PART I:

1. A beam of unpolarized light with intensity 50 W/m² is sent into a system of two polarizing sheets with polarizing directions at angles $\theta_1 = 30°$ and $\theta_2 = 90°$ to the y axis. The intensity of the light transmitted by the system is:

    a. 25 W/m²

    b. 9.375 W/m²

    ⓒ 6.25 W/m²

    d. 0 W/m²

    e. None of the above, my answer is ____________

6 pts

$I_1 = \frac{50}{2} = 25$

$I_2 = 25 \cos^2(90-30) = 6.25$ W/m²

2. Two waves travel between two points along paths that have the same length of 430 nm. One travels in a medium that has an index of refraction of 3.5, while the other travels in air or vacuum.

    a. There is no time delay between the 2 waves.

    b. The time of travel in air is $5.02 \times 10^{-15} s$

    c. The wave in the medium travels faster than in air.

    d. The time of travel in the medium is $1.43 \times 10^{-15} s$

    ⓔ None of the above.

6 pts

$v = \frac{d}{t} \Rightarrow d = v t$

$n = \frac{c}{v} \Rightarrow v =$

$d = d$

$\Rightarrow \frac{d}{n_1} t_1 = d t$

$\Rightarrow t_1 = n_1$

$t_1 = n_1 t_2$; $t_2 = 1.433 \times 10^{-15}$ in the air

$t_1 = \frac{d n}{c} = 5.016 \times 10^{-15}$ in medium

3. The Sun delivers about $1000 W/m^2$ of energy to the Earth's surface via electromagnetic radiation. The total power that is incident on a roof of dimensions 9.00 m × 20.0 m is:

    a. $1.8 \times 10^7 W$

    ⓑ $1.8 \times 10^5 W$

    c. Cannot be determined because the value of the surface of the Earth is not given.

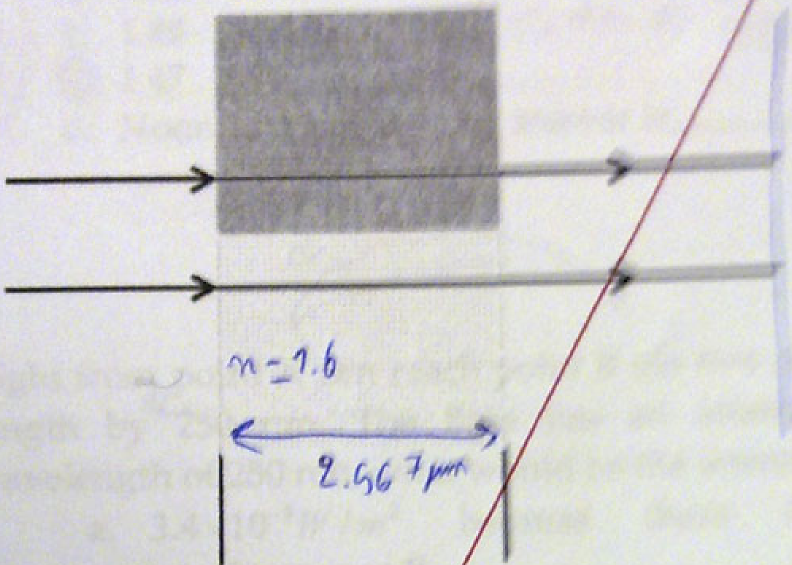
    d. $1.0 \times 10^3 W$

    e. None of the above, my answer is____________

6 pts

$I = \frac{P}{A} = \frac{P}{9 \times 20} = 1000 \Rightarrow P = 1000 \times 180 = 1.8 \times 10^5 W$

4. In figure, the two light waves have wavelength 550 nm before entering media 1 and 2. Medium 1 is now just air, and medium 2 is a transparent plastic layer of index of refraction 1.600 and thickness 2.567 μm. What is the phase difference of the emerging waves in wavelengths and what type of interference would the waves produce at a point on a distant screen?



a. 2.8 wavelength, fully destructive interference
b. 2.8 wavelength, fully constructive interference
c. 0.8 wavelength, intermediate interference closer to fully constructive
d. 2.8 wavelength, intermediate interference closer to fully destructive
e. None of the above, my answer is 7.4 intermediate interference closer to fully destructive

5. At what incident angle is sunlight reflected fully plane-polarized from an air-glass (n = 1.52) surface?
a. 56.7°
b. 5.67°
c. 33.3°
d. 3.33°
e. None of the above, my answer is ____________

6. A beam of light of wavelength 550 nm traveling in air is incident on a slab of transparent material. The incident beam makes an angle 40.0° with the normal, and the refracted beam makes an angle of 26.0° with the normal. The index of refraction of the material is:
   a. 1.33
   b. 1.52
   c. 1.49
   d. 1.47
   e. None of the above, my answer is__________

$n_1 \sin\theta_1 = n_2 \sin\theta_2 \Rightarrow n_2 = \frac{\sin\theta_1}{\sin\theta_2} = 1.47$

6 pts

7. Light from point A can reach point B via two different paths which differ in length by 250 nm. The light has an intensity of $3.4\times10^{-5} W/m^2$. For a wavelength of 250 nm, what would be the intensity of the light at point B?
   a. $3.4\times10^{-5} W/m^2$ because there is maximum constructive interference at B.
   b. $1.36\times10^{-4} W/m^2$
   c. $1.36\times10^{-5} W/m^2$ which is 4 times the intensity of the individual wave.
   d. Zero because there is fully destructive interference at B.
   e. None of above, my answer is __________

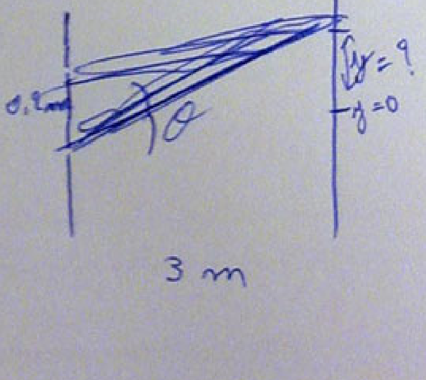
6 pts

$I = 4I_0 \cos^2\frac{1}{2}\phi$; $\phi = \frac{2\pi\Delta L}{\lambda} = 2\pi$

$= 1.36\times10^{-4}\ W/m^2$

8. When yellow light having a wavelength of 580 nm, shines through two slits 0.2 mm apart, an interference pattern is formed on a screen 3 meters away. What is the deviation along the screen between the middle of the third order bright and the middle of the central maximum?
   a. 1.29 mm
   b. 8.7 mm
   c. 17.4 mm
   d. 26.1 mm
   e. None of the above, my answer is __________

6 pts



$y = \frac{D\lambda}{d} m = \frac{D\lambda 3}{d}$

$= 0.0261\ m$

$= 26.1\ mm$

9. Unpolarized light falls on two crossed Polaroids. A third Polaroid, with axis at 45° to each of the other two, is placed between them. Then,

   a. No light passes through.
   b. 1/8 of the original intensity gets transmitted.
   c. 1/2 of the original intensity gets transmitted.
   d. 1/4 of the original intensity gets transmitted.
   e. None of the above, my answer is ______________

6 pts

$I_1 = \frac{I_0}{2}$

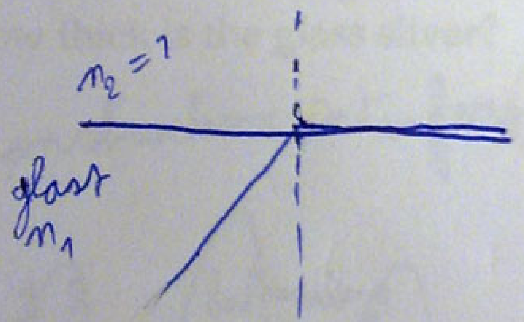
$I_2 = I_1 \cos^2 45° = I_1 \frac{1}{2} = \frac{I_0}{4}$

$I_3 = I_2 \cos^2 45° = \frac{I_0}{4}\left(\frac{1}{2}\right) = \frac{I_0}{8}$

10. If total internal reflection occurs at an angle of incidence of 45° at the interface between glass and air, what is the index of refraction of the glass?

   a. 1.20
   b. 1.50
   c. 1.41
   d. 1.43
   e. None of the above, my answer is __________

6 pts



$\theta = \sin^{-1} \frac{n_2}{n_1}$

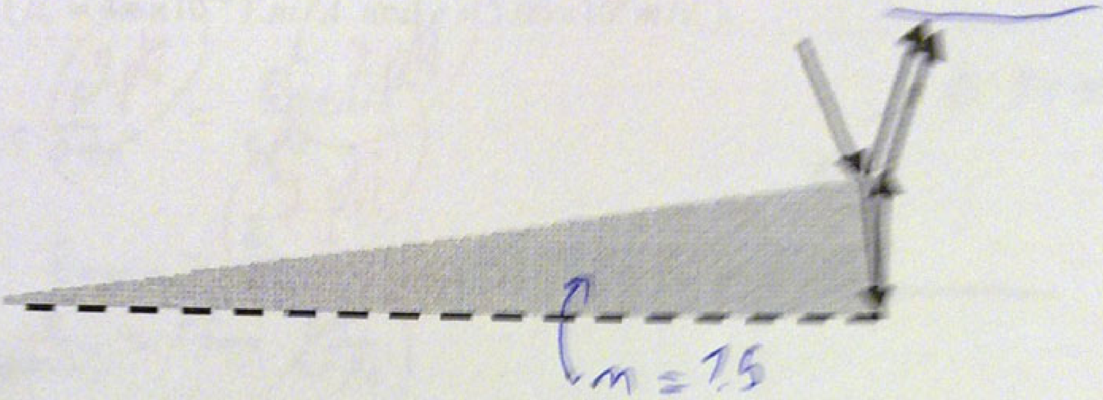
$(\sin 45°)\, n_1 = n_2$

$\Rightarrow n_1 = \frac{n_2}{\sin 45} = 1.41$

PART II

Problem 1

A small sliver of glass is perfectly wedge-shaped. When viewed with monochromatic 475 nm blue light, 17 tightly-spaced bright blue bands can be viewed along its 1 cm length.



a) Since the edge of the wedge ends on a bright fringe, would you use the relationship for constructive or destructive interference?

b) State the equation for thin films that you will use to determine the thickness of the wedge at its widest edge.

c) What is the wavelength of the light in the glass sliver?

d) How thick is the glass sliver?

a) constructive interference 5 pts b) $\Delta L = (m + \frac{1}{2})\lambda_n$

Not enough → make ... deter...

$\Delta L = \frac{1}{2}\lambda$ destructive

$\Delta L = (m + \frac{1}{2})\lambda$ destructive

$\Delta L = (m + \frac{1}{2} + \frac{1}{2})\lambda = (m + 1)\lambda$ constructive

$\lambda_n = \frac{\lambda}{n} = \frac{475}{1.5} \times 10^{-9} = 3.166 \times 10^{-7}$ m 5 pts

$\Delta L = \frac{1}{2}\lambda_n$

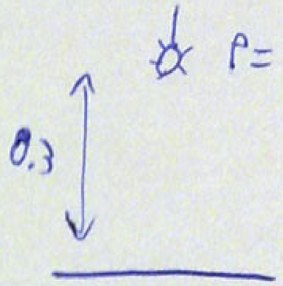
$\Delta L = (m + \frac{1}{2})\lambda_n$

Problem 2

What are the estimated maximum amplitudes of the electric and magnetic fiel of the light that is incident on this page because of the visible light coming fro your desk lamp? The distance from the bulb (treated as a point source) is 0.30 The output of the bulb in the form of visible light is 3.0 ($\mu_o = 4\pi \times 10^{-7} T.m/A$ and $c = 3.00 \times 10^8 m/s$).

$$I = \frac{P}{4\pi r^2} = \frac{E_{rms}^2}{c\mu_0}$$

2 pts 2 pts



$$E_{rms} = \frac{E}{\sqrt{2}}$$

2 pts

$$\frac{3}{4\pi(3^2)} = E_{rmA}^2 \left(\frac{1}{c\mu_0}\right)$$

$$\Rightarrow E_{rmf} = \sqrt{\frac{c\mu_0}{4\pi 3}} = 3.16$$

$E_{rmf} = 3.16 \ N/m$

$E_{max} = 3.16(\sqrt{2}) = 4.47 \ N/m^2$