Physics 133 Homework 6
Sources of Magnetic Fields and Magnetic Force
Due Wednesday November 25

Problem 1.
An infinitely long wire is bent into the shape shown on the figures page: two semi-infinite straight parts connected by a semi-circle of radius R. The current in the wire is I. Find the magnitude of the magnetic field at the center of the semi-circle. Express your answer in terms of μ_0, I and R.

Problem 2.
Four particles, labeled 1, 2, 3, and 4, follow the paths shown on the figures lage. There is a constant, uniform magnetic field that points **into the page**. What can you conclude about the charges of the particles?

Problem 3.
A particle with a charge of -1.5 Coulombs moves with a velocity $\vec{v} = 6\hat{i} - 3\hat{j}$ m/sec in a constant magnetic field. The force that the particle feels is $\vec{F} = 2\hat{i} + 4\hat{j} + 3\hat{k}$ Newtons. The magnetic field lies in the y-z plane. Find the magnetic field. You can express your answer in terms of the unit vectors $\hat{i}$, $\hat{j}$, $\hat{k}$.

Problem 4.
A conducting metal bar of mass 1 Kg rests on a pair of rods. The conducting bar is 1 meter long. The rods make an angle of 30° with the horizontal. There is a constant magnetic field of magnitude 2 Tesla which points upward. The rods have a resistance of 5 Ohms/meter and are connected to a 20 Volt battery. There is no friction between the conducting bar and the rods. The rod stays in place because the magnetic, gravitational, and normal forces balance. See the figure on the figures page. What is the value of x in the figure, such that the rod remains stationary?

Problem 5.
Three infinitely long wires are parallel to each other and equi-distant from each other as shown in the figures page. In the bottom two wires, the current flows out of the page. In the top wire, the current flows into the page. What net force does the top wire feel due to the bottom two?

Problem 6.
A mass spectrometer is used to find the mass of ions. An ion of mass m and charge

q starts at rest. It is accelerated through a voltage difference of magnitude V. It then enters a region in which there is a uniform magnetic field, B. After traveling in a semi-circle, it hits the side a distance x from where it entered the region of the magnetic field. See the figure on the figures page. Determine the mass m of the ion in terms of B, q, V, and x.

Problem 7.
A rectangular wire lies next to an infinitely long straight wire as shown in the figures page. A current of I_1 flows in the straight wire, and a current of I_2 flows in the rectangular wire. The dimensions of the wire are l and w, and the rectangular is located a distance d from the straight wire. What is the force that the rectangular wire feels due to the straight wire?

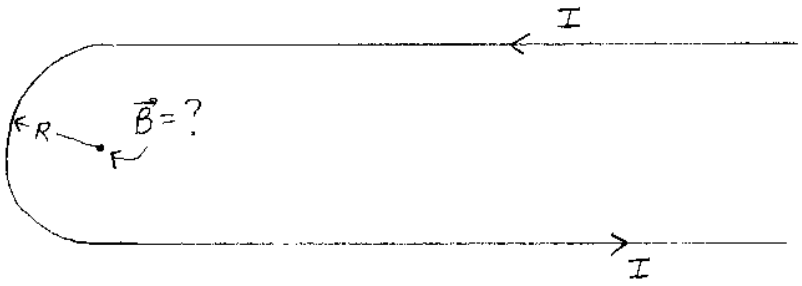
Problem 8.
A wire is bent into the shape of a rectangle of sides 5 cm by 10 cm. A current of 2 amps flows in the wire. The long axis side of the wire lies along the z-axis, and the rectangle makes an angle of 30° with the x-axis as shown in the figure on the figures page. A uniform magnetic field of magnitude 0.5 Tesla points in the x-direction. What is the torque that the rectangle experiences?

Problem 9.
Two long parallel wires, each having a mass per unit length μ, are supported by strings of length L. Each wire carries the same current I, and the wires repel each other. The angle between the strings is θ as shown on the figures page. Find an expression for the magnitude of the current. Express your answer in terms of θ, μ, μ_0, L, and g.

See the next three pages for the figures

Figures for Homework 6, PHY133

(1)



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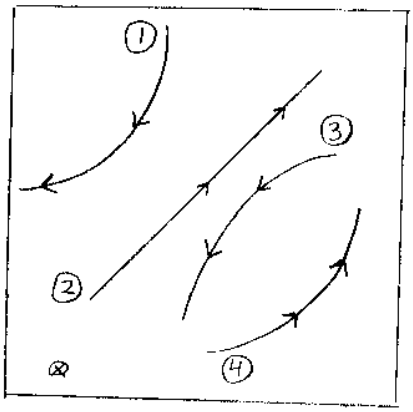

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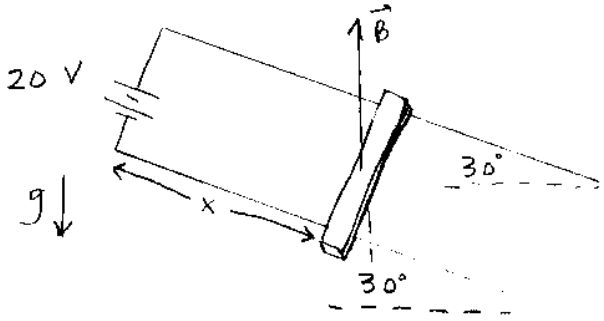

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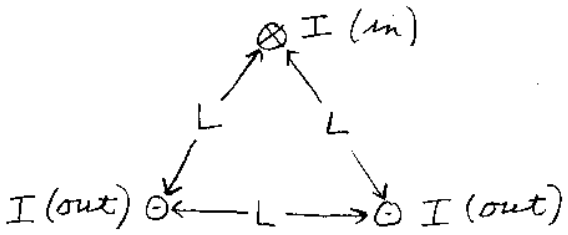

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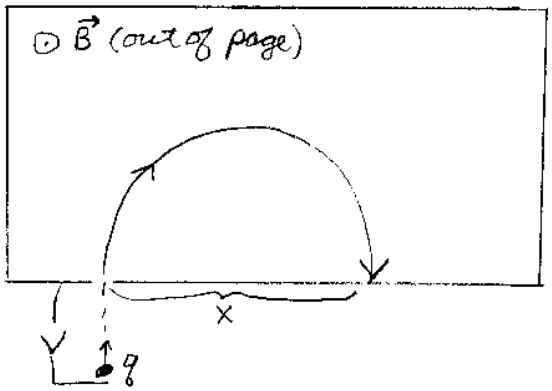

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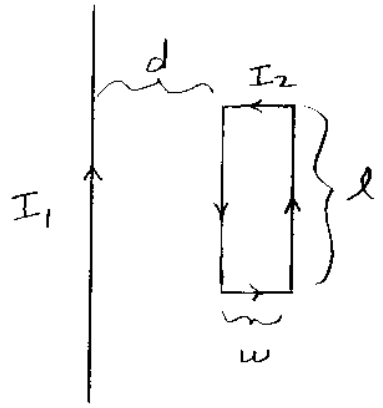

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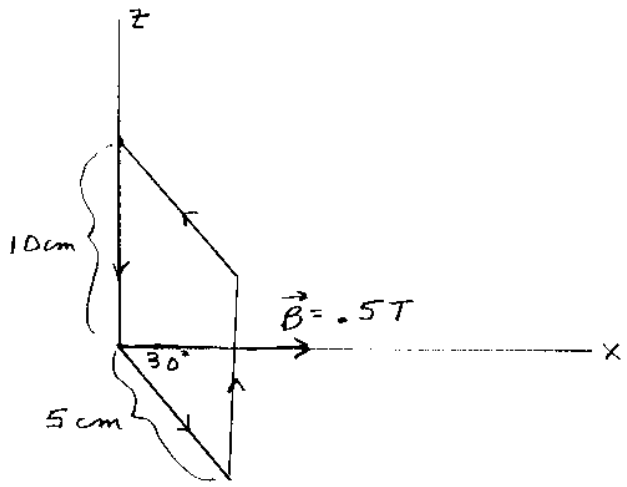

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