UNIVERSITY OF GAZIANTEP
DEPARTMENT OF ENGINEERING PHYSICS
EP 106 General Physics II
Final Exam *FALL SEMESTER*

Date: 30/05/2019 Time: 10:30 Duration: 90 min.

Ques.	Mark
1	
2	
3	
4	
5	
Total	

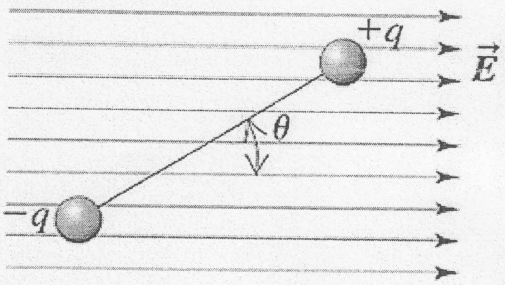
EDUCATION : ☐ 1st Ed. ☐ 2nd Ed.
DEPARTMENT : ☐ CE ☐ MME ☐ IE ☐ ME ☐ TE

Name	Surname	Student No	Signature
	— SOLUTIONS —		

- Cheating is a serious offence and may lead to your dismissal from the university.
- Ignore air resistance in all problems unless otherwise stated.
- Write clearly your solutions steps to the space provided and results to the boxes.
- Constants: $\pi=3.14$, $k= 9\times10^{9}\ N.m^2/C^2$, $\varepsilon_o = 8.85\times10^{-12}\ C^2/N.m^2$, $m_e=9.1^{-31}\ kg$, $|e|=1.6\times10^{-19}\ C$, $\mu_o= 4\pi\times10^{-7}\ T.m/A$
- $1\ mm=10^{-3}\ m$, $1\ cm= 10^{-2}\ m$, $1nm =10^{-9}\ m$, $1\ pm = 10^{-12}\ m$, $1\ h = 3600\ s$, $1\ min = 60\ s$, $1\ rev = 2\pi\ rad$.

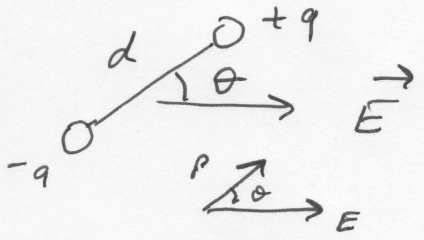
QUESTION 1 (20 %)

Two point charges $q_1= -5\mu C$ and $q_2= +5\mu C$ are separated by 4 mm, forming an electric dipole.



(a) Find magnitude of the electric dipole moment.

$$p = qd$$
$$= (5\times10^{-6})(4\times10^{-3})$$
$$= 20\times10^{-9}\ C.m$$
$$= 2\times10^{-8}\ C.m$$



$$p = 2\times10^{-8}\ C.m$$

(b) The charges are placed in a uniform electric field whose direction makes an angle of $\theta = 53^0$ with the line connecting the charges. What is the magnitude of this field if the torque exerted on the dipole has magnitude of 72×10^{-9} N.m?

$$\tau = pE\sin\theta \quad \text{(torque)}$$

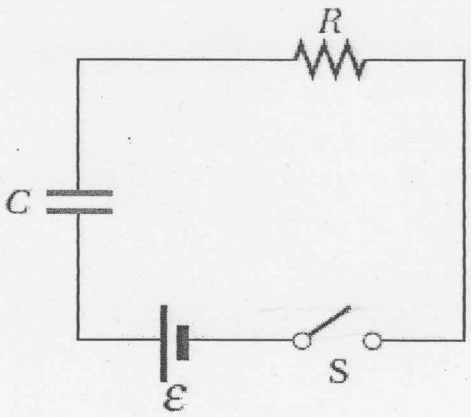
Solving for E:

$$E = \frac{\tau}{p\sin\theta} = \frac{72\times10^{-9}}{(20\times10^{-9})\sin 53^\circ} = 4.5\ \frac{N}{C}$$

$$E = 4.5\ N/C$$

QUESTION 2 (20 %)

Consider a series *RC* circuit for which
$R = 10^6\ \Omega$, $C = 5 \times 10^{-6}$ F, and $\varepsilon = 30$ V.
Assume that the capacitor is initially uncharged.



(a) Find the time constant (τ) of the circuit

$$\tau = RC$$
$$= (1 \times 10^{6})(5 \times 10^{-6})$$
$$= 5.0\ s$$

$\tau = 5\ s$

(b) Find the maximum charge on the capacitor at time $t = 5\tau$ after the switch is closed.

$$Q_{max} = C\varepsilon$$
$$= (5 \times 10^{-6})(30)$$
$$= 150 \times 10^{-6}\ C$$
$$= 150\ \mu C$$

$Q_{max} = 150\ \mu C$

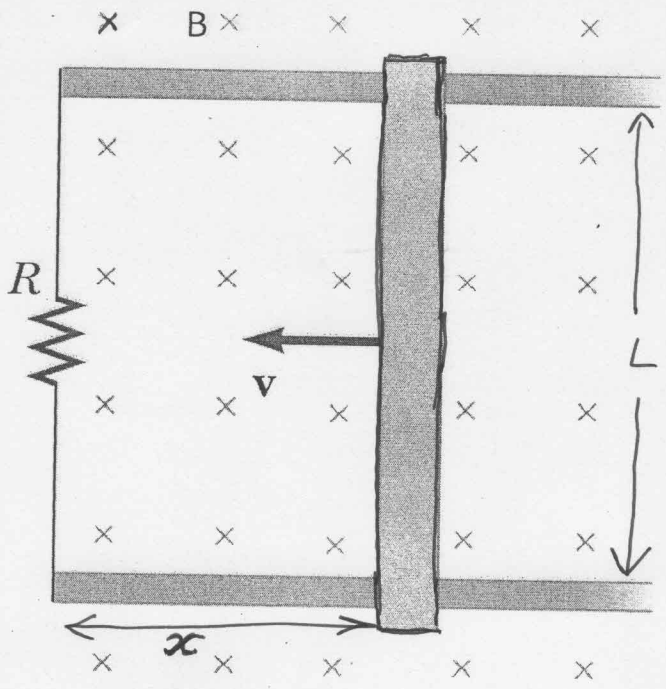
(c) Find the current in the resistor 10 s after the switch is closed.

$$I = \frac{\varepsilon}{R} e^{-t/\tau}$$
$$= \frac{30}{1 \times 10^{+6}} e^{-\frac{10}{5}}$$
$$= 30 \times 10^{-6}\ e^{-2}$$
$$= 4.06 \times 10^{-6}\ A$$
$$= 4.06\ \mu A$$

$I = 4.06\ \mu A$

QUESTION 3 (20 %)

An iron rod of length 0.2 m moves with a velocity in a uniform magnetic field of magnitude $B = 0.6$ T. Magnetic field is perpendicular to the direction of motion of rod shown in Figure. The electromotive force (emf) induced in the moving rod is found to be 12 mV. Assume that rails have negligible resistance.



(a) What is the speed of the rod?

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

$$= -\frac{d}{dt}(BA) = -\frac{d}{dt}(BLx)$$

$$= BL\frac{dx}{dt} = BLv$$

$$v = \frac{\mathcal{E}}{BL} = \frac{12\times10^{-3}}{(0.6)(0.2)} = 0.1\ \frac{m}{s}$$

$v = 0.1$ m/s

(b) If the total resistance of the system (R) is 2.2 kΩ, find the induced current in the circuit?

$$I = \frac{\mathcal{E}}{R} = \frac{12\times10^{-3}}{2.2\times10^{3}} = 5.45\times10^{-6}\ A$$

$I = 5.45\times10^{-6}$ A

(c) Find the direction (cw or ccw) of induced current by using Lenz Law.

Magnetic flux is decreasing while the rod is moving. The current in the circuit should be clock wise since magnetic flux must increase

C. W.

(d) What is the power delivered on the resistor while the rod is moving?

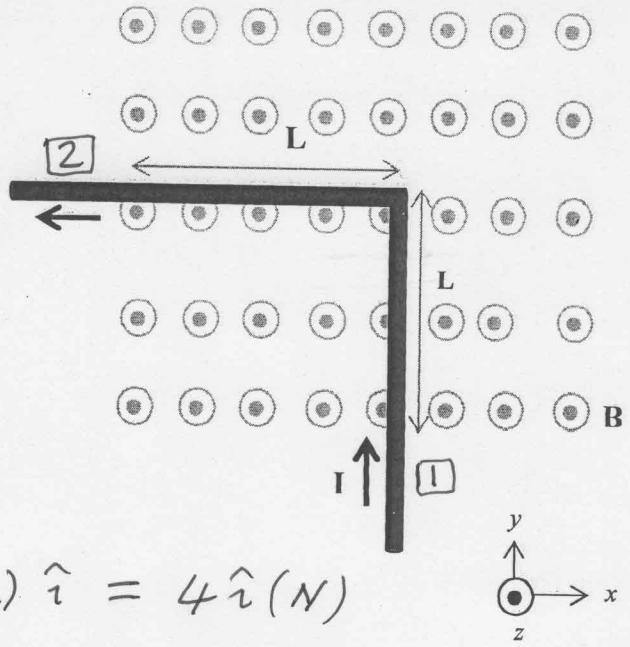
$$P = I^2R = (5.45\times10^{-6})^2(2.2\times10^{3})$$

$$= 6.53\times10^{-8}\ W$$

$P = 6.53\times10^{-8}$ W

QUESTION 4 (20 %)

A 20 A current is flowing through a wire inserted into a uniform magnetic field of $B = 2$ T as shown in Figure. The wire is bent such that the angle between them is 90°. The lengths of the sections of the wire in the field are $L = 10$ cm in x-y plane.
Find the magnitude and direction (in unit vector notation) of the magntic force acting on the wire.



- Force on segment [1]

$$\vec{F}_1 = I\vec{L} \times \vec{B} = I(L\hat{j}) \times (B\hat{k})$$
$$= ILB\,\hat{i}$$
$$= (20)(0.1)(2)\,\hat{i} = 4\hat{i}\,(N)$$

- Force on segment [2]

$$\vec{F}_2 = I\,L(-\hat{i}) \times (B\hat{k}) = ILB\,\hat{j} = (20)(0.1)(2)\hat{j} = 4\hat{j}\,(N)$$

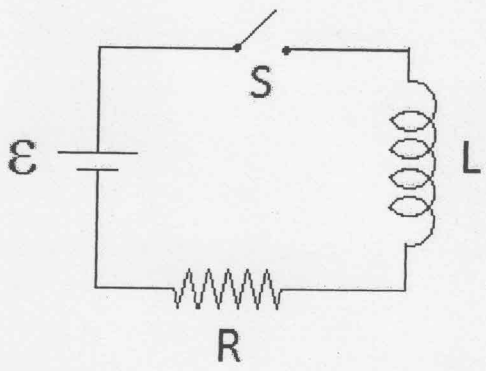
- Total force: $\vec{F} = \vec{F}_1 + \vec{F}_2 = (4\hat{i} + 4\hat{j})\,N$

$|\vec{F}| = 4\sqrt{2}\ N = 5.7\ N$

$F = 5.7\ N$ $\qquad$ $\vec{F} = (4\hat{i} + 4\hat{j})\,N$

QUESTION 5 (20 %)

Consider a series RL circuit as shown in Figure. Assume that $\varepsilon = 20$ V, $L = 50$ mH, $R = 10\ \Omega$ and the swicth S is closed at time $t = 0$.



(a) What is the time constant of the circuit?

$$\tau = \frac{L}{R} = \frac{50 \times 10^{-3}}{10} = 5 \times 10^{-3}\ s$$
$$= 5\ ms$$

$\tau = 5 \times 10^{-3}\ s$

(b) Calculate the current in the circuit at time $t = 4$ ms.

$$I = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$
$$= \frac{20}{10}\left(1 - e^{-4/5}\right)$$
$$= 2\,(1 - 0.449)$$

$I = 1.1\ A$

$I = 1.1\ A$