**Phsx 2220 - Homework #9**

34-1.   (a) The wavelength of the most energetic x rays produced when electrons are accelerated to a kinetic energy of 18 GeV in the Stanford Linear Accelerator and then slam into a solid target is 0.067 fm. What is the frequency of these x rays? (b) A VLF (very low frequency) radio wave has a frequency of only 30 Hz. What is its wavelength?

34-2.   An airplane flying at a distance of 10 km from a radio transmitter receives a signal of power 10 $\mu W/m^2$. Calculate (a) the amplitude of the electric field at the airplane due to this signal; (b) the amplitude of the magnetic field at the airplane; and (c) the total power of the transmitter, assuming the transmitter to radiate uniformly in all directions.

34-3.   It has been proposed that a spaceship might be propelled in the solar system by radiation pressure, using a large sail made of foil. How large must the sail be if the radiation force is to be equal in magnitude to the Sun's gravitational attraction? Assume that the mass of the ship + sail is 1500 kg, that the sail is perfectly reflecting, and that the sail is oriented perpendicularly to the Sun's rays. The mass of the Sun is 1.99 x 10^{30} kg, and the Earth-Sun distance is 1.50 x 10^{11} m. The energy per second of sunlight crossing each m^2 of area at Earth's location in 1365 W/m^2.

34-4.   A beam of unpolarized light is sent through two polarizing sheets placed one on top of the other. What must be the angle between the polarizing directions of the sheets if the intensity of the transmitted light is to be one-third of the incident intensity?

34-5.   Light in vacuum is incident on the surface of a glass slab. In the vacuum the beam makes an angle of 32.0° with the normal to the surface, while in the glass it makes an angle of 21.0° with the normal. What is the index of refraction of the glass?

34-6.   In the figure at right, a 2.00 m long vertical pole extends from the bottom of a swimming pool to a point 50.0 cm above the water. Sunlight is incident at 55° above the horizon. What is the length of the shadow of the pole on the level bottom of the pool?
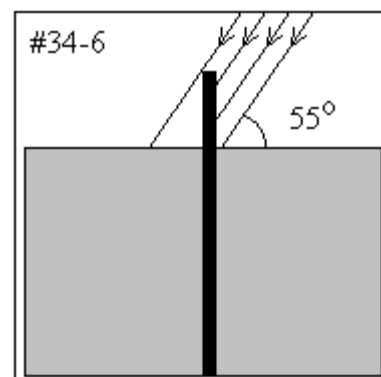
34-7. In the figure at right, a ray of light is perpendicular to the face ab of a glass prism (n = 1.52). Find the largest value for the angle ϕ so that the ray is totally reflected at face ac if the prism is immersed (a) in air and (b) in water.

#34-7
Incident light
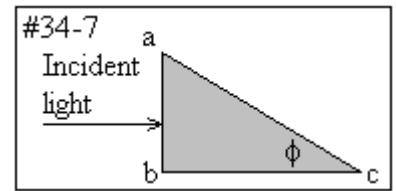
35-8. The figure at right shows an overhead view of a corridor with a plane mirror M mounted at one end. A burglar B sneaks along the corridor directly toward the center of the mirror. If d = 3.0 m, how far from the mirror will she be when the security guard S can first see her in the mirror?

#35-8
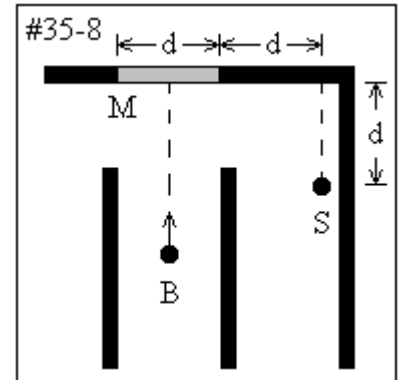
35-9. A concave shaving mirror has a radius of curvature of 35.0 cm. It is positioned so that the (upright) image of a man's face is 2.50 times the size of the face. How far is the mirror from the face?

35-10. You look downward at t penny that lies at the bottom of a pool of liquid with depth d and index of refraction n, as shown. Because you view with two eyes, which intercept different rays of light from the penny, you perceive the penny to be where extensions of the intercepted rays cross, at depth d_a instead of d. Assuming that the intercepted rays are close to a vertical axis through the penny, show that $d_a = d/n$. (*Hint*: Use the small-angle approximation that $\sin \theta = \tan \theta = \theta$ in radians.)

#35-10
To left eye   To right eye
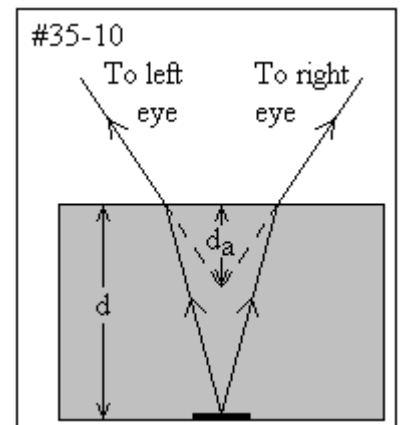
35-11. A lens is made of glass having an index of refraction of 1.5. One side of the lens is flat, and the other convex with a radius of curvature of 20 cm. (a) Find the focal length of the lens. (b) If an object is placed 40 cm in front of the lens, where will the image be located?

35-12. A movie camera with a (single) lens of focal length 75 mm takes a picture of a 180 cm high person standing 27 m away. What is the height of the image of the person on the film?