Physics 232 Homework up to Final Exam – 4/16/13 at 3:00 pm
General Physics 2 Weekly HW Due Tuesday 5 pm

<table>
<tr><td colspan="2">Daily</td><td colspan="2">Daily</td><td>Daily</td><td>Weekly</td></tr>
<tr><td colspan="2"></td><td colspan="2">Fri 3/15 – E10: B3 (ans is $5ar^2$), B5</td><td>Mon 3/18 – E11: B6, B7</td><td>Fri 3/15 at 2 pm– E10: S1, S5</td></tr>
<tr><td colspan="2">Wed 3/20 – E12.1-3: B1, B2</td><td colspan="2">Fri 3/22 – no class</td><td>Mon 3/25 – no daily</td><td>Tues 3/26 at 8 am – #1-2; E11: S4(a-d), S5, S6, E12: S1</td></tr>
<tr><td>Wed 3/27 – E12.4 -6: B7, B8, #3</td><td>Th 3/28 – E13.1-3: B1, B3</td><td colspan="2">Fri 3/29 – E13.4-6: S2 & E14.1-2: B1</td><td>Mon 4/1 – E14.1-5: B3, B4</td><td>Tues 4/2 – #4-5; E12: S8, S10, R1, E14: S1, S3</td></tr>
<tr><td colspan="2">Wed 4/3 – E14.4-6: B6, B8</td><td colspan="2">Fri 4/5 – E15: B2, B3, B5, B7</td><td>Mon 4/8 – E16: B3, B6</td><td>Tues 4/9 – #6-10; E15: S2, S5</td></tr>
<tr><td colspan="2">Wed 4/10 – E16: B7, S6</td><td colspan="2">Fri 4/12 – no daily</td><td>Mon 4/15 – review</td><td>Thurs 4/11 at 1 pm – #11-12; E16: S1, S9</td></tr>
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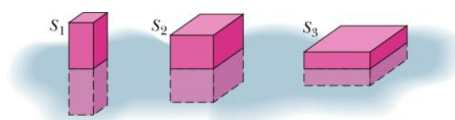
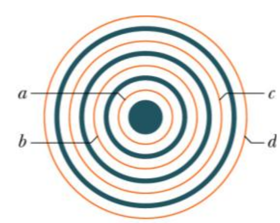
1. The figure shows three Gaussian surfaces, each half-submerged in a large, thick metal plate with a uniform surface charge density. Gaussian surface S_1 is the tallest and has the smallest square end caps; surface S_3 is shortest and has the largest square end caps; and S_2 has intermediate values. Rank the surfaces according to (a) the charge they enclose, (b) the magnitude of the electric field at points on their top end cap, (c) the magnitude of the net electric flux through that top end cap, and (d) the net electric flux through their bottom end cap, greatest first.

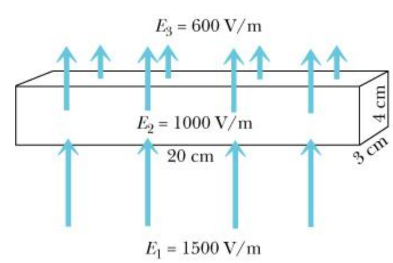


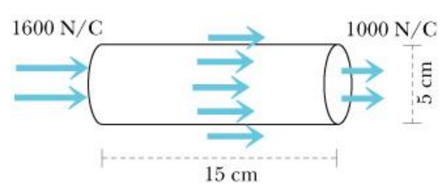
2. An isolated conductor of arbitrary shape has a net charge of $+10\times10^{-6}$ C. Inside the conductor is a cavity within which is a point charge $q = +3.0\times10^{-6}$ C. What is the charge (a) on the cavity wall and (b) on the outer surface of the conductor?

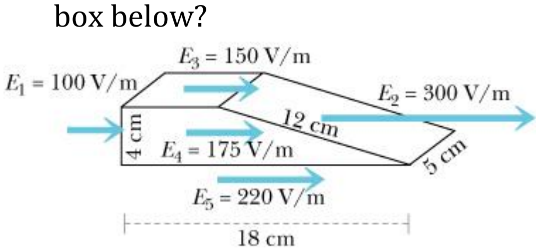
3. The figure shows four circular Amperian loops (red) and, in cross section, four long circular conductors (blue), all of which are concentric. Three of the conductors are hollow cylinders; the central conductor is a solid cylinder. The currents in the conductors are, from smallest radius to largest radius, 4 A out of the page, 9 A into the page, 5 A out of the page, and 3 A into the page. Rank the Amperian loops according to the magnitude of $\oint \vec{B}\cdot d\vec{S}$ around each, greatest first.



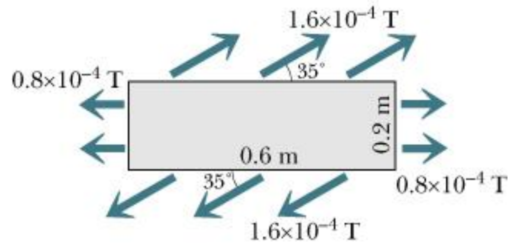
4. For each part below, the measured pattern of either the electric or magnetic field is shown. From this information, what can you conclude about the contents of each box? Include a numerical result.
   a. The electric field is vertical and has the values indicated.
   b. The electric field is horizontal and has the values indicated on the surface of a cylinder as shown.
   c. How much charge is in the irregularly shaped box below?





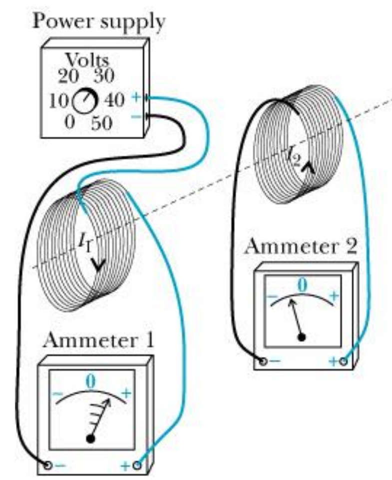


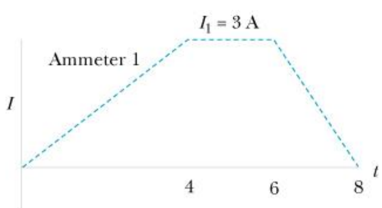
d. Here is a measured pattern of magnetic field in space. How much current I passes through the shaded area? In what direction?



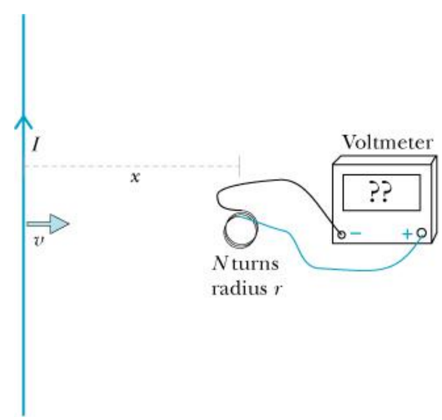
5. Suppose that a parallel-plate capacitor has circular plates with radius R = 30 mm and a plate separation of 5.0 mm. Suppose also that a sinusoidal potential difference with a maximum value of 150 V and a frequency of 60 Hz is applied across the plates; that is $V = (150\text{ V})\sin[2\pi(60\text{ Hz})\,t]$ (a) find $B_{max}(R)$, the maximum value of the induced magnetic field that occurs at r=R. (b) Plot $B_{max}(r)$ for $0 < r < 10$ cm.

6. Two coils of wire are near each other, positioned on a common axis. Coil 1 is connected to a power supply whose output voltage can be adjusted by turning a knob, so that the current I_1 in coil 1 can be varied, and I_1 is measured by ammeter 1. Current I_2 in coil 2 is measured by ammeter 2. The ammeters have needles that deflect positive or negative depending on the direction of current passing through the ammeter, and ammeters read positive if conventional current flows into the "+" terminal. A graph of I_1 vs. time is shown. Draw a graph of I_2 vs. time over the same time interval. Explain your reasoning.





7. A long straight wire carrying current I is moving with speed v toward a small circular coil of radius r containing N turns, which is attached to a voltmeter as shown. The long wire is in the plane of the coil. (Only a small portion of the wire is shown in the diagram.) At the instant when the long wire is a distance x from the center of the coil, what is the voltmeter reading? Include both magnitude and sign. (Remember that a voltmeter reads "+" if the higher potential is connected to the "+" terminal of the voltmeter.) Explain.



8. A length of copper wire carries a current of 10 A, uniformly distributed through its cross section. Calculate the energy density of (a) the magnetic field and (b) the electric field at the surface of the wire. The wire diameter is 2.5 mm, and its resistance per unit length is 3.3 Ω/km.

9. A doorbell requires 0.4 A at 6 V. It is connected to a transformer whose primary coil, containing 2000 turns, is connected to a 120-V ac power line. (a) How many turns should there be in the secondary coil? (b) Assuming 100 percent efficiency in power transmission, what is the current in the primary?

10. (a) Write an equation describing a sinusoidal transverse wave traveling on a cord in the $+x$ direction with a wavelength of 10 cm, a frequency of 400 Hz, and an amplitude of 2.0 cm. (b) What is the maximum speed of a point on the cord? (c) What is the speed of the wave?

11. The electric field of an electromagnetic wave oscillates in the y direction and the Poynting vector is given by $\vec{S}(x,t) = <(100\mathrm{W/m^2})\cos^2[(10\mathrm{m^{-1}})x - (3\times10^9\,\mathrm{Hz})t],0,0>$. (a) What is the direction of propagation of the wave? (b) Find the wavelength and the frequency. (c) Find the electric and magnetic fields.

12. It has been proposed that a spaceship might be propelled in the solar system by radiation pressure, using a large sail made of foil. How large must the sail be if the radiation force is to be equal in magnitude to the Sun's gravitational attraction? Assume that the mass of the ship plus sail is 1500 kg, that the sail is perfectly reflecting, and that the sail is oriented perpendicular to the Sun's rays. It might also be useful to know that the Sun's mass is 1.99 x 10^{30} kg, radius is 6.96 x 10^{8} m, and radiation power is 3.90 x 10^{26} W.