

FIFTH MIDTERM

1

Name: Zhao Hai Huang

Discussion Instructor (circle): Andrade El-Gendy Mimoto Owen

Discussion Section # _____

Student ID #: _____

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

A beam of laser light has an electric field described by:

$$E = (4.00 \times 10^{-2} \text{ V/m}) \cos [(1.25 \times 10^6)x + (4.75 \times 10^{14})t]$$

where x is in meters and t in seconds.

- (a) Calculate the wavelength of the light in nm.

$$\lambda = \frac{2\pi}{k} = \frac{2 \times 3.14159}{1.25 \times 10^6} = 5.03 \times 10^{-6} \text{ m} = 5030 \text{ nm}$$

- (b) Calculate the frequency, f , for this light.

$$f = \frac{\omega}{2\pi} = \frac{4.75 \times 10^{14}}{2\pi} = 7.56 \times 10^{13} \text{ Hz}$$

- (c) Calculate the velocity for this light wave (not the true value of c , but close).

$$v = \frac{\omega}{k} = \frac{4.75 \times 10^{14}}{1.25 \times 10^6} = 3.8 \times 10^8 \text{ m/s}$$

(group velocity = 0)
 phase velocity

- (d) Calculate the energy density at the maximum value of the electric field.

It is ok not to consider the energy of magnetic field.

$$U = U_E + U_B = 2 \cdot \frac{1}{2} \epsilon_0 E^2 = 8.85 \times 10^{-12} \text{ (F/m)} \times (4.00 \times 10^{-2} \text{ V/m})^2 = 1.42 \times 10^{-14} \text{ J/m}^3$$

- (e) Calculate the instantaneous value of the Poynting vector at the maximum of the electric field. Use the true value of needed.

$$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B} = \frac{E^2}{\sqrt{\frac{\mu_0}{\epsilon_0}}} = \frac{(4.00 \times 10^{-2})^2}{\sqrt{\frac{4\pi \times 10^{-7}}{8.85 \times 10^{-12}}}} = 4.25 \times 10^{-6} \text{ W/m}^2$$