E. PHYSICS: LIGHT AND GEOMETRIC OPTICS

OVERALL EXPECTATIONS

By the end of this course, students will:

E1. evaluate the effectiveness of technological devices and procedures designed to make use of light, and assess their social benefits;

E2. investigate, through inquiry, the properties of light, and predict its behaviour, particularly with respect to reflection in plane and curved mirrors and refraction in converging lenses;

E3. demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

SPECIFIC EXPECTATIONS

E1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

E1.1 analyse a technological device or procedure related to human perception of light (e.g., eyeglasses, contact lenses, infrared or low light vision sensors, laser surgery), and evaluate its effectiveness [AI, C]

Sample issue: Laser surgery corrects vision by surgically reshaping the cornea to correct refractive defects in the eye. While the procedure is effective in most cases, it poses risks and can in some cases lead to poor night vision.

Sample questions: How do anti-glare night vision glasses help people who have difficulty driving at night? How do eyeglasses with colour filters help people with dyslexia to read?

E1.2 analyse a technological device that uses the properties of light (e.g., microscope, retroreflector, solar oven, camera), and explain how it has enhanced society [AI, C]

Sample issue: Cameras can produce a range of optical effects, from highly detailed and realistic to manipulated and abstract. Photographic images are used for a wide range of purposes that benefit society, including in the areas of culture, education, security, policing, entertainment, and the environment. However, the widespread use of cameras raises privacy concerns.

Sample questions: How do vision sensors help the Canadian Food Inspection Agency improve food safety? How are photonics used in the early diagnosis of diseases such as cancer? How have optical fibres enhanced our ability to communicate information? How do all of these technologies benefit society? How are outdoor lights such as street or stadium lights designed to limit light pollution in surrounding areas?

E2. Developing Skills of Investigation and Communication

By the end of this course, students will:

E2.1 use appropriate terminology related to light and optics, including, but not limited to: *angle of incidence, angle of reflection, angle of refraction, focal point, luminescence, magnification, mirage,* and *virtual image* [C]

E2.2 use an inquiry process to investigate the laws of reflection, using plane and curved mirrors, and draw ray diagrams to summarize their findings [PR, C]

E2.3 predict the qualitative characteristics of images formed by plane and curved mirrors (e.g., location, relative distance, orientation, and size in plane mirrors; location, orientation, size, type in curved mirrors), test their predictions through inquiry, and summarize their findings [PR, AI, C]

E2.4 use an inquiry process to investigate the refraction of light as it passes through media of different refractive indices, compile data on their findings, and analyse the data to determine if there is a trend (e.g., the amount by which the angle of refraction changes as the angle of incidence increases varies for media of different refractive indices) [PR, AI, C]

E2.5 predict, using ray diagrams and algebraic equations, the position and characteristics of an image produced by a converging lens, and test their predictions through inquiry [PR, AI, C]

E2.6 calculate, using the indices of refraction, the velocity of light as it passes through a variety of media, and explain the angles of refraction with reference to the variations in velocity [PR, C]

E3. Understanding Basic Concepts

By the end of this course, students will:

E3.1 describe and explain various types of light emissions (e.g., chemiluminescence, bioluminescence, incandescence, fluorescence, phosphorescence, triboluminescence; from an electric discharge or light-emitting diode [LED])

E3.2 identify and label the visible and invisible regions of the electromagnetic spectrum

E3.3 describe, on the basis of observation, the characteristics and positions of images formed by plane and curved mirrors (e.g., location, orientation, size, type), with the aid of ray diagrams and algebraic equations, where appropriate

E3.4 explain the conditions required for partial reflection/refraction and for total internal reflection in lenses, and describe the reflection/refraction using labelled ray diagrams

E3.5 describe the characteristics and positions of images formed by converging lenses (e.g., orientation, size, type), with the aid of ray diagrams

E3.6 identify ways in which the properties of mirrors and lenses (both converging and diverging) determine their use in optical instruments (e.g., cameras, telescopes, binoculars, microscopes)

E3.7 identify the factors, in qualitative and quantitative terms, that affect the refraction of light as it passes from one medium to another

E3.8 describe properties of light, and use them to explain naturally occurring optical phenomena (e.g., apparent depth, shimmering, a mirage, a rainbow)