Homework #6

Phys 2220

1. The electromagnetic waves that carry FM radio range in frequency from 87.9 MHz to 107.9 MHz. What is the range of wavelengths for these EM waves?

2. A spacecraft in orbit around the moon measures its altitude by reflecting a pulsed 10 MHz radio signal from the surface. If the spacecraft is 30 km high, what is the time between the emission of the pulse and the detection of the echo?

3. Communication with submerged submarines via radio waves is difficult because seawater is conductive and absorbs electromagnetic waves. Penetration into the ocean is greater at longer wavelengths, so the United States has radio installations that transmit at 76 Hz for submarine communications. What is the wavelength of these very low frequency waves?

4. How fast would you need to be travelling for a red stop light (wavelength = 670 nm) to appear green (wavelength = 510 nm)?

5. Only 37 % of the intensity of a polarized light wave passes through a polarizing filter. What is the angle between the electric field and the axis of the filter?

6. A 200 mW horizontally polarized laser beam passes through a polarizing filter whose axis is 25^o from vertical. What is the intensity of the laser beam as it emerges from the filter?

7. Unpolarized light, with intensity $I_0 = 100\ W/m^2$, passes through a vertical polarizing filter The light then passes through a horizontal filter, which blocks all of the light; the intensity transmitted through the pair of filters is zero. Suppose a third polarizer with axis 45^o from vertical is inserted between the first two. What is the transmitted intensity now?

8. A light wave has a 670 nm wavelength in air. Its wavelength in a transparent solid is 420 nm.
   (a) What is the speed of light in this solid?
   (b) What is the light's frequency in the solid?

9. A helium-neon laser beam has a wavelength in air of 633 nm. It takes 1.28 ns for the light to travel through 28.0 cm of an unknown liquid. What is the wavelength of the laser beam in the liquid?

10. Light from a sodium lamp (λ=589nm) illuminates two narrow slits. The fringe spacing on a screen 150 cm behind the slits is 4.0 mm. What is the spacing (in mm) between the two slits?

11. Light from a helium-neon laser (λ=633nm) is used to illuminate two narrow slits. The interference pattern is observed on a screen 3.1 m behind the slits. Thirteen bright fringes are seen, spanning a distance of 52 mm. What is the spacing (in mm) between the slits?

12. Two narrow slits are 0.12 mm apart. Light of wavelength 550 nm illuminates the slits, causing an interference pattern on a screen 1.0 m away. Light from each slit travels to the m=1 maximum on the right side of the central maximum.
    (a) How much farther did the light from the left slit travel than the light from the right slit?

13. A diffraction grating with 750 slits per mm is illuminated by light which gives a first-order diffraction angle of 34.0^{o}. What is the wavelength of the light?

14. Light of wavelength 600 nm illuminates a diffraction grating. The second-order maximum is at angle 39.4^{o}. How many lines per millimeter does this grating have?

15. A diffraction grating with 600 lines per mm is illuminated with light of wavelength 520 nm. A very wide viewing screen is 2.1 m behind the grating.
    (a) What is the distance between the two m=1 fringes?
    (b) How many bright fringes can be seen on the screen?

16. Light of wavelength 500 nm in air enters a glass block with index of refraction n = 1.5.
    (a) When the light enters the block, which of the following properties of the light will not change?
    (b) When the light enters the block, which of the following properties of the light will not change?

        The speed of the light
        The frequency of the light
        The wavelength of the light