## Chapter 35 Homework

**Due: 8:00am on Thursday, April 22, 2010**

**Note:** To understand how points are awarded, read your instructor's Grading Policy.

[Return to Standard Assignment View]

### Problem 35.11

**Part A**

A square parallel-plate capacitor 5.50 cm on a side has a 0.580 mm gap. What is the displacement current in the capacitor if the potential difference across the capacitor is increasing at $500,000\ \text{V/s}$?

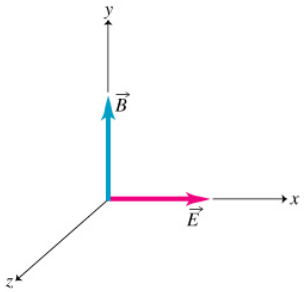
**ANSWER:** $2.31\times10^{-5}$ A

*Correct*

### Electric and Magnetic Field Vectors Conceptual Question

**Part A**

The electric and magnetic field vectors at a specific point in space and time are illustrated. Based on this information, in what direction does the electromagnetic wave propagate?




**Hint A.1** Right-hand rule for electromagnetic wave velocity

*Hint not displayed*

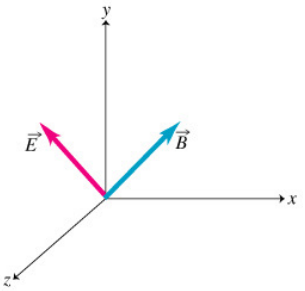
**ANSWER:**

- $+x$
- $-x$
- $+y$
- $-y$
- (•) $+z$
- $-z$
- at a $+45°$ angle in the $xy$ plane

*Correct*

**Part B**

The electric and magnetic field vectors at a specific point in space and time are illustrated. ($\vec{E}$ and $\vec{B}$ are in the $xy$ plane. Both vectors make $45°$ angles with the $+y$ axis.) Based on this information, in what direction does the electromagnetic wave propagate?



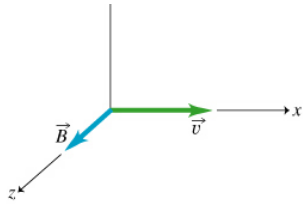

**ANSWER:**

- $+x$
- $-x$
- $+y$
- $-y$
- $+z$
- (•) $-z$
- at a $-45°$ angle in the $xy$ plane

*Correct*

**Part C**

The magnetic field vector and the direction of propagation of an electromagnetic wave are illustrated. Based on this information, in what direction does the electric field vector point?




**Hint C.1** **Working backward with the right-hand rule**

***Hint not displayed***

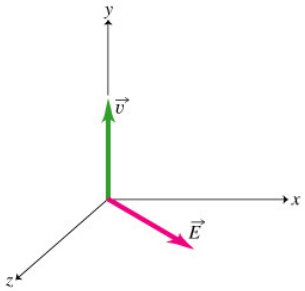
**ANSWER:**

- +x
- –x
- +y
- –y
- +z
- –z
- at a +45° angle in the *xz* plane

***Correct***

**Part D**

The electric field vector and the direction of propagation of an electromagnetic wave are illustrated. ($\vec{E}$ is in *xz* plane and makes a 45° angle with the $+x$ axis.) Based on this information, in what direction does the magnetic field vector point?




**Hint D.1** **Working backward with the right-hand rule**

***Hint not displayed***

**ANSWER:**

- +x
- –x
- +y
- –y
- +z
- –z
- at a –45° angle in the *xz* plane

***Correct***

## Electromagnetic Waves Ranking Task

**Part A**

Rank these electromagnetic waves on the basis of their speed (in vacuum).

**Hint A.1** **Relating speed, frequency, and wavelength**

Like all waves, the relationship among wave speed, frequency, and wavelength is

$$c = f\lambda.$$

**Rank from fastest to slowest. To rank items as equivalent, overlap them.**

**ANSWER:**

View

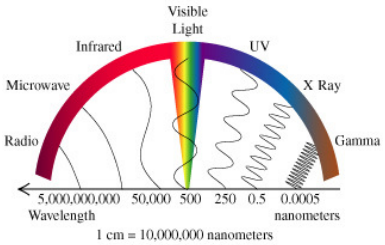
***Correct***

**Part B**

Rank these electromagnetic waves on the basis of their wavelength.

**Hint B.1** **Electromagnetic spectrum**

Different wavelength electromagnetic waves have historically been given different names. The traditional names for the various wavelengths are listed below.




**Hint B.2** **Radio waves**

By examining a radio dial, you will discover that FM radio stations broadcast with frequencies between 88 and 108 $\mathrm{MHz}$ (megahertz, or millions of cycles per second) and AM radio stations broadcast between 520 and 1720 $\mathrm{kHz}$ (kilohertz, or thousands of cycles per second).

**Hint B.3** **Visible light**

***Hint not displayed***

**Rank from longest to shortest. To rank items as equivalent, overlap them.**

**ANSWER:**

View
***Correct***

**Part C**

Rank these electromagnetic waves on the basis of their frequency.

**Rank from largest to smallest. To rank items as equivalent, overlap them.**

**ANSWER:**

View
***Correct***

## Problem 35.14

The magnetic field of an electromagnetic wave in a vacuum is $B_z = (3.0\,\mu\mathrm{T})\sin((1.00\times10^7)x - \omega t)$, where $x$ is in $\mathrm{m}$ and $t$ is in $\mathrm{s}$.

**Part A**

What is the wave's wavelength?

**ANSWER:**

$\lambda = 6.28\times10^{-7}$ $\mathrm{m}$
***Correct***

**Part B**

What is the wave's frequency?

**ANSWER:**

$f = 4.77\times10^{14}$ $\mathrm{Hz}$
***Correct***

**Part C**

What is the wave's electric field amplitude?

**ANSWER:**

$E_0 = 900$ $\mathrm{V/m}$
***Correct***

## Problem 35.19

A radio receiver can detect signals with electric field amplitudes as small as 380 $\mu\mathrm{V/m}$.

**Part A**

What is the intensity of the smallest detectable signal?

**ANSWER:** $1.92\times10^{-10}$ $\mathrm{W/m^2}$ *Correct*

## Problem 35.21

A radio antenna broadcasts a 1.0 MHz radio wave with 24.0 kW of power. Assume that the radiation is emitted uniformly in all directions.

**Part A**

What is the wave's intensity 32.0 km from the antenna?

**ANSWER:** $1.87\times10^{-6}$ $\mathrm{W/m^2}$ *Correct*

**Part B**

What is the electric field amplitude at this distance?

**ANSWER:** $3.75\times10^{-2}$ V/m *Correct*

## Radiation Pressure

A communications satellite orbiting the earth has solar panels that completely absorb all sunlight incident upon them. The total area $A$ of the panels is $10\ \mathrm{m^2}$.

**Part A**

The intensity of the sun's radiation incident upon the earth is about $I = 1.4\ \mathrm{kW/m^2}$. Suppose this is the value for the intensity of sunlight incident upon the satellite's solar panels. What is the total solar power $P$ absorbed by the panels?

**Hint A.1** **Definition of intensity**

*Hint not displayed*

**Express your answer numerically in kilowatts to two significant figures.**

**ANSWER:** $P =$ **14** *Correct* kW

**Part B**

What is the total force $F$ on the panels exerted by radiation pressure from the sunlight?

**Hint B.1** **Time derivative of a kinetic energy in relation to momentum**

*Hint not displayed*

**Hint B.2** **Working out the power incident upon the panels**

Once you have found a relation between the time derivative of the energy $K$ and the momentum $p$, recall that, in classical mechanics, we define power to be

$$P = \frac{dK}{dt},$$

whereas forces are given by

$$F = \frac{dp}{dt}.$$

Now find a symbolic expression for the power $P$ delivered by radiation in terms of the force $F$ imparted by the radiation.

**Your answer will involve the speed of light $c$.**

**ANSWER:** $P = Fc$ *Correct*

**Hint B.3** **Getting the units right**

*Hint not displayed*

**Express the total force numerically, to two significant figures, in units of newtons.**

**ANSWER:** $F =$ $4.70\times10^{-5}$ *Correct* N

## Problem 35.53

For a science project, you would like to horizontally suspend an 8.5 by 11 inch sheet of black paper in a vertical beam of light whose dimensions exactly match the paper.

**Part A**

If the mass of the sheet is 1.0 g, what light intensity will you need?

**ANSWER:** $4.87\times10^{7}$ $\mathrm{W/m^2}$
*Correct*

**Problem 35.25**

Only 20.0% of the intensity of a polarized light wave passes through a polarizing filter.

**Part A**

What is the angle between the electric field and the axis of the filter?

**ANSWER:** 63.4 °
*Correct*

**Problem 35.27**

Unpolarized light with intensity 320 $\mathrm{W/m^2}$ passes first through a polarizing filter with its axis vertical, then through a polarizing filter with its axis 40.0 ° from vertical.

**Part A**

What light intensity emerges from the second filter?

**ANSWER:** 93.9 $\mathrm{W/m^2}$
*Correct*

**Score Summary:**

Your score on this assignment is 99.2%.
You received 59.49 out of a possible total of 60 points.