PHYSICS

Secondary V

Forces and Energy

PHS-5043-2

DEFINITION OF THE DOMAIN FOR SUMMATIVE EVALUATION

JULY 2000

Québec

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Direction de la formation générale des adultes
Service de l'évaluation des apprentissages

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1. Introduction

This definition of the domain for summative evaluation describes and classifies the essential and representative elements of the Physics Program – specifically, for the course entitled *Forces and Energy*. It presents an overview of the program, but should by no means replace the program itself. The purpose of defining the domain is to ensure that all summative evaluation instruments are consistent with the overall program.

The organization of this definition of the domain is the same as that of those of other courses. The content of each section is, however, specific to the *Forces and Energy* course.

The definition of the domain for summative evaluation is used to prepare examinations that are valid from one version to another, from year to year, and from one school board to another, taking into account the responsibilities shared by the Ministère de l'Éducation and the school boards.

2. Program Orientations and Consequences for Summative Evaluation

Orientations	Consequences
The purpose of this program is to provide students with rigorous training in the use of the scientific method. Students become familiar with the basic concepts of physics and either acquire or improve the skills related to the experimental method.	The evaluation should test the students' knowledge and understanding of the basic concepts of physics and of the experimental method.
Students acquire an understanding of various phenomena that goes beyond the mere ability to apply formulas in solving mathematical problems.	The evaluation should involve problem situations that test the students' understanding of various phenomena. The evaluation should not focus solely on calculations and their results.
The program presents scientific knowledge from a historical, technological and social perspective.	The evaluation should also reflect the relationship between the related content and the history–technology–society (HTS) perspective.
In this program, considerable time is devoted to the experimental approach and students are required to perform experiments.	A major part of the evaluation process should focus on the experimental method. In addition to the items pertaining to objectives that relate to the experimental method, items that test the students' understanding of the related content may refer to laboratory work.
To help students acquire or improve the skills related to the experimental method, the course entitled *Forces and Energy* focuses on having students integrate the different aspects of the experimental method.	In the course entitled *Forces and Energy*, evaluation items relating to the experimental method should involve having the students write up an experimental procedure and a laboratory report.

3. Course Content for Purposes of Summative Evaluation

Themes

- **Related Content**
  - Gravitational acceleration:
    - gravitational attraction
      - effects
      - graphic representation
      - related natural phenomena
    - explanation of gravitational variations
    - distinction between mass and weight

  - Concept of force, Newton's Laws and momentum:
    - definition and units of measurement of force
    - statement and interpretation of Newton's Laws
    - force and momentum

  - Friction or air resistance:
    - drawing force vectors
    - determining factors
    - analysis of specific cases

  - Archimedian buoyant force:
    - determining factors
    - analysis of specific cases

  - Restoring force of a spring:
    - definition and units of measurement
    - analysis of specific cases

  - Kinetic energy and gravitational or elastic potential energy:
    - definition and units of measurement
    - analysis of specific cases

  - Pressure:
    - definition and units of measurement
    - analysis of specific cases

  - Different types of levers:
    - law of levers
    - operation of levers

- Problem solving relating to:
  - gravitational force
  - Newton's Second Law
    - graphic and algebraic representation
    - analysis of specific cases
    - net force and equilibrant force
  - work and conservation of energy
  - friction or air resistance
  - Archimedes' Principle
  - extension of a spring or pressure
  - mechanical advantage and efficiency of a machine

- **History-Technology-Society Perspective (HTS)**
  - Relationships between the history of dynamics and developments in physics and technology:
    - gravitational force
    - knowledge about aerodynamics
    - technical evolution of machines
  - Use of dynamics in technical applications:
    - microgravity research
    - friction or air resistance
    - Archimedes' Principle
    - springs
    - hydraulic lift cylinder
    - mechanical transmission
  - Social changes and environmental consequences:
    - development of aerodynamics
    - development and application of dynamics

- **Experimental Method**
  - Experimental procedure:
    - choice of necessary equipment
    - stages of work
  - Laboratory report:
    - clear and organized presentation of all the parts of the laboratory report
    - description of the experiment conducted
    - presentation of the results
    - rigorous analysis of the results
    - discussion of the results
    - conclusion to be drawn from the results, given the problem to be solved

Skills

- **Understanding:** Applying acquired knowledge to deduce information.
- **Analyzing:** Examining the components of a phenomenon in order to determine relationships.

4. Table of Dimensions

Themes Skills	Related Content 55%	HTS Perspective 15%	Experimental Method 30%
Understanding **30%**	Gravitational acceleration (3%) Concept of force, Newton's Laws and momentum (3%) Archimedian buoyant force (3%) Kinetic energy and potential energy (3%) Pressure (3%) **(1) 15%**	Relationships between history and developments in physics (5%) - gravitational force - knowledge about aerodynamics - technical evolution of machines Use of dynamics in technical applications (5%) - absence of gravity - friction or air resistance - Archimedes' Principle - springs - hydraulic lift cylinder - mechanical transmission Social changes and environmental consequences (5%) - development of aerodynamics - development and application of dynamics **(3) 15%**	
Analyzing **70%**	Friction or air resistance (4%) Restoring force of a spring (4%) Different types of levers (4%) Problem solving - gravitational force (4%) - Newton's Second Law (4%) - work and conservation of energy (4%) - friction or air resistance (4%) - Archimedes' Principle (4%) - extension of a spring and pressure (4%) - mechanical advantage and efficiency of a machine (4%) **(2) 40%**		Writing up an experimental procedure (10%) - necessary equipment - instructions Laboratory report (20%) - clear and organized presentation - description of the experiment - presentation of the results - analysis of the results - discussion of the results - conclusion **(4) 30%**

5. Observable Behaviours

Dimension 1

- Given a series of statements that describe the effects of gravitational attraction or related natural phenomena or that explain, in specific cases, the difference between mass and weight, choose those which are true. Justify one's choice or correct false statements to make them valid. (3%)

- Given a series of statements, choose those in which the definition of force, its units of measurement, its relation to momentum or the effects of applying force to an object are properly associated with specific cases in which forces are involved. Justify one's choice or correct false statements to make them valid. (3%)

- Given an experimental situation aimed at determining the factors influencing Archimedian buoyant force, interpret the results, suggest changes to be made to the system to change the Archimedian buoyant force or predict how certain changes made to the system will affect the Archimedian buoyant force. Justify one's answers. (3%)

- Describe a specific case involving gravitational force or force applied to a spring in terms of work, kinetic or potential energy and conservation of energy. (3%)

- Given a specific case where pressure is exerted by a solid, predict the effect of a change in the area or the force or suggest at least one change which makes it possible to vary the pressure involved. Justify one's answer using the definition of pressure. (3%)

Dimension 2

- In one or more specific cases involving friction or air resistance, illustrate the points at which forces are applied, suggest at least two ways to vary these forces and specify the effects of these changes on the type of motion involved. (4%)

- Among several springs, the characteristics of which are known, choose one or more which are most appropriate for a given use. Justify one's choice. (4%)

- On a diagram of a lever, indicate the location of the fulcrum, the points at which the effort force and resistance force are applied, the lever arm and the resistance distance, and then, for this specific case, explain the application of the law of levers. (4%)

- Solve problems related to gravitational force and its manifestations. (4%)

- Solve problems related to the application of Newton's Second Law in specific cases where several forces are involved. (4%)

- Solve problems related to work and conservation of energy. (4%)

- Solve problems related to the effects of friction or air resistance on a system's energy. (4%)

- Solve problems related to the application of Archimedes' Principle. (4%)

- Solve problems related to the extension of springs or pressure. (4%)

- Choose the simple machine most suited to do a given type of work. Justify one's choice. The student must choose from among simple machines; the characteristics of which are provided. (4%)

Dimension 3

- Explain the relationships between the history of dynamics and developments in physics and technology. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

- Explain the use of dynamics in technical applications. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

- Briefly describe the situation that prevailed before a given event contributed to the development or use of dynamics and specify the new possibilities resulting from this development. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

Dimension 4

- Write up an experimental procedure that could be used to solve a problem related to the study of forces. The suggested procedure must include a list of necessary equipment and a set of clearly written instructions. The necessary equipment will be chosen from a list of materials generally used in physics and provided with the exam. (10%)

- Perform a laboratory experiment according to a given experimental procedure and write a laboratory report. The experiment can be on any subject studied in any of the three modules in the program. All the parts of the laboratory report must be presented in a clear and organized manner; the report must include an accurate description of the experiment performed and of the results (presentation, analysis and discussion), as well as a clear conclusion related to the problem stated. (20%)

6. Explanation of the Content and Weighting

In accordance with the objectives of the *Secondary V Physics Program*, students should acquire a theoretical knowledge of physics, while examining the historical, technological and social aspects of this discipline. Students should also acquire or improve the skills related to the experimental method. The summative evaluation will reflect this principle.

Two factors were considered in determining the relative importance of the dimensions pertaining to the experimental method: the progress made in acquiring or improving the skills related to the experimental method and the relative importance of the experimental method in the evaluation scheme used in the youth sector. As in the youth sector, the experimental method accounts for 25% of the overall mark for the three courses in the program. However, the relative importance of this theme varies from one course to another. It accounts for 30% of the mark obtained in the *Forces and Energy* course.

The dimensions related to the history-technology-society perspective account for 15% of the mark obtained in each of the three courses.

Given the relative importance of the previously mentioned dimensions, evaluation pertaining to the related content accounts for 55% of the mark obtained in this course.

The relative importance of any skill to be developed in the course is determined by adding up the weightings given to the observable behaviours pertaining to that skill. In the *Forces and Energy* course, the relative importance of each skill is as follows:

UNDERSTANDING	30%
ANALYZING	70%

7. Description of the Examination

A. Type of Examination

The examination for purposes of summative evaluation will be administered at the end of the course. It consists of two parts:

- One part is a written examination covering dimensions 1 to 3, inclusive, and is worth 70% of the course mark. It consists of restricted-response, short-answer or extended-response items.

- The part covering dimension 4 has both a written and laboratory component and is worth 30% of the course mark.

All the observable behaviours for each dimension must be taken into account.

B. Characteristics of the Examination

The part covering dimensions 1 to 3 is written in a single session lasting no more than 120 minutes. Students are permitted to use a calculator and must be provided with formulas and appropriate information required by dimensions 2 and 3. An example of a list of formulas is given in Appendix 1.

The part covering dimension 4 is administered in the laboratory in a single session lasting no more than 120 minutes. The appropriate information must be incorporated into each related item or group of items.

C. Pass Mark

The pass mark for the entire examination is 60%.

Formulas

$$\vec{F} = m\vec{a}$$

$$\vec{F}_g = m\vec{g}$$

$$\vec{F}_b = \rho V\vec{g}$$

$$\vec{F} = k\vec{x}$$

$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$

$$W = F_{//}\Delta d$$

$$E_g = mgh$$

$$E_p = \frac{kl^2}{2}$$

$$E_k = \frac{mv^2}{2}$$

$$E_t = E_p + E_k$$

$$F_E l_E = F_R l_R$$

$$p = \frac{F}{A}$$

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

$$F_g = G\frac{m_1 m_2}{d^2}$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + ...\vec{F}_n$$

a	acceleration
A	area
d	distance between masses
E_g	gravitational potential energy
E_k	kinetic energy
E_p	potential energy
E_t	total energy
F	force
$F_{//}$	force parallel to displacement
F_b	buoyant force
F_g	gravitational force
F_E	effort force
F_R	resistance force
g	acceleration due to gravity
G	gravitational constant
h	height
k	force constant of a spring
l_E	effort arm
l_R	resistance arm
m	mass
p	pressure
v	velocity
V	volume
W	work
x	displacement
Δd	distance travelled
Δt	time interval
Δp	change in pressure
ρ	density
$\vec{}$	vector quantity

Constants

g	Acceleration due to gravity (earth)	9.8 m/s^2
c	Speed of light in a vacuum	3.00 x 10^8 m/s

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