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

Date: 21/03/2019 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

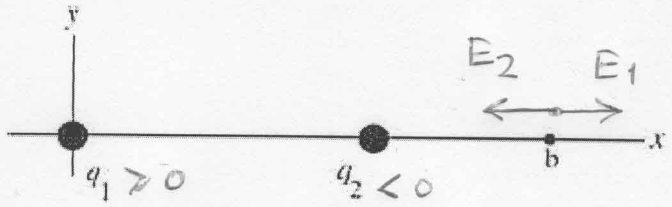
Name	Surname	Student No	Signature
	SOLUTIONS		

- 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: π=3.14, k = 9×10^9 N.m^2/C^2, ε_o = 8.85×10^{-12} C^2/N.m^2, m_e=9.1^{-31} kg, |e|=1.6×10^{-19} C, μ_o= $4\pi\times10^{-7}$T.m/A
- 1 mm=10^{-3} m, 1 cm= 10^{-2} m, 1nm =10^{-9} m, 1 km = 10^3 m, 1 h = 3600 s, 1 min = 60 s, 1 rev = 2π rad.

QUESTION 1 (20 %)

A point charge q_1=+2 nC is at the origin (x = 0), and a second point charge q_2= −5 nC is on the x-axis at x = 0.7 m.

(a) Find the electric field (magnitude and direction) at x = 1.2 m (point b) on the -axis



$$E_{1x} = \frac{k|q_1|}{r_1^2} = 9\times10^9 \frac{2\times10^{-9}}{(1.2)^2} = 12.5 \text{ N/C} \quad +x \text{ direction}$$

$$E_{2x} = \frac{k|q_2|}{r_2^2} = 9\times10^9 \frac{5\times10^{-9}}{(0.5)^2} = 180 \text{ N/C} \quad -x \text{ direction}$$

$$E_x = E_{1x} + E_{2x} = 12.5 - 180 = -167.5 \text{ N/C} \quad -x \text{ dir.}$$

$$E_y = 0$$

$$E_z = 0$$

$E = 167.5$ N/C	$-x$ direction

(b) Find the net electric force that the two charges would exert on an electron placed at point b.

Force acting on electron is

$$\vec{F} = -e\vec{E}$$

$$= (-1.6\times10^{-19} \text{ C})(-167.5\,\hat{i} \text{ N/C})$$

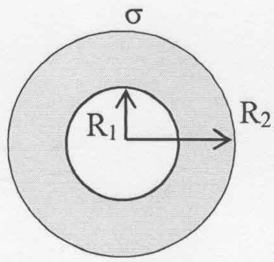
$$= 2.68\times10^{-17} \text{ N} \quad (+x \text{ dir})$$

$\vec{F} = 2.68\times10^{-17}\,\hat{i}$ (N)

QUESTION 2 (20 %)

Charge Q is uniformly distributed on a <u>conducting</u> spherical shell. The surface charge density is given by $\sigma = +8.0\times10^{-6}$ C/m^2. Inner and outer radius of the shell are respectively given by R_1 =5 cm and R_2 =10 cm.

(a) What is the total charge (Q) on the surface of the sphere?



$$Q = \sigma A = \sigma\, 4\pi R_2^2$$
$$= \left(8\times10^{-6}\ \frac{C}{m^2}\right)\left(4\pi (0.1\,m)^2\right)$$
$$= 1\times10^{-6}\ C$$
$$= 1\ \mu C$$

$$\boxed{Q = 1\times10^{-6}\ C}$$

(b) What is the electric field at r =3 cm where r is the distance from the center of the sphere?

$$\oint \vec{E}\cdot d\vec{A} = E(4\pi r^2) = \frac{q_{enc}}{\varepsilon_0}$$

$E = 0$ since $q_{enc} = 0$

$$\boxed{E = 0}$$

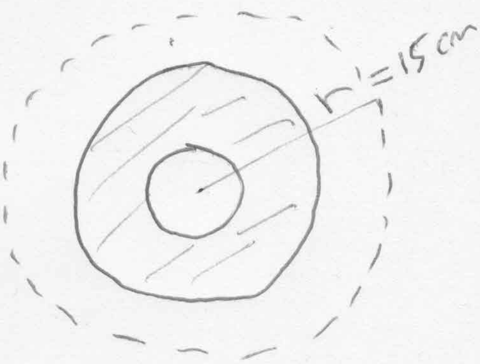
(c) What is the electric field at r =8 cm where r is the distance from the center of the sphere?

$$\oint \vec{E}\cdot d\vec{A} = E(4\pi r^2) = \frac{q_{enc}}{\varepsilon_0}$$

$E = 0$ since $q_{enc} = 0$
inside the conductor.

$$\boxed{E = 0}$$

(d) What is the electric field at r =15 cm where r is the distance from the center of the sphere?



$$\oint \vec{E}\cdot d\vec{A} = E(4\pi r^2) = \frac{q_{enc}}{\varepsilon_0}$$

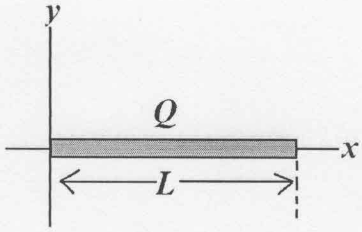
$$E(4\pi r^2) = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2} = k\frac{Q}{r^2}$$
$$= (9\times10^9)\frac{1\times10^{-6}}{(0.15)^2}$$
$$= 4\times10^5\ N/C$$

$$\boxed{E = 4\times10^5\ N/C}$$

QUESTION 3 (20 %)

A thin rod of length $L = 1$ m lies along the x axis with its left end at the origin. It has a uniform linear charge distribution $\lambda = -3.2$ C/m.
How many electrons are there on the rod contributing to the total charge?



$$\text{charge density} = \frac{\text{charge}}{\text{length}}$$

$$\lambda = \frac{Q}{L}$$

$$\Rightarrow Q = \lambda L = \left(-3.2\ \frac{C}{m}\right)(1m) = -3.2\,C$$

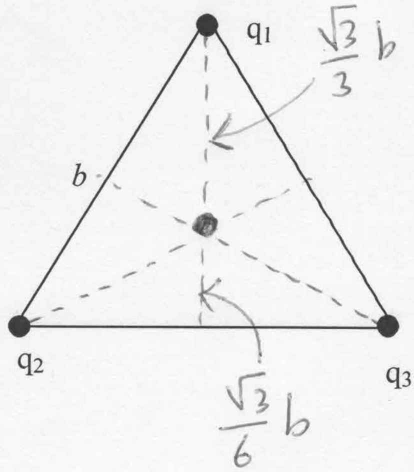
Number of electronic charges can be found from quantization.

$$n = \frac{Q}{e} = \frac{-3.2\ C}{-1.6\times10^{-19}\,C} = 2\times10^{19}\ \text{electrons}$$

$$\boxed{n = 2\times10^{19}}$$

QUESTION 4 (20 %)

Three particles ($q_1 = +2$ nC, $q_2 = -2$nC, $q_3 = +2$nC) are located at the corner of a equılateral triangle of side $b = 20$ cm.
Find the electric potential at the center of the triangle.



$$V = V_1 + V_2 + V_3$$

$$= \frac{kq_1}{\frac{\sqrt{3}}{3}b} + \frac{kq_2}{\frac{\sqrt{3}}{3}b} + \frac{kq_3}{\frac{\sqrt{3}}{3}b}$$

$$= \frac{k}{\frac{\sqrt{3}}{3}b}(q_1 + q_2 + q_3)$$

Let $q = 2nC$

$$= \frac{k}{\frac{\sqrt{3}}{3}b}(q - q + q)$$

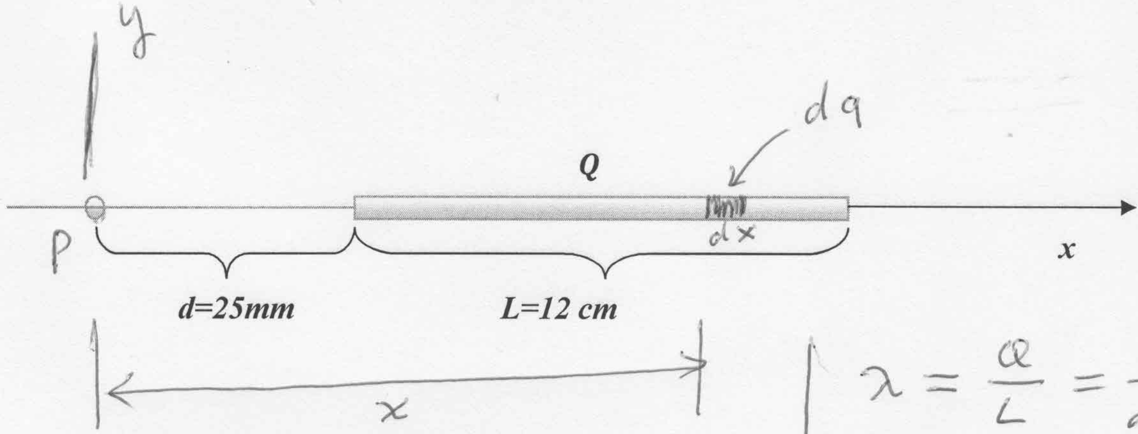
$$= \frac{kq}{\frac{\sqrt{3}}{3}b}$$

$$= \frac{(9\times10^9)(2\times10^{-9})}{\frac{\sqrt{3}}{3}(0.2)} = 155.88\ \text{Volt}$$

$$\boxed{V = 155.88\ V}$$

QUESTION 5 (20 %)

Figure shows a thin plastic rod of length L= 12 cm and uniform positive charge Q= 56.1 fC lying on an x axis (1fC = 1×10^{-15} C). If the potential at infinity is assumed to be zero, find the electric potential at point P on the axis, at distance d= 25 mm from the rod.



$$\lambda = \frac{Q}{L} = \frac{dq}{dx}$$

or $dq = \lambda dx = \frac{Q}{L} dx$

Electric potential at point P:

$$V = k \int \frac{dq}{r}$$

$$= k \int_{d}^{d+L} \frac{\lambda dx}{x}$$

$$= k\lambda \left[\ln(d+L) - \ln(d) \right]$$

$$= k \frac{Q}{L} \left[\ln\left(\frac{d+L}{d} \right) \right]$$

$$= 9\times10^{9} \frac{56.1\times10^{-15}}{0.12} \left(\ln\left(\frac{0.025+0.12}{0.025} \right) \right)$$

$$= 7.4\times10^{-3} \text{ Volt}$$

$$\boxed{V = 7.4\times10^{-3}\ V}$$