$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - \theta)}{x^2 + y^2} \quad \text{---} \; ①$$

But $\sin(\pi - \theta) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}}$ --- ②

subst ② into ①

$$B = \frac{\mu_0 I}{4\pi} \int_{a}^{a} \frac{dl \, x}{(x^2+y^2)(x^2+y^2)^{1/2}}$$

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \, x}{(x^2+y^2)^{3/2}}$$

Recall ...

Subset eqn (2) into (1), $dw = -q_0 E\,dL$ --- (3)

Total work done in moving the test charge from A to B is: $W(A \to B) = -q_0 \int_A^B E\,dL$ --- (4)

From the definition of the potential difference,

$$V_B - V_A = \frac{W(A \to B)}{q_0} \quad \text{--- (5)}$$

Subset eqn (4) into (5)

$$V_B - V_A = -\int_A^B E\,dL \quad \text{--- (6)}$$

C

$Q_1 = 10nC,\ Q_2 = -2nC,\ x = 0,\ x = 4$

$r = 0$

For x, $V = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$

Using special integers

$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2}\frac{y}{(x^2+y^2)^{1/2}}$$

∴ Equation (3) becomes

$$B = \frac{\mu_0 I x}{4\pi}\left[\frac{y}{x^2(x^2+y^2)^{1/2}}\right]_{-a}^{a}$$

$$B = \frac{\mu_0 I x}{4\pi}\left[\frac{2a}{x^2(x^2+a^2)^{1/2}}\right]$$

$$B = \frac{\mu_0 I}{4\pi x}\left[\frac{2a}{(x^2+a^2)^{1/2}}\right]$$

$(x^2+a^2)^{1/2} \approx a$ as $a \to \infty$

$$\therefore B = \frac{\mu_0 I}{2\pi x}$$

5 Biot-Savart law is a mathematic expression which illustrate the magnetic field produced by a stable electric current in the particular electric magnetic of physics. It states that the magnetic field is directly proportional to the product permeability of the free space (μ_0) the current (I) the change in lenth (dl), the radius (r) and inversely proportional to the square of radius (r^2)

$$\vec{dB} = \frac{\mu_0}{4\pi} \frac{I\, dl \times \hat{r}}{r^2}$$

$\mu_0 = 4\pi \times 10^{-7}$ Tm

5b.

Applying the Biot savart law we find the magnitude of the field $\vec{dB}$

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin\theta}{r^2}$$ $\sin(\pi - \theta) = \sin\theta$

$$\therefore B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - \theta)}{r^2}$$

from the diagram, $r^2 = x^2 + y^2$

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl \sin(\pi - \theta)}{x^2 + y^2} \quad \text{---} ①$$

But $\sin(\pi - \theta) = \frac{x}{\sqrt{x^2 + y^2}} = \frac{x}{(x^2+y^2)^{1/2}}$ --- ②

subst ② into ①

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl\, x}{(x^2+y^2)(x^2+y^2)^{1/2}}$$

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl\, x}{(x^2+y^2)^{3/2}}$$

Recall that $dl = dy$

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{x}{(x^2+y^2)^{3/2}}\, dy \quad \text{---} ③$$

$$= \frac{\mu_0 I x}{4\pi}\int_{-a}^{a} \frac{1}{(x^2+y^2)^{3/2}}\, dy$$

$0 = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{x} + \frac{Q_2}{x+4}\right]$ divide through by $\frac{1}{4\pi\varepsilon_0}$

$0 = \left[\frac{Q_1}{x} + \frac{Q_2}{x+4}\right]$

$= \frac{Q_2}{x+4} = \frac{Q_1}{x} = -\left(\frac{-2\times10^{-6}}{x+4}\right) \times \frac{10\times10^{-6}}{x}$

$2\times 10^{-6}x = 10\times10^{-6}x + 4\times10^{-5}$

$8\times10^{-6}x = -4\times10^{-5}$

$x = \frac{-4\times10^{-5}}{8\times10^{-6}} = -5$

$\therefore x = -5$

for y $V = 4\pi\varepsilon_0\left[\frac{Q_1}{y} + \frac{Q_2}{4-y}\right]$ divide through by $\frac{1}{4\pi\varepsilon_0}$

$0 = \left[\frac{Q_1}{y} + \frac{Q_2}{4-y}\right]$

$\frac{Q_2}{4+y} = \frac{Q_1}{y} = -\left[\frac{-2\times10^{-6}}{4+y}\right] = \left[\frac{10\times10^{-6}}{y}\right]$

$2\times10^{-6}y = 4\times10^{-5} - 10\times10^{-6}y$

$12\times10^{-6}y = 4\times10^{-5}$

$y = \frac{4\times10^{-5}}{12\times10^{-6}} = 3.33$

$\therefore y = 3.33$

for Z, $V = 4\pi\varepsilon_0\left[\frac{Q_1}{Z} + \frac{Q_2}{4+Z}\right]$ divide through by $\frac{1}{4\pi\varepsilon_0}$

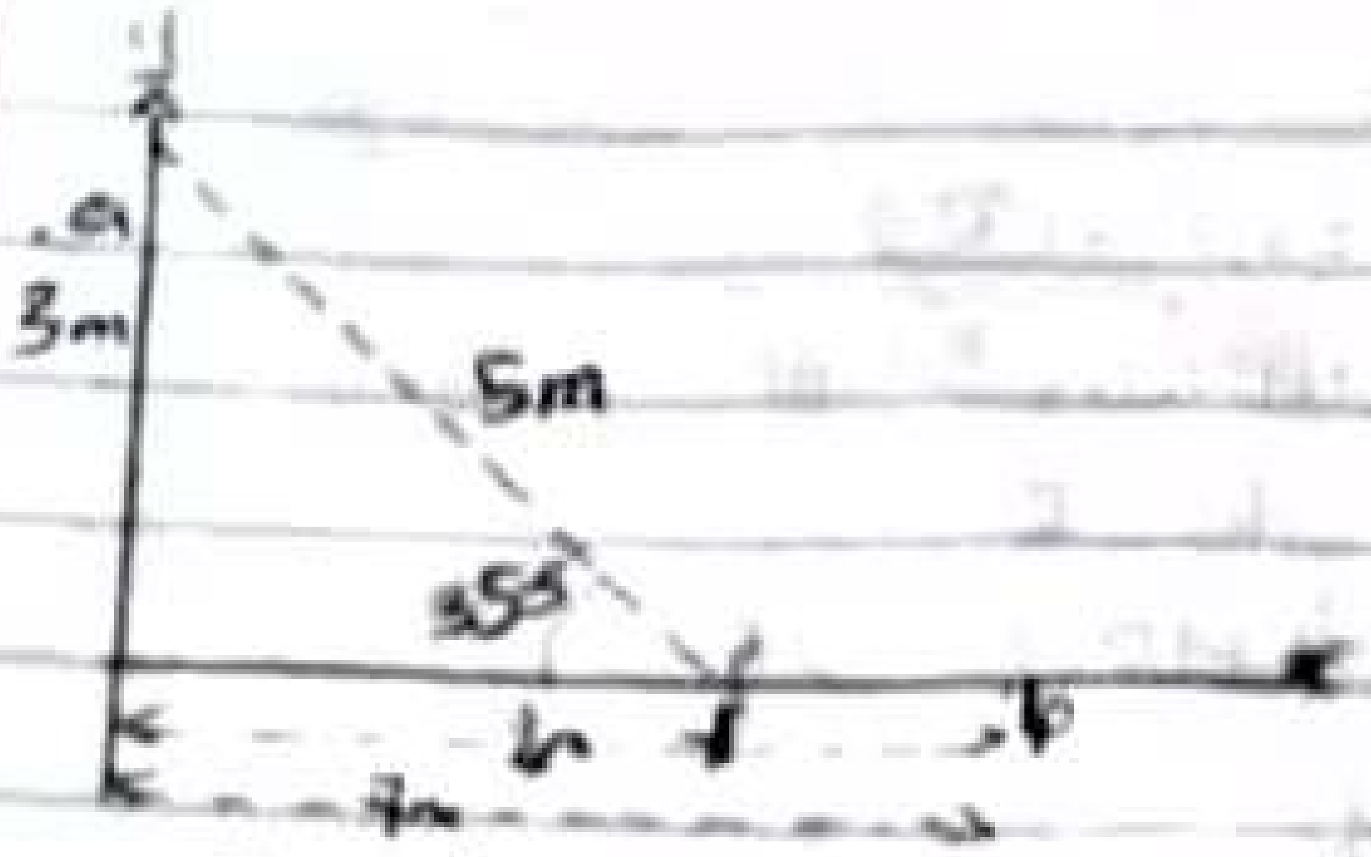
$0 = \left[\frac{Q_1}{Z} + \frac{Q_2}{4+Z}\right]$

$\frac{Q_2}{4+Z} = \frac{Q_1}{4} = -\left[\frac{-2\times10^{-6}}{4+Z}\right] = \left[\frac{10\times10^{-6}}{4}\right]$

$8\times10^{-6} = 4\times10^{-5} + 10\times10^{-6}Z$

$-3.2\times10^{-5} = 10\times10^{-6}Z$

2b



$K = 9\times10^{9}\ Nm^2C^{-2}$; $q_1 = 8\times10^{-9}C$

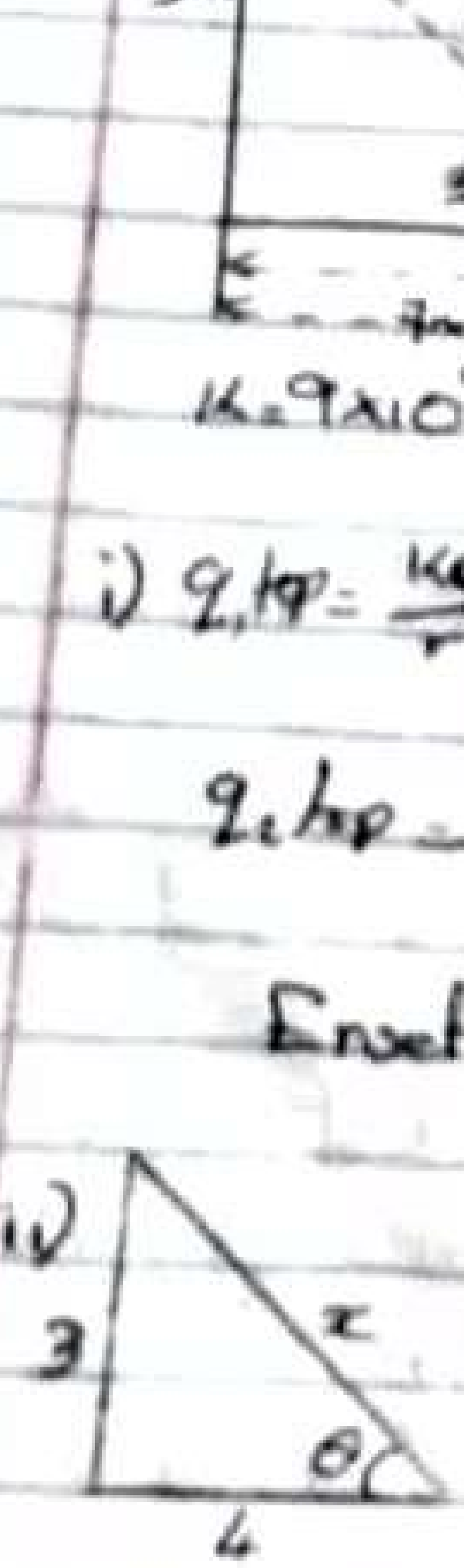
$q_2 = 12\times10^{-9}C$

i) q_1 to P $= \frac{Kq_1}{r^2} = \frac{(9\times10^{9})(8\times10^{-9})}{(7)^2} = 1.47\ N/C$

q_2 to P $= \frac{Kq_2}{r^2} = \frac{(9\times10^{9})(12\times10^{-9})}{3^2} = 12\ N/C$

$E_{net} = (12 + 1.47) = 13.47 \simeq 13.5\ N/C$

ii)



using pythagoras theorem

$x = \sqrt{3^2+4^2} = 5$

$\tan\theta = 3/4$, $\tan\theta = 0.75$

$\therefore \theta = \tan^{-1}0.75 = 36.87°$

q_1 to Q $= \frac{Kq_1}{r^2} = \frac{(9\times10^{9})(8\times10^{-9})}{(5)^2} = 8tro\ 8N/C$

q_2 to Q $= \frac{Kq_2}{r^2} = \frac{(9\times10^{9})(12\times10^{-9})}{4^2} = 4.32\ N/C$

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

$$E_q = \sqrt{(0)^2 + (10264.52568)^2}$$

Since $E_q = 0$

$$0 = 9\times10^9 q + 10264.52568$$

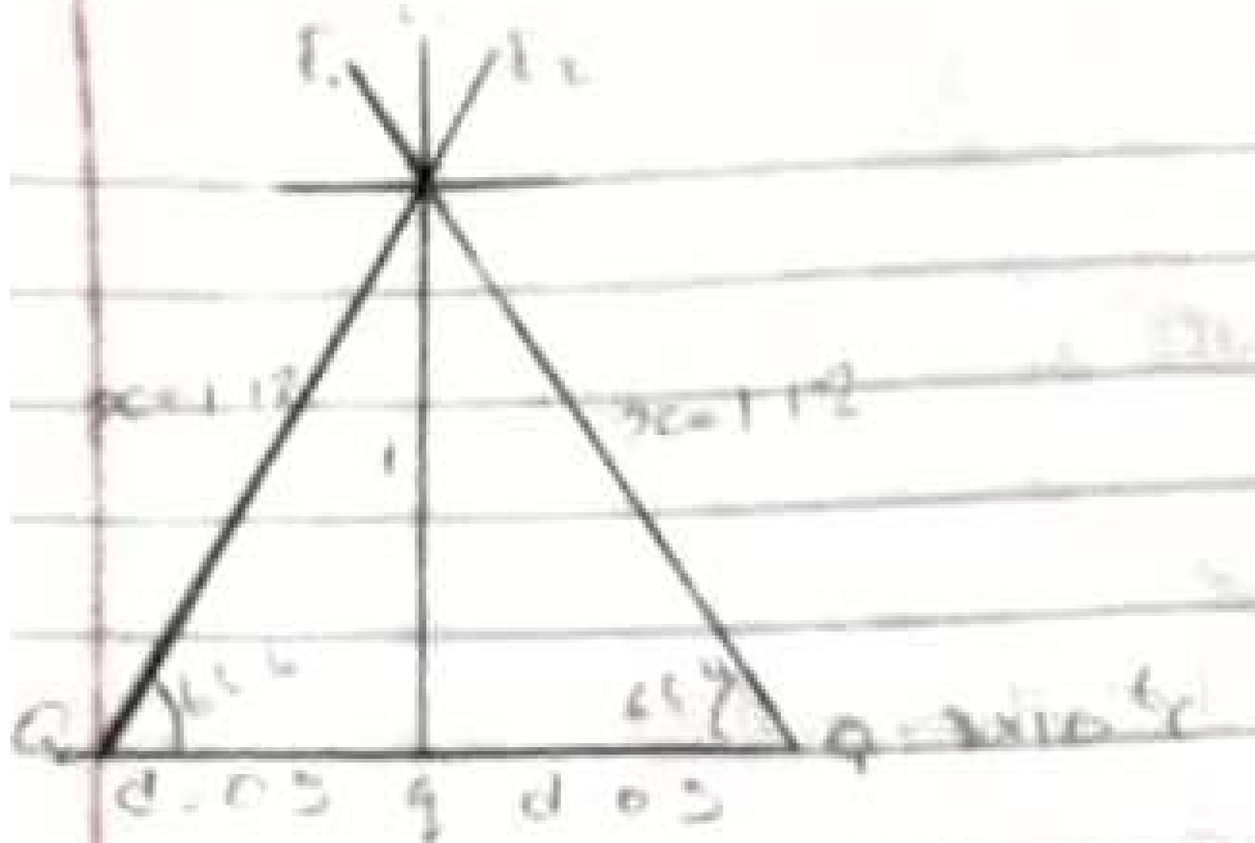
make q subject of formular

$$q = \frac{10264.52568}{9\times10^9}$$

$$q = 1.140502853\times10^{-6}$$

$$q = 11.4\mu C$$

2a Electric field Intensity	Electric field
Electric field Intensity [E] is the force ~~of~~ per unit charge $E = \frac{F(N)}{q_0(C)}$	Electric field is a region of space in which an electric charge will experiencer an electric force



$x^2 = 1^2 + 0.5^2$

$= \sqrt{1.25}$

$x = \sqrt{1.25}$

$x = 1.12$

$\tan\theta = \frac{opp}{adj}$

$\tan\theta = \frac{1}{0.5}$

$\theta = \tan^{-1}(2)$

$\theta = 63.4$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2}$

$= 57397.9598$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times q}{1}$

$= 9\times10^9 q$

Vector	Angle	X-component	Y-compo…
$E_1 = 57397.95918$	63.4°	$E_1\cos\theta =$ 2570.045789	$E_1\sin\theta =$ 5132.26…
$E_2 = 57397.95918$	63.4°	$E_2\cos\theta =$ 2570.045789	$E_2\sin\theta$ 5132.2…
$E_q = 9\times10^9 q$	90°	$E_q\cos\theta = 0$	$E_q\sin\theta$
		$E_x = 0$	$E_y =$…

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PHY 102

1a Induction charging is a method used to charge an object without actually touching the object to any ~~order~~ other charged object. An understanding of charging by induction requires an understanding of the nature of a conductor and an understanding of the polarization process. When charging by induction a charged object is brought close to but does not touch the conductor. In the end the conductor has charge of the opposite sign as the charge on the object.

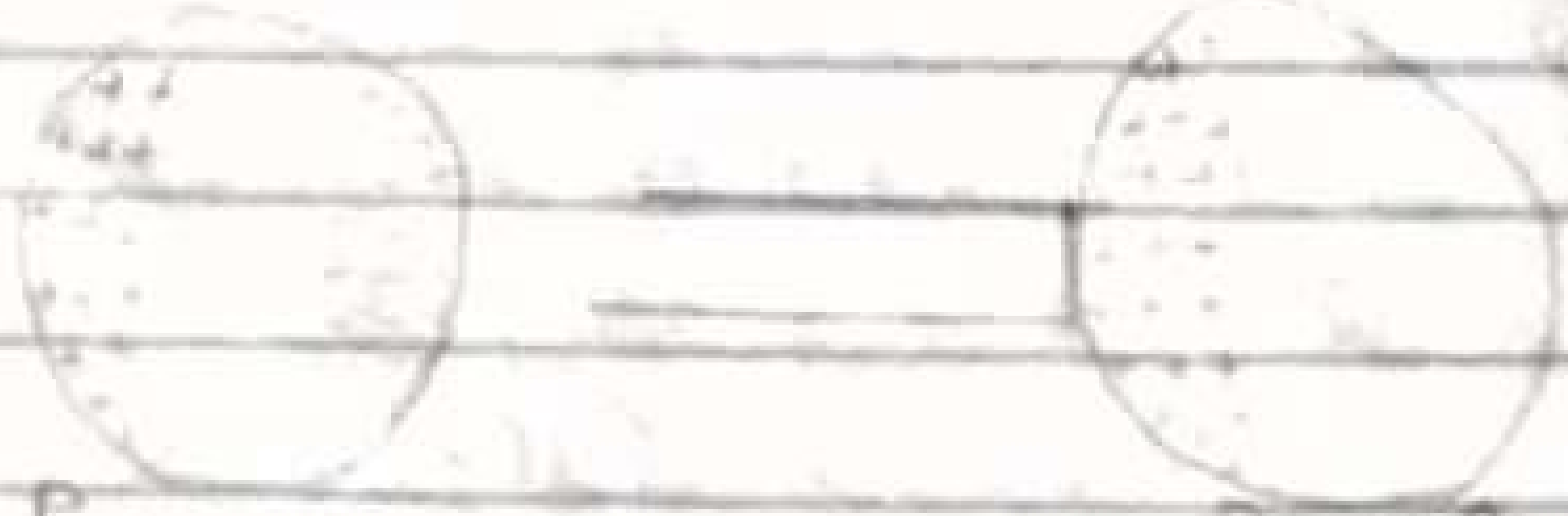

Fig 12a Fig 12b

$$E = \frac{-32\times10^{-9}}{10\times10^{-6}} = -3.2$$

When $v=0$, $x=-9m$ and $3.33m$

Vector	Angle	x-component	Y-component
q_1 to $Q = 8N/C$	90°	$8\cos 90^\circ = 0N/C$	$8\sin 90^\circ = 8N/C$
q_2 to $Q = 4.32N/C$	36.87°	$4.32\cos 36.87^\circ = 3.46N/C$	$4.32\sin 36.87^\circ = 2.592N/C$

$\Sigma E_x = 3.46N/C$ $\quad \Sigma E_y = 10.592N/C$

$$E_{net} = \sqrt{(\Sigma E_x)^2 + (\Sigma E_y)^2}$$
$$= \sqrt{(3.46)^2 + (10.592)^2}$$
$$\therefore E_{net} = 11.14\ N/C$$

3. i Volume charge density $\rho = \frac{dQ}{dv}$ $\quad dQ = \rho dv$
ii Surface charge density, $\sigma = \frac{dQ}{dA}$ $\quad dQ = \sigma dv$
iii Linear charge density $\lambda = \frac{dQ}{dL}$ $\quad dQ = \lambda dL$

3b Electric field is 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)

Work done, $dW = F \cdot dL$ --- ①

But $F = -q \cdot E$ --- ②