

14B - concave mirror problems

1. Suppose you bend a sheet of aluminum to form a reflective surface that resembles a concave mirror when the axis is vertical. The bent reflective sheet has a focal length of 17 cm.
 - A) Where must you stand so that the image of your eye appears at 23 cm?
 - B) If your eye is 2.7 cm tall, how tall will the image be?
2. You look in to a metallic mixing bowl which resembles a spherical concave mirror. When you are 35 cm in front of the bowl, you see an image at 42 cm. What is the focal length and radius of curvature of the bowl?
3. You place an electric heater 3.00 m in front of a concave spherical mirror that has a focal length of 30.0 cm.
 - A) Where would the heat be focused?
 - B) If the heater is 15 cm tall, how tall is the image?
4. A new line of makeup offers concave spherical mirrors in their pressed powder compacts. The focal length for one of these mirrors is 17.5 cm.
 - A) If this mirror is used at a distance of 15.0 cm, where does the image appear?
 - B) What is the magnification of the image?

14 C - Convex Mirror Problems

5. As you turn the knob of a faucet to draw bath water, you see your reflection in the water spout. The focal length of the spout is -33 cm. How far away from the spout are you if your image appears to be 16.1 cm behind the spout? What is the magnification of the image?
6. You see your reflection in your friend's mirrored sunglasses. If each lens has a focal length of -12 cm, and your image appears 9.0 cm behind the sunglasses, how far from your friend are you standing? What is the magnification of the image?
7. To supervise customers, many stores install spherical convex mirrors in strategic locations. Suppose one store has a spherical convex mirror with a magnification of 0.11. Suppose you are 1.75 m tall.
 - A) How tall is the image?
 - B) How far in front of the mirror are you when the image appears 42 cm behind the mirror?
8. A stainless-steel ladle, used to serve soup, is like a spherical convex mirror. If the focal length of the ladle is 27 cm and you are 43 cm in front of the ladle, where does the image appear? What is the magnification of the image?

15A - Refraction problems

9. A beam of light is passed through a layer of ice into a fresh-water lake below. The angle of incidence for the light in the ice is 55.0° , while the angle of refraction for the light in the water is 53.8° . Calculate the index of refraction of the ice, using 1.33 as the index of refraction of fresh water.
10. The Chinese skillfully carve figurines made of a translucent greenish material called serpentine. A ray of light traveling in air strikes the flat surface of a

serpentine figurine ($n = 1.555$). If the ray in the serpentine makes an angle of 33° with the normal, what is the angle of incidence?

11. When light in air enters an opal mounted on a ring, it travels at a speed of 2.07×10^8 m/s. What is opal's index of refraction?
12. When light enters a pearl, it travels at a speed of 1.97×10^8 m/s. What is the pearl's index of refraction?
13. Nephrite jade was once used virtually everywhere by Neolithic man for polished stone weapons. Nephrite jade was also important in ancient oriental art. Suppose light passes from air at an angle of incidence of 59.2° into a thin ornate handle of a nephrite jade vase ($n = 1.61$) on display at a museum. Determine the angle of refraction in the jade.
14. Amber is a fossil resin of trees that lived tens of millions of years ago. Sometimes insects were trapped by the resin and fossilized inside. Suppose a ray of light traveling in air strikes a 2 mm thick clear amber pendant ($n = 1.54$) at an angle of 17° with the normal. Find the angles of refraction at each surface.

15C Critical angle problems

15. The critical angle for light traveling from a green tourmaline gemstone into air is 37.8° . What is tourmaline's index of refraction?
16. The critical angle for light traveling from an aquamarine gemstone into air is 39.18° . What is the index of refraction for aquamarine?
17. The critical angle for light traveling from almandine garnet into air ranges from 35.3° to 33.1° . Calculate the range of almandine garnet's index of refraction.
18. Light moves from olivine ($n = 1.670$) into onyx. If the critical angle for olivine is 62.85° , what is the index of refraction for onyx?
19. Light moves from a clear andalusite ($n = 1.64$) crystal into ivory. If the critical angle for andalusite is 69.9° , what is the index of refraction for ivory?
20. Find the critical angle for light traveling from ruby ($n = 1.766$) into air.
21. Find the critical angle for light traveling from emerald ($n = 1.576$) into air.

15 B Thin Lens Problems

22. An object is placed 13 cm in front of a converging lens. The image forms 19 cm behind the lens and is 3.0 cm tall. Determine the focal length of the lens and the height of the object.
23. An object that is 15 cm tall is placed 44 cm in front of a diverging lens. A virtual image appears 14 cm in front of the lens. Determine the focal length of the lens and the height of the image.
24. A microscope slide is placed in front of a converging lens with a focal length of 3.6 cm. The lens forms a real image of the slide 15.2 cm behind the lens. How far is the lens from the slide?
25. Where must an object be placed to form an image 12 cm in front of a diverging lens with a focal length of -44 cm?
26. In the projection booth of a movie theatre, film is placed in front of a converging lens with a focal length of 9.0 cm. The lens forms a magnified real image on a screen 18 m behind the lens. How far is the lens from the film?