

**Physics 2301 Honors, Spring 2008
Sample Exam 4**

$e = 1.60 \times 10^{-19} \text{ C}$, $m(\text{electron}) = 9.11 \times 10^{-31} \text{ kg}$, $\epsilon_0 = 8.845 \times 10^{-12} \text{ C}^2/\text{Nm}^2$,
 $k_e = 9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$, $m(\text{proton}) = 1.67 \times 10^{-27} \text{ kg}$. $\mu = \text{micro} = 10^{-6}$, $m = \text{milli} = 10^{-3}$
 $\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m}/\text{A}$, $c = 3.00 \times 10^8 \text{ m/s}$

Short Questions: (10 points each), drop the low one

1. A source of EM waves that radiates isotropically emits 3.5 kW of power. When the EM waves are measured 550 m away from the source, what is the electric field amplitude?

2. If we double the wavelength and triple the electric field amplitude of an electromagnetic wave, what happens to its intensity?
 - a) it is the same
 - b) it is one-fourth as large
 - c) it is one-ninth as large
 - d) it is four times larger
 - e) it is nine times larger

3. A plastic rod with $n=1.42$ is to be used as a light guide. What is the maximum angle from the normal that light can enter the face of the rod and still undergo total internal reflection?

4. A person's eyes are 1.90 m above the ground. How close must they be to a 2.50 m deep, 3.00 m diameter cylindrical pool of water if they can just barely see the edge of the bottom?

5. A diverging lens placed 34 cm from an object forms an image which is $1/2$ the size of the object. What is the lens's focal length?

6. Two slits form an interference pattern on a screen 3.5 m away when illuminated with 550 nm light. The bright maxima are 1.6 cm apart on the screen. How far apart are the slits?

7. When rifle fishing, do you aim at, above, or below the image of a fish in the water, and WHY?

8. A soap bubble with $n=1.33$ strongly reflects 550 nm light. What is its thickness?

9. What would happen to 550 nm light falling on a thin film of oil on water with the same thickness as the film in problem 8?

Long Questions (20 points each), drop the low one.

1. A laser emits a beam with a diameter of 5.00 mm and a wavelength of 1.50 micrometers. The beam travels in empty space in the z direction, and has a power of 2.00 kW.

a) Write down an expression for the electric field of the laser as a function of position and time.

b) How much energy per unit volume is in the beam?

c) If the beam strikes a perfectly absorbing circular disc of diameter 2.5 mm, which lies perpendicular to the beam, how much force does it exert?

d) How much energy does the disc absorb in 10.0 s?

2. An equilateral prism is made of glass with $n_1=1.50$ at 550 nm and $n_2=1.47$ at 650 nm. Rays of 550 nm and 650 nm light are incident on one face at an angle of 45 degrees to the normal.

a) find the overall angle by which each of the rays of light are deviated.

b) find the angular separation of the rays after they leave the prism.

c) Is it possible for the 550 nm light to undergo total internal reflection at the second face of the prism? If so, find the critical angle of incidence at the first face.

3. A converging lens with a focal length of 20 cm forms an image of a 3.0 cm tall object which is 40 cm from the lens.

a) Draw a ray diagram of the imaging process using three rays as described in class.

b) Describe the image (i.e., is it erect? real or virtual? magnified or demagnified?)

c) Calculate the image distance

d) Calculate the image height