NAME

PHYS-1200 PHYSICS II QUIZ 2 NOVEMBER 1, 2006

SOLUTIONS

PART A.

1. B
2. D
3. B
4. D
5. B
6. C
7. B
8. A

PART B.

1. a) **DECREASING** According to the right hand rule, the displacement current must be directed upward to produce the magnetic field shown, so the electric field must be decreasing.

   b) **DECREASING** According to the right hand rule, the displacement current must be directed downward to produce the magnetic field shown, so the electric field must be decreasing.

2. a) $|\Delta f| = f_{beat}$, so $|\Delta f|$ = <u>5.0 Hz</u>

   b) **LOWER THAN THE TUNING FORK** Increasing the tension increased the wave speed in the string, and therefore increased the frequency. Since the beat frequency decreased, raising the frequency of the string brought its frequency closer to that of the tuning fork. Therefore, it started out lower than the tuning fork.

3. a) ↑ The direction of the displacement current is the same as the current in the wire.

   b) ↑ The emf in the inductor opposes the increasing current.

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PART C.

1. a) $f = \frac{1}{2\pi}\sqrt{\frac{k}{M+m}} = \frac{1}{2\pi}\sqrt{\frac{500\text{ N/m}}{2.0\text{ kg}+0.5\text{ kg}}}$ <u>f = 2.25 Hz</u>

b) The maximum potential energy equals the maximum kinetic energy. Immediately after the bullet hits, the system has maximum kinetic energy.

$U_{\max} = K_{\max} = ½(M + m)V^2 = ½\ (2.0\text{ kg} + 0.5\text{ kg})(3.0\text{ m/s})^2$ <u>$U_{\max}$ = 11.3 J</u>

c) $v_{\max} = \omega x_{\max}$, so $x_{\max} = \frac{v_{\max}}{\omega} = \frac{v_{\max}}{\sqrt{\frac{k}{M+m}}} = \frac{3.0\text{ m/s}}{\sqrt{\frac{500\text{ N/m}}{2.0\text{ kg}+0.5\text{ kg}}}}$ <u>$x_{\max}$ = 0.21 m = 21 cm</u>

Or, using energy, $U_{\max} = ½\ k\ x_{\max}{}^2$, so $x_{\max} = \sqrt{\frac{2U_{\max}}{k}} = \sqrt{\frac{2(11.3\text{ J})}{500\text{ N/m}}} = 0.21\text{ m}$

d) **NO**

Before the collision, $K = ½mv^2 = ½(0.5\text{ kg})(15\text{ m/s})^2 = 56.25\text{ J}$

After the collision, $K = K_{\max} = 11.3$ J (from part b)

. The equation is of the form, $\vec{B} = B_m \cos\,[kx + \omega t]\ \hat{z}$,

so $k = 0.040\pi\text{ m}^{-1}$, and $\omega = 1.2\pi\times10^7\text{ s}^{-1}$.

a) $k = \frac{2\pi}{\lambda}$, so $\lambda = \frac{2\pi}{k} = \frac{2\pi}{0.040\pi\text{ m}^{-1}}$ λ = <u>50 m</u>

b) $\omega = 2\pi f$, so $f = \frac{\omega}{2\pi} = \frac{1.2\pi\times10^7\text{ s}^{-1}}{2\pi}$ f = <u>6.0×10^6 Hz = 6.0 MHz</u>

c) Since it is an electromagnetic wave, its speed in vacuum is v = <u>$c = 3.0\times10^8$ m/s</u>

Alternatively, $v = \frac{\omega}{k} = \frac{1.2\pi\times10^7\text{ s}^{-1}}{0.040\pi\text{ m}^{-1}} = 3.0\times10^8\text{ m/s}$,

or $v = f\lambda = (6.0\times10^6\text{ Hz})(50\text{ m}) = 3.0\times10^8\text{ m/s}$

d) **Negative *x* direction.** Since there is a positive sign in $kx + \omega t$, the wave is moving in the negative x direction.

e) **– *y***

Since the wave is moving in the negative x direction, $\vec{E}\times\vec{B}$ must point in the negative x direction. At $x = 0$ and $t = 0$, $\vec{B}$ points in the + $\hat{z}$ direction, so $\vec{E}$ points in the – $\hat{y}$