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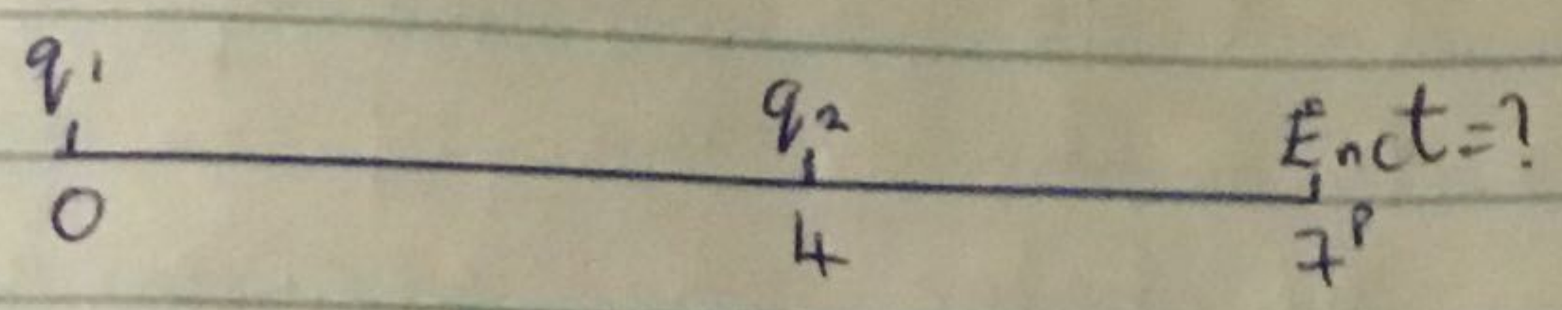
17/ENG02/020
PHY

2a) An Electric field is a region in space where an electric charge will experience an electric force, while Electric Field Intensity is the force per unit charge acting on a charged particle in an electric field.

bi)



$q_1 = 8 \times 10^{-9} C$, $q_2 = 12 \times 10^{-9} C$, $r_1 = 7m$, $r_2 = 3m$

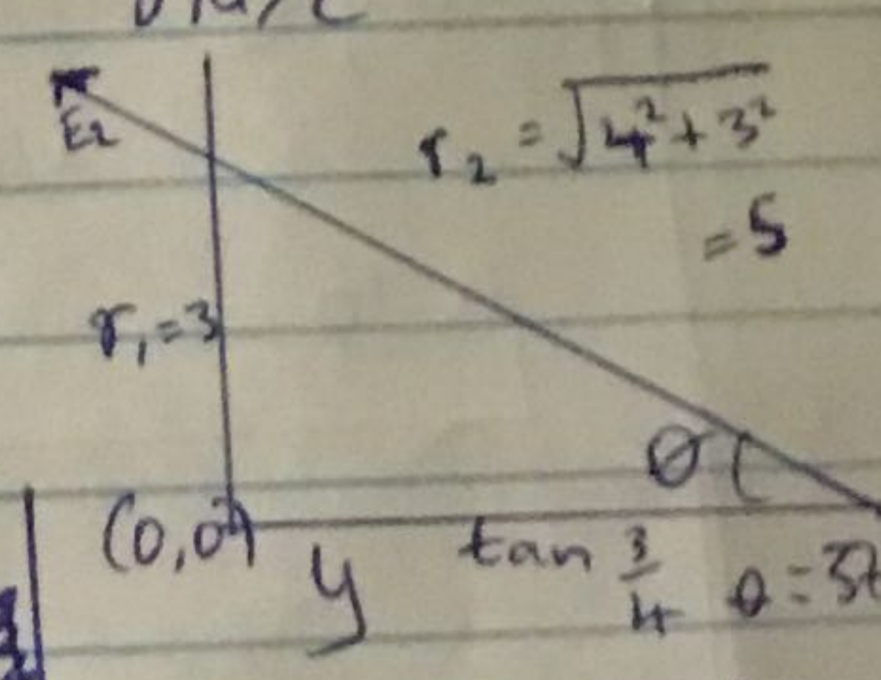
$E_1 = \frac{Kq_1}{r_1^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7^2} = 1.47\ N/C$

$E_2 = \frac{Kq_2}{r_2^2} = \frac{(9 \times 10^9)(12 \times 10^{-9})}{3^2} = 12\ N/C$

$E_{net} = E_1 + E_2 = 13.47\ N/C \simeq 13.5\ N/C$

ii) $E_1 = \frac{Kq}{r_1^2} = \frac{(9 \times 10^9)(8 \times 10^{-9})}{3^2} = 8\ N/C$

$E_2 = \frac{Kq_2}{r_2^2} = \frac{(9 \times 10^9)(12 \times 10^{-9})}{5^2} = 4.32\ N/C$



E	θ	x	y
E_1	90°	$+ 8\cos 90 = 0$	$+ 8\sin 90 = 8$
E_2	37°	$-4.32\cos 37 = -3.45$	$+ 4.32\sin 37 = 2.59$

$\Sigma E_x = -3.45$ $\quad \Sigma E_y = 10.59$

$E_{net} = \sqrt{(-3.45)^2 + (10.59)^2} = \sqrt{124}$

$= 11.14\ N/C$

3 a i Volume charge density $\rho = \frac{dQ}{dv} \rightarrow dQ = \rho dv$

ii Surface ~~change~~ charge density $\sigma = \frac{dQ}{dA} \rightarrow dQ = \sigma dA$

iii Linear charge density $\lambda = dQ/dL \rightarrow dQ = \lambda dL$

b In moving a charge from a point A to another point B along an arbitrary path in an electric field, an external force, $F = -q_0 E$ must act to counter the force, $F = q_0 E$ which the field exerts on the charge

Work done on the charge dW is given as,

$$dW = F \cdot dL \quad \cdots \text{①}$$

$$dW = -q_0 E dL \cdots \text{②} \qquad [F = -q_0 E]$$

Total workdone in moving test charge from A to B

$$W(A \rightarrow B)_{avg} = -q_0 \int_A^B E \, dL \quad \cdots \text{③}$$

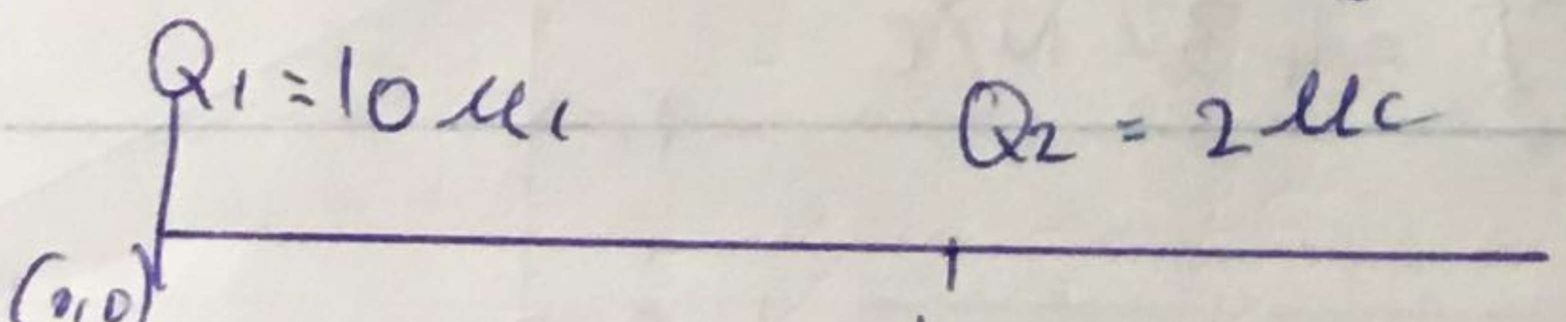
From the definition of potential difference

$$V_B - V_A = \frac{W(A \rightarrow B)_{Ag}}{q_0} \cdots \text{④}$$

putting ④ into ③

$$V_B - V_A = -\int_A^B E \, dL$$

c.



Let the point where $v = 0$ be x

$\therefore r_1 = |x|$, $r_2 = |4 - x|$ $\quad V = K\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right] = 0$

$$\frac{Q_1}{r_1} = -\frac{Q_2}{r_2}, \quad \frac{10 \times 10^{-6}}{|x|} = -\frac{(-2 \times 10^{-6})}{|4 - x|}$$

$$\frac{2 \times 10^{-6} |x|}{2 \times 10^{-6}} = \frac{10 \times 10^{-6} |4 - x|}{2 \times 10^{-6}}; \quad |x| = 5|4 - x|$$

4.
a. Magnetic flux, ϕ is defined as the strenght of magnetic field, represented by lines of force

$$\phi_B = \int \vec{B} \cdot d\vec{A} = BA \cos\theta$$

b. $M_e = 9.11 \times 10^{-31}$ Kg
$B = 0.35$ weber $/m^2$
$q = 1.60 \times 10^{-19}$ C
$\omega = ?$

$\therefore$ ω (angular speed / cyclotron frequency)

$$= \frac{1.6 \times 10^{-19} \times 0.35}{9.11 \times 10^{-31}}$$

$$\omega = 6.15 \times 10^{10} \text{ rad/s}$$

c. The electron oscillates at an angular frequency of 6.15×10^{10} rad/s

6a. In an electric guitar, the coil (the pickup coil) is placed near the vibrating guitar string, which is made up of a metal that can be magnetised. A permanent magnet inside the coil magnetizes ~~Proparan~~ of the string nearest the coil. When the string vibrates at some frequency, its magnetized segment produces a changing magnetic flux through the coil. the changing flux induces an emf in the coil that is fed to an amplifier. the output of the amplifier is sent to the loudspeaker, which produces the sound waves, we hear.

b. $N = 300 \quad A = (0.1)^2 = 0.01\,m^2 \quad |e| = ?$

$R = 2.0\Omega \quad \Delta\phi_B = 10T \quad \Delta t = 0.5s$

i. induced emf $|e| = \dfrac{N\Delta\phi}{\Delta t} = \dfrac{300 \times 0.01 \times 10}{0.5} = 60V$

ii. Induced current $= \dfrac{|e|}{B} = \dfrac{60}{2} = 30A$

c. $A = 0.05 \times 0.08 = 4 \times 10^{-3}\,m^2 \quad I = 0.1A$

$N = 75 \quad R = 8\Omega \quad \Delta\phi_B = ? \quad \Delta t\ ?$

$I = \dfrac{|e|}{R} \qquad |e| = 8 \times 0.1A = 0.8V$

$|e| = \dfrac{N\Delta B}{\Delta t} \ : \ \dfrac{\Delta B}{\Delta t} = \dfrac{0.8}{75 \times 4 \times 10^{-3}} = 2.7\ T/s$