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Physics 125, Analytical Physics II **Section 99**

Date Thr, May 7, 2009 at 11:00 *Final Exam*

New Material

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1. [3pt] A proton is traveling due north as it enters a region that contains a magnetic field. The proton is deflected downward toward the earth. (Ignore the effects of gravity in this problem.) Which of the following is a possible direction for the magnetic field?

A) south
B) north
C) west
D) downward, toward the earth.
E) east

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2. [3pt] Which one of the following statements concerning the magnetic force on a charged particle in a magnetic field is true?

A) It acts in the direction of motion for a positively charged particle.
B) It is a maximum if the particle moves parallel to the field.
C) It is a maximum if the particle is stationary.
D) It depends on the component of the particle's velocity that is perpendicular to the field.
E) It is zero if the particle moves perpendicular to the field.

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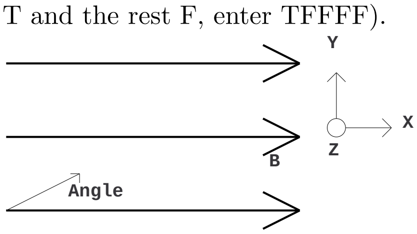
3. [5pt] A 8 g particle carrying a charge of 92 μC enters a uniform 8 T magnetic field at a speed of 54 m/s and with an angle of 58° with respect to the field lines, as shown in the figure. Answer the following questions: (Select T-True, F-False, If the first is T and the rest F, enter TFFFF).



A) The particle's speed varies as it passes through the B-Field.
B) Since the force is normal to the velocity, the path of the particle will be a helix.
C) The y-component of the particle's velocity is unchanged as it passes through the B-Field.
D) The force on the particle is in the -z direction.
E) The work done by the field on the particle is zero as the force is normal to the displacement.

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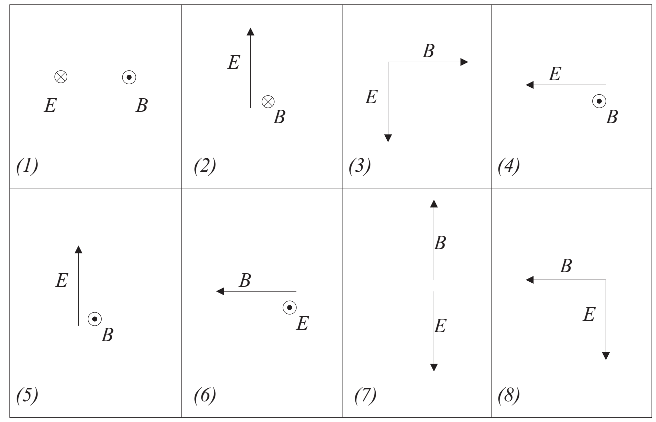
4. [3pt] The 8 figures below show 8 different orientations of a magnetic and electric field. Suppose an electron is moving through the region. For each lettered question below, indicate one orientation of the fields which applies. Note that for some statements, there may be more than one acceptable figure; you need only specify one that works, however.



A) If the particle is moving to the left, which orientation of fields could allow the particle to pass through undeflected?
B) If the particle is moving out of the page, which orientation of fields could allow the particle to pass through undeflected?
C) If the particle is moving downwards, which orientation of fields could allow the particle to pass through undeflected?

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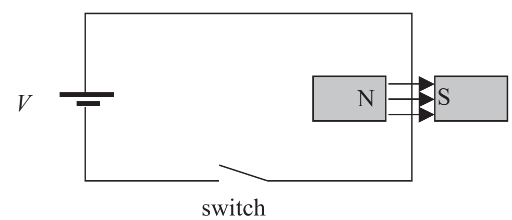
5. [3pt] A long straight vertical segment of wire traverses a magnetic field as shown in the diagram. The switch is closed and a current flows through the wire. Which one of the following statements concerning the effect of the magnetic force on the section of the wire between the magnet is true? (Ignore the effects of gravity in this problem.)



A) The wire will be pushed to the left.
B) The wire will have no net force acting on it.
C) The wire will be pushed to the right.
D) The wire will be pushed out of the plane of the paper.
E) The wire will be pushed into the plane of the paper.

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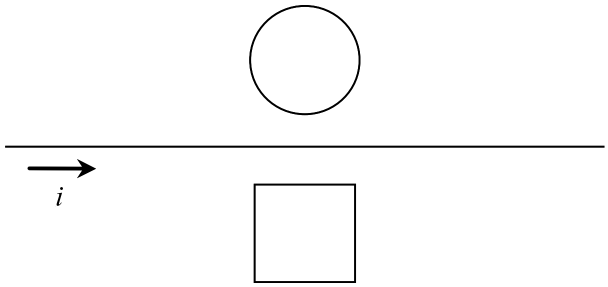
6. [3pt] A long wire which carries a current and two loops positioned on either side of it are shown in the figure. The current in the wire is decreasing with time. The direction of the induced current in the square and circular loops are, respectively:



A) zero and clockwise
B) counterclockwise and zero
C) counterclockwise and clockwise
D) both zero
E) clockwise and counterclockwise

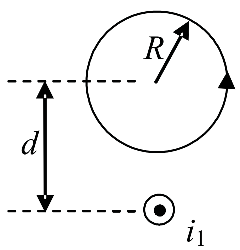
7. [4pt] In some region, a magnetic field points along the x-axis with a strength 2.40×10^{-3} T. A cosmic ray electron passes through the region with a velocity $(4.51\hat{\imath} - 9.40\hat{k}) \times 10^5$ m/s. What is the magnitude of the force on the electron, in pN?

A) 1.65×10^{-4} B) 1.93×10^{-4} C) 2.26×10^{-4} D) 2.64×10^{-4}
E) 3.09×10^{-4} F) 3.61×10^{-4} G) 4.23×10^{-4} H) 4.95×10^{-4}

8. [4pt] An electron of kinetic energy 1.81 keV moves in a plane that is perpendicular to a uniform magnetic field. The orbit radius is 24.00 cm. What is the magnitude of the magnetic field, in T?

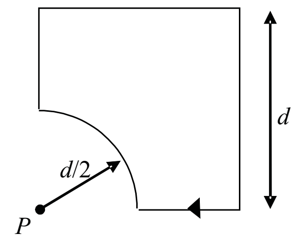
A) 4.44×10^{-5} B) 6.43×10^{-5} C) 9.33×10^{-5} D) 1.35×10^{-4}
E) 1.96×10^{-4} F) 2.84×10^{-4} G) 4.12×10^{-4} H) 5.98×10^{-4}

9. [4pt] A current $i_1 = 13.1$ A flows in a very long straight wire pointing out of the page. A current $i_2 = 6.5$ A flows in a circular loop of radius $R = 29.2$ cm which is in the plane of the paper and whose center is a distance $d = 49.9$ cm away from the wire, as shown in the figure. What is the magnitude of the magnetic field (in T) at the center of the circular loop?

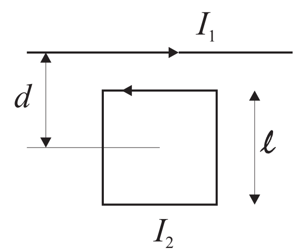


A) 3.28×10^{-6} B) 4.22×10^{-6} C) 5.43×10^{-6} D) 7.00×10^{-6}
E) 9.01×10^{-6} F) 1.16×10^{-5} G) 1.49×10^{-5} H) 1.92×10^{-5}

10. [5pt] A current i flows around a loop as shown in the figure. The loop has two straight sides of length d, two straight sides of length $d/2$, and a curved portion of radius $d/2$. Find the magnetic field at point P, at the center of the circular arc. Make sure you specify the magnitude and direction of the magnetic field. You must show all of your work to receive full credit for this problem. Make sure you express your final answer in terms of the variables given in the problem and fundamental constants, and that your final expression is simplified as much as possible.

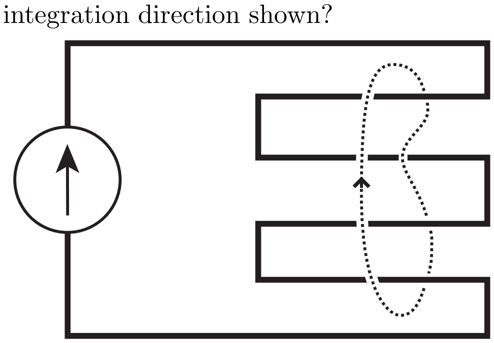


11. [5pt] In the figure below, a long straight wire carries a current $I_1 = 5.8$ A. Find the magnitude of the net force (in N) on a rigid square loop of wire of side $\ell = 5.50$ cm. The center of the loop is $d = 10.50$ cm from the wire and the loop carries a current $I_2 = 10.0$ A.



A) 3.42×10^{-6} B) 4.47×10^{-6} C) 5.84×10^{-6} D) 7.63×10^{-6}
E) 9.98×10^{-6} F) 1.30×10^{-5} G) 1.71×10^{-5} H) 2.23×10^{-5}

12. [3pt] In the figure, the power supply sends a current of 2 A through the wire (solid line) in the direction showm. What is the value of $\oint \vec{B} \cdot d\vec{s}$ (in T · m) around the dotted line path, using the integration direction shown?



A) -7.54×10^{-6} B) -5.03×10^{-6} C) -2.51×10^{-6}
D) -1.26×10^{-6} E) 1.26×10^{-6} F) 2.51×10^{-6}
G) 5.03×10^{-6} H) 7.54×10^{-6}

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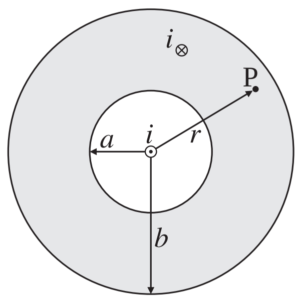
13. [4pt] A long, coaxial cable consists of a thin central wire and an outer conductor. The inner wire and outer conductor carry equal and opposite currents. The current in the outer conductor is distributed uniformly. The radii of the outer conductor are $a = 2.10\,\text{cm}$ and $b = 3.78\,\text{cm}$. The magnetic field at point P which is a distance $r = 3.15\,\text{cm}$ away from the center has a magnitude $8.36\,\mu\text{T}$. What is the current in the thin central wire (in A)?



A) 2.98 B) 3.37 C) 3.80 D) 4.30
E) 4.86 F) 5.49 G) 6.20 H) 7.01

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14. [3pt] For a solenoid of length 0.61 m and diameter 7 cm, it is determined that a current of 2.5 A through the solenoid wire results in a magnetic field of strength 17 mT at the solenoid center. What is the total number of times that the wire wraps around the solenoid?

A) 2.01×10^3 B) 2.58×10^3 C) 3.30×10^3 D) 4.23×10^3
E) 5.41×10^3 F) 6.93×10^3 G) 8.87×10^3 H) 1.14×10^4

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15. [4pt] A circular loop of radius 31 cm and 70 turns is located in the plane of the paper. A uniform magnetic field of 0.25 T enters the paper from above, making an angle of 20° with the surface of the paper. The loop is connected in series with a 261 Ω resistor (the wire has negligible resistance). The magnetic field is now increased at a constant rate to 0.60 T in 17 s. Calculate the magnitude of the induced current in the loop during that time.

A) 3.04×10^{-4} B) 3.56×10^{-4} C) 4.17×10^{-4} D) 4.87×10^{-4}
E) 5.70×10^{-4} F) 6.67×10^{-4} G) 7.81×10^{-4} H) 9.13×10^{-4}

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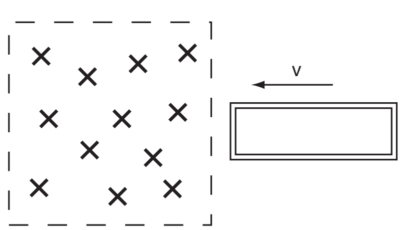
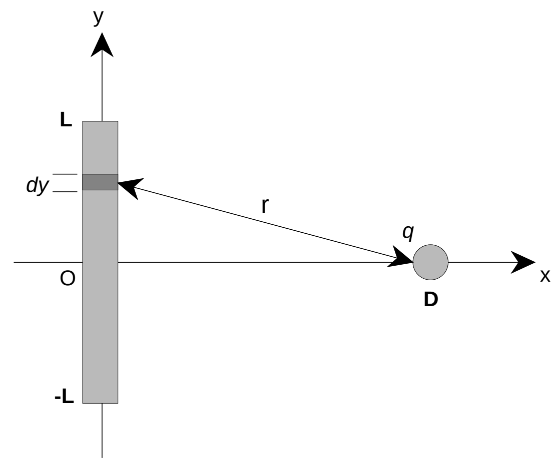
16. [4pt] The figure shows a rectangular coil of wire with 100 turns, height 1.5 cm, and length 9.5 cm. The coil is entering the region between the poles of a C magnet with a velocity 2.10 m/s. We may approximate the magnetic field as a square region with strength B =0.013 T, and zero magnetic field outside that square. What magnitude EMF is generated in the coil, in V?



A) 4.10×10^{-2} B) 5.45×10^{-2} C) 7.24×10^{-2} D) 9.63×10^{-2}
E) 1.28×10^{-1} F) 1.70×10^{-1} G) 2.27×10^{-1} H) 3.01×10^{-1}

Review Material



17. [5pt] A charge Q is distributed uniformly along a rod extending from $y = -L$ to $y = +L$, as shown in the diagram. A charge q (the same sign as Q) is placed at (D,0. Consider the situation as described above and the following statements. If the statement is true, answer T, if it is false, answer F, and if the answer cannot be determined from the information provided, answer C.

A)The total force on q is generally in the $\nearrow$ direction.
B)The net force on q in the x-direction equals zero.
C)The charge on a segment of the rod of infinitesimal length dy is given by $dQ = (Q/L^2)dy$
D)The net force on q in the y-direction does equal zero.
E)The magnitude of the force on charge q due to the small segment dy is $dF = (kqQ/2Lr)dy$

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18. [4pt] In testing, a guitar string of length 61.0 cm is found to have resonant frequencies at 690 Hz and 920 Hz, but no intevening frequencies. If the mass of the vibrating part of the string is 1.7 g, then what is the tension in the string (in N)?

A) 2.98×10^1 B) 3.96×10^1 C) 5.27×10^1 D) 7.01×10^1
E) 9.33×10^1 F) 1.24×10^2 G) 1.65×10^2 H) 2.19×10^2

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19. [4pt] White light reflected at perpendicular incidence from a uniform soap film has an interference maximum at the wavelength 571.4 nm and a minimum at the wavelength 500.0 nm, with no minima or maxima between those wavelengths. If n =1.37 for the film, what is the film thickness in nm?

A) 4.48×10^2 B) 5.06×10^2 C) 5.72×10^2 D) 6.46×10^2
E) 7.30×10^2 F) 8.25×10^2 G) 9.32×10^2 H) 1.05×10^3

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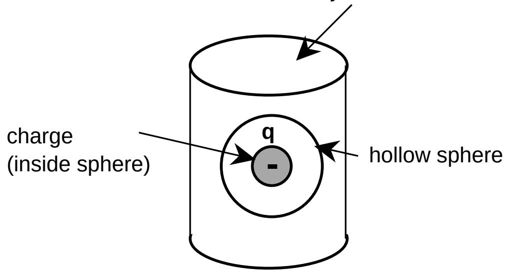
20. [3pt] A ball of mass 0.750 g and carrying a positive charge, q = 34.5 μC, is suspended on a string of negligible mass in a uniform horizontal electric field. We observe that the ball hangs at an angle of $\theta = 15.0°$ from the vertical. What is the magnitude of the electric field, in V/m?

A) 3.10×10^1 B) 3.50×10^1 C) 3.96×10^1 D) 4.47×10^1
E) 5.06×10^1 F) 5.71×10^1 G) 6.46×10^1 H) 7.29×10^1

21. [4pt] A right solid conducting cylinder has a total charge of +6.10 mC. Inside the cylinder a charge $q = -1.40$ mC rests at the center of a hollow sphere as shown in the diagram below. What is the charge on the surface of the hollow sphere, in mC?

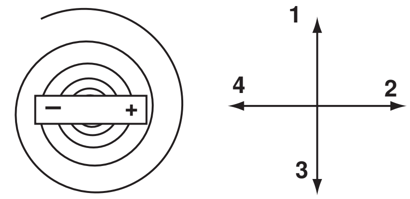


A) 1.20 B) 1.40 C) 1.64 D) 1.92
E) 2.24 F) 2.62 G) 3.07 H) 3.59

22. [4pt] What is the charge on the outside surface of the cylinder, in mC?

A) 7.33×10^{-1} B) 1.06 C) 1.54 D) 2.24
E) 3.24 F) 4.70 G) 6.81 H) 9.88

23. [4pt] An electret is a manufactured device with a permanent electric dipole moment. Suppose that you design a device to measure electric fields by sensing the torque on an electret. Your electret has a length of 1.3 mm, and has 0.45 μC on each end. You mount it on a coiled spring that will deflect for torques as small as 0.120 N·m. What is the smallest electric field strength that your device can sense, in N/C?



A) 2.05×10^8 B) 2.56×10^8 C) 3.21×10^8 D) 4.01×10^8
E) 5.01×10^8 F) 6.26×10^8 G) 7.83×10^8 H) 9.78×10^8

24. [4pt] Suppose you are sensing a field, and that after trying various orientations you have determined that the orientaion shown in the picture results in the maximum clockwise torque. In what direction is the electric field? (Numbers refer to the cross on the right of the picture.)

A) 3
B) The direction is not uniquely determined
C) 4
D) Into the page
E) Out of the page
F) 2
G) 1

25. [4pt] A special weather balloon is made of two helium-filled balloons that, once aloft, each form a sphere with a radius 1.3 m and mass 0.016 kg. Cosmic rays charge the non-conducting surface of each of the balloons to +3.9 μC. Initially, the two spheres are touching, but then a catch is released and they are allowed to float appart from each other until a tether line between them (length 5.4 m) is pulled taught. If we assume that the air is so thin that air resistance is negligible, what speed will each balloon have just before the tether is pulled taught?

A) 1.60×10^{-1} B) 2.32×10^{-1} C) 3.37×10^{-1} D) 4.89×10^{-1}
E) 7.08×10^{-1} F) 1.03 G) 1.49 H) 2.16

26. [4pt] Once the two spheres are seperated by the tether, what is the electric potnetial at the center of one of them (in V)?

A) 3.13×10^4 B) 4.17×10^4 C) 5.54×10^4 D) 7.37×10^4
E) 9.81×10^4 F) 1.30×10^5 G) 1.73×10^5 H) 2.31×10^5