

Physics 116 - Exam II

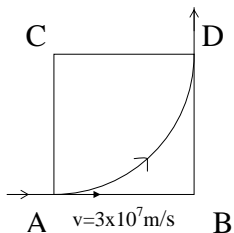
3 March 2004

Please do not turn the page until you are told to. When you do so, make sure that you have all three problems on your copy of the test.

In order to get credit on a problem, you must show your work. If you only write down an answer without the work leading up to it, you will get no credit for it, even if it is the right answer.

(1) A magnetic field is present in the square region ABCD ($AB = 5 \text{ cm}$) shown in the figure. The magnetic field is perpendicular to the page. An electron enters at A from the left with a speed of $3 \times 10^7 \text{ m/s}$ and subsequently follows the trajectory shown.

(a) (5 points) If the electron follows the path in the figure, does the magnetic field go into the paper or out of the paper?



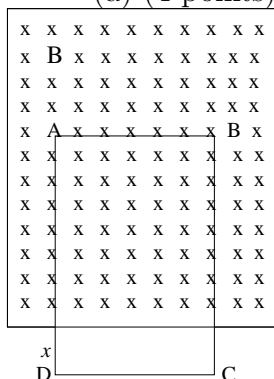
(b) (5 points) Calculate the magnitude of the magnetic field so that the electron exits at D and its direction is now vertical.

(c) (5 points) What is the speed of the electron at point D?

(d) (5 points) How much time did the electron spend from A to D?

(2) A loop ABCD starts to fall out of a region with a magnetic field of magnitude B directed into the page as shown in the figure. Let $AB = l$, and $AD = h$. At some time t , the distance of point D below the field region is x . The mass of the loop is m , its resistance is R .

(a) (4 points) At time t , what is the magnetic flux through the loop?



(b) (4 points) If the speed of the loop at that instant is v , what is the magnitude of the induced emf in the loop?

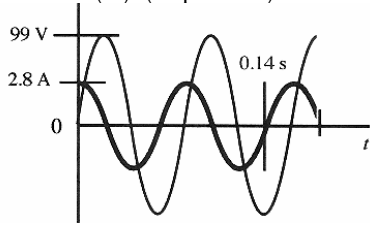
(c) (4 points) In what direction is the current flowing due to this emf?

(d) (4 points) What is the force exerted on the loop due to the magnetic field and the induced current?

(e) (4 points) Suppose the loop originally is at rest and starts falling. What will happen to its speed v ? Will it continue accelerating? Will it reach a constant velocity, and if so, what is this velocity? (Assume that the loop does not entirely leave the region of magnetic field.)

(3) The graph shows the voltage across and the current through a single circuit element connected to an AC generator.

(a) (4 points) Please determine the frequency of the generator.



(b) (4 points) Please determine the *rms* voltage across this element.

(c) (4 points) Please determine the *rms* current through this element.

(d) (4 points) What is the reactance of this element?

(e) (4 points) Identify the circuit element. Specify the value of the capacitance if it is a capacitor, the value of the inductance, if it is an inductor, or the value of the resistance if it is a resistor.

$$F = k \frac{|q_1||q_2|}{r^2}$$

$$k = \frac{1}{4\pi\epsilon_0}$$

$$\vec{E} = \frac{\vec{F}}{q_0}$$

$$E = k \frac{|q|}{r^2}$$

$$\Phi_E = \Sigma(E \cos \theta) \Delta A$$

$$\Phi_E = \frac{Q_{encl}}{\epsilon_0}$$

$$V = \frac{EPE}{q_0}$$

$$E = -\frac{\Delta V}{\Delta s}$$

$$q = CV$$

$$Energy = \frac{1}{2} CV^2$$

$$I = \frac{\Delta q}{\Delta t}$$

$$V = IR$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$R_{eq} = R_1 + R_2 + \dots$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$$

$$C_{eq} = C_1 + C_2 + \dots$$

$$F = q(v \sin \theta) B$$

$$F = ILB \sin \theta$$

$$\mu = NIA$$

$$\tau = NIAB \sin \phi$$

$$B = \frac{\mu_0 I}{2\pi R}$$

$$B = N \frac{\mu_0 I}{2R}$$

$$B = \mu_0 n I$$

$$n = N/L$$

$$\Sigma B_{||} \Delta l = \mu_0 I_{encl}$$

$$\mathcal{E} = BLv$$

$$\Phi_B = BA \cos \theta$$

$$\mathcal{E} = -N \frac{\Delta \Phi_B}{\Delta t}$$

$$\mathcal{E} = -L \frac{\Delta I}{\Delta t}$$

$$Energy = \frac{1}{2} LI^2$$

$$\frac{I_P}{I_S} = \frac{V_S}{V_P} = \frac{N_S}{N_P}$$

$$X_C = \frac{1}{\omega C}$$

$$X_L = \omega L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$V_{rms} = I_{rms} Z$$

$$V_{rms} = \frac{V}{\sqrt{2}}$$

$$\tan \phi = \frac{X_L - X_C}{R}$$

$$\bar{P} = I_{rms} V_{rms} \cos \phi$$

$$f_0 = \frac{1}{2\pi \sqrt{LC}}$$

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

$$c = \frac{E}{B}$$

$$u = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2\mu_0} B^2$$

$$S = cu$$

$$f_0 = f_s \left(1 \pm \frac{v_{rel}}{c} \right) \quad \text{if } v_{rel} \ll c$$

$$\bar{S} = \bar{S}_0 \cos^2 \theta$$

.....other.....

$$F_{cp} = m \frac{v^2}{r}$$

$$KE = \frac{1}{2}mv^2$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

.....constants.....

$$g = 9.8 \text{ m/s}^2$$

$$k \approx 9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$$

$$e = 1.60 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/(\text{N} \cdot \text{m}^2)$$

$$c \approx 3 \times 10^8 \text{ m/s}$$