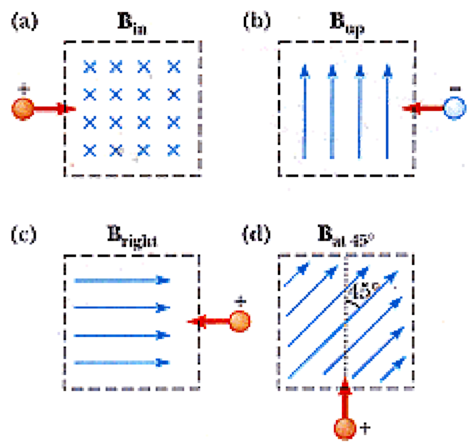
Physics 114 2001
Exam II
Chapters 25-29

Answer 8 of the following 9 questions or problems. Each one is weighted equally. **Clearly** mark on your blue book which number you do not want graded. If you are not sure which one you do not want graded you may put down two choices (**not more than two)** and the one that is most incorrect will dropped.

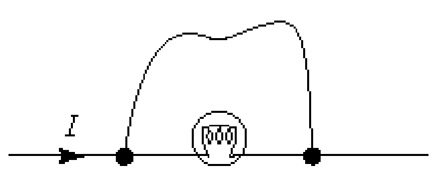
1. Determine the initial direction of the deflection of charged particles as they enter the magnetic fields as shown below



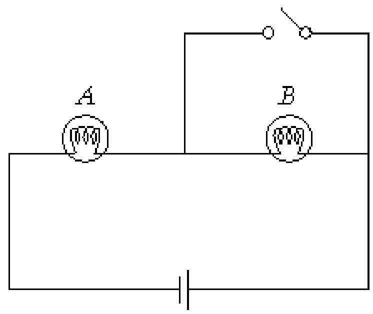
2. Consider a simple parallel-plate capacitor whose very large plates are given equal and opposite charges and are separated by a small distance d. If we then increase the separation between the plates but still have the distance between the plates being much smaller than the area of the plates, what happens to each of the following? Neglect fringe effects at the edges of the capacitor.

   a) the field between the plates
   b) the field outside the plates
   c) the potential difference between the plates
   d) the energy stored in the system
   e) the charge on the plates
   f) the capacitance of the system

3. In the following DC circuits,
   a. Charge flows through a light bulb. Suppose a wire is connected across the bulb as shown. When the wire is connected, what happened to the brightness of the bulb? Explain.

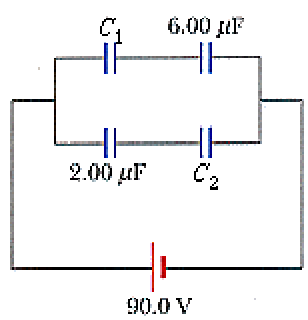


b. The circuit below consists of two identical light bulbs burning with equal brightness and a single 12 V battery. When the switch is closed, what happens to brightness of bulb A? Explain.



4. You connect a battery to a resistor, producing a potential difference V across it and causing a current to flow through the resistor. Next, the resistor is removed from the circuit and cut in half crosswise (so its length is halved). One of the halves is placed back into the circuit, with the battery connected to it. (a) What happens to the potential difference across the resistor? (b) What happens to the current across the resistor?

5. Consider the system of capacitors shown below with C1 = 3.00 μF and C2 = 4.00 μF.

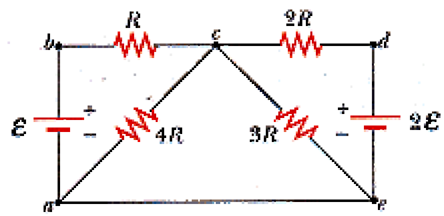


   a. Find the equivalent capacitance of the system.
   b. Find the potential difference across each capacitor.
   c. Find the charge on each capacitor.
   d. Find the total energy stored by the group.

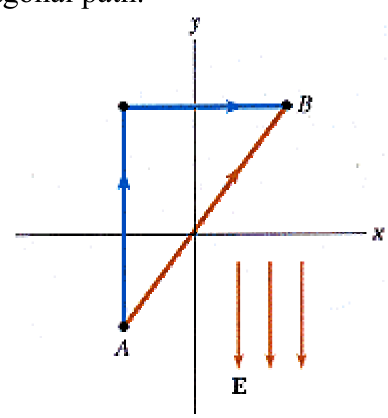
6. Suppose that you wish to fabricate a uniform wire out of 1.00 g of copper (resistivity = 1.7 x 10^{-8} Ω-m). The wire is to have a resistance of R = 0.500 , and all of the copper is to be used.
   a. What is the length of this wire?

b. What is the diameter of this wire?

7. If R = 1.00 k and ε = 250 V in the Figure below, determine (a) which resistors are in series and which are in parallel. (b) Reduce the circuit to a simpler one combining and series or parallel resistors. Clearly draw and name all currents in the circuit, naming identical currents with the same name. (c) Derive at least one equation relating these currents using Kirchoff's junction rule. Clearly mark on your drawing of the circuit which junctions you are looking at. (d) Derive more equations using Kirchoff's loop rule so that you have as many unknowns as equations. Clearly indicate which loops you are analyzing. **You do not need to solve the equations (that might take too long).**



8. A wire 2.80 m in length carries a current of 5.00 A in a region where a uniform magnetic field has a magnitude of 0.390 T. Calculate the magnitude of the magnetic force on the wire for the following angles between the magnetic field and the current, (a) 60.0° (b) 90.0°, and (c) 120.0°.
9. A uniform electric field of magnitude 325 V/m is directed in the negative y direction as shown below. The coordinates of point A are (-0.200, -0.300) m, and those of point B are (0.400, 0.500) m. (a) Calculate the potential difference V_B - V_A, using the vertical and horizontal paths. (b) Calculate the potential difference V_B - V_A, using the diagonal path.



Possibly Useful Information

$$F = \frac{1}{4\pi\varepsilon_0}\frac{|q_1||q_2|}{r^2}$$

$$\varepsilon_0 = 8.85 \times 10^{-12}\,(C^2 / N - m^2)$$

$e = 1.6 \times 10^{-19}$ C

$$\vec{E} = \vec{F}/q_0$$

$$E = \frac{|q|}{4\pi\varepsilon_0 r^2}$$

$$\varepsilon_0 \Phi = \varepsilon_0 \oint \vec{E}.d\vec{A} = q_{enc}$$

$\Delta x = x_2 - x_1$, $\Delta t = t_2 - t_1$

$\bar{v} = \Delta x / \Delta t$

$\bar{s} =$ (total distance) / Δt

$v = dx/dt$

$\bar{a} = \Delta v / \Delta t$

$a = dv/dt = d^2x/dt^2$

$v = v_o + at$

$g = 9.8\ m/s^2$

$x - x_o = v_o t + (½)at^2$

$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

$v^2 = v_o^2 + 2a(x - x_o)$

$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1$

$x - x_o = ½(v_o + v)t$

$\Delta\vec{r} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$

$x - x_o = vt - 1/2at^2$

$\bar{\vec{v}} = \Delta\vec{r} / \Delta t$, $\vec{v} = d\vec{r} / dt$

$\vec{a} = d\vec{v} / dt$

$\bar{\vec{a}} = \Delta\vec{v} / \Delta t$

$\Delta U = U_f - U_i = -W$

$\Delta V = V_f - V_i = -W/q_0 = \Delta U/q_0$

$U = -W_\infty$

$V = -W_\infty/q_0$

$$V_f - V_i = -\int_i^f \vec{E}.d\vec{s}$$

$$V = -\int_i^f \vec{E}.d\vec{s}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$$

$$V = \sum_{i=1}^{n} V_i = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i}$$

$$V = \frac{1}{4\pi\varepsilon_0}\int \frac{dq}{r}$$

$$E_s = \frac{\partial V}{\partial s}$$

$$E_x = \frac{\partial V}{\partial x}; E_y = \frac{\partial V}{\partial y}; E_z = \frac{\partial V}{\partial z}$$

$$E = \frac{\Delta V}{\Delta s}$$

$$U = -W = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$

$Q = CV$

$$C = \frac{\varepsilon_0 A}{d}$$

$$C = 2\pi\varepsilon_0 \frac{l}{\ln(b/a)}$$

$$C = 4\pi\varepsilon_0 \frac{ab}{b - a}$$

$C = 4\pi\varepsilon_0 R$

$C_{eq} = \sum C_j$ (parallel)

$$\frac{1}{C_{eq}} = \sum \frac{1}{C_j} \text{ (series)}$$

$u = \frac{1}{2}\varepsilon_0 E^2$

$I = dQ/dt$

$\rho = 1/\sigma$

$R = \rho L / A$

$P = IV$

$P_{emf} = I\varepsilon$

$$\frac{1}{R_{eq}} = \sum \frac{1}{R_j} \text{ (parallel)}$$

$I = (\varepsilon/R)e^{-t/RC}$

$I = (Q/RC)e^{-t/RC}$, $I_0 = (Q/RC)$

$\vec{F} = q\vec{v} \times \vec{B}$

$d\vec{F} = Id\vec{s} \times \vec{B}$

$\vec{\mu} = NI\vec{A}$

$B = \mu_0 I/2\pi r$

$F/l = (\mu_0 I_1 I_2)/2\pi a$

$I_d = \varepsilon_0 d\Phi_E / dt$

$$U = \frac{Q^2}{2C} = \frac{1}{2}CV^2$$

$C = \kappa C_0$

$V = IR$

$P = I^2R = V^2/R$

$I = \varepsilon/(R + r)$

$R_{eq} = \sum R_j$ (series)

$q(t) = Q(1 - e^{-t/RC})$

$q(t) = Qe^{t/RC}$

$\vec{F} = I\vec{L} \times \vec{B}$

$\tau = \vec{\mu} \times \vec{B}$

$d\vec{B} = \frac{\mu_0}{4\pi} Id\vec{s} \times \vec{r} / r^3$, $\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$B = \mu_0 nI$ (solenoid)

$\oint \vec{B}.d\vec{s} = \mu_0 I_{enc}$

$B = (\mu_0 IN)/(2\pi r)$ (toroid)

$\Phi_B = \int \vec{B}.d\vec{A}$