

© Gouvernement du Québec
Ministère de l'Éducation et de l'Enseignement supérieur, 2018

ISSN 1927-8578 (Online)

Legal Deposit – Bibliothèque et Archives nationales du Québec, 2018

This document is available on the website of the Ministère de l'Éducation et de l'Enseignement supérieur.

TABLE OF CONTENTS

INTRODUCTION	4
1. ELEMENTS TO BE EVALUATED.....	5
1.1 Evaluation Criteria	5
1.2 Additional Information on the Compulsory Concepts.....	5
1.3 Proficiency in Knowledge and the Ability to Use It	5
2. CONTENT OF THE UNIFORM EXAMINATIONS.....	6
2.1 Science and Technology (555-410)	6
2.2 Applied Science and Technology (557-410)	7
3. CONDITIONS FOR ADMINISTERING THE EXAMINATIONS.....	8
3.1 Duration of the Examinations.....	8
3.2 Procedure.....	8
3.3 Permitted Materials.....	8
3.3.1 Science and Technology (555-410).....	8
3.3.2 Applied Science and Technology (557-410).....	8
3.3.3 Rules for using calculators or other materials.....	9
3.4 Measures Adapting the Conditions for Administering Ministerial Examinations.....	9
4. MARKING THE UNIFORM EXAMINATIONS	9
4.1 Responsibility for Marking the Examinations.....	9
5. RESULTS ON THE UNIFORM EXAMINATIONS	10
5.1 June 2018 Examinations	10
5.2 July 2018 and January 2019 Examinations.....	10
6. EVALUATION OF THE <i>PRACTICAL</i> COMPONENT	10
7. SUBJECT MARK AND MINIMUM PERFORMANCE STANDARD	10
7.1 Weighting.....	10
Appendix I Compulsory Concepts on Which Students May Be Tested in Science and Technology (555-410)	11
Appendix II Compulsory Concepts on Which Students May Be Tested in Applied Science and Technology (557-410).....	12
Appendix III Periodic Table of the Elements	13
Appendix IV Formulas and Quantities – Science and Technology	14
Appendix V Formulas and Quantities – Applied Science and Technology	15

INTRODUCTION

This information document outlines the main components of the uniform examinations for the Secondary IV science programs, namely Science and Technology and Applied Science and Technology. Among other things, this document was designed to guide teachers in the preparatory work they must do throughout the year to ensure that their students can pass these examinations.

The Ministère de l'Éducation et de l'Enseignement supérieur (MEES) is responsible for producing uniform examinations for the *Theory* component of each program, which are to be administered in the June, July and January examination sessions. Each examination is based on the Framework for the Evaluation of Learning, the Progression of Learning and the Québec Education Program. Information gathered on examinations administered in previous years is also taken into account. In addition, MEES encourages the participation of the school system by inviting teachers and education consultants from different schools to contribute to the development and validation of these examinations.

Schools must administer each uniform examination at the appointed time in the official schedule established by the Minister.

The examinations for the *Practical* component are developed by educational institutions. However, these examinations must take into account the instructions in this document in order to ensure a measure of uniformity. It should be noted that the prototype examinations for the experimental method and technological design process were updated during the 2013-2014 school year. These examinations are intended to assist teachers in familiarizing themselves with the evaluation process for the *Practical* component and are available on MEES' password-protected site.

New this year

- MEES has introduced a new scannable answer sheet for the June 2018 examination. Additional information in this regard will be provided in the Marking Guide for the examination.
- The appendices that used to be part of the Question Booklet will now be found in a document entitled *Reference Document*. Additional information in this regard is provided in sections 2.1 and 2.2 of this document.

1. ELEMENTS TO BE EVALUATED

1.1 Evaluation Criteria

The evaluation criteria for each uniform examination are as follows:

- Proficiency in subject-specific knowledge targeted in the Progression of Learning
- Relevant use of scientific and technological knowledge
- Appropriate formulation of explanations or solutions

1.2 Additional Information on the Compulsory Concepts

The compulsory concepts in the Science and Technology (ST) and Applied Science and Technology (AST) programs are indicated in Appendices I and II by major area (The Living World, The Material World, The Earth and Space, and The Technological World). Most of these concepts will be covered in the June 2018, July 2018 and January 2019 uniform examinations, except for the italicized concepts, which educational institutions are responsible for testing.

MEES has decided not to include concepts related to The Living World in the above-mentioned examinations. As these concepts can be tested more effectively at the local level than by means of ministerial examinations, educational institutions are entirely responsible for evaluation in this regard. An analysis of student answers on past examinations and teachers' comments have revealed that the variety of settings encountered in the different regions of Québec has an impact on the answers given to questions on concepts related to The Living World. For example, students living in urban, forest or rural areas experience their respective environments in specific ways, which may sometimes result in different interpretations of the realities presented in these questions.

However, because environmental issues are an integral part of the knowledge students develop in this subject, they are incorporated into questions related to the other major areas. For example, a situation involving a human disturbance, such as a toxic spill, would be particularly suitable for measuring students' comprehension of the concepts of catchment area and watershed divide. Other situations related to The Living World, and ecology in particular, could also be used in the ministerial examination.

1.3 Proficiency in Knowledge and the Ability to Use It

Proficiency in knowledge means that the student is able to carry out a written task that shows that he or she knows and understands a concept (element, operation, relationship, model) related to science and technology. The ability to use knowledge means that the student is capable of applying a combination of concepts (elements, operations, relationships, models) related to science and technology. The questions relating to the student's proficiency in knowledge and ability to use it may be multiple-choice or constructed-response questions and involve one of the following:

- Identification or understanding of a concept
- Identification or formulation of examples pertaining to a concept
- Simple application of a formula or an idea related to a concept
- Understanding of a combination of concepts
- Application of a complex procedure
- Explanation or justification of one or more concepts that may require analysis

2. CONTENT OF THE UNIFORM EXAMINATIONS

2.1 Science and Technology (555-410)

The uniform examination for Science and Technology requires students to analyze situations and a technical object. Working alone, students must solve various problems using their knowledge of the compulsory concepts in three of the four areas of the program.

The examination, which consists of 25 questions worth 4 marks each, is divided into three parts:

- Part A consists of 15 multiple-choice questions worth 60% of the examination mark. These questions, which evaluate students' proficiency in or ability to use knowledge relating to the compulsory concepts, are presented in the Question Booklet.
- Part B consists of 5 constructed-response questions worth 20% of the examination mark. These questions are presented in the Student Booklet.
- Part C consists of 5 questions on the technological analysis of a technical object and is worth 20% of the examination mark. These questions are also presented in the Student Booklet.

The examination consists of:

- a Question Booklet
- a Student Booklet
- a Reference Document, which includes the list of formulas and quantities, the periodic table of the elements, and the diagrams of the technical object
- a scannable answer sheet (for the June examination)
- a visual aid (an animated video showing how a technical object works)
- a Marking Guide for teachers

Distribution and Weighting of the Questions Related to Each Area of the Science and Technology Program

	Number of Questions per Part	The Living World	The Earth and Space	The Material World	The Technological World	Weighting
Part A	15	---	4	10	1	60%
Part B	5	---	1	3	1	20%
Part C	5	---	---	---	5	20%
Total	25	---	20%	52%	28%	100%

2.2 Applied Science and Technology (557-410)

The uniform examination for Applied Science and Technology requires students to analyze situations and a technical object. Working alone, students must solve various problems using their knowledge of the compulsory concepts in three of the four areas of the program.

The examination, which consists of 25 questions worth 4 marks each, is divided into three parts:

- Part A consists of 15 multiple-choice questions worth 60% of the examination mark. These questions, which evaluate students' proficiency in or ability to use knowledge relating to the compulsory concepts, are presented in the Question Booklet.
- Part B consists of 4 constructed-response questions worth 16% of the examination mark. These questions are presented in the Student Booklet.
- Part C consists of 6 questions on the technological analysis of a technical object and is worth 24% of the examination mark. These questions are also presented in the Student Booklet.

The examination consists of:

- a Question Booklet
- a Student Booklet
- a Reference Document, which includes the list of formulas and quantities, and the diagrams of the technical object
- a scannable answer sheet (for the June examination)
- a visual aid (an animated video showing how a technical object works)
- a Marking Guide for teachers

Distribution and Weighting of the Questions Related to Each Area of the Applied Science and Technology Program

	Number of Questions per Part	The Living World	The Earth and Space	The Material World	The Technological World	Weighting
Part A	15	---	1	9	5	60%
Part B	4	---	1	2	1	16%
Part C	6	---	---	---	6	24%
Total	25	---	8%	44%	48%	100%

3. CONDITIONS FOR ADMINISTERING THE EXAMINATIONS

3.1 Duration of the Examinations

The official schedule indicates that the duration of the examinations is 3 hours, which should be amply sufficient for all students to finish the examination and review their answers. However, an additional 15 minutes must be allotted, if needed, as provided for under section 4.3.7 of the *Administrative Guide for the Certification of Studies and Management of Ministerial Examinations*.

3.2 Procedure

Students must work alone, considering questions and analyzing problems that test their knowledge or their ability to use it. They must also analyze different aspects of a technical object. An animated video showing the workings of the technical object to be analyzed must play continuously during the examination. Since the three parts of the examination can each stand alone, students can start by answering the questions in any part they so choose.

Students must first read through the examination questions and reference materials presented in the Question Booklet, the Student Booklet and the Reference Document. They must then answer the questions in the Student Booklet and on the scannable answer sheet (for the June examinations) by carrying out all the work according to the instructions provided.

The school must ensure that the examination room has the equipment for showing the animated video and that each student has a clear view of it.

While viewing the animated video of the technical object, students are forbidden from communicating with one another or asking the invigilator questions about the technical object.

3.3 Permitted Materials

3.3.1 Science and Technology (555-410)

Only the following materials may be used during the examination:

- Ruler
- Calculator with or without a graphic display

3.3.2 Applied Science and Technology (557-410)

Only the following materials may be used during the examination:

- Ruler
- Calculator with or without a graphic display

3.3.3 Rules for using calculators or other materials¹

Calculators with or without a graphic display that are designed primarily to perform mathematical calculations may be used during ministerial examinations. Computers, tablets, electronic organizers and calculators with an alphanumeric keyboard (QWERTY or AZERTY) are, however, prohibited.

Prior to the examination, students must be duly informed in writing of the rules regarding the use of calculators on a ministerial examination.

The data and programs stored in the calculator's memory must be erased before the examination. Before the day of the examination, students must have been given the opportunity to learn how to reset their calculator's memory. In addition, it is forbidden to store programs in the calculator's memory during the examination. Using a calculator containing programs or data stored in the memory will be considered a form of cheating.

User guides, memory expansion features or any other calculator accessories are not permitted during the examination. Students may not share their calculator with another student. The use of a memory-aid sheet is also prohibited.

During the examination, students are strictly forbidden to have in their possession any electronic device (smartphone, portable media player, smart watch, etc.) that can be used to communicate, surf the Internet, translate texts, or create, save or consult data. Any student who violates this rule will be expelled from the examination room and will be considered to have cheated on the examination.

3.4 Measures Adapting the Conditions for Administering Ministerial Examinations

Measures that adapt the conditions for administering ministerial examinations may be taken to enable students with specific needs to demonstrate their learning. For further information on the implementation of these measures, please refer to the documents made available to schools by the Direction de la sanction des études.

4. MARKING THE UNIFORM EXAMINATIONS

4.1 Responsibility for Marking the Examinations

With respect to the June 2018 examinations, Part A will be marked by MEES and Parts B and C will be marked by educational institutions. Every part of the July 2018 and January 2019 examinations will be marked by educational institutions.

In grading the examination papers, teachers must refer to the instructions in the Marking Guide provided by MEES and should form a marking committee to ensure that they have a common understanding of these instructions. By analyzing some of the examination papers submitted, the committee will be better able to determine what is expected of students.

¹ At a later date, the Direction de la sanction des études will provide instructions regarding the use of technology tools during the examinations.

5. RESULTS ON THE UNIFORM EXAMINATIONS

The result obtained on either of the uniform examinations is expressed as a mark out of 100 and is the sum of the results for each of Parts A, B and C. This result counts for 50% of the *Theory* component.

5.1 June 2018 Examinations

Once Parts B and C have been marked by educational institutions, the scannable answer sheet must be forwarded to the Direction de la sanction des études. All calculations for determining the final mark for the June 2018 examinations are carried out by MEES.

5.2 July 2018 and January 2019 Examinations

All questions on the July 2018 and January 2019 examinations are marked by educational institutions. Details on how to submit the results for these examinations will be specified at a later date by the Direction de la sanction des études.

6. EVALUATION OF THE *PRACTICAL* COMPONENT

With regard to the *Practical* component, teachers must evaluate student learning by means of examinations in a laboratory or workshop. These examinations involve the experimental method or the technological design process. This component, which is administered and marked by educational institutions, is calculated out of 100 and counts for 40% of the student's subject mark.

It is not advisable to use a single examination per year to evaluate the *Practical* component, as that would entail deriving 40% of the student's final mark from a single evaluation situation. To obtain meaningful results, it is recommended that students be evaluated on an individual basis each term.

Rubrics for evaluating students' work on practical examinations involving the experimental method and the technological design process are included in the prototype examinations available on MEES' password-protected site. It is a good idea to use these rubrics throughout the year.

7. SUBJECT MARK AND MINIMUM PERFORMANCE STANDARD

The subject mark is based on the result for each component, weighted in accordance with the percentages established by MEES and presented in the Framework for the Evaluation of Learning. Students earn credits for the program if they obtain a subject mark of at least 60%.

Additional information in this regard is available in the *Processing of results* section on MEES' website at www.education.gouv.qc.ca.

7.1 Weighting

The weighting for the two components is the same for both the Science and Technology program and the Applied Science and Technology program.

Practical component: 40% (school mark only)

Theory component: 60% (30% for the moderated school mark and 30% for the uniform examination mark)

Compulsory Concepts on Which Students May Be Tested in Science and Technology (555-410)

The scope of each concept is defined in the Progression of Learning.
Educational institutions are responsible for testing the concepts shown in *italics*.

The following are also evaluated: Techniques related to diagram drawing and graphic representation (isometric representation, perspective drawing).

The Living World	The Material World	The Technological World
Ecology – Study of populations (density, distribution, biological cycles) Dynamics of communities – Biodiversity – Disturbances Dynamics of ecosystems – Trophic relationships – Primary productivity – Material and energy flow – Chemical recycling	Physical properties of solutions – Concentration (g/L, %, ppm) – Electrolytes – pH scale – Electrolytic dissociation – Ions – Electrical conductivity Chemical changes – Combustion – Photosynthesis and respiration (carbon cycle) – Acid-base neutralization reaction – Balancing chemical equations – Law of conservation of mass Organization of matter – Rutherford-Bohr atomic model – Lewis notation – Groups and periods in the periodic table Electricity and electromagnetism – Electrical charge – Static electricity – Ohm's law – Electrical circuits – Relationship between power and electrical energy Electromagnetism – Forces of attraction and repulsion – Magnetic field of a live wire Transformation of energy – Law of conservation of energy – Energy efficiency – Distinction between heat and temperature	Mechanical engineering – Characteristics of the linking of mechanical parts – Guiding controls – Construction and characteristics of motion transmission systems (friction gears, pulleys and belt, gear assembly, sprocket wheels and chain, wheel and worm gear) – Speed changes – Construction and characteristics of motion transformation systems (screw gear system, cams, connecting rods, cranks, slides and rotating slider crank mechanisms, rack-and-pinion drive) Electrical engineering – Power supply – Conduction, insulation and protection – Control – Transformation of energy (electricity and light, heat, vibration, magnetism) Materials – Constraints – Characteristics of mechanical properties – Types and properties – Plastics (thermoplastics, thermosetting plastics) – Ceramics – Composites – Modification of properties (degradation, protection)
The Earth and Space		
Biogeochemical cycles – Carbon cycle – Nitrogen cycle Climate zone – Factors that influence the distribution of biomes – Marine biomes – Terrestrial biomes Lithosphere – Minerals – Permafrost – Energy resources – Soil profile (horizons) Hydrosphere – Catchment area – Ocean circulation – Glacier and pack ice – Salinity – Energy resources Atmosphere – Greenhouse effect – Atmospheric circulation – Air mass – Cyclone and anticyclone – Energy resources Space – Solar energy flow – Earth-Moon system (gravitational effect)		

Compulsory Concepts on Which Students May Be Tested in Applied Science and Technology (557-410)

The scope of each concept is defined in the Progression of Learning.
Educational institutions are responsible for testing the concepts shown in *italics*.

The following are also evaluated: Techniques related to diagram drawing and graphic representation (multiview orthogonal projection, isometric representation, perspective drawing), use of scales.

The Living World	The Material World	The Technological World
Dynamics of ecosystems – <i>Disturbances</i> – <i>Trophic relationships</i> – <i>Primary productivity</i> – <i>Material and energy flow</i> – <i>Chemical recycling</i> – <i>Factors that influence the distribution of biomes</i> – <i>Ecosystems</i>	Chemical changes – Combustion – Oxidation Electricity – Electrical charge – Static electricity – Ohm's law – Electrical circuits – Relationship between power and electrical energy Electromagnetism – Forces of attraction and repulsion – Magnetic field of a live wire – Magnetic field of a solenoid – Electromagnetic induction Transformation of energy – Law of conservation of energy – Energy efficiency – <i>Distinction between heat and temperature</i> Fluids – Archimedes' principle – Pascal's principle – Bernoulli's principle Force and motion – Force – Types of forces – Equilibrium of two forces – Relationship between constant speed, distance and time – Mass and weight	Graphical language – Multiview orthogonal projection (general drawing) – Functional dimensioning – Developments (prism, cylinder, pyramid, cone) – Standards and representations (diagrams, symbols) Mechanical engineering – Adhesion and friction of parts – Linking of mechanical parts (degree of freedom of a part) – Guiding controls – Construction and characteristics of motion transmission systems (friction gears, pulleys and belt, gear assembly, sprocket wheels and chain, wheel and worm gear) – Speed changes, <i>resisting torque</i>, <i>engine torque</i> – Construction and characteristics of motion transformation systems (screw gear system, connecting rods, cranks, slides, cams, eccentrics and rotating slider crank mechanisms, rack-and-pinion drive) Electrical engineering – Power supply – Conduction, insulation and protection (resistance and coding, <i>printed circuit</i>) – Control [types: unipolar (single-pole), <i>bipolar (double-pole)</i>, unidirectional (single-throw), bidirectional (double-throw)] – Transformation of energy (electricity and light, heat, vibration, magnetism) – Other functions [capacitor (condenser), diode, <i>transistor</i>, relay, <i>other semi-conductors</i>] Materials – Constraints – Characteristics of mechanical properties – <i>Heat treatments</i> – Types and properties - Plastics (thermoplastics, thermosetting plastics) - Ceramics - <i>Composites</i> – Modification of properties (degradation, protection) Manufacturing – Manufacturing (characteristics of drilling, tapping, threading and bending) – <i>Measurement and inspection</i> – <i>Direct measurement (vernier caliper)</i> – <i>Control, shape and position (plane, section, angle)</i>
The Earth and Space		
Lithosphere – <i>Minerals</i> – Energy resources Hydrosphere – Catchment area – Energy resources Atmosphere – <i>Air mass</i> – Cyclone and anticyclone – Energy resources Space – <i>Solar energy flow</i> – Earth-Moon system (gravitational effect)		

PERIODIC TABLE OF THE ELEMENTS

Key																		VIII A																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Element symbol												Atomic number		Atomic mass																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
1 H hydrogen 1.01												13 Al aluminum 26.98		14 Si silicon 28.09		15 P phosphorus 30.97		16 S sulphur 32.07		17 Cl chlorine 35.45		18 Ar argon 39.95																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
3 Na sodium 22.99												5 B boron 10.81		6 C carbon 12.01		7 N nitrogen 14.01		8 O oxygen 16.00		9 F fluorine 19.00		10 Ne neon 20.18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
11 Mg magnesium 24.31												13 Al aluminum 26.98		14 Si silicon 28.09		15 P phosphorus 30.97		16 S sulphur 32.07		17 Cl chlorine 35.45		18 Ar argon 39.95																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
19 K potassium 39.10												21 Sc scandium 44.96		22 Ti titanium 47.90		23 V vanadium 50.94		24 Cr chromium 52.00		25 Mn manganese 54.94		26 Fe iron 55.85		27 Co cobalt 58.93		28 Ni nickel 58.71		29 Cu copper 63.55		30 Zn zinc 65.39		31 Ga gallium 69.72		32 Ge germanium 72.59		33 As arsenic 74.92		34 Se selenium 78.96		35 Br bromine 79.90		36 Kr krypton 83.80																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
37 Rb rubidium 85.47												39 Y yttrium 88.91		40 Zr zirconium 91.22		41 Nb niobium 92.91		42 Mo molybdenum 95.94		43 Tc technetium 98.91		44 Ru ruthenium 101.07		45 Rh rhodium 102.91		46 Pd palladium 106.40		47 Ag silver 107.87		48 Cd cadmium 112.41		49 In indium 114.82		50 Sn tin 118.71		51 Sb antimony 121.75		52 Te tellurium 127.60		53 I iodine 126.90		54 Xe xenon 131.30																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
55 Cs caesium 132.91												56 Ba barium 137.33		57-71 lanthanoids		72 Hf hafnium 178.49		73 Ta tantalum 180.95		74 W tungsten 183.85		75 Re rhenium 186.21		76 Os osmium 190.20		77 Ir iridium 192.22		78 Pt platinum 195.09		79 Au gold 196.97		80 Hg mercury 200.59		81 Tl thallium 204.37		82 Pb lead 207.20		83 Bi bismuth 208.98		84 Po polonium (209)		85 At astatine (210)		86 Rn radon (222)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
87 Fr francium (223)												88 Ra radium (226)		89-103 actinoids		104 Rf rutherfordium (267)		105 Db dubnium (268)		106 Sg seaborgium (271)		107 Bh bohrium (272)		108 Hs hassium (270)		109 Mt meitnerium (276)		110 Ds darmstadtium (281)		111 Rg roentgenium (280)		112 Cn copernicium (285)		113 Nh nihonium (284)		114 Fl flerovium (289)		115 Mc moscovium (288)		116 Lv livermorium (293)		117 Ts tennessine (292)		118 Og oganesson (294)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

FORMULAS AND QUANTITIES

Science and Technology

FORMULAS

$$C = \frac{m}{V}$$

C : concentration
 m : quantity of solute
 V : quantity of solution

$$P = VI$$

P : electrical power
 V : potential difference
 I : electric current intensity

$$V = RI$$

V : potential difference
 R : resistance
 I : electric current intensity

$$E = P\Delta t$$

E : energy consumed
 P : electrical power
 Δt : time difference

$$\text{Energy efficiency (\%)} = \frac{\text{Amount of useful energy}}{\text{Amount of energy consumed}} \times 100$$

QUANTITIES

NAME	SYMBOL	VALUE
Density of water	ρ	1.0 g/mL or 1.0 kg/L or 1000 kg/m ³
Kilowatt hour	kW•h	1 kW•h = 3 600 000 J

FORMULAS AND QUANTITIES

Applied Science and Technology

FORMULAS	
$V = RI$ V : potential difference R : resistance I : electric current intensity	$F_g = mg$ F_g : gravitational force m : mass g : intensity of the gravitational field
$E = P\Delta t$ E : energy consumed P : electrical power Δt : time difference	$v = \frac{d}{\Delta t}$ v : speed d : distance Δt : time difference
$P = VI$ P : electrical power V : potential difference I : electric current intensity	
Energy efficiency (%) = $\frac{\text{Amount of useful energy}}{\text{Amount of energy consumed}} \times 100$	

QUANTITIES		
NAME	SYMBOL	VALUE
Intensity of the gravitational field on Earth	g	9.8 N/kg
Kilowatt hour	kW•h	1 kW•h = 3 600 000 J

