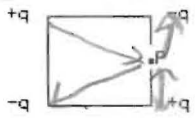
Exam FINAL EXAM PHYSICS 2B Spring 2010

Name_Professor S.K. Sinha_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Four charges of equal magnitudes but opposite signs are arranged at the corners of a square, as shown here. In which arrangement is the magnitude of the electric field at point P a maximum?

A)

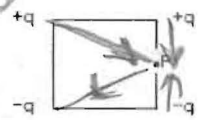


y comps subtract, x cancel

B)

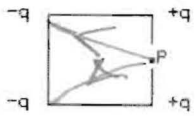
$|E| = 0$

C)



y comp's add, x cancel

D)



X comps are weaker than y

E) The maximum electric field occurs in more than one of these arrangements.

$\varepsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$ $\quad m_e = 9.1 \times 10^{-31}$ kg

$\mu_0 = 4\pi \times 10^{-7} \frac{Tms}{C}$ $\quad m_p = 1.67 \times 10^{-27}$ kg

$e = 1.6 \times 10^{-19}$ C $\quad K = 9 \times 10^9 \frac{Nm^2}{C^2}$

$Q_{enc} \propto E$

$E = 0$ inside conductors

$Q_A = 0$ (else $E \neq 0$ in inner shell)

$Q_B = -30\,nC/m$

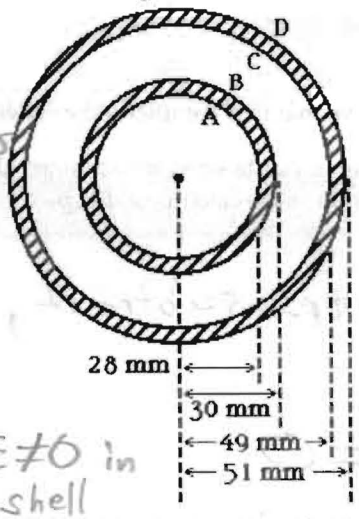
$Q_C + Q_B + Q_A = 0$ else $E \neq 0$ in outer shell

$Q_C = -Q_B = 30\,nC/m$

$Q_D + Q_C = -50\,nC/m$

$Q_D = -80\,nC/m$

Figure 23.6

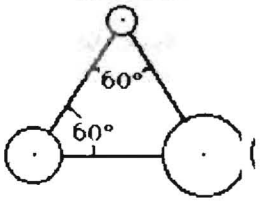


The cross section of a long coaxial cable is shown, with radii as given. The linear charge density on the inner conductor is -30 nC/m and the linear charge density on the outer conductor is -50 nC/m. The inner and outer cylindrical surfaces are respectively denoted by A, B, C, and D, as shown.

2) In Figure 23.6, the linear charge densities on surfaces C and D, in nC/m, are closest to:

A) 0 and -50 B) -30 and -20 C) +30 and -50 D) -20 and -30 E) +30 and -80

Figure 24.5



3) In Figure 24.5, three conducting spheres of radii 1 meter, 2 meters and 3 meters are connected by wires 50 meters long, as shown here. A charge of 4 x 10-4 coulombs is initially placed on the large sphere. Determine the charge on the large sphere in electrostatic (not mechanical) equilibrium.

A) 2.57 x 10-4 coulomb

B) 0.67 x 10-4 coulomb

C) 1.33 x 10-4 coulomb

D) 2.0 x 10-4 coulomb

E) Zero

$V_{surface}$ = same for all conductors

$\frac{q_s}{1} = \frac{q_m}{2} = \frac{q_L}{3} \Rightarrow 2q_s = q_m$

$3q_m = 2q_L$

$q_s + q_m + q_L = 4 \times 10^{-4}$

$q_s = \frac{1}{3} q_L$

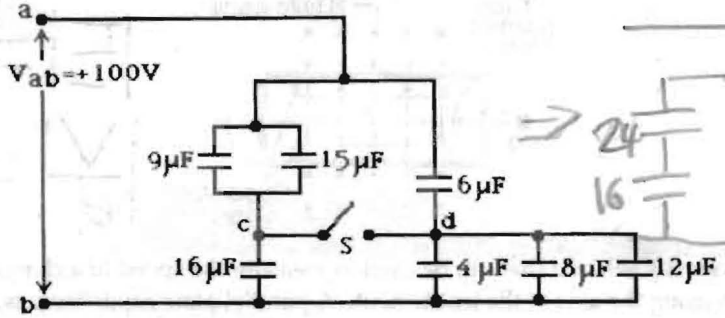
$q_m = \frac{2}{3} q_L$

$q_s + q_m$

$2q_L = 4 \times 10^{-4}$

$q_L = 2 \times 10^{-4}$

Figure 25.1



The capacitive network shown is assembled with initially uncharged capacitors. A potential difference, V_{ab} = +100 V, is applied across the network. The switch S in the network is kept open throughout.

4) In Figure 25.1, the total energy stored in the seven capacitors, in mJ, is closest to:

A) 72 B) 96 C) 144 D) 48 E) 120

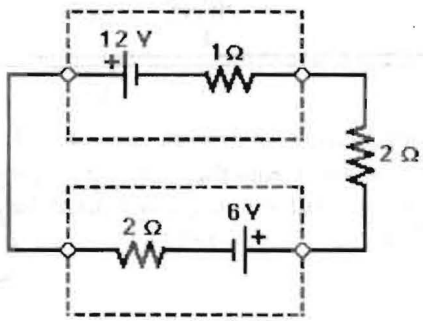
Situation 26.1

The density of free electrons in gold is 5.90 x 10^{28} m^{-3}. The resistivity of gold is 2.44 x 10^{-8} Ω • m at a temperature of 20°C and the temperature coefficient of resistivity is 0.004 $(°C)^{-1}$. A gold wire, 0.8 mm in diameter and 20 cm long, carries a current of 300 ma.

5) In Situation 26.1, the drift velocity of the electrons in the wire is closest to:

A) 6.0 x 10^{-5} m/s
B) 1.2 x 10^{-4} m/s
C) 8.0 x 10^{-5} m/s
D) 1.0 x 10^{-4} m/s
E) 1.4 x 10^{-4} m/s

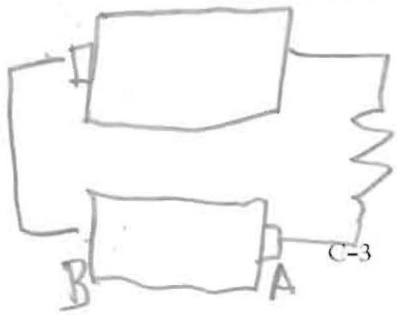
Figure 26.3



A circuit has two batteries and a resistor as shown. The dashed rectangles indicate a battery with its internal resistance.

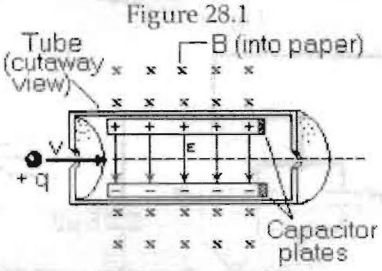
6) In Figure 26.3, the terminal voltage of the 6 V battery is closest to:

A) −1.2 V B) −2.4 V C) +2.4 V D) +1.2 V E) +3.6 V



no deflection $\Rightarrow F=0 \Rightarrow q(E+v\times B)=0$

Figure 28.1



$|E|=|vB|$

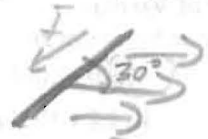
$\left|\frac{V}{d}\right|=vB$ $V=vBd$ $=200$

7) In Figure 28.1 is a velocity selector that can be used to measure the speed of a charged particle. A beam of particles is directed along the axis of the instrument. A parallel plate capacitor sets up an electric field E which is oriented perpendicular to a uniform magnetic field B. If the plates are separated by 4 mm and the value of the magnetic field is 0.1 T, what voltage between the plates will allow particles of speed 5 x 105 m/s to pass straight through without deflection?

A) 2240 V B) 200 V C) 600 V D) 146 V E) 4.60 V

8) A circular coil of wire of 200 turns and diameter 2 cm carries a current of 5A. It is placed in a magnetic field of 0.30 T with the plane of the coil making an angle of 30° with the magnetic field. What is the torque on the coil?

A) 0.22 N • m B) 0.56 N • m C) 0.047 N • m D) 0.082 N • m E) 0.15 N • m

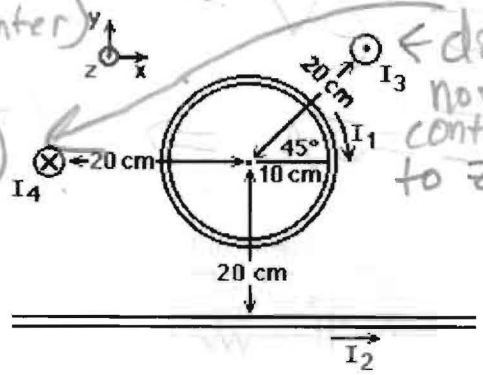


$\tau = ABNI\cos\theta$
$= .0816$

$B_{Loop} = \frac{\mu_0 I}{2R_{Loop}}$ (at center) $(-\hat{z})$

$B_{wire} = \frac{\mu_0 I}{2\pi r}(+\hat{z})$

Figure 29.1



← does not contribute to z_{comp}

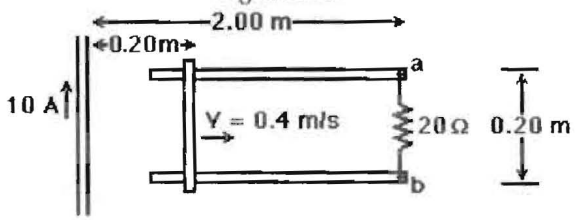
A circular loop of radius 10 cm and three long straight wires carry currents of $I_1 = 10$ A, $I_2 = 20$ A, $I_3 = 30$ A, and $I_4 = 40$ A, respectively, as shown. Each straight wire is 20 cm from the center of the loop.

9) In Figure 29.1, the z-component of the resultant magnetic field at the center of the loop is closest to:

A) −80 μT B) +80 μT C) +40 μT D) −40 μT E) −10 μT

$B = \frac{\mu_0}{2}\left(\frac{20}{.2\pi} - \frac{10}{.1}\right) = -42\ \mu T$

Figure 30.3



A long vertical wire carries a steady 10 A current. A pair of rails are horizontal and are 0.20 m apart. A 20 ohm resistor connects points a and b, at the end of the rails. A bar is in contact with the rails, and is moved by an external force with a constant velocity of 0.40 m/s, as shown. The bar and the rails have negligible resistance. At a given instant t1, the bar is 0.20 m from the wire, as shown.

10) In Figure 30.3, at time t_1, the induced current and its direction through the resistor are closest to:

A) 0.04 μA, from a to b
B) 0.12 μA, from b to a
C) 0.02 μA, from a to b
D) 0.02 μA, from b to a
E) 0.04 μA, from b to a

$B = \frac{\mu_0 I}{2\pi r}$ $\Phi_B = \int \frac{\mu_0 I}{2\pi r} dr = \frac{\mu_0 I}{2\pi} \int \frac{1}{r} dr$

$\mathcal{E} = \frac{\partial \Phi_B}{\partial t} = -\frac{\mu_0 I}{2\pi} \left[\frac{d}{dr} \int \frac{1}{r} dr\right] \frac{dr}{dt}$

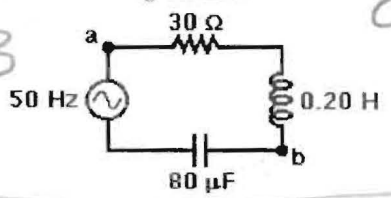
$I = V/R = 4 \times 10^{-8}$

from A to B

$= \frac{\mu_0 I}{2\pi r} v$

$= 8 \times 10^{-7}$

Figure 32.3



A series circuit has a 50 Hz ac source, a 30 ohm resistor, a 0.20 H inductor, and an 80 μF capacitor, as shown. The rms current in the circuit is 2.5 A.

11) In Figure 32.3, the voltage amplitude of the source is closest to:

A) 65 V B) 85 V C) 135 V D) 115 V E) 95 V

$V_{RMS} = 94.5$ $V_{max} = 133$

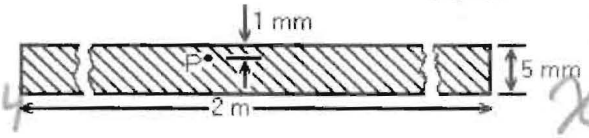
$V_{RMS} = \frac{V_{max}}{\sqrt{2}}$

$I_{RMS} = \frac{V_{RMS}}{X_{total}} = 2.5$

$\omega = 2\pi f = 314$

$X_L = \sqrt{R^2 + \left(\omega L^2 - \frac{1}{\omega C}\right)^2} = 37.8$

Figure 23.7



12) In Figure 23.7, an insulating slab 5 mm x 2 m x 2 m has a charge of 8 x 10−11 coulomb distributed uniformly throughout its volume. Determine the electric field at point P, which is located within the slab beneath its center, 1 mm from one of the faces.

A) 13.6 V/m B) 22.6 V/m C) 0.68 V/m D) 33.9 V/m E) 56.5 V/m

$\sum EA = \frac{3mm\, A\rho}{\varepsilon_0}$

$\rho = \frac{8 \times 10^{-11}}{4 \times .005}$

$E = \frac{3mm\, \rho}{2\varepsilon_0} = .678$