UNIVERSITY OF GAZIANTEP
DEPARTMENT OF ENGINEERING PHYSICS

EP 106 General Physics II
Second Midterm Exam *SUMMER SCHOLL*

Date: 11/08/2006 Time: 100 min.

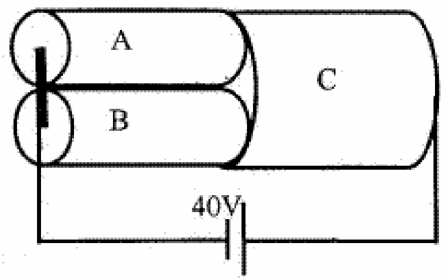
Ques.	Mark
1	7
2	
3	
4	
5	xxxxx
6	xxxxx
Total	
Out of	100 %

Name	Surname	Dep.	Signature
SOLUTIONS !!!			

- The steps of solution of each problem should be shown clearly in the space provided.
- Write your answers in boxes if provided, otherwise your answer will not be considered.
- Useful constants: $g = 9.8\ m/s^2$, $k = 9\times10^9\ Nm^2/C^2$, $e = -1.602\times10^{-19}C$, $\varepsilon_0 = 8.85\times10^{-12}\ C^2/Nm^2$

QUESTION 1 (25 %)

The isolated two conductors A and B having equal length of 10m and radii of 2mm are connected in series to another conductor C having length of 5m and radius of 4mm as seen in figure. The resistivities of the conductors are $1.6\times10^{-6}\Omega$-m, $1.6\times10^{-6}\Omega$-m, and $3.2\times10^{-6}\ \Omega$-m, respectively. If a potential difference 40 volt is applied between the ends of the composite wire determine:



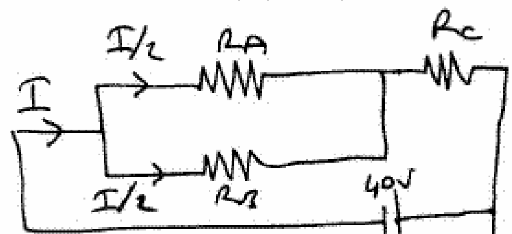
a) the resistance value of each wire,

$R_A = \rho_A \frac{L_A}{A_A} \Rightarrow R_A = (1.6\times10^{-6}) * \frac{10}{\pi(2\times10^{-3})^2}$

$R_A = 1.27\ \Omega$ and $R_B = 1.27$ since $\rho_A = \rho_B$

$R_c = \rho_c \frac{L_c}{A_c} \Rightarrow R_c = (3.2\cdot10^{-6}) \frac{5}{\pi(4\times10^{-3})^2}$

$R_c = 0.318\ \Omega$



$R_A = R_B = 1.27\ \Omega$
$R_c = 0.318\ \Omega$

b) the current density in each wire,

$R_A // R_B \Rightarrow R_{Eq} = \frac{R_A R_B}{R_A + R_B} \Rightarrow R_{eq} = 0.635\ \Omega$ and $R_T = R_{eq} + R_c \Rightarrow R_T = ?$

$R_T = 0.953\ \Omega \Rightarrow V = IR_T \Rightarrow I = \frac{40V}{0.953\Omega} \Rightarrow I = 41.97\ Amp.$

$J_A = \frac{I/2}{A_A} \Rightarrow J_A = \frac{20.98\ Amp}{\pi(2\times10^{-3})^2} \Rightarrow$ $J_A = 1.67\cdot10^6\ Amp/m^2 = J_B$

$J_c = \frac{I}{A_c} \Rightarrow J_c = \frac{I}{A_c} \Rightarrow J_c = \frac{41.97}{\pi(4\times10^{-3})^2} \Rightarrow$ $J_c = 0.835\times10^6\ Amp/m^2$

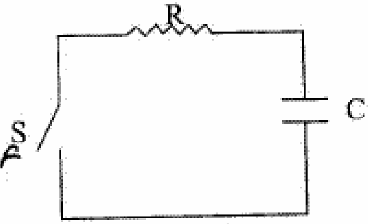
c) the potential differences across each wire.

$V_A = \left(\frac{I}{2}\right) * R_A \Rightarrow$ $V_A = 26.65V = V_B$

$V_c = I * R_c \Rightarrow$ $V_c = 13.35V$

QUESTION 2 (25 %)

An RC circuit is discharged by closing a switch at time t=0. The initial potential difference across the capacitor is 100 V. If the potential difference has decreased to 10 V after 10 sec.



$V_0=100V$, $t=10sec.$, $V_c(t=10)=10V$, $C=0.05\mu F$

$t=12sec \Rightarrow V_c=?$

a) What is the time constant of the circuit?

$V_c=V_0 e^{-t/RC} \Rightarrow 10V=100V * e^{-\frac{10}{RC}} \Rightarrow RC=\frac{10}{\ln 10}=\tau$

$RC=\tau=4.34sec.$ $[R=4.34/0.05*10^{-6} \Rightarrow R\cong 8.7*10^{7}\Omega]$

$\tau=4.34 sec.$

b) What will the potential difference across the capacitor after t=12 sec?

$V_c=V_0 e^{-t/\tau} \Rightarrow$

$V_c(t=12)=100\, e^{-\frac{12}{4.34}}$

$V_c(t=12)=6.31V$

$V_C= 6.31V$

c) What will the amount of charge be on each plate of the capacitor after t=12 sec?

$q_c=q_0 e^{-t/RC} \Rightarrow q_c(t=12)=(V_0 C)\, e^{-t/\tau}$

$q_c(t=12sec)=(0.05*10^{-6})(100)\, e^{-\frac{12}{4.34}} \Rightarrow q_c=3.15*10^{-7}C$

$Q_C= 3.15*10^{-7}C$

d) What is the current through the resistor after t=12 sec? if C=0.05μF.

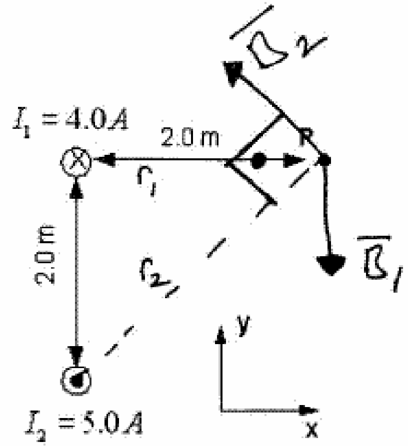
$I_R=I_0 e^{-t/\tau} \Rightarrow I_R(t=12)=\left(\frac{V_0}{R}\right)e^{-t/\tau}$

$I_R=\frac{100}{8.7*10^{+7}}*e^{-12/4.34} \Rightarrow I_R=7.25*10^{-8}Amp.$

$I_R= 7.25*10^{-8}A$

QUESTION 3 (25 %)

Two wires carrying currents I_1 and I_2 are *2.0 m* apart each other. A point ***P*** is located as shown in Figure.



a) Find the magnitude and direction of the resultant magnetic field at point ***P***.

$|\bar{B}_1| = \frac{\mu_0 I_1}{2\pi r_1} \Rightarrow |\bar{B}_1| = 4.0 * 10^{-7}\,T$

and $\boxed{\vec{B}_1 = 4.0*10^{-7}\,T\,(-\hat{y})}$

$|\bar{B}_2| = \frac{\mu_0 I_2}{2\pi r_2} \Rightarrow |\bar{B}_2| = 3.54*10^{-7}\,T$ and $\bar{B}_2$ has x and y components:

$|\vec{B}_{2x}| = +|B_2|\cos(45°) \Rightarrow \vec{B}_{2x} = 2.51*10^{-7}\,T\,(-\hat{x})$ and $\vec{B}_{2y} = B_2 \sin(45)\,(\hat{y})$

$\vec{B}_{2y} = 2.48*10^{-7}\,T\,(-\hat{y})$, So that the $\bar{B}$ has 2 components:

$\bar{B}_x = 2.51*10^{-7}\,T\,(-\hat{x})$

$\bar{B}_y = \bar{B}_1 + \bar{B}_{2y} \Rightarrow \bar{B}_y = 1.52*10^{-7}\,(-\hat{y}) \Rightarrow \boxed{|\bar{B}| = 2.9*10^{-7}\,T}$

and $\theta = \tan^{-1}\left(\frac{\bar{B}_x}{\bar{B}_y}\right) \Rightarrow \boxed{\theta = 31° \text{ below } (-x) \text{ direction.}}$

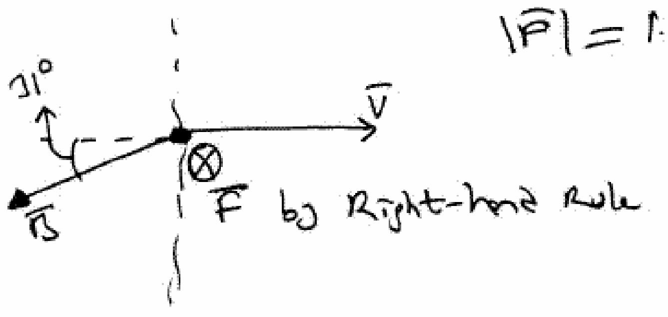
$\|B\|$ = $2.9/10^{-7}$ in the (-x/-y)-direction

b) At some instant in time, a proton is at point ***P*** moving with a speed of $5\times10^6\,m/s$ in the x-direction. What is the magnitude and direction of the magnetic force on the proton.

$\bar{F}_B = q\,\bar{V}\times\bar{B} \Rightarrow |\bar{F}| = qvB\sin(\theta)$

$|\bar{F}| = (+1.6*10^{-19})(5*10^{6})(2.9*10^{-7})\sin(149°)$

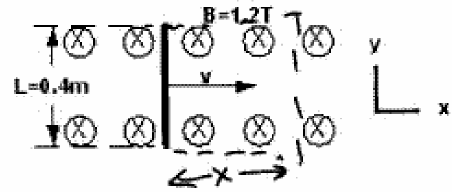
$|\bar{F}| = 1.2*10^{-19}\,N$, in the direction of 'into the paper' ⊗



$\|F\|$ = $1.2*10^{-19}$ N in the (⊗)-direction

QUESTION 4 (25 %)

An iron rod of length *0.40 m* moves with a velocity *v* in a magnetic field, of magnitude *B=1.2 T* that is perpendicular to the direction of motion of the rod, as shown in Figure. The *EMF* (Electro-motive force) induced in the moving rod is found to be *2.40 V*



a) What is the speed of the rod?

$\mathcal{E} = -\frac{d\Phi_B}{dt}$, $\Phi_B = B * S$ where $\bar{B} \perp \bar{S}$ then $S = L * X$

and $\mathcal{E} = -\frac{d}{dt}(B * L * X) \Rightarrow |\mathcal{E}| = |BL \frac{dx}{dt}| \Rightarrow |\mathcal{E}| = BL|V|$ then

$|V| = \frac{\mathcal{E}}{BL} \Rightarrow |V| = \frac{2.4V}{1.2 * 0.4} \Rightarrow |V| = 5 m/s$

|v| = 5m/s.

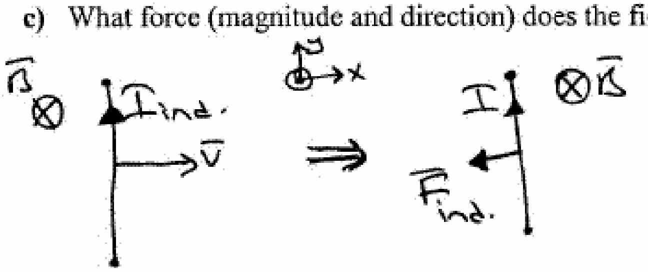
b) If the total resistance of the rod is assumed to be *1.2 ohms*, what is the induced current on the rod?

Since $V = IR$ (Ohm's Law), then one writes

$|\mathcal{E}| = I * R \Rightarrow I = \frac{|\mathcal{E}|}{R} \Rightarrow I_{induced} = \frac{2.4V}{1.2\Omega} \Rightarrow I_{ind} = 2Amp$

I = 2.0 A

c) What force (magnitude and direction) does the field exert on the rod as a result of this current?



so, $\bar{F} = I \bar{L} \times \bar{B}$

$|\bar{F}| = I|L||B| \sin(90^\circ)$

$|\bar{F}| = ILB$ then

$|F| = 2 * 0.4 * 1.2$, and

$|F| = 0.960N$

|F| = 0.960N in the ($-\hat{x}$)-direction