Physics - Optics Problems

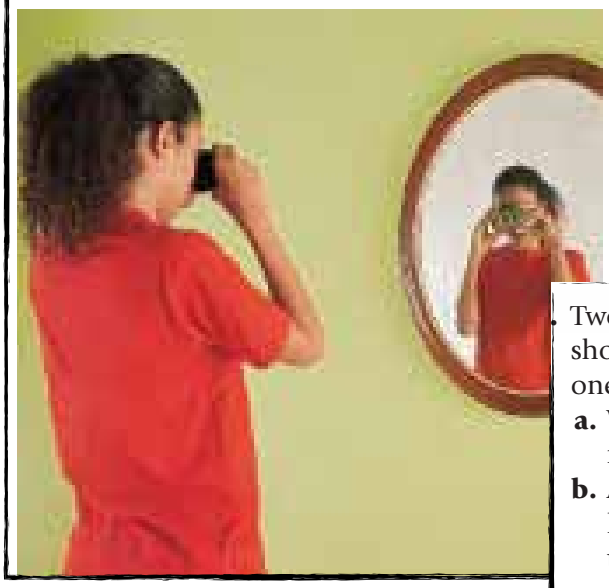
Plane Mirrors

1. If the angle of incidence of a ray of light is 42°, what is each of the following?
   A) the angle of reflection
   B) the angle the incident ray makes with the mirror
   C) the angle between the incident ray and the reflected ray

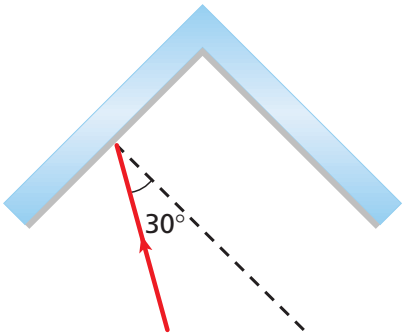
2. If a light ray reflects off a plane mirror at an angle of 35° to the normal, what was the angle of incidence of the ray?

3. A ray of light strikes a mirror at an angle of 53° to the normal.
   A) What is the angle of reflection?
   B) What is the angle between the incident ray and the reflected ray?

4. **Picture in a Mirror** Penny wishes to take a picture of her image in a plane mirror, as shown in **Figure 17-18.** If the camera is 1.2 m in front of the mirror, at what distance should the camera lens be focused?



5. Two adjacent plane mirrors form a right angle, as shown in **Figure 17-19.** A light ray is incident upon one of the mirrors at an angle of 30° to the normal.
   a. What is the angle at which the light ray is reflected from the other mirror?
   b. A retroreflector is a device that reflects incoming light rays back in a direction opposite to that of the incident rays. Draw a diagram showing the angle of incidence on the first mirror for which the mirror system acts as a retroreflector.



Concave Spherical (Converging) Mirrors

6. A concave mirror has a focal length of 10.0 cm. What is its radius of curvature?

7. An object is 36.0 cm in front of a concave mirror with a 16.0-cm focal length. Determine the image position.

8. A concave mirror has a 7.0-cm focal length. A 2.4-cm-tall object is 16.0 cm from the mirror. Determine the image height.

9. A dentist uses a small mirror with a radius of 40 mm to locate a cavity in a patient's tooth. If the mirror is concave and is held 16 mm from the tooth, what is the magnification of the image?

Convex Spherical (Diverging) Mirrors

10. A convex mirror has a focal length of 15.0 cm. A candle of 8.0 cm height is placed 60.0 cm from the mirror. What is the lightbulb's image position and height?

11. How far does the image of a car appear behind a convex mirror, with a focal length of 6.0 m, when the car is 10.0 m from the mirror?

12. A convenience store uses a convex surveillance mirror to monitor the store's aisles. Each mirror has a radius of curvature of 3.8 m.

    A) What is the image position of a customer who stands 6.5 m in front of the mirror?
    B) What is the image height of a customer who is 1.7 m tall?

Snell's Law

13. A laser beam in air is incident upon ethanol at an angle of incidence of 37.0°. What is the angle of refraction?

14. Light travels from flint glass into ethanol. The angle of refraction in the ethanol is 25.0°. What is the angle of incidence in the glass?

15. A beam of light strikes the flat, glass side of a water filled aquarium at an angle of 40.0° to the normal.
    A) At what angle does the beam enter the glass (n=1.50)?
    B) At what angle does the beam enter the water (n=1.33)?

Table 18-1
Indices of Refraction for Yellow Light (λ = 589 nm in vacuum)

Medium	*n*
Vacuum	1.00
Air	1.0003
Water	1.33
Ethanol	1.36
Crown glass	1.52
Quartz	1.54
Flint glass	1.62
Diamond	2.42

Index of Refraction

16. What is the speed of light as it travels through a diamond?

17. The speed of light in a clear plastic is 1.90 x10^8 m/s. A ray of light strikes the plastic at an angle of 22.0°. At what angle is the ray refracted?

18. Find the critical angle for light traveling from ruby (n = 1.766) into air.

19. The critical angle for light traveling from a green gemstone into air is 37.8°. What is the gem's index of refraction?

Convex Thin Lenses (Converging)

20. A 2.25-cm-tall object is 8.5 cm to the left of a *convex* lens of 5.5 cm focal length.
    A) Find the image position
    B) Find the height.

21. A 2.0-cm-tall object is located 25 cm from a convex lens with a focal length of 5.0 cm.
    A) What is the orientation of the image?
    B) Calculate the image position
    C) Calculate the height

22. A convex lens with a focal length of 22.0 cm is used to view a 15.0-cm-long pencil located 10.0 cm away.
    A) Calculate the image position
    B) Calculate the height

Concave Thin Lenses (Diverging)

23. A double concave lens has a focal length of -24 cm. A candle is placed 72 cm from the lens.
    A) What is the magnification of the image?

24. A diverging lens has a focal length of -15.0 cm. An object placed near it forms a 2.0 cm high image at a distance of 5.0 cm on the *same side* of the lens.

    A) What is the object position?
    B) What is the object height?