a body and the variation in energy within that body		★		★	
Applies the mathematical relationship between work and energy ($W = \Delta E$)		★		★	
1. Mechanical energy					
a. Explains qualitatively a transformation of mechanical energy in a given situation (e.g. a merry-go-round in motion)					★
b. Applies the mathematical relationships associated with kinetic energy, types of potential energy (gravitational, elastic), work and heat					★
c. Analyzes quantitatively a transformation of mechanical energy in a given situation					★
2. Hooke's Law					
a. Explains qualitatively the relationship between the energy of a helical spring, its force constant and the change in its length compared to its length at rest, in a given situation (e.g. the springs in a mattress)					★
b. Applies the mathematical relationship between elastic potential energy, the force constant and the change in length in a given situation ($E = ½k\ell^2$)					★
Relationship between power and electrical energy					
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		★		★	
Applies the mathematical relationship between electrical energy consumed, the power of an electrical appliance and the amount of time it is in operation ($E = P\Delta t$)		★		★	
3. Relationship among power, work and time					
a. Explains qualitatively the relationship between the power of a system, the work done and the time taken to do the work					★
b. Applies the mathematical relationship between power, work and time ($P = W/\Delta t$)					★

1. "Application" is understood to mean a technical object, a system, a product or a process.

Physics - Secondary V Optional Program

Geometric optics

Studying geometric optics gives students the opportunity to acquire scientific and technical knowledge of phenomena and applications[1] involving the deviation of light rays.

Over the course of their secondary school education, students have explored increasingly complex phenomena, problems and applications. They have acquired knowledge related to The Material World, The Living World, The Earth and Space and the Technological World. By using the experimental method, modelling and carrying out analysis, they are able to describe, understand and explain the laws and models governing the behaviour of light rays. Students learn to apply this new knowledge in a variety of contexts to explain phenomena or make predictions. In this way, they acquire a better understanding of how the paths followed by light rays affect the way we see the world around us and of the related applications.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge.	Secondary				
	AST	AST – SE	ST	ST – EST	PHY
	3	4	3	4	5
Secondary Cycle One Light Describes properties of light (propagation in a straight line, diffuse reflection by surfaces) Explains different phenomena using the properties of light (cycles of day and night, seasons, phases of the Moon, eclipses)					
Secondary Cycle Two Only those concepts specific to the Physics program are identified by a number. Light blue shading indicates that the student acquired this knowledge in Secondary III or IV.					
Deviation of light waves					
Describes how light rays are deviated by a plane reflective surface	★		★		
Determines the angle of reflection of a light ray on the surface of a plane mirror	★		★		
Describes how light rays are deviated when they pass through the surface of a translucent convex or concave surface	★		★		
1. Snell's Laws (Reflection)					
a. Incident and reflected rays					
i. Defines a light ray as a theoretical structure indicating the direction of the propagation of light					★
ii. Identifies incident rays and reflected rays in a diagram or an actual[2] situation					★
iii. Distinguishes diffuse reflection from specular reflection in various situations					★
b. Angle of incidence and reflection					
i. Measures the angles of incidence and angles of reflection in a diagram or an experiment					★
ii. Explains qualitatively and quantitatively a phenomenon using the Law of Reflection (e.g. minimum height a mirror must have in order for a person to see the full length of his/her body, extent of a field of vision)					★
Focal point of a lens					
Determines the focal point of concave and convex lenses	★		★		
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)	★		★		
Sensory receptors (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	★		★		
2. Snell's Law (Refraction)					
a. Incident and refracted rays					
i. Identifies incident rays and refracted rays in a diagram or an actual situation					★
b. Angle of incidence and refraction					
i. Measures the angles of incidence and the angles of refraction in a diagram or an experiment					★
c. Index of refraction					
i. Defines the index of refraction of a medium as the ratio of the speed of light in a vacuum to the speed of light in that medium (n = c/v)					★
ii. Determines, in experiments or mathematically, the indices of refraction of various media					★
iii. Explains qualitatively and quantitatively a phenomenon using the Law of Refraction ($n_1 \sin\Theta_1 = n_2 \sin\Theta_2$) (e.g. a straw in a glass of water)					★
iv. Explains the phenomenon of total internal reflection (e.g. mirage, fibre optics)					★
3. Images					
a. Type of image					
i. Explains the distinction between a real image and a virtual image					★
b. Image characteristics					
i. Determines the characteristics of the image formed in a given situation (mirrors and lenses)					★
ii. Applies the mathematical relationships that make it possible to determine the position, orientation and height of an object or its image in the case of mirrors or lenses ($M = h_i/h_o = -d_i/d_o$; $1/d_o + 1/d_i = 1/f$)					★

1. "Application" is understood to mean a technical object, a system, a product or a process.
2. This should be limited to cases involving plane or spherical mirrors.

Physics - Secondary V Optional Program

Techniques

It can be useful to refer to the techniques related to science and technology that were covered earlier.[1] The compulsory techniques for physics are divided into two categories, depending on whether they are related to laboratory work or measurement. Many of them require the use of instruments and tools. Safety in the workshop and laboratory should be a constant concern for users.

→ Student constructs knowledge with teacher guidance. ★ Student applies knowledge by the end of the school year. Student reinvests knowledge.	Secondary				
	AST	AST – SE	ST	ST – EST	PHY
A. Techniques related to laboratory work	3	4	3	4	5
1. Safely using laboratory or workshop materials and equipment [2]					
a. Uses laboratory materials and equipment safely (e.g. never aims a laser beam toward a person's face, makes sure the apparatus is properly secured)	→	★	→	★	
2. Using observational instruments					
a. Uses observational instruments appropriately (e.g. photographic camera, video camera, probe)					
B. Measurement techniques	3	4	3	4	5
1. Verifying the repeatability, accuracy and sensitivity of measuring instruments					
a. Takes the same measurement several times to check the repeatability of the instrument used		★		★	
b. Carries out the required operations to ensure the accuracy of a measuring instrument (e.g. calibrates a probe, positions a measuring instrument properly in the setup)		★		★	
c. Chooses a measuring instrument by taking into account the sensitivity of the instrument (e.g. uses a stopwatch instead of an analogue clock)		★		★	
2. Interpreting the results of measurement					
a. Determines the error attributable to a measuring instrument (e.g. the error in a measurement made using a dynamometer corresponds to half of the smallest division on the scale, the error in a measurement made using a measuring tape correcponds to the value of the smallest division on the scale)		★		★	
b. Estimates the errors associated with the user and the environment when taking a measurement (e.g. in the case of a stopwatch, the error associated with reaction time is estimated to be 0.1 seconds)		★		★	
c. 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)		★		★	
d. Expresses the value of a measurement with its absolute or relative uncertainty (e.g. 24.1 ± 0.1 cm^3 or 24.1 cm^3 ± 0.4 %)					★

1. See the *Techniques* section in the *Progression of Learning in Secondary School* (Secondary I to IV) documents.
2. When a 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.

Physics - Secondary V Optional Program

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.	Secondary					
	Cycle One	AST	AST – SE	ST	ST – EST	PHY
A. Exploration strategies		3	4	3	4	5
1. Studying a problem or a phenomenon from different points of view (e.g. social, environmental, historical, economic)						
2. Distinguishing between the different types of information useful for solving the problem						
3. Referring to similar problems that have already been solved						
4. Becoming aware of his or her previous representations						
5. Drawing a diagram for the problem or illustrating it						
6. Formulating questions						
7. Putting forward hypotheses (e.g. individually, in teams, as a class)						
8. Exploring various ways of solving the problem						
9. Anticipating the results of his or her approach						
10. Imagining solutions to a problem in light of his or her explanations						
11. Taking into account the constraints involved in solving a problem or making an object (e.g. specifications, available resources, time allotted)						
12. Examining his or her mistakes in order to identify their source						
13. Using different types of reasoning (e.g. induction, deduction, inference, comparison, classification)						
14. Using empirical approaches (e.g. trial and error, analysis, exploration using one's senses)						
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		3	4	3	4	5
1. Using different sources of information (e.g. books, newspapers, Web sites, magazines, experts)						
2. Validating sources of information						
3. Using technical design to illustrate a solution (e.g. diagrams, sketches, technical drawings)						
4. Using different tools for recording information (e.g. diagrams, notes, graphs, procedures, logbook)						
5. Using a variety of observational techniques and tools						
6. Selecting suitable techniques or tools for observation	★					
C. Analytical strategies		**3**	**4**	**3**	**4**	**5**
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		**3**	**4**	**3**	**4**	**5**
1. Using different means of communication to propose explanations or solutions (e.g. oral presentation, written presentation, procedure)						
2. Organizing information for a presentation (e.g. tables, diagrams, graphs)						
3. Exchanging information						
4. Comparing different possible explanations for or solutions to a problem in order to assess their relevance (e.g. full-group discussion)						
5. Using tools to display information in various formats (e.g. data tables, graphs, diagrams)	★					