SPSP 320

Due at the Final, Tues, 27 Feb 07

Take-home part of final -- worth about 20% -- This is open-book, consult anyone you wish (especially me!), but the work you submit must be your own.

1. Review for final! You are given 2 cases of 2 waves that superpose (i.e., are at the same place at the same time).

For Case A:

\[ E_1 = E_{01} \sin (kz - \omega t) \]  this electric vector points in the \(+x\) direction
\[ E_2 = E_{01} \sin (kz - \omega t + \pi/2) \]  this electric vector points in the \(+x\) direction

(a1) What direction is the resultant wave \([E_1 + E_2]\) traveling in?
\(+x\)  \(-x\)  \(+y\)  \(-y\)  \(+z\)  \(-z\)  (Circle one.)

(a2) Is this resultant wave linearly polarized? If so, in what direction?

\[ \begin{array}{ll} 
\text{yes} & \text{no} \\
\pm x & \pm y & \pm z & \text{other—explain: } \end{array} \]

For Case B:

\[ E_1 = E_{01} \sin (kz - \omega t) \]  this electric vector points in the \(+x\) direction
\[ E_2 = E_{01} \sin (kz - \omega t + \pi/2) \]  this electric vector points in the \(+y\) direction

(b1) What direction is the resultant wave \([E_1 + E_2]\) traveling in?
\(+x\)  \(-x\)  \(+y\)  \(-y\)  \(+z\)  \(-z\)  (Circle one.)

(b2) Is this resultant wave linearly polarized? If so, in what direction?

\[ \begin{array}{ll} 
\text{yes} & \text{no} \\
\pm x & \pm y & \pm z & \text{other—explain: } \end{array} \]

(b3) What is the amplitude of the resultant wave? (Explain or show method!)

(c) Compare and contrast the Case A and Case B resultant waves: what is similar about them? what is different?
2. Two incoming electromagnetic waves with the same linear polarization and different amplitudes, $E_{01} = 2.0 \text{ V/m}$ and $E_{02} = 3.0 \text{ V/m}$, superpose to form an interference pattern. 
(a1) Can the minimum in the interference pattern be zero? Why or why not?

(a2) Since it cannot be zero, calculate the ratio of the minimum intensity [$= \text{irradiance}$] to the intensity of the first wave, $I_{\text{min}} / I_1$. Recall that intensity $[I]$ is proportional to amplitude squared [$E_0^2$].

(b) Calculate the ratio of the maximum intensity [$= \text{irradiance}$] to the intensity of the first wave, $I_{\text{max}} / I_1$.

(c) Find the fringe contrast. [Look up the formula in the book!]

3. (a1) In a 2-slit interference pattern, what is the path difference between the waves from the 2 slits at the location of the first minimum on the screen? Express your answer as a multiple of the wavelength of the light [$\lambda$].

(a2) What is the path difference between the waves from the 2 slits at the location of the second minimum on the screen? Express your answer as a multiple of the wavelength of the light [$\lambda$].

(a3) What is the path difference between the waves from the 2 slits at the location of the third minimum on the screen? Express your answer as a multiple of the wavelength of the light [$\lambda$].
(b1) In a 2-slit interference pattern, what is the path difference between the waves from the 2 slits at the location of the zeroth order maximum on the screen? Express your answer as a multiple of the wavelength of the light [\( \lambda \)].

(b2) What is the path difference between the waves from the 2 slits at the location of the first maximum on the screen? Express your answer as a multiple of the wavelength of the light [\( \lambda \)].

(b3) What is the path difference between the waves from the 2 slits at the location of the \( m \)th maximum on the screen? Express your answer as a multiple of the wavelength of the light [\( \lambda \)].

4. In Young's experiment, narrow double slits separated by 0.120 mm diffract monochromatic light of wavelength 632.8 nm onto a screen. The distance between the 5th minimum to the left of center and the 5th minimum to the right of center on the screen is 34.73 mm. How far is the screen from the slits?