PHYSICS

Secondary V

Optics

PHS-5041-2

DEFINITION OF THE DOMAIN
FOR SUMMATIVE EVALUATION

JULY 2000

Québec

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Direction de la formation générale des adultes
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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 *Optics*. 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 *Optics* 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 *Optics* focuses on familiarizing students with the different aspects of the experimental method.	In the course entitled *Optics*, evaluation items relating to the experimental method should involve having the students identify parameters and variables, produce tables of results and handle laboratory equipment.

3. Course Content for Purposes of Summative Evaluation

Themes

- **Related Content**
  - Phenomena of umbra and penumbra:
    - illustration
    - light intensity
    - interpretation
  - Phenomenon of reflection:
    - diagram
    - diffuse reflection and specular reflection
    - laws
  - Phenomenon of refraction:
    - diagram
    - interpretation
    - laws
  - Total internal reflection:
    - critical angle in relation to two media
    - description
  - Optical power:
    - lenses
    - systems of lenses
  - Path of light rays in the eye:
    - diagram
    - normal vision
    - eye defects
    - appropriate correction techniques
  - Light, curved mirrors and lenses:
    - production of light
    - particle and wave models of light
    - perception of colour of light and objects
    - characteristics and use of curved mirrors
    - characteristics of lenses
  - Path of light rays in a prism and dispersion of white light
  - Electromagnetic spectrum

- Paths of the principal rays:
  - curved mirrors
  - lenses

- Problem solving relating to:
  - reflection by plane mirrors
  - curved mirrors
  - index of refraction
  - lenses

- **History-Technology-Society Perspective (HTS)**

  - Relationships between the history of optics and the evolution of science and technology:
    - interpretation of vision
    - historical development of optical instruments
    - evolution of knowledge related to the nature of light

  - Technical applications of optics:
    - plane mirrors
    - Newtonian telescope
    - curved mirrors
    - total internal reflection
    - lenses
    - invisible waves

  - Social changes:
    - artificial light
    - curved mirrors
    - fibre optics
    - optical instruments

- **Experimental Method**

  - Processing experimental data:
    - identifying measured and constant parameters and independent and dependent variables
    - making tables of results

  - Handling laboratory equipment

Skills

- **Knowing:** Describing or recognizing manifestations or components of a scientific or technical phenomenon.

- **Understanding:** Applying acquired knowledge to deduce information.

- **Analyzing:** Examining the components of a phenomenon in order to determine relationships.

4. Table of Dimensions

<table>
<tr><th>Themes

Skills</th><th>Related Content

70%</th><th>HTS Perspective

15%</th><th>Experimental Method

15%</th></tr>
<tr><td>Knowing

7%</td><td>Light, curved mirrors and lenses (7%)
- Production of light
- Particle and wave models
- Perception of colour
- Characteristics and use of curved mirrors
- Characteristics of lenses

(1) 7%</td><td></td><td></td></tr>
<tr><td>Understanding

43%</td><td>Phenomenon of reflection (4%)

Phenomenon of refraction (4%)

Path of light rays in the eye (4%)

Path of light rays in a prism and dispersion of white light (4%)

Electromagnetic spectrum (4%)

Paths of the principal rays
- Curved mirrors (4%)
- Lenses (4%)

(2) 28%</td><td>Relationships between the history of optics and the evolution of science and technology (5%)
- vision
- optical instruments
- nature of light

Technical applications of optics (5%)
- plane mirrors
- Newtonian telescope
- curved mirrors
- total internal reflection
- lenses
- invisible waves

Social changes (5%)
- artificial light
- curved mirrors
- fibre optics
- optical instruments

(4) 15%</td><td></td></tr>
<tr><td>Analyzing

50%</td><td>Phenomena of umbra and penumbra (5%)

Total internal reflection (5%)

Optical power (5%)

Problem solving:
- plane mirrors (5%)
- curved mirrors (5%)
- index of refraction (5%)
- lenses (5%)
(3) 35%</td><td></td><td>Processing experimental data (7%)
- identifying parameters and variables
- making tables and drawing graphs

Handling laboratory equipment (8%)

(5) 15%</td></tr>
</table>

5. Observable behaviours

Dimension 1

- Given a series of statements, choose those which correctly describe or explain the production of light, the particle and wave models of light, the perception of the colour of light and objects, the characteristics and uses of curved mirrors and the characteristics of lenses. Justify one's choice or correct false statements to make them valid. (7%)

Dimension 2

- Given a series of diagrams or statements concerning the laws of reflection, choose those which correctly illustrate or describe the laws of reflection. Justify one's choice or correct false statements to make them valid. (4%)

- Given a series of diagrams or statements, choose those which correctly illustrate or explain the phenomenon of refraction. Justify one's choice or correct false statements to make them valid. (4%)

- Given a statement or diagram concerning an eye defect, suggest an appropriate correction technique. Justify one's suggestion, using a ray diagram if necessary. (4%)

- For a given prism, calculate the angle of deviation of a light ray of a given colour or determine the location of this ray in relation to one or more rays of different colours. A diagram illustrating the situation is provided. (4 %)

- Given a series of statements, choose those which correctly classify groups of waves in an electromagnetic spectrum according to their energy, frequency or wavelength. Justify one's choice or correct false statements to make them valid. A diagram of an electromagnetic spectrum giving no numerical values may be provided. (4%)

- Using the paths of the principal rays, determine the characteristics or location of the image, the object or the mirror in an example involving the use of a concave or convex mirror. (4%)

- Using the paths of the principal rays, determine the characteristics or location of the image, the object or the lens in an example involving the use of a concave or convex lens. (4%)

Dimension 3

- Interpret a diagram illustrating a situation involving umbra and penumbra and predict the effects of one or more of the following changes: movement of the source, screen or object; change in the characteristics of the source or in the size of the object. Justify one's interpretation or prediction using a ray diagram or the particle model of matter if necessary. (5%)

- For a specific case of refraction, state whether there is total internal reflection. Justify one's answer. (5%)

- Choosing from among a group of lenses with known optical powers or focal lengths, suggest a combination of at least three lenses which makes it possible to produce a lens system of a given optical power or focal length. (5%)

- Solve problems related to reflection of light by plane mirrors (mystery boxes, field of vision, etc.), using ray diagrams as needed. (5%)

- Determine algebraically the characteristics or location of the image, the object or the mirror in an example involving the use of a concave or convex mirror. (5%)

- Interpret the results of a laboratory experiment aimed at determining the index of refraction of different substances. (5%)

- Determine algebraically the characteristics or location of the image, the object or the lens in an example involving the use of a concave or convex lens. (5%)

Dimension 4

- Explain the relationships between the history of optics and the evolution of science and technology. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

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

- Briefly describe the situation that prevailed before the advent of a given technical application and the new possibilities resulting from its implementation. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

Dimension 5

- Given information on one or more experiments, specify the constant parameters, the dependent variable and the independent variable and make tables of results. (7%)

- In the laboratory, demonstrate the ability to use equipment appropriately. Given tasks are not necessarily part of a complete experimental procedure. (8%)

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. Summative evaluation instruments 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 15% of the mark obtained in the *Optics* 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 70% 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 *Optics* course, the relative importance of each skill is as follows:

KNOWING	7%
UNDERSTANDING	43%
ANALYZING	50%

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 4, inclusive, and is worth 85% of the course mark. It consists of restricted-response, short-answer or extended-response items.

- The part covering dimension 5 has both a written and laboratory component and is worth 15% 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 4 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 4. An example of a list of formulas is given in Appendix 1.

The part covering dimension 5 is administered in the laboratory in a single session lasting no more than 90 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

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$\frac{h_i}{h_o} = \frac{d_i}{f} = \frac{f}{d_o}$$

$$f^2 = d_i d_o$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$P = \frac{1}{f}$$

$$P_t = P_1 + P_2 + \ldots + P_n$$

$$M = \frac{h_i}{h_o}$$

$$\text{sine} = \frac{\text{opposite side}}{\text{hypotenuse}}$$

$$\text{cosine} = \frac{\text{adjacent side}}{\text{hypotenuse}}$$

n_1 and n_2	indices of refraction
θ_1 and θ_2	angle of incidence and angle of refraction
h_i	height of image
h_o	height of object
d_i	image distance
d_o	object distance
f	focal length
P	optical power of a lens or a system of lenses
M	magnification

Constant

c	Speed of light in a vacuum	3.00×10^8 m/s

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