1. Consider the interface of water with class (say at the bottom of a beaker filled with water). Given: The index of refraction for water is $n_w = 1.33$ and the index of refraction for this particular glass is $n_g = 1.52$. A ray of light with incident angle $\theta_w = 60.0^\circ$ comes from water towards the glass (drawings are encouraged!). Find the angle of reflection and refraction.

2. The wavelength of the red light from a helium-neon laser is 633 nm in air but only 474 nm in the aqueous humor inside of your eye. Calculate the index of refraction of this substance and the speed and frequency of this light in it. *Hint: The frequency of light doesn't change!*

3. Sunlight reflects off the smooth surface of a swimming pool. For what angle of reflection is the reflect light completed polarized? Given: $n_{air} = 1.00, n_{H_2O} = 1.33$; $\sin(90 - \theta) = \cos\theta$. Drawings are encouraged.

4. While conducting a photo-electric effect experiment with light of a certain frequency, you find that a reverse potential difference of 1.25 V is required to reduce the current to zero. Find KE_{max}, the maximum Kinetic energy. Given, the charge of the electron: $e = 1.60 \times 10^{-19} C$. When the voltage is turned back down to zero, how fast will the fastest electrons travel? Given, the mass of an electron: $m_e = 9.11 \times 10^{-31} kg$.

5. An interesting proposition. Imagine reversing the photoelectric effect. Imagine that the voltage between the plates is off when light strikes one plate and liberates an electron, but before the electron reaches the second plate, the voltage is increased to stopping potential so that the electron slows down, comes to a stop, and then accelerates back towards the plate, impacting the plate with the same kinetic energy it had at liberation.

   Surprise! A photon is released.

   Electrons in an x-ray tube accelerate through a potential difference of 10.0 kV before striking a metal target. If an electron produces one photon on impact with the target, what is the minimum wavelength of the resulting photon (which is an x-ray here)? Given, the charge of the electron: $e = 1.60 \times 10^{-19} C$ and $hc = 1240 eV \cdot nm$ is Planck's constant times the speed of light given in eV units and nm units.

6. A given doublet-slit arrangement had $d = (0.150e-3)\,\text{m}$, $L = (1.40)\,\text{m}$, $\lambda = (643e-9)\,\text{m}$, and we consider the results of sending light through the arrangement that at a point P located $y = (1.80e-2)\,\text{m}$ from the center of a screen (see Figure P37.19).

   (a) What is the path difference δ for the rays from the two slits arriving at P.

(b) Express this path difference in terms of λ.

(c) Does this correspond to a minimum, maximum, or intermediate on the screen?

7. Consider a radio-wave transmitter and receiver separated by a distance of $d = 50$ m both of height $h = 35$ m. Determine the longest wavelengths that interfere constructively.

8. Sound with a frequency of 650 Hz from a distant sources (means assume that the wave is coherent and planar) passes through a door 1.10 m wide in a sound-absorbing wall. Find the number and angular direction of the diffraction minima at listening posts along a line parallel to the wall.

9. A painting with dots of pure pigment with approximate diameter $(2e-3)$ m. Assume light of wavelength $\lambda = (500e-9)$ m and the average human pupil diameter is $(5e-3)$ m. How far away must the average person be to not see the pixels?

10. The helium-neon laser with wavelength $\lambda = (632.8e-9)\,m$ is used to calibrate a diffraction grating. If the first-order maximum occurs at $20.5°$, what is the spacing between adjacent grooves in the grating?

11. A diffraction grating has 4200 rulings/cm. On a screen 2.00 m from the grating, it is found that for a particular order m, the maxima corresponding to two closely spaced wavelengths of sodium (589.0 nm and 589.6 nm) are separated by 1.54 mm. Determine the value of m.

12. Light from a helium-neon laser $\lambda = 632.8$ nm is incident on a single slit. What is the maximum width of the slit for which no diffraction minima are observed?