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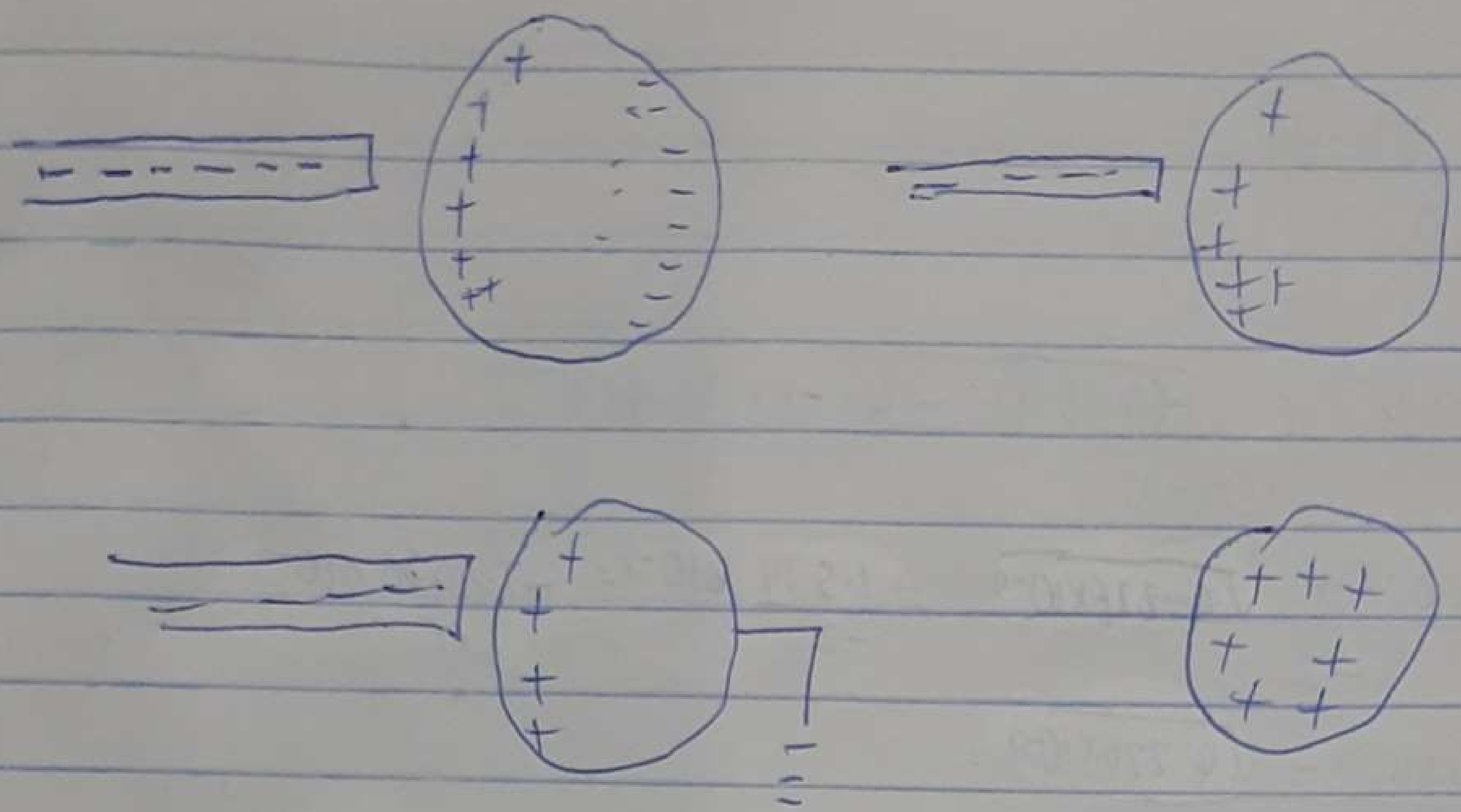
MATRIC NO: 19/MHS01/368

MBBS(MEDICINE AND SURGERY) PHYS 102

1a)



1b) Solution

$F = \frac{K q_1 q_2}{r^2}$ $F = 1.0N$ $r = 2m$ $K = 9 \times 10^9 Nm^2C^{-2}$

$q_1 + q_2 = 5 \times 10^{-5} C$

$1.0 = \frac{9 \times 10^9 \times q_1 q_2}{(2)^2}$

$q_1 q_2 = \frac{4}{9 \times 10^9}$

$q_1 q_2 = 4.44 \times 10^{-10} C^2$

$q_2 = 5.0 \times 10^{-5} C - q_1$

$q_1 q_2 = 4.44 \times 10^{-10}$

$q_1 (5.0 \times 10^{-5} - q_1) = 4.44 \times 10^{-10}$

$q_1 \cdot 5 \times 10^{-5} - q_1^2 = 4.44 \times 10^{-10}$

$-q_1^2 + 5 \times 10^{-5} q_1 = 4.44 \times 10^{-10}$ rewrite as $q_1^2 - 5 \times 10^{-5} q_1 = 4.44 \times 10^{-10}$

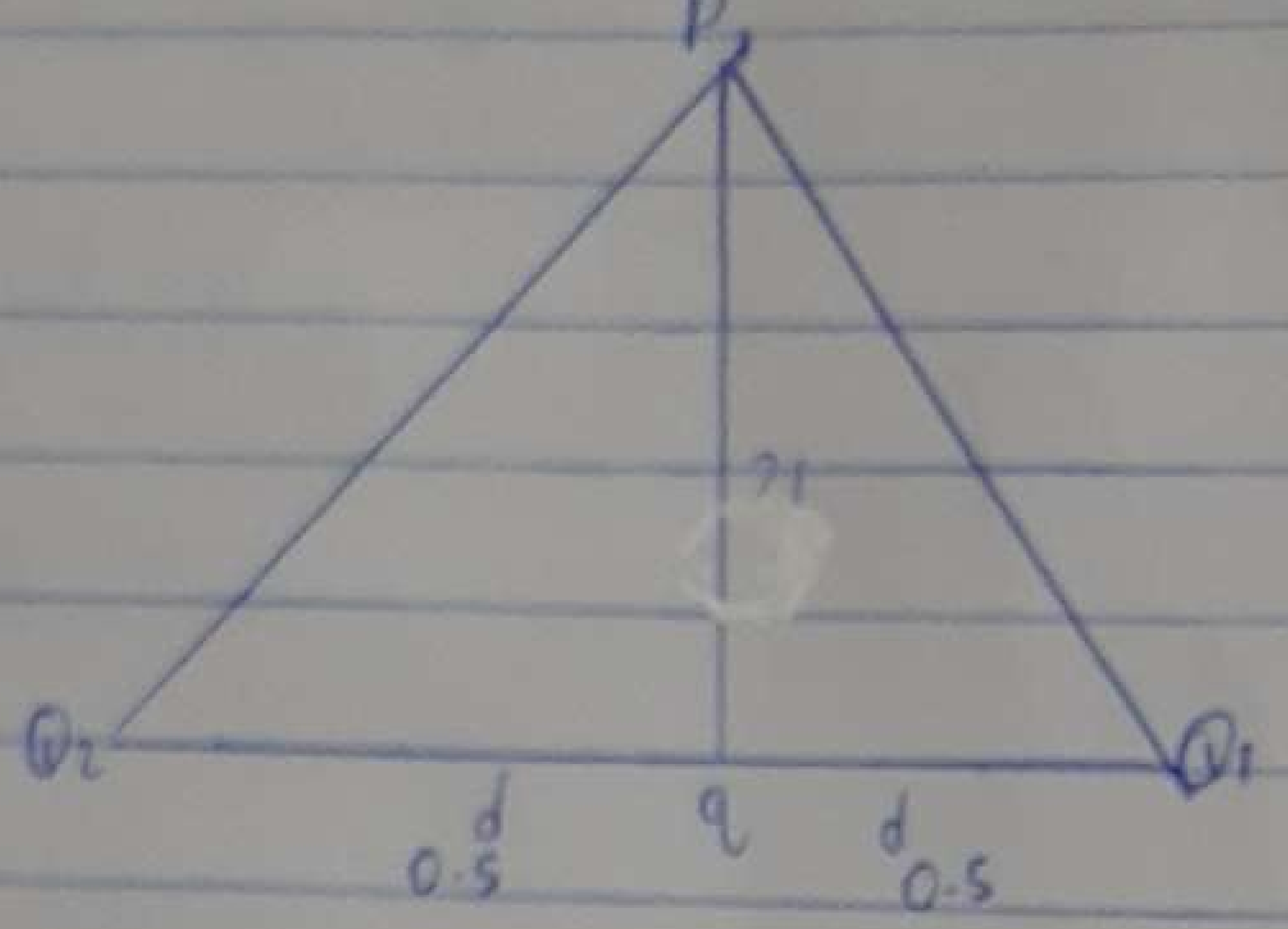
using quadratic equation

$a = +1$, $b = -5.0 \times 10^{-5}$, $c = 4.44 \times 10^{-10}$

$$\frac{(5\times10^{-5}) \pm \sqrt{(5\times10^{-5})^2 - 4(4.44\times10^{-10})}}{2}$$

$q_1 = 3.84\times10^{-5}\,C \quad , q_2 = 1.16\times10^{-5}\,C$

c)



$F = \frac{kq_1q_2}{r^2}$ $\quad q_2 = 8\times10^{-6}\,c \quad , d\,or\,r = 0.5$

$F = \frac{9\times10^9\times(8\times10^{-6})^2}{(0.5)^2}$

$F = 5.76\times10^{-10}$

$5.76\times10^{-1} = \frac{7.2\times10^3}{0.25}$

$\frac{7.2\times10^3 q}{7.2\times10^3} = \frac{1.44\times10^{-1}}{72}$

$2.88 = 9\times10^9\times8\times10^{-6}\times q$

2a) Electric field is a region of space in which an electric charge will experience an electric force.

while

Elatric field intensity is defined as the force per unit charg. mathematically written as $E = \frac{F(N)}{q_o(C)}$

2b) $\vec{E} = \frac{k(q)}{r^2}$

$(E_x)_{net} = \sum E_x = E_{x_1} + E_{x_2}$

$(E_y)_{net} = \sum E_y = E_{y_1} + E_{y_2}$

$E_{net} = \sqrt{(E_x)^2 + (E_y)^2}$

3a) i) Formulation of volume charge density:

Volume charge density is defined as the limiting charge per unit volume i.e $\rho = qv$

where q is the charge and v is the volume of distribution

ii) Formulation of surface charge density:

Surface charge density is present only in conducting surfaces and describes the whole amount of charge (q) per unit area it is written as $\sigma = qA$ where q is the charge and A is the area of the surface.

iii) Formulation of linear charge density:

Linear charge density is the quantity of charge per unit length, measured in coulombs per meter (cm^{-1}), it is written as $\lambda = ql$ where q is the charge and l is the length over which it is distributed

3b) The electric potential difference between two points in an electric field can be defined as the work done per unit charge against electrical forces when a charge is transported from one point to the other. It is measured in volt (v) or joules per coulomb (J/C). Workdone = qV

There fore the elemental workdone dW is given as

$$dW = F \cdot dL \quad \text{---} (1)$$

$$F = -q_0 E \quad \text{---} (2)$$

Substitute equation (2) in (1) which yields

$$dW = -q_0 E dL \quad \text{---} (3)$$

Then total workdone in moving a test charge from A to B:

$$W(A-B)_{ag} = -q_0 \int_A^B E dL \quad (4)$$

Electric potential difference: $V_B - V_A = \frac{W(A-B)_{ag}}{q_0}$

3c) $V = \frac{kQ}{r}$

A the left

$V = \frac{k \times 10}{x} - \frac{k2}{(4+x)}$

$x = -40/8 = -5m$

∴ In between

$V = k10/x - 2k/4-x$ a

$0 = 4 - x - 2x$

$x = 4/3$

to the right

$V = \frac{10k}{x} - \frac{2k}{x-4}$

$10x - 40 = 2x$

$8x = 40$

$x = 5m.$

4a) <u>Magnetic Flux</u>

Magnetic flux is what generates the field around a magnetic material --- The SI unit of the magnetic flux is the weber (wb) (Vs^{-1} is the derived units). It is written as: $\Phi_B = B \cdot A$ or $\Phi_B = BA\cos(\theta)$ when dealing with angle between the planar area where B = magnetic field, A = Surface Area, θ = Angle between the magnetic field and normal to the surface

4b)

4c)

5a) The Biot-savart law is an equation that describes the magnetic field created by a current-carrying wire, and allows you to calculated its strength at various points. $dB = \frac{\mu I dl \sin\theta}{4\pi r^2}$

5b) $B = \frac{\mu_0 I}{2\pi r}$

Solution

The distance from the axis of the conductor is equal to the radius : $r = \frac{\mu_0 I}{2\pi B}$, where $\mu_0 = 4\pi \times 10^{-7}$, $T \cdot m/A$ = permeability of free space

$r = \frac{4\pi \times 10^{-7} \times 10A}{2 \times 3.142 \times 0.5 \times 10^{-4} T}$, $r = 4 \times 10^{-3} m$ ∴ for a semi-infinite straight wire.

6a) Faraday's law stated that a changing magnetic field produces electricity. Therefore a guitar will produce electricity only for as long as the magnetic field is changing - in other words for only as long as the metal string is moving. Once the string stops vibrating, the sound stops.

6b) From faradays laws

Induced emf $e = \frac{N A \phi}{\Delta t} = (NS) = \frac{\Delta B}{\Delta t}$

$= \frac{(300)(10 \times 10^{-2})^2 (10-0)}{0.5s}$

i) Induced emf $= 60V$

ii) Induced current $I = \frac{e}{R} = \frac{60}{2} = 30A$.

6c) <u>Solution</u>

~~W~~with ohm's laws the emf induced in one coil

$$\varepsilon_1 = \frac{IR}{N}$$

$$= \frac{0.1\,A \times 8\Omega}{75\,\text{turns}}$$

$$= 0.01067\,V$$

Faradays law is applied.

$$\varepsilon_1 = \frac{d\phi_B}{dt}$$

$$= \frac{d(A \cdot B)}{dt}$$

$$\varepsilon_1 = A\, dB/dt$$

$$\therefore dB/dt = \frac{\varepsilon_1}{A}$$

Rate at which the magnetic field changes $= \frac{0.01067V}{5\times10^{-2} \times 8\times10^{-2}} = 2.6675\,T/S$