

NAME:

Physics 11

Exam 3

Spring 2009

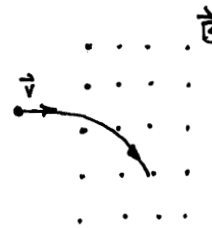
Science is facts: just as houses are made of stones, so is science made of facts; but a pile of stones is not a house and a collection of facts is not necessarily science.

–Henri Poincare

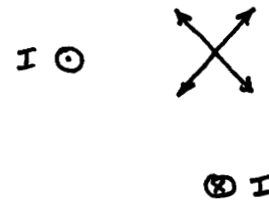
Rules: All answers must be accompanied by clear and concise explanations, appropriate calculations, and diagrams. Where appropriate, the correct physical units must be included in answers. Partial credit can be earned if correct reasoning is clearly expressed.

Shorter Questions (each worth 5 points)

- 1 A charged particle moves into a magnetic field and deflects as shown in the figure. What is the sign of the particle's electric charge?



- 2 Two long wires are oriented perpendicular to the page and carry currents in opposite directions as shown. Circle the vector that best describes the total magnetic field at the point indicated.



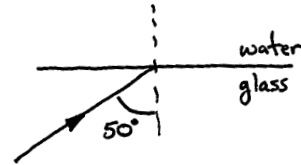
- 3 A step-down transformer decreases 5000V on the primary side to 120V on the secondary side. If a hairdryer is plugged in on the secondary side and draws 5A, how much current will this cause to flow on the primary side of the transformer?

- 4 A local FM radio station operates at a frequency of 107.7 Megahertz (Mega= 1 million). What is the wavelength of electromagnetic waves generated by this station?

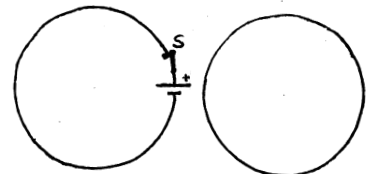
5 In a particular mass spectrometer, Carbon 14 atoms travel with a radius of 25cm. What would the radius for a Carbon 12 atom be in the same spectrometer?

6 A long wire carries a current of 20 A. At what distance from the wire is its magnetic field magnitude equal to the earth's magnetic field (0.5×10^{-4} T)?

7 A beam of light is incident on an interface between glass ($n = 1.50$) and water ($n = 1.33$), at an angle of 50° in the glass. At what angle does the beam go into the water?

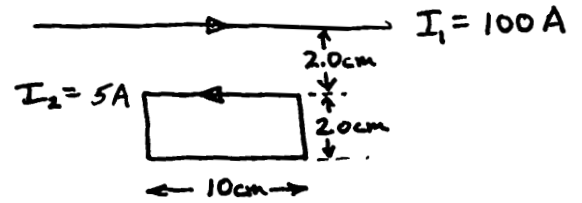


8 Two wire loops lie in a plane along side each other, as shown. Current is flowing in the loop on the left. When the switch in the loop on the left is opened, what direction does the induced current flow in the loop on the right? EXPLAIN YOUR REASONING.



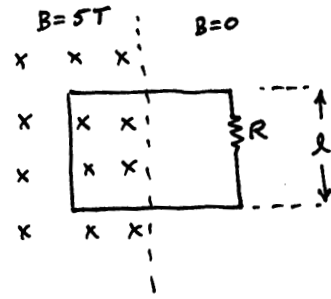
Longer Questions

- 9 (10 points) A rectangular loop of wire lies in the same plane as a long, straight wire, as shown in the figure. There is a current of 100A in the long wire and a current of 5A flows in the loop. The direction of each current is indicated in the figure.



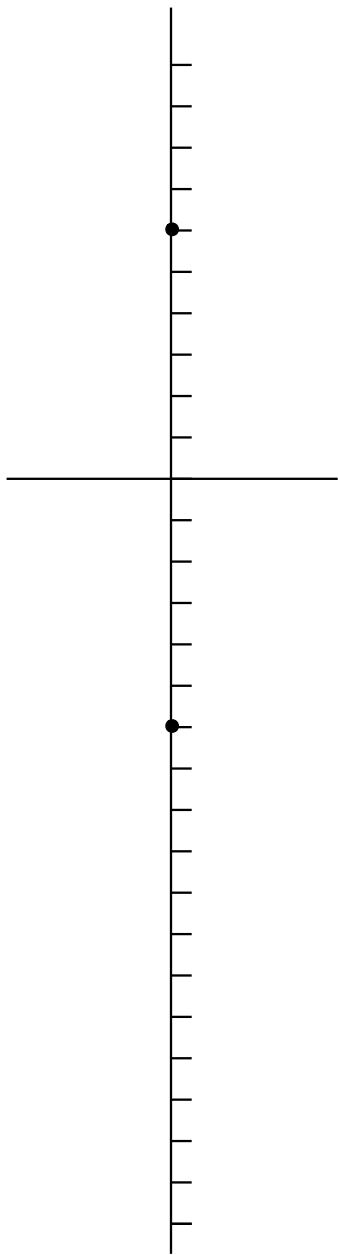
- What is the magnetic field (magnitude and direction) a distance 2.0cm from the long wire?
- What is the magnetic field (magnitude and direction) a distance 4.0cm from the long wire?
- What is the net force on the loop due to the long wire (magnitude and direction)?

- 10 (15 points) A wire loop of width $\ell = 20\text{cm}$ and resistance $R = 10\Omega$ is pushed *into* a region of uniform magnetic field $B = 5\text{T}$ at a constant speed $v = 5\text{m/s}$. The magnetic field points in the direction indicated in the diagram.



- What is the emf generated?
- What is the magnitude of the current that flows in the loop?
- What direction does the current flow? EXPLAIN YOUR REASONING.
- How much force is required to push the loop in at the constant speed of 5m/s ?

- 11** (15 points) An object that is 1cm tall is placed 20 cm in front a converging lens with focal length 30 cm.
- a) Where is the image located?
 - b) Describe the image.
 - c) How tall is the image?
 - d) Construct a ray diagram for the configuration (use the diagram axis provided on the next page—the focal points have been indicated for you.



Useful Information

$$F_B = qvB \sin \theta$$

$$r = \frac{mv}{qB}$$

$$F_{21} = \frac{\mu_0 I_1 I_2 \ell}{2\pi r}$$

$$m = \frac{qB'r}{v} = \frac{qB'B}{E}r$$

$$I = \frac{\varepsilon}{R}$$

$$V_{peak} = \sqrt{2}V_{rms}$$

$$I_s V_s = I_p V_p$$

$$\lambda f = c$$

$$\sin \theta_c = \frac{n_2}{n_1}$$

$$f = \frac{r}{2}$$

$$F_B = I\ell B \sin \theta$$

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

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

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

$$\varepsilon = Bv\ell$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$P = I_p^2 R$$

$$\theta_r = \theta_i$$

$$d_i = d_o$$

$$\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$$

$$qvB = m\frac{v^2}{r}$$

$$\mathbf{B}_{tot} = \mathbf{B}_1 + \mathbf{B}_2 + \mathbf{B}_3 + \dots$$

$$qvB' = m\frac{v^2}{r}$$

$$\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$$

$$\varepsilon = NBA\omega \sin \omega t$$

$$P = IV$$

$$E = cB$$

$$n_2 \sin \theta_2 = n_1 \sin \theta_1$$

$$h_i = h_o$$

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

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

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

$$e = 1.6 \times 10^{-19} \text{C}$$

$$m_e = 9.11 \times 10^{-31} \text{kg}$$

$$m_p = 1.67 \times 10^{-27} \text{kg}$$