INFORMATION DOCUMENT

COMPLEMENTARY EXAMINATIONS

APPLIED SCIENCE AND TECHNOLOGY
Second Year of Secondary Cycle Two 557-410
(Secondary IV)

May and June 2009

Québec

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[http://www.mels.gouv.qc.ca/DGFJ/de/docinfosec.htm].

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INTRODUCTION

In this first year of implementation of the Applied Science and Technology program, the Ministère de l'Éducation, du Loisir et du Sport is offering two **complementary examinations** for 2009. Schools are not obliged to administer these examinations, but the Ministère encourages them to do so.

This document contains information about the complementary examinations in Secondary IV Applied Science and Technology. The examinations focus on the three subject-specific competencies and include a two-part **practical examination** and a **written examination.** These components can be administered in any order.

The complementary examinations illustrate how learning is evaluated and prepare schools for the introduction of the uniform examination. Each year, an information document will specify the status of the applied science and technology examinations.

The information document also describes a tool that will be offered to schools and school boards to help them evaluate learning. It consists in an example of a complementary examination to evaluate Competency 2. It is described in **Appendix I.**

1. STRUCTURE OF THE COMPLEMENTARY EXAMINATIONS

Part One of the practical examination requires that students apply the **experimental method.** It takes place in the lab, in May or June 2009. Technical assistance should be offered during this part of the examination.

The documents associated with the *Experimental Method* section of the practical examination are:

- a student booklet presenting the evaluation context and students' mandate
- an answer booklet in which students show all of their work

Part Two of the practical examination requires that students apply the **design process.** It takes place in the workshop, in May or June 2009. Technical assistance should be offered during this part of the examination.

The documents pertaining to the *Design Process* section of the practical examination are:

- a student booklet presenting the evaluation context, students' mandate and the materials and tools needed
- an answer booklet in which students show all of their work

The written examination, which is divided into three parts, can be administered in the classroom. Part A contains short-answer questions, Part B contains questions concerning the analysis of a technical object, and Part C contains long-answer questions.

Part B of the examination calls for a television and DVD player or a projector and computer for the virtual animation included in the part on the analysis of a technical object. If it is impossible to obtain such equipment, a two-dimensional model is available, but technical assistance may be required.

The written examination contains 15 questions. The following table presents the distribution of questions and the total number of marks allotted.

Distribution of Questions and Marks for the June 15, 2009, Written Examination

PART OF THE EXAMINATION	TYPE OF QUESTIONS	TOTAL MARKS
Part A	Short-answer questions	40
Part B	Technological analysis	60
Part C	Long-answer questions	

The examination includes:

- a student booklet presenting the evaluation situations and background information
- an answer booklet in which students show all of their work
- a virtual animation of a technical object or a two-dimensional representation of a technical object (one per student)

2. CONTENT OF THE COMPLEMENTARY EXAMINATIONS

2.1 Practical Examination: The Experimental Method

2.1.1 Competencies and target criteria

This practical examination evaluates the four criteria associated with the competency *Seeks answers or solutions to scientific or technological problems* and the final two criteria of the competency *Communicates in the languages used in science and technology*.

2.1.2 Documents

This examination involves problem solving using the experimental method. Each student must work alone. Students must read the evaluation context and the mandate in the *Student Booklet* and examine the available materials. Then, they must show all their work in the *Answer Booklet*.

2.1.3 Compulsory concepts, strategies and techniques

The examination focuses on only some of the compulsory concepts in the Québec Education Program. It targets the main resources in the program content, i.e. the knowledge grouped together in the compulsory concepts or in methods, strategies and techniques.

Compulsory Concepts

THE MATERIAL WORLD	THE TECHNOLOGICAL WORLD
Electricity and electromagnetism • Ohm's law • Electrical circuits	**Electrical engineering** • Power supply • Conduction, insulation and protection

Strategies and Techniques

EXPLORATION STRATEGIES	ANALYTICAL STRATEGIES	SCIENCE
• Referring to similar problems that have already been solved • Anticipating the results of a method	• Identifying the constraints and important elements related to the problem-solving situation • Using different types of reasoning (e.g. inductive and deductive reasoning, comparison, classification, prioritization) in order to process information	• Safely using laboratory materials and equipment • Using measuring instruments

2.1.4 Preparation of materials

The technical assistant must prepare the materials needed for the examination. It is strongly recommended that he or she be present during the practical examination.

2.2 Practical Examination: The Design Process

2.2.1 Competencies and target criteria

This practical examination evaluates the four criteria associated with the competency *Seeks answers or solutions to scientific or technological problems* and the final two criteria of the competency *Communicates in the languages used in science and technology*.

2.2.2 Documents

This examination involves problem solving using the design process. Each student must work alone. Students must design a functional prototype taking into account the constraints listed in the specifications. To this end, they must read the evaluation context and the mandate in the *Student Booklet* and examine the available tools and materials. Then, they must design their prototype and record all the steps in the process in the *Answer Booklet*.

2.2.3 Compulsory concepts, strategies and techniques

The examination focuses on only some of the compulsory concepts in the Québec Education Program. It targets the main resources in the program content, i.e. the knowledge grouped together in the compulsory concepts or in methods, strategies and techniques.

Compulsory Concepts

THE MATERIAL WORLD	THE TECHNOLOGICAL WORLD
Electricity • Electrical circuits • Electrical charge	**Mechanical engineering** • Guiding controls **Electrical engineering** • Power supply • Typical controls • Conduction, insulation and protection • Other functions (diode)

Strategies and Techniques

STRATEGIES		TECHNIQUES	
EXPLORATION STRATEGIES	ANALYTICAL STRATEGIES	GRAPHICAL LANGUAGE	MANUFACTURING
• Developing various scenarios • Exploring various possible solutions	• Identifying the constraints and important elements related to the problem-solving situation • Dividing a complex problem into simpler subproblems • Reasoning by analogy in order to process information and adapt scientific and technological knowledge	• Drawing schematic diagrams	• Safely using machines and tools • Measuring and laying out • Performing verification and control tasks • Making a part

2.2.4 Preparation of materials

The technical assistant must prepare the materials needed for the examination. It is strongly recommended that he or she be present during the practical examination.

2.3 June 2009 Written Examination

The written examination lasts three hours and can be administered in the classroom. To view the virtual animation of the technical object to be analyzed, special equipment is necessary (e.g. television and DVD player, multimedia projector and computer). If it is impossible to obtain such equipment, a two-dimensional model is available.

2.3.1 Competency and target criteria

This examination evaluates the final three criteria associated with the competency *Makes the most of his or her knowledge of science and technology.*

2.3.2 Documents

Each student must work alone. Students are required to ask themselves questions and analyze problems. They must also perform a detailed analysis of several aspects of a technical object.

First, students must read the evaluation contexts and background information in the *Student Booklet.* Then, they must show all of their work in the *Answer Booklet*.

2.3.3 Compulsory concepts and strategies

The examination focuses on only some of the compulsory concepts in the Québec Education Program. It targets the main resources in the program content, i.e. the knowledge grouped together in the compulsory concepts or in strategies and methods.

Compulsory Concepts

THE TECHNOLOGICAL WORLD	THE MATERIAL WORLD	THE EARTH AND SPACE	THE LIVING WORLD
Mechanical engineering • Adhesion and friction of parts • Linking of mechanical parts (freedom of movement) • Guiding controls • Construction and characteristics of motion transmission systems **Electrical engineering** • Power supply • Conduction, insulation and protection • Typical controls • Transformation of energy (electricity and light, heat) • Other functions (condenser, diode, transistor, solid-state relay) **Materials** • Characteristics of mechanical properties	**Chemical changes** • Combustion **Electricity and electromagnetism** **Electricity** • Ohm's law • Electrical circuits • Relationship between power and electrical energy **Electromagnetism** • Magnetic field of a live wire **Force and motion** • Relationship between constant speed, distance and time	**Hydrosphere** • Catchment area	**Ecology** • Dynamics of ecosystems • Disturbances

Strategies

STRATEGIES	
EXPLORATION STRATEGIES	ANALYTICAL STRATEGIES
• Collecting as much scientific, technological and contextual information as possible to define a problem • Considering various points of view on scientific or technological issues	• Identifying the constraints and important elements related to the problem-solving situation • Dividing a complex problem into simpler subproblems • Using different types of reasoning in order to process information • Reasoning by analogy in order to process information and adapt scientific and technological knowledge • Selecting relevant criteria to help him/her determine where he/she stands on a scientific or technological issue

2.3.4 Preparation of materials

If it is impossible to obtain the equipment needed to view the virtual animation (e.g. television and DVD player, multimedia projector and computer), each classroom should be equipped with two-dimensional representations of the object. Each student should have his or her own model. Production of these models could require technical assistance.

Graphing calculators prohibited

To ensure fairness, graphing calculators and all other calculators that can store information are prohibited during the applied science and technology examination.

3. CONDITIONS FOR ADMINISTERING THE COMPLEMENTARY EXAMINATIONS

3.1 Date of Examination

The following table illustrates a possible schedule and provides information on how to administer the complementary examinations.

EXAMPLE OF A SCHEDULE FOR ADMINISTERING THE COMPLEMENTARY EXAMINATIONS IN APPLIED SCIENCE AND TECHNOLOGY

SPRING 2009

TYPE OF EXAMINATION	TIME OF YEAR	LOCATION
Practical examination Experimental method (C1 and C3)	May or June (classroom time or examination schedule)	Laboratory
Practical examination Design process (C1 and C3)	May or June (classroom time or examination schedule)	Workshop
Written examination (C2)	June 15, 9:00 a.m. to 12:00 p.m.[1]	Classroom

Educational institutions that decide to administer a complementary examination on the date stipulated in the official calendar must use the examination in full. After this date, changes may be made to the examination on the condition that the teachers are notified.[2]

N.B.: The Ministère will not provide complementary examinations for the August 2009 and January 2010 examination periods.[3]

3.2 Duration

The duration of the written examination in the official calendar is three hours. An additional 15 minutes must be allotted as needed.[4] The *Experimental Method* section of the practical examination lasts one and a half hours, and the *Design Process* section, two and a half hours.

4. CORRECTION OF THE COMPLEMENTARY EXAMINATIONS

4.1 Responsibility for Correction

The educational institutions are responsible for correcting the examinations in accordance with instructions provided by the Ministère. In order to ensure a uniform understanding of the evaluation tools, teachers should form a correction committee. Analysis of a few student copies will help the team determine the expected quality level based on the proposed evaluation criteria.

1. See the June 2009 examination schedule on the following Web site: [http://www.mels.gouv.qc.ca/sanction/horaires/Juin2009.pdf].
2. Québec, Ministère de l'Éducation, du Loisir et du Sport, *Administrative Manual for the Certification of Secondary School Studies, General Education. Youth Sector* (Québec: Gouvernement du Québec, 2007), 21: [http://www.mels.gouv.qc.ca/sanction/guide-fgj/fgj-2007_a.pdf].
3. *Administrative Manual.*
4. *Administrative Manual.*

4.2 Characteristics of the Correction Tools

The experimental method and design process parts of the practical examination are corrected using evaluation rubrics provided by the Ministère. These rubrics focus on the criteria evaluated and their observable indicators. The four criteria associated with Competency 1 are evaluated, as are criteria 2 and 3 of Competency 3.

The questions on the written examination are corrected using answer keys provided by the Ministère. The answer keys for Parts B and C focus on the criteria evaluated and their observable indicators. Criteria 2, 3 and 4 of Competency 2 are evaluated.

5. RESULTS

5.1 Practical Examination

The four criteria associated with the competency *Seeks answers or solutions to scientific or technological problems* are equally weighted. The same applies to the two final criteria associated with the competency *Communicates in the languages used in science and technology.* The result for each of the two competencies is expressed as a mark out of 100.

The scientific method and the design process evaluated in the practical examination have the same relative importance. Thus, the result obtained on the practical examination will be made up of the average of the results for each competency on the *Experimental Method* and *Design Process* parts of the examination.

5.2 June 2009 Written Examination

Part A and Parts B and C of the June 2009 written examination are weighted respectively at 40% and 60%. The result obtained on this examination is expressed as a mark out of 100 and is the sum of the results for each of the three parts.

6. CONSIDERATION OF THE RESULTS OBTAINED ON THE COMPLEMENTARY EXAMINATIONS

Schools are responsible for establishing, in their evaluation standards and methods, the way in which they will consider the results obtained on the complementary examinations. The Ministère encourages them to take into account the results obtained on the complementary examinations, if applicable, in establishing the students' subject results.

The result for a competency evaluated in a complementary examination may be combined with the result for this competency established in the competency report, in a proportion determined by the school.

Results obtained on the complementary examinations are not required to be submitted to the Direction de la sanction des études.

7. SUBJECT RESULT AND MINIMUM PERFORMANCE STANDARD

The subject result is based on the result for each competency, weighted in accordance with the conversion tables established by the Minister. Students pass if they obtain a subject result of at least 60%.

Applied Science and Technology:

- Competency 1: 40%
- Competency 2: 40%
- Competency 3: 20%

The subject result must be submitted to the Direction de la sanction des études.

APPENDIX I

DESCRIPTION OF THE EVALUATION TOOL
PROVIDED BY THE MINISTÈRE DURING THE YEAR

Tool: Example of a Complementary Examination	
Aim	To illustrate the form and content of the June 2009 **written examination** in applied science and technology
Content	The example of the complementary examination will focus on the competency *Makes the most of his/her knowledge of science and technology.* It will address the four areas of the Applied Science and Technology program. **Part A** (short-answer questions) In this part: • A compulsory concept is addressed in each of the four areas. • Students must provide short answers in order to demonstrate their understanding of certain elements of the program content. **Part B** (technological analysis) In this part: • Questions involve the analysis of a technical object. Students have three options. They can use: o three-dimensional models of the technical object o two-dimensional representations of the technical object o a virtual animation (available on the MELS Web site) **Part C** (long-answer questions) In this part: • Questions related to an evaluation criterion associated with Competency 2 are corrected using an answer key.
Documents	• Student Booklet • Answer Booklet • Guide for Administering and Correcting the Examination • Materials required (see the Guide) • Manufacturing and Assembly Data Sheets • Three-dimensional models of the technical object or a virtual animation of the technical object or two-dimensional representations of the technical object

APPENDIX II

COMPONENTS OF THE COMPLEMENTARY EXAMINATIONS

Practical Examination: The Experimental Method

- Student Booklet
- Answer Booklet
- Guide for Administering and Correcting the Examinations
- Materials required (see the Guide)

Practical Examination: The Design Process

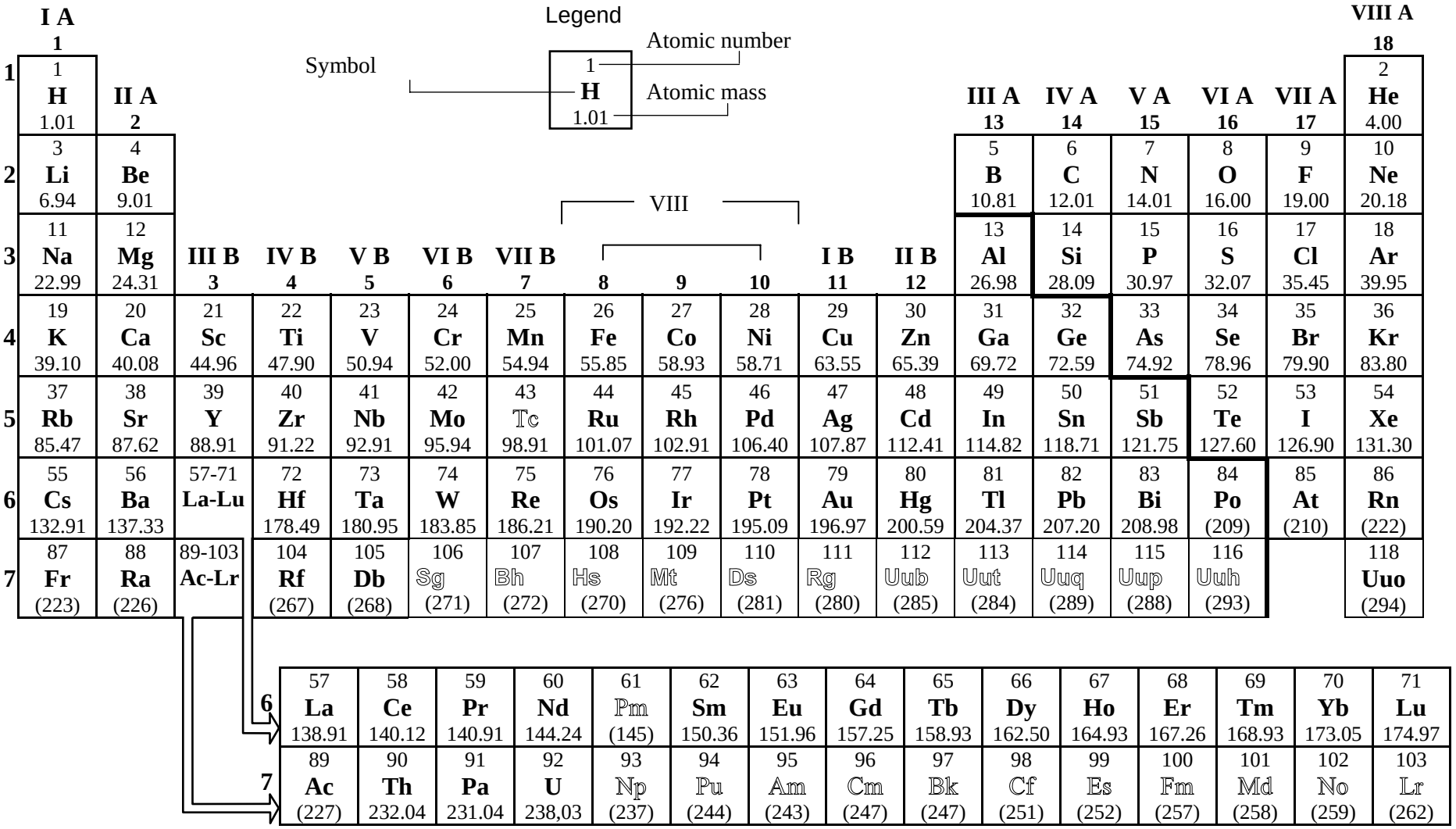
- Student Booklet
- Answer Booklet
- Guide for Administering and Correcting the Examinations
- Materials required (see the Guide)

Written Examination

- Student Booklet
- Answer Booklet
- Guide for Administering and Correcting the Examinations
- Materials required (see the Guide)
- Virtual animation of the technical object OR two-dimensional representation of the technical object

APPENDIX III

PERIODIC TABLE OF ELEMENTS



	I A 1	II A 2	III B 3	IV B 4	V B 5	VI B 6	VII B 7	VIII 8	VIII 9	VIII 10	I B 11	II B 12	III A 13	IV A 14	V A 15	VI A 16	VII A 17	VIII A 18
1	1 **H** 1.01																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 Tc 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.40	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
6	55 **Cs** 132.91	56 **Ba** 137.33	57-71 **La-Lu**	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.20	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.20	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** (226)	89-103 **Ac-Lr**	104 **Rf** (267)	105 **Db** (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (293)		118 **Uuo** (294)

6	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 Pm (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
7	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238,03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

APPENDIX IV

LIST OF FORMULAS

FORMULAS

$C = \frac{m}{V}$	C: concentration m: mass V: volume	$F_g = mg$	F_g: gravitational force m: mass g: intensity of the gravitational field
$U = \frac{E}{q}$	U: potential difference E: energy transferred q: charge	$P = \frac{F}{A}$	P: pressure F: force perpendicular to the surface A: area of the surface over which the force is distributed
$E = P_{é} \Delta t$	E: energy consumed P_e: electrical power Δt : time difference	$P_{é} = \frac{W}{\Delta t}$	P_e: electrical power W: work Δt : time difference
$I = \frac{q}{\Delta t}$	I: intensity of the current q: charge Δt : time difference	$P_{é} = UI$	P_e: electrical power U: potential difference I: intensity of the electrical current
$U = RI$	U: potential difference R: resistance I: intensity of the electrical current	$v = \frac{d}{\Delta t}$	v: average speed d: distance Δt : time difference

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

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