

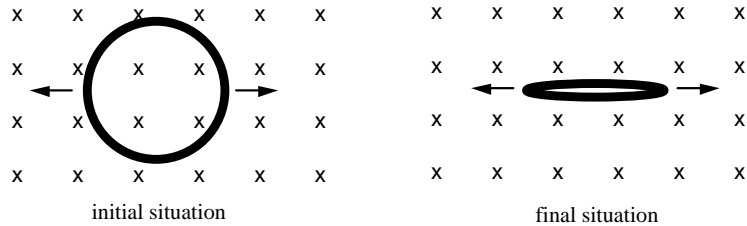
Name: KEY

Phys.116 Exam II
19 July 2004

Please do not turn the page until you are told to do so. 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 flexible, circular conducting loop of radius 0.15 m and resistance 4.0 Ω lies in a uniform magnetic field of 0.25 T. The loop is pulled on opposite sides by equal forces and stretched until its enclosed area is essentially zero m², as suggested in the drawings. It takes 0.30 s to close the loop.



a.(7 points) Determine the magnitude of the emf induced in the loop.

$$\mathcal{E} = -N \frac{\Delta\Phi_B}{\Delta t} = -NB \frac{\Delta A}{\Delta t} = -NB \frac{(0 - \pi R^2)}{\Delta t} = -1(0.25) \frac{-\pi(0.15)^2}{0.3} = 0.059 \text{ V}$$

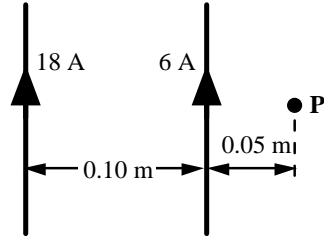
b.(7 points) At what rate is heat generated in the loop?

$$P = \frac{V^2}{R} = \frac{0.059^2}{4} = 0.87 \text{ mW}$$

c.(6 points) What is the direction of the *induced* magnetic field generated by the current induced in the loop while the loop is being stretched?

While the loop is being stretched, its area is decreasing, and so is the magnetic flux through the loop. A magnetic field will be induced in the loop to oppose this decrease. The induced B-field will have to be in the same direction as the original field, or into the page.

2. Two long, straight wires separated by 0.10 m carry currents of 18 A and 6 A in the same direction as shown.



a.(7 points) Determine the magnitude of the magnetic field at the point **P**.

$$B = B_1 + B_2 = \frac{\mu_0 I_1}{2\pi R_1} + \frac{\mu_0 I_2}{2\pi R_2} = \frac{\mu_0}{2\pi} \left(\frac{I_1}{R_1} + \frac{I_2}{R_2} \right) = \frac{4\pi \times 10^{-7}}{2\pi} \left(\frac{18}{0.10 + 0.05} + \frac{6}{0.05} \right) = 4.8 \times 10^{-5} \text{ T}$$

b.(6 points) What is the direction of the magnetic field at the point **P**?

By the right hand rule, both magnetic fields due to the two currents are directed into the paper at point P, and so is their sum.

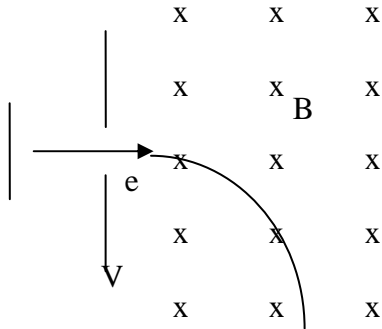
c.(7 points) What is the force per unit length (magnitude and direction) that the 6A current exerts on the 18 A current?

$$F = I_1 L B_2 = I_1 L \frac{\mu_0 I_2}{2\pi d}$$

$$\frac{F}{L} = I_1 \frac{\mu_0 I_2}{2\pi d} = 18 \frac{4\pi \times 10^{-7} (6)}{2\pi (0.10)} = 2.2 \times 10^{-4} \text{ N to the right}$$

3. In an experiment designed to measure the strength of a uniform magnetic field, electrons are accelerated from rest (by means of an electric field) through a potential difference of 350 V. After leaving the region of the electric field, the electrons enter a magnetic field and travel along a curved path because of the magnetic force exerted on them. The radius of the path is measured to be 7.50 cm.

a.(5 points) Sketch on the diagram the subsequent circular trajectory.



b.(5 points) Calculate the kinetic energy of the electron after it has been accelerated through the potential difference.

$$KE = qV = 1.6 \times 10^{-19} (350) = 5.6 \times 10^{-17} \text{ J}$$

c.(5 points) Calculate the velocity of the electron.

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

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(5.6 \times 10^{-17})}{9.11 \times 10^{-31}}} = 1.1 \times 10^7 \text{ m/s}$$

d.(5 points) Assuming the magnetic field is perpendicular to the beam, what is the magnitude of the field?

$$\sum F = ma = m \frac{v^2}{R}$$

$$qvB \sin \theta = m \frac{v^2}{R}; \sin \theta = 1$$

$$B = \frac{mv}{qR} = \frac{(9.11 \times 10^{-31})(1.1 \times 10^7)}{(1.6 \times 10^{-19})(0.075)} = 8.4 \times 10^{-4} \text{ T}$$