FINAL EXAMINATION

PHYS-1200 PHYSICS II MAY 9, 2006

PART A.

1. C	5. D	8. E	11. D	18. E
2. B	6. B	9. D	12. E	19. B
3. C	7. B	10. B	13. D	20. A
4. D			14. C	
			15. E	
			16. E	
			17. D	

PART B.

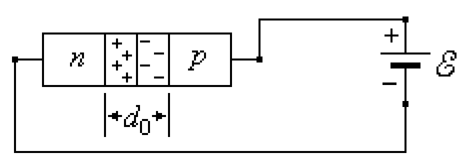
1. According to Gauss's law the flux emerging from a closed surface is given by, $\Phi = \oint \vec{E} \cdot d\vec{A} = \dfrac{q}{\varepsilon_0}$, where q is the net charge enclosed within the surface. Then,

   a) The surface S_1 encloses $+q$, so $\underline{\Phi_1 = +q/\varepsilon_0}$

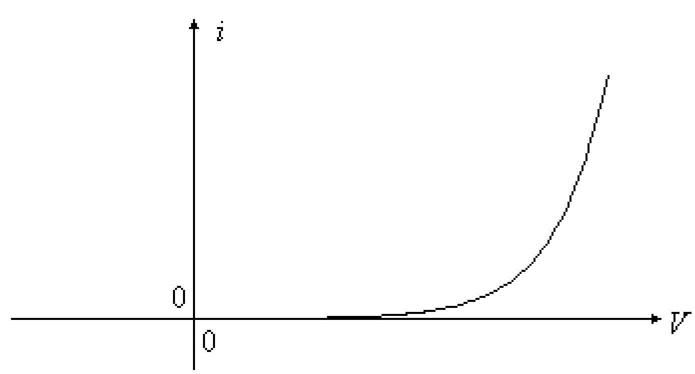
   b) The surface S_2 encloses $-2q$, so $\underline{\Phi_2 = -2q/\varepsilon_0}$

   c) The surface S_3 encloses $q - 2q = 0$, so $\underline{\Phi_3 = -q/\varepsilon_0}$

2. a)



b)



3. a) **GREATER THAN 500 Hz**

   b) **EQUAL TO 500 Hz**

   c) **LESS THAN 500 Hz**

   d) **EQUAL TO 500 H**

4. a) **Beam A** Longer wavelengths spread over larger angles.

   b) **Beam B** Faster electrons produce shorter wavelengths, and beam B has shorter wavelengths.

PART C.

1. a) **THE MAGNETIC FIELD IS INCREASING**

   b) $R = \frac{\mathcal{E}}{i} = \frac{0.020\text{ V}}{5.0\text{ A}}$

$$\underline{R = 4.0 \times 10^{-3}\ \Omega = 4.0\text{ m}\Omega}$$

   c) $|\mathcal{E}| = \left|\frac{d\Phi_B}{dt}\right| = \left|\frac{d(BA)}{dt}\right| = A\left|\frac{dB}{dt}\right|$. Since $A = \pi r^2$, this becomes, $|\mathcal{E}| = \pi r^2\left|\frac{dB}{dt}\right|$. Then,

$$\left|\frac{dB}{dt}\right| = \frac{|\mathcal{E}|}{\pi r^2} = \frac{0.020\text{ V}}{\pi(0.10\text{ m})^2}$$

$$\left|\frac{dB}{dt}\right| = 0.64\text{ T/s}$$

2. a) $T = 2\pi\sqrt{LC} = 2\pi\sqrt{(1.60\times10^{-2}\text{ H})(2.0\times10^{-6}\text{ F})}$ $\underline{T = 1.12\times10^{-3}\text{ s}}$

b) **IN SERIES WITH THE OTHER CAPACITOR**
To lower the period, the capacitance must be lowered. Adding a capacitor in parallel will lower the capacitance.

c) Call the desired period T_0 and the desired capacitance C_0. Then, $T_0 = 2\pi\sqrt{LC_0}$, so

$\sqrt{LC_0} = \frac{T_0}{2\pi}$, and $C_0 = \frac{1}{L}\left(\frac{T_0}{2\pi}\right)^2$. Also, $\frac{1}{C_0} = \frac{1}{C} + \frac{1}{C'} = L\left(\frac{2\pi}{T_0}\right)^2$. Then,

$$\frac{1}{C'} = L\left(\frac{2\pi}{T_0}\right)^2 - \frac{1}{C} = (1.6\times10^{-2}\text{ H})\left(\frac{2\pi}{1.00\times10^{-3}\text{ s}}\right)^2 - \frac{1}{2.0\times10^{-6}\text{ F}} = 1.317\times10^5\text{ F}^{-1}$$

$\underline{C' = 7.59\times10^{-6}\text{ F}}$

3. a) The easy way is to use $k = \frac{2\pi}{\lambda}$, so $\lambda = \frac{2\pi}{k} = \frac{2\pi}{1.08\times10^9\text{ m}^{-1}}$ $\underline{\lambda = 5.8\times10^{-9}\text{ m} = 5.8\text{ nm}}$

Also, $E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$. Since $p = \frac{h}{\lambda}$ this becomes $E = \frac{h^2}{2m\lambda^2}$. Then, $\lambda^2 = \frac{h^2}{2mE}$, and

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.63\times10^{-34}\text{ J}\cdot\text{s}}{\sqrt{2(9.11\times10^{-31}\text{ kg})(0.0445\text{ eV})(1.6\times10^{-19}\text{ J/eV})}} = 5.8\times10^{-9}\text{ m}$$

The same result.

b) $P(L/2 < x < \infty) = \int_{L/2}^{\infty}\psi_1^2(x)dx = \int_{L/2}^{\infty}A^2e^{-2\alpha x}dx = A^2\int_{L/2}^{\infty}e^{-2\alpha x}dx = \frac{A^2}{-2\alpha}\left[e^{-2\alpha x}\right]_{L/2}^{\infty}$

$P(L/2 < x < \infty) = \frac{A^2}{-2\alpha}\left[e^{-\infty} - e^{-2\alpha L/2}\right] = \frac{A^2}{-2\alpha}\left[0 - e^{-\alpha L}\right]$ $\underline{P(L/2 < x < \infty) = \frac{A^2}{2\alpha}e^{-\alpha L}}$

c) $P(-L/2 < x < L/2) = 1 - 2P(L/2 < x < \infty)$

This is true because:
$P(-\infty < x < -L/2) + P(-L/2 < x < L/2) + P(L/2 < x < \infty) = 1$, so
$P(-L/2 < x < L/2) = 1 - P(-\infty < x < -L/2) - P(L/2 < x < \infty)$.
However, from symmetry. $P(-\infty < x < -L/2) = P(L/2 < x < \infty)$. Therefore,
$P(-L/2 < x < L/2) = 1 - 2P(L/2 < x < \infty)$