1. What is the thinnest film of MgF₂ (n = 1.38) on glass that produces a strong reflection for orange light with a wavelength of 601 nm?

2. A very thin oil film (n=1.25) floats on water (n=1.33). What is the thinnest film that produces a strong reflection for green light with a wavelength of 500 nm?

3. Antireflection coatings can be used on the inner surfaces of eyeglasses to reduce the reflection of stray light into the eye, thus reducing eyestrain. A 90-nm-thick coating is applied to the lens. What must be the coating’s index of refraction to be most effective at removing 480 nm? Assume that the coating’s index of refraction is less than that of the lens.

4. A helium-neon laser (λ=633nm) illuminates a single slit and is observed on a screen 1.50 m behind the slit. The distance between the first and second minima in the diffraction pattern is 4.75 mm. What is the width (in mm) of the slit?

5. You want to photograph a circular diffraction pattern whose central maximum has a diameter of 1.0 cm. You have a helium-neon laser (λ=633nm) and a 0.11 mm diameter pinhole. How far behind the pinhole should you place the viewing screen?

6. Light passes through a 10 μm wide slit and is viewed on a screen 1 m behind the slit. What will happen to the band of light if the width of the slit is narrowed?
   - The band will become narrower.
   - The band will become wider.
   - The band will stay about the same.

7. The figure shows an object O in front of a plane mirror. Use ray tracing to determine from which locations A-D the object’s image is visible.
   - A, B, D
   - B, D
   - A, B, C
   - B, C
   - C, D

   Figure 1: For problem 7.
8. A light ray leaves point A in the figure, reflects from the mirror, and reaches point B. How far below the top edge does the ray strike the mirror?

![Diagram of light ray reflected off mirror]

Figure 2: For problem 8.

9. A laser beam in air is incident on a liquid at an angle of 38.0° with respect to the normal. The laser beam's angle in the liquid is 22.0°. What is the liquid's index of refraction?

10. A 4.4 m wide swimming pool is filled to the top. The bottom of the pool becomes completely shaded in the afternoon when the sun is 24° above the horizon. How deep is the pool?

11. A thin glass rod is submerged in oil. What is the critical angle for light traveling inside the rod?

12. A concave cosmetic mirror has a focal length of 52 cm. A 3.0 cm long mascara brush is held upright 26 cm from the mirror.
   a) Determine the location of its image.
   b) Determine the height of its image.
   c) Is the image upright or inverted?
   d) Is the image real or virtual?

13. The illumination lights in an operating room use a concave mirror to focus an image of a bright lamp onto the surgical site. One such light has a mirror with a focal length of 11.0 cm. Find the position of its lamp when the patient is positioned 1.0 m from the mirror.

14. A convex mirror, like the passenger-side rearview mirror on a car, has a focal length of -2.0 m. An object is 4.0 m from the mirror.
   a) Determine the location of its image.
   b) Is the image upright or inverted?
   c) Is the image real or virtual?

15. An object is 6 cm in front of a convex mirror with a focal length of 10 cm.
   a) Determine the location of the image.
   b) Is the image upright or inverted?
   c) Is the image real or virtual?

16. It's nighttime, and you've dropped your goggles into a swimming pool that is 2.5 m deep. If you hold a laser pointer 1.5 m directly above the edge of the pool, you can illuminate the goggles if the laser beam enters the water 2.8 m from the edge. How far are the goggles from the edge of the pool?
17. The figure shows a cross-section of a fiber optic core and the surrounding cladding. What is the largest entry angle $\theta$ for which light will successfully propagate down the fiber if entering from air?

Figure 3: For problem 17.