Physics 112 Sample Test 2

NAME _____

Please complete this page and turn it in.   Write down each relationship under its name.

Lorentz Force (single charge)   Lorentz Force (current element)

Force on a current carrying wire of length L

Magnetic Moment   Torque on a current Loop

Biot-Savart Law   Ampere's Law

Magnetic field due to:

Infinite wire   Arc of current   Loop of current on central axis

Definition of Magnetic flux   Faraday's Law

Physics 112 Sample Test 2

NAME _____

Lorentz Force (single charge)

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

Lorentz Force (current element)

$$dF = dq\vec{E} + Id\vec{l} \times \vec{B}$$

Force on a current carrying wire of length L

$$\vec{F} = I(\vec{L} \times \vec{B})$$

Magnetic Moment

$$\vec{\mu} = NI\vec{A}$$

Torque on a current Loop

$$\vec{T} = \vec{\mu} \times \vec{B}$$

Biot-Savart Law

$$db = \frac{\mu_0}{4\pi} \frac{Idl \times \hat{r}}{r^2}$$

Ampere's Law

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{enc}$$

Magnetic field due to:

Infinite wire

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

Arc of current

$$B = \frac{\mu_0 I \theta}{4\pi r}$$

Loop of current on central axis

$$B = \frac{\mu_0 I}{2} \frac{a^2}{(x^2 + a^2)^{3/2}}$$

Definition of Magnetic flux

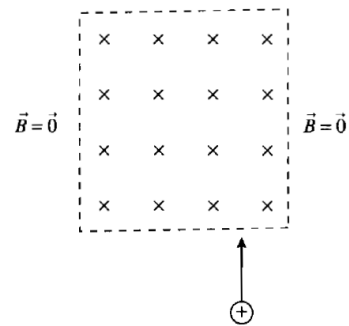$$\Phi_B = \oint \vec{B} \cdot d\vec{A}$$

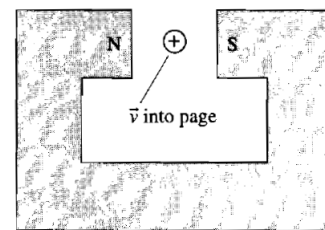Faraday's Law

$$V = -\frac{d\Phi}{dt}$$

1. Concepts

The magnetic field is constant magnitude inside the dotted lines and zero outside. Sketch and label the trajectory of the charge for

a. A very weak field.

b. A moderate field.

c. A strong field.

A positive ion, initially traveling into the page, is shot through the gap in a magnet. Is the ion deflected up, down, left, or right? Explain.

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A positive ion is shot between the plates of a parallel-plate capacitor.

a. In what direction is the electric force on the ion?

b. Could a magnetic field exert a magnetic force on the ion that is opposite in direction to the electric force? If so, show the magnetic field on the figure.
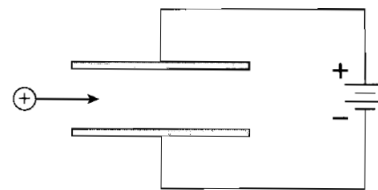
Two current-carrying wires cross at right angles.

a. Draw magnetic force vectors on the wires at the points indicated with dots.

b. If the wires aren't restrained, how will they behave?
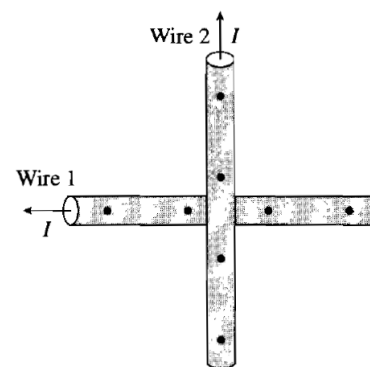
A current loop is placed between two bar magnets. Does the loop move to the right, move to the left, rotate clockwise, rotate counterclockwise, some combination of these, or none of these? Explain.

A square current loop is placed in a magnetic field as shown.

a. Does the loop undergo a displacement? If so, is it up, down, left, or right? If not, why not?
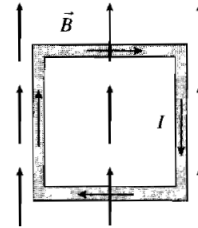
b. Does the loop rotate? If so, which edge rotates out of the page and which edge into the page? If not, why not?

The south pole of a bar magnet is brought toward the current loop. Does the bar magnet attract the loop, repel the loop, or have no effect on the loop? Explain.
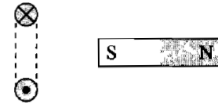
2. A particle of charge q and mass m starts at rest and is accelerated through a potential difference ΔV applied across two parallel plates. It then enters a region of uniform magnetic field (pointing out of the paper) where its trajectory becomes circular. After following a half-circle of diameter d, the ion passes through a small opening and hits a detector.

(a) Is the sign of the ion's charge positive or negative?

(b) Is the sign of charge on the left plate positive or negative?

(c) Find an express for the potential required to hit the detector, ΔV, in terms of B, d, m, and q.

ΔV

q

d

detector

B_{out}
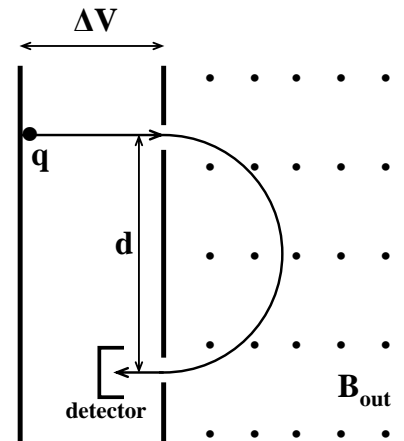
A loop of wire has the shape of two concentric semicircles connected by two radial segments. The loop carries a current I = 420 A in the direction indicated by the arrows on the straight segments. Use the Biot-Savart Law to find the magnitude and direction of the magnetic field at point P, located at the center of both semicircles. Let R = 29 cm.
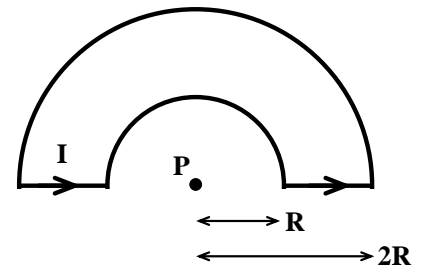
For full credit, you should derive your equations for magnetic field from first principles. Don't simply write down the results from memory.

A coaxial cable consists of a thick, solid inner conductor of radius R_1 surrounded by a hollow, very thin outer conductor of radius R_2. The two conductors carry currents I_1 and I_2, respectively, where **$I_1 > I_2$**. The currents flow in opposite directions, and the current densities are uniform throughout the conductors.
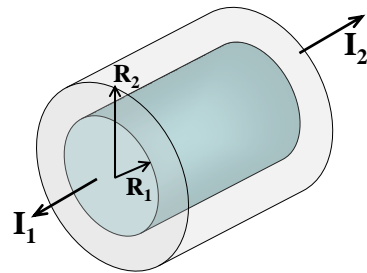

Use Ampere's law to determine the magnitudes and directions of the magnetic field vectors for these three regions: $r < R_1$, $R_1 < r < R_2$, and $r > R_2$. Draw cross-sectional sketches for each.

For full credit, you should derive your equations for magnetic field from first principles (Ampere's Law). Don't simply write down the results from memory.

In the figure is a U-shaped conducting rail that is oriented vertically and immersed in a horizontal magnetic field (that points into the paper). The rail has no electrical resistance and does not move. A slide bar with mass m, length L, and resistance R can slide vertically without friction while maintaining electrical contact with the rail. The slide wire is released from rest. It accelerates downward because of its own weight and eventually reaches a terminal velocity v_{term}.

(a) Explain why the bar reaches a terminal velocity instead of accelerating uniformly under the force of gravity.

(b) Find an expression for the terminal velocity using only the given parameters and known constants.
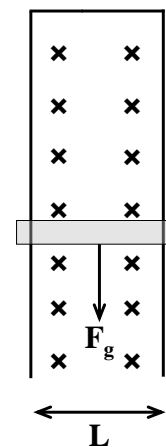
A charged particle is fired into the end of a solenoid with a velocity v that makes an angle of θ with the solenoid's central axis. The solenoid carries a current I and has N turns along its length. How many revolutions does the electron make along its helical path within the solenoid by the time it emerges from the solenoid's opposite end?