Introduction: Light & Optics

Unit: Light & Optics

Topics covered in this chapter:

This chapter discusses the behavior and our perception of light.

- *Electromagnetic Waves* discusses properties and equations that are specific to electromagnetic waves (including light).
- *Color* discusses properties of visible light and how we perceive it.
- *Reflection* and *Mirrors* discuss properties of flat and curved mirrors and steps for drawing ray tracing diagrams.
- *Refraction* and *Lenses* discuss properties of convex and concave lenses and steps for drawing ray tracing diagrams.
- *Polarization, Diffraction,* and *Scattering* discuss specific optical properties of light.

One of the new skills learned in this chapter is visualizing and drawing representations of how light is affected as it is reflected off a mirror or refracted by a lens. This can be challenging because the behavior of the light rays and the size and location of the image changes depending on the location of the object relative to the focal point of the mirror or lens. Another challenge is in drawing precise, to-scale ray tracing drawings such that you can use the drawings to accurately determine properties of the image, or of the mirror or lens.

Use this space for summary and/or additional notes:

Standards addressed in this chapter:

Massachusetts Curriculum Frameworks (2016):

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

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AP® Physics 2 Learning Objectives:

6.A.1.2: The student is able to describe representations of transverse and longitudinal waves. [**SP 1.2**]

6.A.1.3: The student is able to analyze data (or a visual representation) to identify patterns that indicate that a particular mechanical wave is polarized and construct an explanation of the fact that the wave must have a vibration perpendicular to the direction of energy propagation. [**SP 5.1**, **6.2**]

6.A.2.2: The student is able to contrast mechanical and electromagnetic waves in terms of the need for a medium in wave propagation. [**SP 6.4**, **7.2**]

6.B.3.1: The student is able to construct an equation relating the wavelength and amplitude of a wave from a graphical representation of the electric or magnetic field value as a function of position at a given time instant and vice versa, or construct an equation relating the frequency or period and amplitude of a wave from a graphical representation of the electric or magnetic field value at a given position as a function of time and vice versa. [**SP 1.5**]

6.C.1.1: The student is able to make claims and predictions about the net disturbance that occurs when two waves overlap. Examples should include standing waves. [**SP 6.4**, **7.2**]

6.C.1.2: The student is able to construct representations to graphically analyze situations in which two waves overlap over time using the principle of superposition. [**SP 1.4**]

6.C.2.1: The student is able to make claims about the diffraction pattern produced when a wave passes through a small opening, and to qualitatively apply the wave model to quantities that describe the generation of a diffraction pattern when a wave passes through an opening whose dimensions are comparable to the wavelength of the wave. [**SP 1.4**, **6.4**, **7.2**]

6.C.3.1: The student is able to qualitatively apply the wave model to quantities that describe the generation of interference patterns to make predictions about interference patterns that form when waves pass through a set of openings whose spacing and widths are small compared to the wavelength of the waves. [**SP 1.4**, **6.4**]

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6.C.4.1: The student is able to predict and explain, using representations and models, the ability or inability of waves to transfer energy around corners and behind obstacles in terms of the diffraction property of waves in situations involving various kinds of wave phenomena, including sound and light. [**SP 6.4**, **7.2**]

6.E.1.1: The student is able to make claims using connections across concepts about the behavior of light as the wave travels from one medium into another, as some is transmitted, some is reflected, and some is absorbed. [**SP 6.4**, **7.2**]

6.E.2.1: The student is able to make predictions about the locations of object and image relative to the location of a reflecting surface. The prediction should be based on the model of specular reflection with all angles measured relative to the normal to the surface. [**SP 6.4**, **7.2**]

6.E.3.1: The student is able to describe models of light traveling across a boundary from one transparent material to another when the speed of propagation changes, causing a change in the path of the light ray at the boundary of the two media. [**SP 1.1**, **1.4**]

6.E.3.2: The student is able to plan data collection strategies as well as perform data analysis and evaluation of the evidence for finding the relationship between the angle of incidence and the angle of refraction for light crossing boundaries from one transparent material to another (Snell's law). [**SP 4.1**, **5.1**, **5.2**, **5.3**]

6.E.3.3: The student is able to make claims and predictions about path changes for light traveling across a boundary from one transparent material to another at non-normal angles resulting from changes in the speed of propagation. [**SP 6.4**, **7.2**]

6.E.4.1: The student is able to plan data collection strategies, and perform data analysis and evaluation of evidence about the formation of images due to reflection of light from curved spherical mirrors. [**SP 3.2**, **4.1**, **5.1**, **5.2**, **5.3**]

6.E.4.2: The student is able to use quantitative and qualitative representations and models to analyze situations and solve problems about image formation occurring due to the reflection of light from surfaces. [**SP 1.4**, **2.2**]

6.E.5.1: The student is able to use quantitative and qualitative representations and models to analyze situations and solve problems about image formation occurring due to the refraction of light through thin lenses. [**SP 1.4**, **2.2**]

6.E.5.2: The student is able to plan data collection strategies, perform data analysis and evaluation of evidence, and refine scientific questions about the formation of images due to refraction for thin lenses. [**SP 3.2**, **4.1**, **5.1**, **5.2**, **5.3**]

6.F.1.1: The student is able to make qualitative comparisons of the wavelengths of types of electromagnetic radiation. [**SP 6.4**, **7.2**]

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6.F.2.1: The student is able to describe representations and models of electromagnetic waves that explain the transmission of energy when no medium is present. [**SP 1.1**]

Topics from this chapter assessed on the SAT Physics Subject Test:

- **Reflection and Refraction**, such as Snell's law and changes in wavelength and speed.
- **Ray Optics**, such as image formation using pinholes, mirrors, and lenses.
- **Physical Optics**, such as single-slit diffraction, double-slit interference, polarization, and color.

1. The Electromagnetic Spectrum
2. Classical Optics
3. Optical Instruments
4. Wave Optics

Skills learned & applied in this chapter:

- Drawing images from mirrors and through lenses.

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