EXAM II

Physics 122 **Fall 2006**

1. One electron collides elastically with a second electron initially at rest. After the collision, the radii of their trajectories are 1.00 cm and 2.40 cm. The trajectories are perpendicular to a uniform magnetic field of magnitude 0.044 T.

   9 (a) In terms of the radii, electronic charge, magnetic field, and electron mass, what are the post collision speeds of the two electrons?

   3,3 (b) What are the post-collision energies of the two particles?

   4 (c) What is the pre-collision speed of the moving electron?

   4,2 (d) What is the pre-collision energy of the moving electron? In Joules? In electron volts?

$\vec{B} \perp \vec{v} \Rightarrow F_B = qvB = ma = \frac{mv^2}{r} \Rightarrow v = \frac{qBr}{m}$

so $v_1 = 7.73 \times 10^7 \frac{m}{s}$, $v_2 = 1.85 \times 10^8 \frac{m}{s}$ //

$KE = \frac{1}{2}mv^2 \Rightarrow \begin{cases} KE_1 = 2.73 \times 10^{-15}\ J \\ KE_2 = 1.57 \times 10^{-14}\ J \end{cases}$ //

elastic collision ⇒ conservation of energy

$KE_0 = KE_1 + KE_2 = 1.84 \times 10^{-14}\ J = 1.15 \times 10^5\ eV$ //

$\Rightarrow v_0 = \sqrt{\frac{2KE_0}{m}} = 2.01 \times 10^8 \frac{m}{s}$ //

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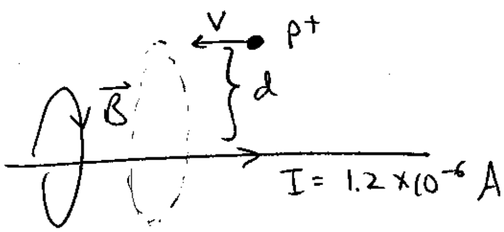
2. A long wire lies flat on a horizontal table, on the surface of the earth, and carries a current of 1.20 μA. A proton moves parallel to the wire (opposite to the current) with a constant speed of 2.30×10^4 m/s at a distance d above the center of the wire.

   8 (a) At d, what is the magnetic field due to the current carrying wire?

   8 (b) What forces act on the proton?

   9 (c) What value must d be for the proton to move parallel to the wire?



use Ampère's Law: $\sum_i \vec{B} \cdot d\vec{l}_i = \mu_0 I_{enclosed}$

$$B \cdot 2\pi d = \mu_0 I$$

$$B = \frac{\mu_0 I}{2\pi d}$$ out of the page //

$\uparrow \vec{F}_B = q\vec{v} \times \vec{B}$

$\downarrow F_g$ //

for equilibrium at d: $\sum F = 0$

$$F_B - F_g = 0$$

$$qvB - mg = 0$$

$$q\frac{v\mu_0 I}{2\pi d} - mg = 0$$

$$d = \frac{\mu_0 q v I}{2\pi m g} = 0.054 \text{ m}$$ //

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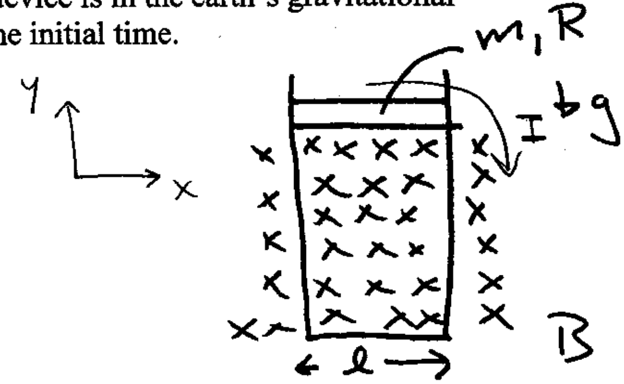
3. As indicated in the figure, there is a sliding bar of mass m and resistance R, that completes the circuit in a magnetic field B. The device is in the earth's gravitational field and the bar is allowed to begin falling at some initial time.



4 (a) In the absence of the magnetic field what is the velocity of the bar as a function of time?

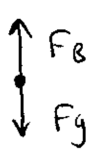
5 (b) What forces act on the bar? Why?

6 (c) Is there a current in the circuit? In what direction? Why?

10 (d) Is there a steady state (time independent) velocity? Why? What is it in terms of m, R, g, l and B?

if $\vec{B} = 0 \Rightarrow \quad v(t) = -gt$ //

- has mass ⇒ gravitational force $F_g = mg$ down
- magnetic flux is decreasing ⇒ current flows ⇒ have a current in a magnetic field ⇒ magnetic force //
- Current flows to oppose change in magnetic flux
  ⇒ Creates $\vec{B}$-field into page
  ⇒ flows CW by right hand rule //



steady state ⇒ $F_B = F_g$

$I \ell B = mg$

$\left(\frac{\varepsilon}{R}\right)\ell B = mg$ by Ohm's Law

$\frac{(B\ell v)}{R}\ell B = mg$ by motional EMF

$\Rightarrow V = mgR/B^2\ell^2$ //

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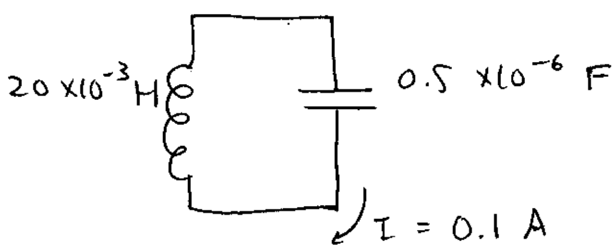
4. An LC circuit consist of a 20.0- mH indicator and a 0.500 –μF capacitor. The maximum instantaneous current is 0.100A.

13 (a) In Joules what is the total energy in the circuit?

12 (b) What is the greatest potential difference across the capacitor?



at max. current, Q of capacitor = 0 ⇒ $U_C = 0$

$U_{TOTAL} = U_L = \frac{1}{2} L I^2 = 1 \times 10^{-4}$ J //

greatest ΔV in capacitor when $I = 0 \Rightarrow U_L = 0$

$U_{TOTAL} = 10^{-4}$ J $= \frac{1}{2} C \Delta V^2$

$\Rightarrow \Delta V = 20$ V //