Physics 132
General Physics II
Grinnell College

Homework XI-XII

Session XI.3

1. For a long solenoid, we discovered in a problem-of-the-day that $B = \mu_o nI$, where n is the number of turns of wire *per unit length* along the solenoid.
a. Use this fact and Faraday's Law of induction to calculate the inductance of a solenoid of cross-sectional area A and length *l*.
b. If a solenoid has 10^4 turns per meter, and is 5 cm in diameter and 50 cm long, and is carrying a current of 10 A which is turned off in a time of 0.001 sec, what is the induced "back voltage" developed?

2. An inductor has an inductance of 5 milliHenrys. A voltage of 5 V is suddenly applied across it. What is the time rate of change (i.e. time derivative) of current? How long does it take before 1 Ampere flows through the inductor?

3. An electromagnetic wave has a frequency of $\omega = 3 \times 10^{12}$ sec^{-1}. What is the wave number k in the expression $\sin(kz-\omega t)$? What is the wavelength of this wave?

Session XII.1

4. We can use a lens as a distance gauge. For example, if I have a lens with a focal length of 50 mm, and I focus an image of an object on a screen which is 51 mm from the lens, how far away is the object?

5. A 2 m tall person is standing 4 meters away from me. I have a camera with a zoom lens (one with an adjustable focal length). I want the person's image on the film to be 2 cm tall. To what focal length should I adjust my lens?

Session XII.2

6. The bowl of a ladle is perfectly spherical, with a diameter of 10 cm. If I point the bowl of the ladle toward the sun, where will I get an image of the sun? Include a sketch.

Session XII.3

7. Water has an index of refraction of about n = 1.3. If sunlight is hitting a lake surface at a 45 ° angle, what is the angle of the water rays inside the water?

8. You know that light hitting a CD is diffracted into a rainbow. Let's use this fact to get a rough estimate of the spacing of the adjacent recording pits on the CD. Consider this to be just like a diffraction grating, and we will guess we get a reasonable

diffraction angle of 10° for light of 500 nm. What must be the spacing between those pits?

9. Not only does visible light exhibit wave properties, but so do x-rays. To see these properties demands slits that are very close--in fact as close together as individual atoms in a crystal! If the spacing between atoms (the equivalent of d for our slits) is 0.15 nm in a particular crystal, and this give an m=1 constructive interference peak at 10°, what is the wavelength of these x-rays? How does this compare to the typical wavelength of visible light of about 500 nm?

Session XII.4

10. I want to build a telescope with lenses of focal lengths 20 cm and 1 cm.

a. Which lens is most appropriate as the eyepiece (the one you look into)? Why?
b. What should be the spacing between the lenses when I focus at a distant (treat as infinity) object?
c. If I try to look at a closer object (say a bird in a tree), this means d_1 for the objective (first lens) is smaller, so d_2 for this same lens must now be longer. This means to focus on a closer object, I must increase the spacing between the two lenses. I make my telescope so I can lengthen the distance between the lenses by 2 cm. What is the closest object can I focus on?