9^{th} HOMEWORK
Due May 15, 2008

1. In the class we have shown that, if a charge is moving with a velocity $\vec{v}$, then the electric field it creates is constantly changing and this changing electric field creates a magnetic field due to the Ampere-Maxwell law. This created magnetic field is exactly

$$\vec{B} = \frac{\mu_0}{4\pi} q \frac{\vec{v} \times \ vecr}{r^3} \tag{1}$$

   Now, imagine a moving charge the creates a magnetic field given by Eq. 1. Since the charge is moving, the magnetic field at any fixed point is changing. This changing magnetic field creates an electric field. Calculate this induced electric field.

2. In the electron gun of a TV tube, an electron is accelerated by a constant electric field and acquires a kinetic energy of $3.2^{-15} J$ within a distance f 2.0 cm. What is the magnitude of the electric field that this accelerated electric generates at a distance 5.0 cm at right angles to its direction of motion?

3. On a radio antenna (a straight piece of wire), electrons move back and forth in unison. Suppose that the velocity of the electrons is $v = v_0 \cos \omega t$, where $v_0 = 8.0 \times 10^{-3}\ m/s$ and $\omega = 6.0 \times 10^6\ rad/s$.

   (a) What is the maximum acceleration of one of the electrons?

   (b) Corresponding to this maximum acceleration, what is the strength of the transverse electric field produced by one electron at a distance of 1.0 km from the antenna in a direction perpendicular to the antenna? What is the time delay (or retardation) between the instant of maximum acceleration and the instant at whic the corresponding electric field reaches a distance of 1.0 km?

   (c) There are 2.0×10^{24} electrons on the antenna. What is the collective electric field produced by all the electrons acting together? Assume that the antenna is sufficiently small so that all the electrons contribute just about the same electric field at a distance of 1.0 km

(d) Assume that at this distance, there is an electron. What will be the maximum acceleration of the electron due to this electric field?

4. A parallel plate capacitor is being charged by a current of 4.0 A

   (a) What is the displacement current between its plates?

   (b) What is the rate of change of electric flux intercepted by each plate?

5. An inductor with $L = 4.0 \times 10^{-2}\ H$ is connected to an oscillating source of emf. This source provides an emf $\mathcal{E} = \mathcal{E}_{max} \sin \omega t$, with $\mathcal{E}_{max} = 0.20\ V$ and $\omega = 6.0 \times 10^3\ rad/s$.

   (a) What is the reactance of the inductor?

   (b) What is the maximum current in the circuit?

   (c) What is the current at time $t = 0$? At time $t = \pi/4\omega$?