

## Topic 16: Geometric Optics

Source: *Conceptual Physics* textbook, laboratory manual, concept development book and CPO physics text and laboratory manual

Types of Materials: Textbooks, laboratory manuals, demonstration, worksheet, activity, websites and good stories

Building on: After studying energy, momentum, electromagnetic waves, vibration and waves, a groundwork has been set to compare mechanical waves to light waves. One example would be Max Plank's packages of light energy ( $E = hf$ ) and Einstein's photoelectric effect that both relate frequency of light to the energy of the electromagnetic waves. Mechanical wave energy is caused by wave amplitude (like sound and water waves) and not the frequency. However, both mechanical waves and light waves have energy and momentum and both refract and interfere, thus showing that some characteristics are the same.

Leading to: With a mechanics background, optical phenomena are more easily understood like reflection, refraction, diffraction and interference. An optical background is helpful in understanding energy absorption and emission in the atom as well as nuclear occurrences like radiation.

Links to Physics: The study of optics explains atomic spectra, reflection, refraction, diffraction and interference, optical microscopes, telescopes, and other optical apparatus. Practical applications include rear view mirrors in cars, glasses, holograms, Polaroid sunglasses, television, etc.

Links to Chemistry: Telescopes can be used to observe atmospheric emission to determine the makeup of the atmosphere.

Links to Biology: Microscopes can be used to study cells. Ophthalmologists use optical apparatus to determine the health of the eye and fit patients for glasses.

Materials:

- (a) Hewitt Labs
  1. Images
  2. Peppers Ghost
  3. The Kaleidoscope
  4. Funland
  5. Camera Obscura
  6. Thin Lens
  7. Lensless Lens
  8. Bifocals
  9. Where's the Point?

10. Air Lens
11. Rainbows without Rain

(b) Hsu Labs

1. Reflection and Refraction
2. Optics
3. Optics and Images
4. Frequency and Wavelength of Light
5. Lasers and Photons

(c) My Lab

Water Waves and Light\*  
(Compare behaviors.)

(d) Worksheet\*

(e) Demonstration

Height of Person in Vertical Mirror\*

(f) Websites

1. "Mystery of the Senses Vision" Video Guide
2. Understand Color Mixing Lab Sim
3. ESPN SportsFigures "Reflecting on Billiards" Video Guide
4. The Law of Reflection and Curved Mirrors Lab Sim
5. Index of Refraction and Snell's Law Lab Sim
6. Converging Lens Lab Sim (Flash)

(g) Good Stories

Thomas Young – The Last Person Who Knew Almost Everything  
Edwin Hubble (1889-1953)

## Thomas Young – The Last Person Who Knew Almost Everything

Thomas Young was born in England on June 16, 1773 of Quaker parentage. He was the youngest of ten children. A child prodigy, he read through the Bible twice by the age of four and was reading and writing by the age of six. By the time he was fourteen, he had knowledge of at least five languages, which eventually extended to more than fourteen.

Young is famous for his work on light and vision. He showed that changes in curvature of the eye's lens focus light, found the cause of astigmatism (which Young himself suffered) and proposed the trichromatic theory of color vision.

Thomas Young was trained as a physician, but because of his blunt truthfulness and his distrust of the practices of purging and bleeding, he was not popular with his patients. Young's interest in science was criticized by medical colleagues as taking time away from his medicine, so he frequently published papers under pseudonyms and anonymously.

Among Young's varied interests was Egyptology. This led him, on the summer of 1814, to take up the study of the Rosetta Stone. Young's breakthrough in deciphering hieroglyphics was simple. He assumed a group of encircled symbols or cartouche represented the Pharaoh Ptolemy and would have a similar pronunciation as in Greek. Then, by using phonetics, Young gave sound values to each of the symbols. Applying this strategy to another inscription confirmed he was on the right track. However, after cracking the code, he ceased further work, calling his achievement the amusement of a few hours' work. Young often left work unfinished, allowing others to take credit.

## Edwin Hubble

In his younger days he was noted more for his athletic abilities rather than his intellectual genius, although he did earn good grades in every subject except for spelling. He won seven first places and a third place in a single high school track meet in 1906. That year he also set a state record for the high jump in Illinois. Hubble was also an amateur heavyweight boxer and, according to one unconfirmed story, promoters urged him to turn professional and fight against the world's heavyweight champion, Jack Johnson.