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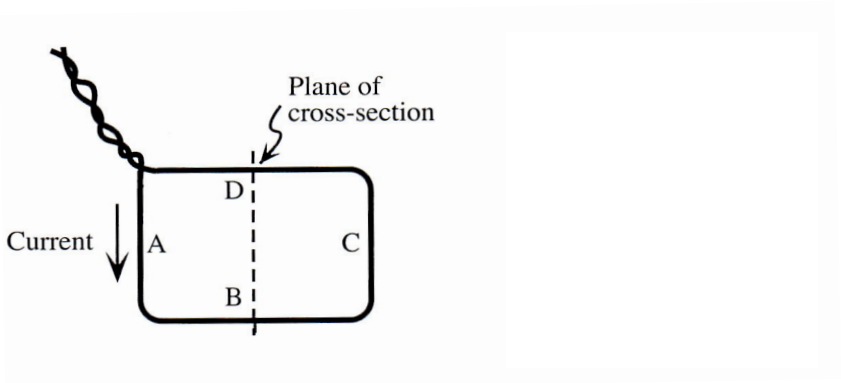
PY212

Discussion Worksheet 7

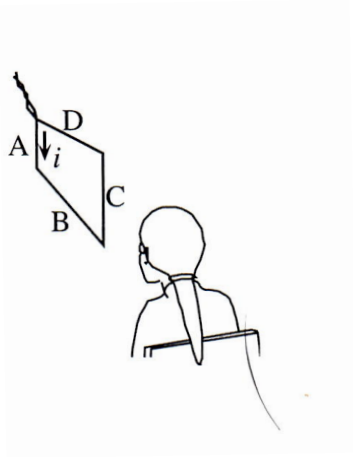
Please work with your partners on the following exercises.

1.) A wire is formed into a loop and the leads are twisted together. The sides of the loop are labeled *A*-*D*. The direction of the current is shown.



a.) On the top diagram at right, sketch magnetic field lines for the loop. Base your answer on your knowledge of the magnetic field of a current-carrying wire.

Explain why it is reasonable to ignore the effect of the magnetic field from the wire leads.



b.) Consider the magnetic field of a bar magnet.

How are the magnetic field lines for the current loop similar to those for a short bar magnet?

Can you identify a *"north"* and *"south"* pole for a current loop?

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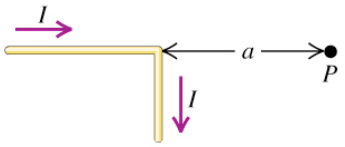
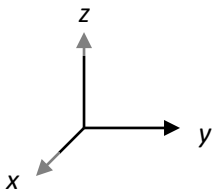
2.) An infinitely long wire with current I is bent, as shown in the figure. Answer the following questions about the magnetic field at a point P a distance a away from the bend.



a.) Is the contribution to the magnetic field due to any portion of the wire zero? Please explain.



b.) Is *Ampere's Law* or the *Biot-Savart Law* more useful for this problem? Explain.

c.) Using the coordinate system shown, draw the vectors $d\hat{l}$ and $\hat{r}$. What is the direction of the magnetic field?

d.) Solve for the magnetic field at the point P. Note that $\int \frac{dx}{\left(a^2+x^2\right)^{3/2}} = \frac{x}{a^2\sqrt{a^2+x^2}}$.

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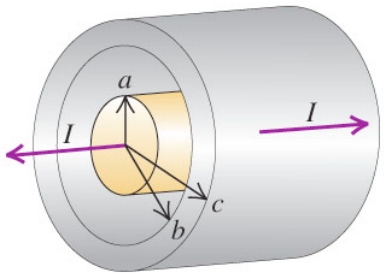
e.) Does your answer make sense, compared to other results? Explain.

3.) A very long, straight wire with a circular cross section of radius a is supported by insulating disks on the axis of a conducting tube with inner radius b and outer radius c (see figure). The central wire and outer tube carry equal currents I in opposite directions. The central wire carries a *non-uniform* (but cylindrically symmetric) current density described by $J_1 = \alpha r$ where r is the distance from the center of the tube. The outer tube has current distributed uniformly over the cross section described by J_2.

a.) Is Ampere's law still applicable? Explain. If so, what Amperian loop should you use?



b.) Describe how the problem must be treated differently because of the *non-uniform* current density?

c.) What is the current enclosed in a circular cross section centered on the tube with radius $r < a$? $a < r < b$? $b < r < c$? $r > c$?

d.) Using your answer from part c, solve for α and J_2 in terms of the known variables.

e.) What is the magnetic field in the regions $r < a$? $a < r < b$? $b < r < c$? $r > c$?

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