Problem Set 2: Phys 256 Fall 2012
Submit online or Place in Phys 256 box, Physics 2nd floor Friday September 28th at 4pm
Total marks 91

1) Do 3.7 a), b), c). The wave has a wavelength of 550nm. **8 marks** In part d), write $\boldsymbol{E}(\mathrm{r},t)$ and $\boldsymbol{B}(\mathrm{r},t)$ **4 marks.** Assume that the fields are zero at y=0 and t=0.
e) Calculate the flux density and energy density. **4 marks**

2) Write an expression in Cartesian coordinates for a harmonic plane **E** wave with E_x=0, with a frequency ω=3 X$0^{15}s^{-1}$, k=1X10^7m^{-1}, for which k is along a line from the origin through the point (1,-1,2). **5 marks**

3) For $\boldsymbol{E} = \left(0.866\,\hat{\boldsymbol{i}} + 0.5\,\hat{\boldsymbol{j}}\right)(3X10^3\ V/m)\exp\left[i\left[1.114X10^7\right]\left(z - 2X10^8\ t\right)\right]$

Assume SI units.
a) Find the direction along which the electric field oscillates; **2 marks**
b) the scalar value of the amplitude of the electric field;**1 mark**
c) the direction of propagation of the wave;**1 mark**
d) the propagation constant and wavelength;**2 marks**
e) the speed and refractive index of the medium;**2 marks**
f) the frequency and angular frequency;**2 marks**
g) the direction of oscillation of the magnetic field and its direction of propagation.**3 marks**

4) a)3.19 **2 marks**
b) What is the energy density and pressure of the pulse? **2 marks**
c) If the peak wavelength is 800nm, what is the length of the pulse in space? **2 marks**
d) What is the total energy of the pulse assuming a single wavelength and a diameter of 2μm? **2 marks**
e) What is the force applied on a reflecting surface? **2 marks**
f) What momentum is carried per unit volume of the wave? **2 marks**
g) What momentum is transferred by the pulse to a reflecting surface? **2 marks**
h) Calculate the power of the pulse. **2 marks**

5) 3.38 **4 marks**

6) 3.39 **2 marks**

7) 3.40 **2 marks**

8) a) 3.44 **4 marks**
b) If a parallel, adjacent wave traverses the vacuum, what is the phase difference between them when the first one exits the glass? Will the two waves interfere constructively or destructively? **5 marks**

9) a) Add these two fields together in a phasor diagrams for ε=0 (in phase) and ε=π (out of phase) in order to find $\vec{E}_T(\vec{r},t) = \vec{E}_0 e^{i\left(\vec{k}\bullet\vec{r}-\omega t+\varphi\right)}$

$$\vec{E}_1(\vec{r},t) = \vec{E}_{01} e^{i\left(\vec{k}\bullet\vec{r}-\omega t\right)}$$

$$\vec{E}_2(\vec{r},t) = \vec{E}_{02} e^{i\left(\vec{k}\bullet\vec{r}-\omega t+\varepsilon\right)}$$

9 marks

b) Given that irradiance, Iα E_0^2 , show that, in the first case, Iα$(E_{01}+E_{02})^2$ and in the second case, Iα$(E_{01}-E_{02})^2$. By writing out the expression for I_1+I_2, show that in both cases, I **is not equal to** I_1+I_2. **4 marks**

c) Draw the general phasor diagram for a phase difference of ε. In this case, $I=I_1+I_2+I_{12}$.**6 marks**

d) From the diagram, give a value of I_{12} in terms of E_{01}, E_{02} and ε, the phase difference. **5 marks**