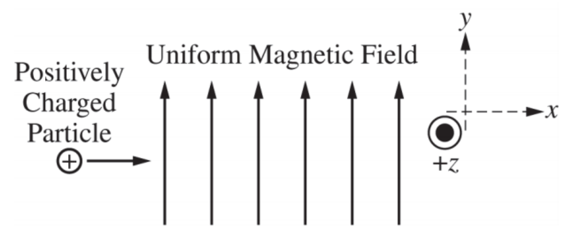
AP Physics C Name: ________________________________

Unit 5 Test: Magnetism Period: ______

Part 1: Multiple Choice - Choose the answers that best answers the questions below. If an exact answer is not present, chose the closest available answer. (4 points each)

1. A positively charged particle moves in the positive x-direction in a uniform magnetic field directed in the positive y-direction. The net force on the particle could be zero if there is also an electric field present in the

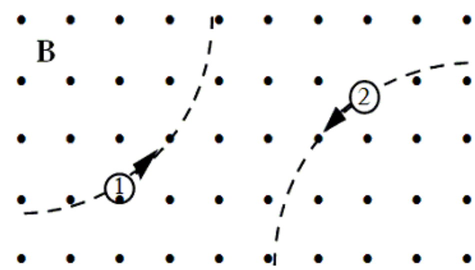


A) positive z-direction
B) negative z-direction
C) positive x-direction
D) negative x-direction
E) negative y-direction

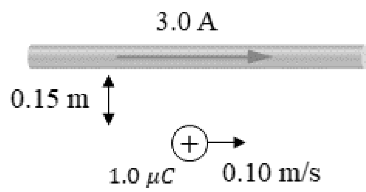
2. A proton of mass m moves in a circular orbit of radius R perpendicular to a uniform magnetic field of magnitude B. Find the period of the proton's orbit.

A) $\frac{2\pi R}{qB}$ B) $\frac{2\pi R^2}{qmB}$ C) $\frac{qB}{2\pi m}$ D) $\frac{2\pi m R^2}{qB}$ E) $\frac{2\pi m}{qB}$

3. Two particles move through a uniform magnetic field that is directed out of the plane of the page. The figure shows the paths taken by the two particles as they move through the field. The particles are not subject to any other forces or fields. Which one of the following statements concerning these particles is true?



A) Both particles are positively charged.
B) Particle 1 is positively charged; particle 2 is negative.
C) Particle 1 is positively charged; particle 2 2 is positive.
D) Both particles are negatively charged.
E) Particle 1 is negatively charged; particle 2 is positive.



4. A small charged particle of charge +1.0 μC that is 0.15 m below a long, straight conducting wire moves at 0.10 m/s to the right as shown. The current in the wire is measured to be 3.0 A. What is the magnitude and direction of the magnetic force on the object?

A) $4x10^{-13}\ N$, towards the wire
B) $3.2x10^{-7}$, towards the wire
C) $2x10^{-13}\ N$, away from the wire
D) $3.2x10^{-13}$, away from the wire
E) $4x10^{-13}\ N$, away from the wire

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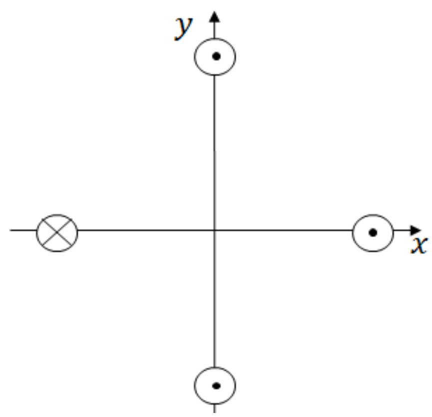
5. A charged particle is moving in a uniform, constant magnetic field. Which one of the following statements concerning the magnetic force exerted on the particle is false?

A) The magnetic force does no work on the particle.
B) The magnetic force is zero if the particle moves perpendicular to the field.
C) The magnetic force changes the velocity of the particle.
D) The magnetic force can act only on a particle in motion.
E) The magnetic force does not change the kinetic energy of the particle.

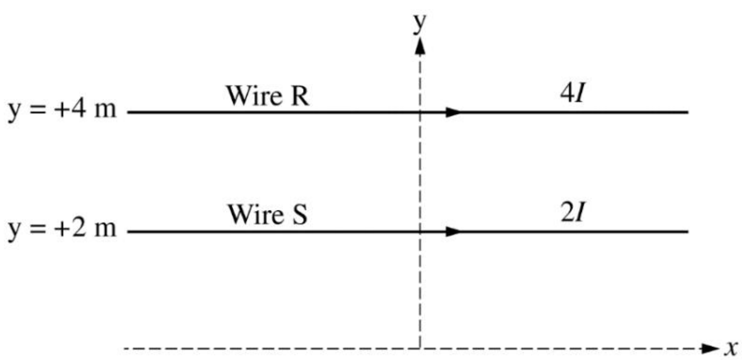
6. A particle (mass = 6.0 mg) moves with a speed of 4000 m/s in a direction that makes an angle of 37° above the positive x axis in the xy plane. At the instant it enters a magnetic field of $(5.0\hat{\imath})$ mT and experiences an acceleration of $(8.0\hat{k})$ m/s^2. What is the charge of the particle?

A) –4.8 μC   B) 9.0 μC   C) –4.0 μC   D) 4.8 μC   E) –5.0 μC

7. Four long, straight wires are perpendicular to the xy-plane. Each wire is the same distance from the origin O, as shown. The wires have equal currents that are in the directions shown. Which of the following best represents the direction of the net magnetic field, if any, at the origin due to the four currents?



A) Up
B) Down
C) To the left
D) To the right
E) Zero



8. Wire R and Wire S are located as shown with current as shown. Assume both are long compared to their distance to the x-axis. What is the magnitude of the magnetic field at the origin due to the two wires?

A) $\frac{\mu_0 I}{2\pi}$ B) $\frac{\mu_0 I}{4\pi}$ C) $\frac{2\mu_0 I}{\pi}$ D) $\frac{\mu_0 I}{\pi}$ E) 0

9. A rectangular coil (0.20 m x 0.80 m) has 200 turns and is in a uniform magnetic field of 0.30 T. When the orientation of the coil is varied through all possible positions, the maximum torque on the coil by magnetic forces is 0.080 N · m. What is the current in the coil?

A) 5.0 mA   B) 1.7 A   C) 8.3 mA   D) 1.0 A   E) 42 mA

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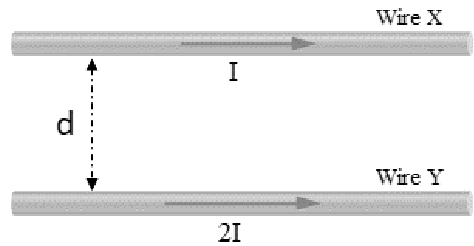
10. Two long, straight parallel wires X and Y are separated by a distance d and carry currents I and 2I, as shown. The force on wire X has magnitude F. If the current in each wire is both doubled and reversed in direction, which of the following is true of the magnitude and direction of the new force on wire X?



	Magnitude	Direction
A)	F	Unchanged
B)	2F	Reversed
C)	2F	Unchanged
D)	4F	Reversed
E)	4F	Unchanged

11. The figure on the right shows a side view of two long, straight, horizontal wires. Wire 1 carries current out of the page of $I_1 = 1.0\ A$. Wire 2 carries current to the left in the plane of this page at $I_1 = 2.0\ A$. Wire 1 is skew to Wire 2 and is a distance of d = 0.5 m above Wire 2. Point P is a distance of d = 0.5 m to the right of Wire 2. Which of the following is closet to the mangitude of the magnetic field at point P?

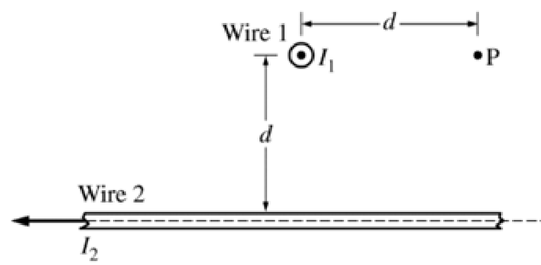
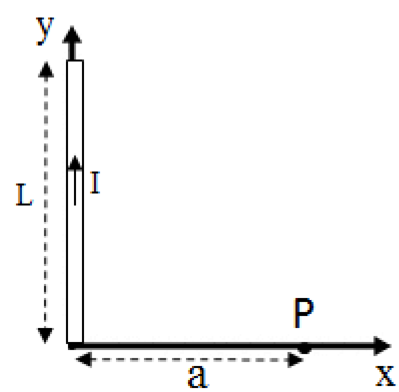


Figure 1. Side view

A) $4.0x10^{-7}\ T$
B) $8.9x10^{-7}\ T$
C) $6.9x10^{-7}\ T$
D) $1.2x10^{-6}\ T$
E) $3.8x10^{-6}\ T$

12. As shown on the right, a wire of length L is placed along the y-axis, with one end at the origin. At one instant, current I flows in the positive y-direction along the length of the wire. Point P is along the x-axis, a distance of a from the origin. Which of the following expression below, when evaluated, would give the magnetic field due to the wire at point P?



A) $B = \frac{\mu_0 I a}{4\pi}\int_0^L \frac{dy}{(a^2+y^2)^{\frac{3}{2}}}$

B) $B = \frac{\mu_0 I a}{2\pi}\int_0^L \frac{dy}{(a^2+y^2)^{\frac{3}{2}}}$

C) $B = \frac{\mu_0 I a}{2\pi}\int_0^L \frac{dy}{(a^2+y^2)^{\frac{1}{2}}}$

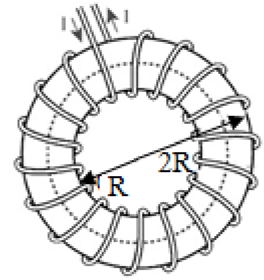
D) $B = \frac{\mu_0 I L}{4\pi}\int_0^a \frac{dx}{(L^2+a^2)^{\frac{1}{2}}}$

E) $B = \frac{\mu_0 I}{4\pi}\int_0^L \frac{dy}{a(a+y)^{\frac{1}{2}}}$

13. A toroid is made of 2000 turns of wire of radius 2.00 cm formed into a donut shape of inner radius 10.0 cm and outer radius 14.0 cm. When a 30.0-A current is present in the toroid, the magnetic field at a distance of 11.0 cm from the center of the toroid is:

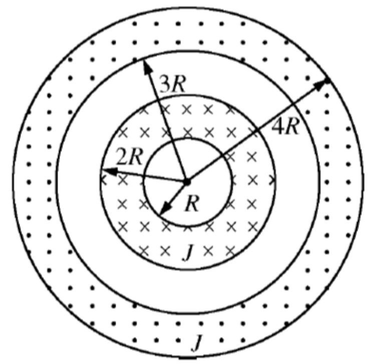
A) 0.0857 T B) 0.109 T C) 0.120 T D) 0.600 T E) 0.685 T

14. A toroid has N turns and has a current of I flowing through its wires. The toroid has an inner radius of R and outer radius of 2R. Which of the following is a correct appliaction of Ampere's Law to find the find the field at a distance of 3R from the center of the toroid?



A) $B(3R) = \mu_0 NI$
B) $B(18\pi R^2) = \mu_0 NI$
C) $B(3R) = 0$
D) $B(6\pi R) = \mu_0 NI$
E) $B(6\pi R) = 0$

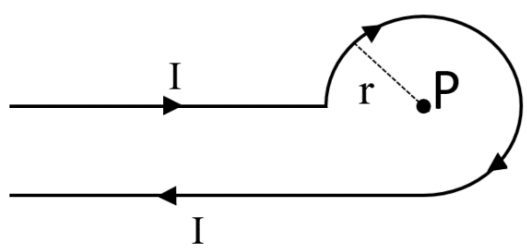
15. Two long, hollow, concentric conducting cylinders carry currents in opposite directions into and out ouf othe plane of the page, as shown in the cross section on the right. The currents are unequal, but the current density J is the same for both cylinders. In which of the following regions can the net magnetic field be zero at some nonzero finite distance r from the central axis?



A) $r < R$ only
B) Both $r < R$ and $R < r < 2R$
C) Both $r < R$ and $2R < r < 3R$
D) Both $r < R$ and $3R < r < 4R$
E) $r > 4R$ only

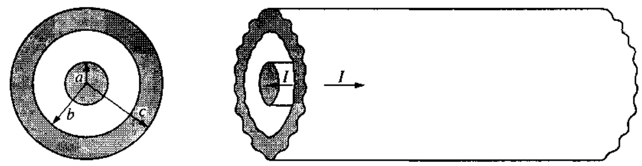
Free Response. You must show all steps required to arrive at the correct answer for the problem below, including any diagrams.

16. A wire carries a current of I and is bent into the shape shown. The wire has a straight segment, then a segment that goes through ¾ of a circle before coming into another straight segment parallel to the first. Point P is along the line that goes the first segment and is in the center of the circular shaped section. The circular section has a radius of r.



a) Determine an expression for the magnetic field at point P. Clearly show your work. (HINT: you want to consider the individual straight sections and the circular sections seperately)

b) Suppose a positive charge is traveling to the right at Point P. What direction would the force on the charge be? Justify your answer.



Cross Section Coaxial Cable

17. A long coaxial cable, a section of which is shown above, consists of a solid cylindrical conductor of radius a, surrounded by a hollow coaxial conductor of inner radius *b* and outer radius c. The two conductors each carry a uniformly distributed current I, but in opposite directions. The current is to the right in the outer cylinder and to the left in the inner cylinder. Assume $\mu = \mu_o$ for all materials in this problem.

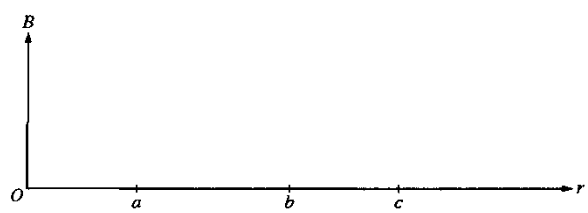
a. Use Ampere's law to determine the magnitude of the magnetic field at a distance r from the axis of the cable in each of the following cases.

i. $0 < r < a$

ii. $b < r < c$

b. What is the magnitude of the magnetic field at a distance r = 2c from the axis of the cable?

c. On the axes below, sketch the graph of the magnitude of the magnetic field B as a function of r, for all values of r. You should estimate and draw a reasonable graph for the field between b and c rather than attempting to determine an exact expression for the field in this region.



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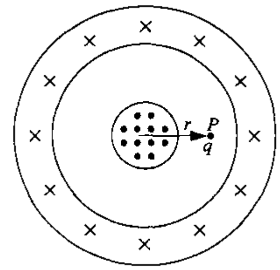
The coaxial cable continues to carry currents I as previously described. In the cross section above, current is directed out of the page toward the reader in the inner cylinder and into the page in the outer cylinder. Point P is located between the inner and outer cylinders, a distance r from the center. A small positive charge q is introduced into the space between the conductors so that when it is at point P its velocity v is directed out of the page, perpendicular to it, and parallel to the axis of the cable.

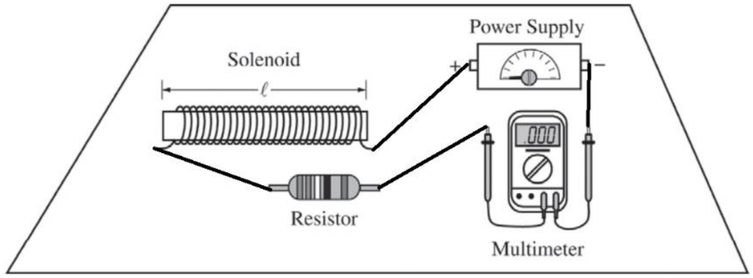


Cross Section

d. i. Determine the magnitude of the force on the charge q at point P in terms of the given quantities.

ii. What is the direction of the force on point P?

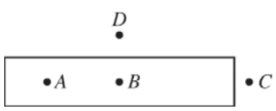
e. If the current in the outer cylinder were reversed so that it is directed out of the page, how would your answers to (d) change, if at all? Justify your answer.



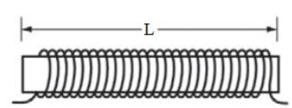
18. To study Ampere's law, a student wires a solenoid in a circuit as shown. The solenoid is of length L with N turns.

a) Using the diagram given above of the circuit, what will be the direction of the magnitude field inside the solenoid?

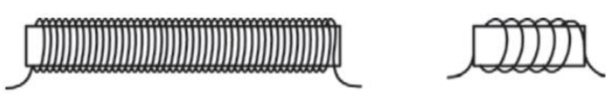
b) The rectangle shown below represent the solenoid (the loops are not shown). Points A, B, and C are along the central axis of the solenoid. B is at the center of the solenoid with D directly above it. At which point would you want to place a magnetic field probe to best measure the strength of the magnetic field of the solenoid. Justify your answer.



c) Using the figure below, draw an Amperian path that could be used to determine the magnitude field of a solid of length L with N turns and a current of I. Using the path you chose, derive an expression for the magnetic field of a solenoid.



The figures below show two different solenoids that will be connected in the circuit. Solenoid 1 has a length $l = .25\ m$ and N = 100 turns. Solenoid 2 has a length $l = .05\ m$ and N = 5 turns.



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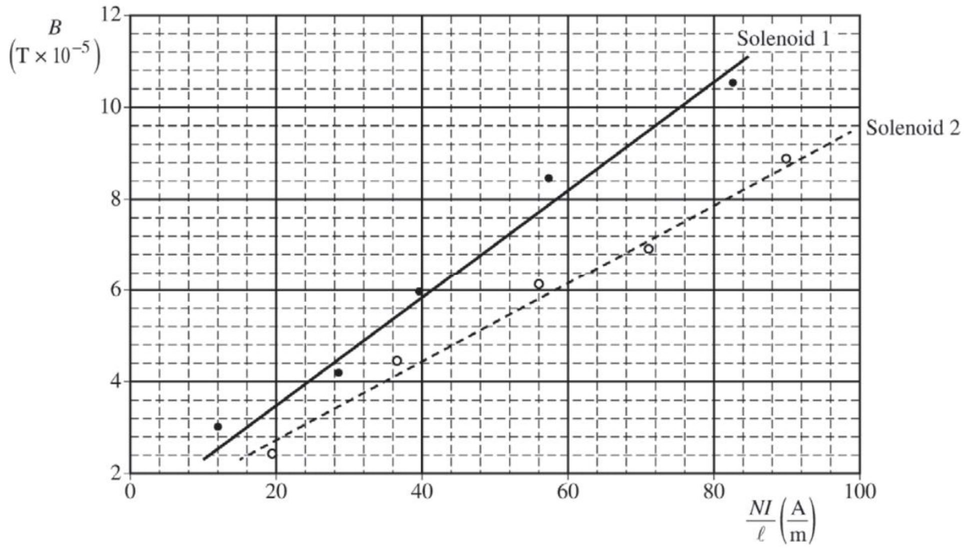
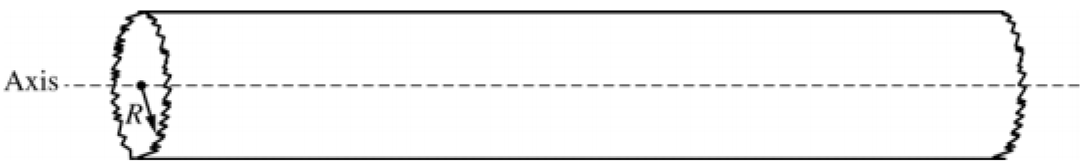
d) A graph of the magnitude of the magnetic field B as a function of $\frac{NI}{l}$ is Chose the best fit line that can be best used to estimate the value of μ_o. Using your chosen best fit, estimate the value of μ_o.



Bonus:



A very long, solid, nonconducting cylinder of radius R has a positive charge of uniform volume density ρ. A section of the cylinder far from its ends is shown in the diagram above. Let r represent the radial distance from the axis of the cylinder. Express all answers in terms of r, R, ρ, and fundamental constants, as appropriate.

Using Gauss's law, derive an expression for the magnitude of the electric field at a radius $r < R$. Draw an appropriate Gaussian surface on the diagram.

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