ElCoM
ELECTRICAL COMPUTER MECHATRONICS

فيزياء عامة 2

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للطالبة المبدعة
رند الشوبكي

إرادة - ثقة - تغيير

Ch-23 The electric field

1] Charge properties خواص الشحنة

→ Charge : q : Q

$[q]$ = Coulomb = C

Remark: $pC = 10^{-12}$ $nC = 10^{-9}$ $\mu C = 10^{-6}$ $mC = 10^{-3}$

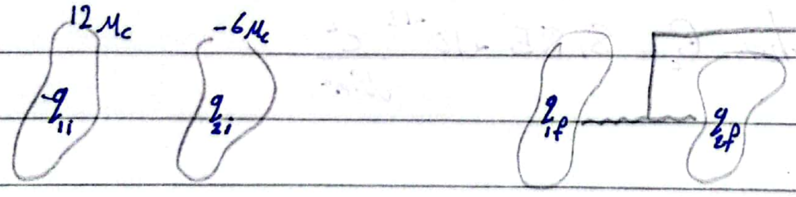
$m = 10^{-3}$ $M = 10^{6}$

→ The Charge is quantized مكممة

• $q = Ne$ when $N = 0, \pm 1, \pm 2 \ldots$ عدد صحيح $e = -1.6 \times 10^{-19}$ C

→ The charge is conserved شحنة محفوظة

Before   After



→ very thin wire   مهمل كتلة و الشحنة

$q_i = q_{1i} + q_{2i}$ $q_f = q_{1f} + q_{2f}$ $\therefore$ $q_i = q_f$

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متماثل

→ special Case :- Two identical objects

← أن يكون من نفس مادة ونفس الشكل

"Cowlbom's Law"

متناسب طرديا

. The electric force is directly proportional to charges product.

→ $F \propto q_1 q_2$ → $F \propto \frac{1}{r^2}$

And inversly proportional to the distance squer.

عكسي

. $F \propto \frac{q_1 q_2}{r^2}$

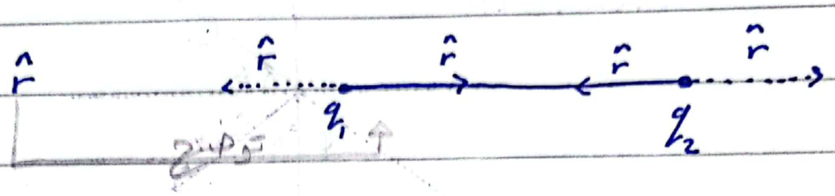
$q_1 \rightarrow q_2$

$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$ when $\epsilon_0 = 8,85 \times 10^{-12} \frac{C^2}{N.m^2}$

$K_e = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9$

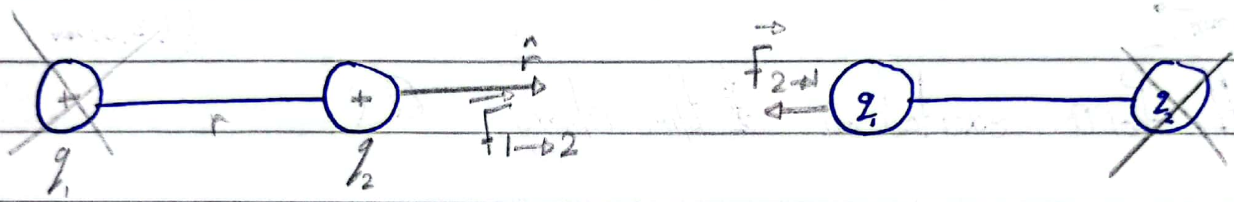
* $F = K_c \frac{q_1 q_2}{r^2}$

• $\vec{F}_{\substack{1\to2 \\ 2\to1}} = K_c \frac{q_1 q_2}{r^2}$ $\hat{r}$



$\hat{r} = \hat{j}, -\hat{j}$ / $\hat{i}, -\hat{i}$ / $\pm(\dots)\hat{i} \pm (\dots)\hat{j}$

cos sin
sin cos



$\therefore \vec{F}_{1\to2} = -\vec{F}_{2\to1}$

Example: Which of the following statments is correct?

a] $\bar{F}_{1\to2} = \bar{F}_{2\to1}$ b] $\bar{F}_{1\to2} = -\bar{F}_{2\to1}$. c] $\bar{F}_{1\to2} = -\bar{F}_{2\to1}$

* Attractive → تجاذب
* Replusire → تنافر

* Origion: نقطة الأصل $(0,0)$

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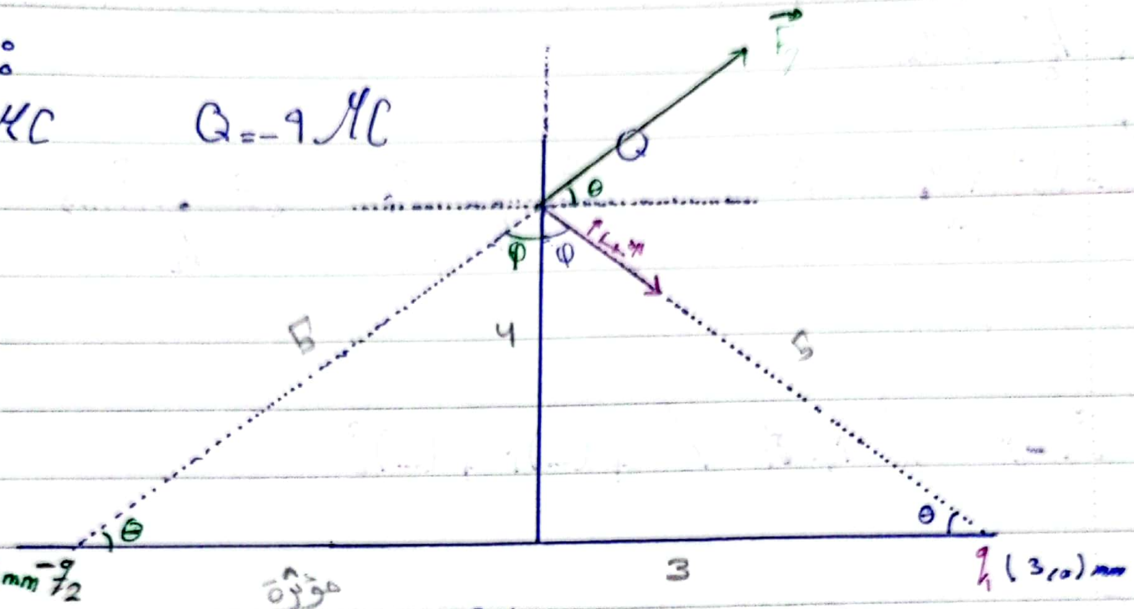
Example:

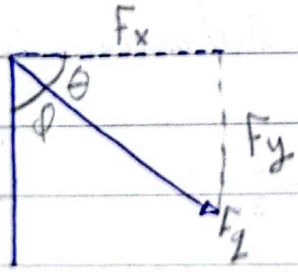
$q = 2\,\mu C \qquad Q = -9\,\mu C$



مؤثرة

Find the force exerted on the charge Q?

$$\vec{F}_{q_1} = 9\times10^{9}\,\frac{(2\times10^{-6})(9\times10^{-6})}{(5\times10^{-3})^2}\left(\overset{\frac{3}{5}}{\cos\theta}\; i \;-\; \overset{\frac{4}{5}}{\sin}\; j\right)$$



ربع رابع سالب ← sin

موجب ← Cos

أخذنا بالنسبة لـ θ

$$= \frac{162}{125}\,10^{3}\,(3i - 4j) = \frac{162}{125}\,(3i - 4j)\ kN, \quad k = 10^{3}$$

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$$F_q = 9\times10^9 \frac{(2\times10^{-6})(9\times10^{-6})}{(5\times10^{-3})^2} \left(\overset{\frac{3}{5}}{\cos\theta}\, i + \overset{\frac{4}{5}}{\sin\theta}\, j\right)$$

تقع في الربع الأول sin موجب Cos موجب

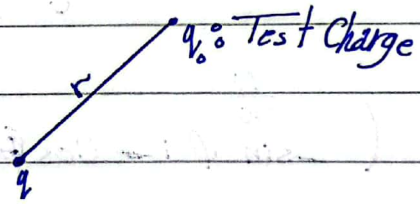
$$= \frac{162}{125}(3i + 4j)\ kN$$

* Remark :- $(q_1 q_2)$ مؤثر عليه لا يتحرك بينما متأثر يتحرك (Q)

* Remark : لما يطلب x comp نجمع فقط i ونضربها بالناتج ولما يطلب y_{comp} نفس الشيء

* 2) The electric field

$$\rightarrow \vec{F}_{q\to q_0} = k_e \frac{q q_0}{r^2}\hat{r}$$



→ We define, the electric field as the electric force per charge q_0 at distance r from the charge q.

$$* \ \vec{E} = \frac{\vec{F}}{q_0} = k_e \frac{q}{r^2}\hat{r} \qquad * \ \vec{E}_{total} = \vec{E}_1 + \vec{E}_2 + \dots$$

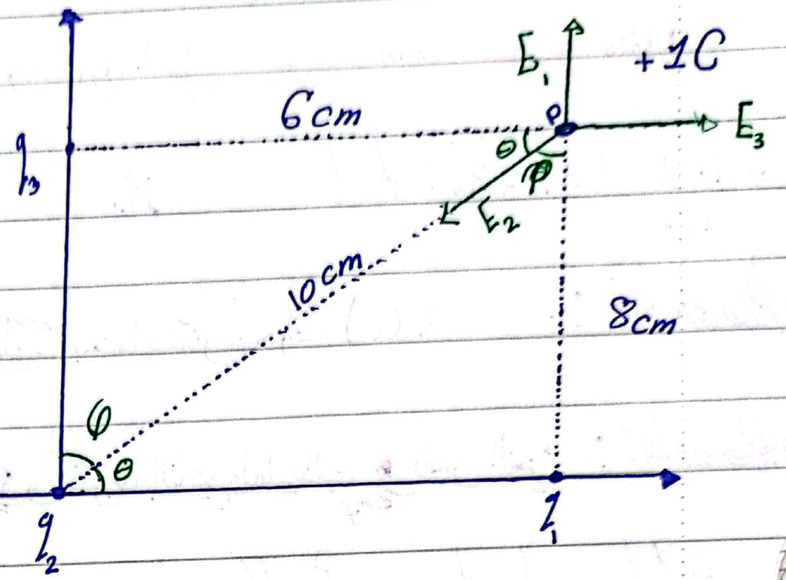
$$* \ \vec{F} = q_0 \vec{E}$$

Example :- Find the electric field at point p as shown in the figure :-

$q_1 = 15\,nC$

$q_2 = -12\,nC$

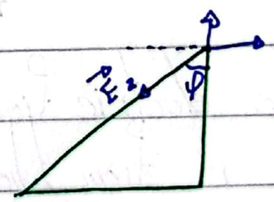
$q_3 = 9\,nC$



$$\vec{E}_1 = \frac{9\times10^{9} \times 15\times10^{-9}}{(8\times10^{-2})^2} = \frac{9\times15\times10^{4}}{64} = 21\,j\ \frac{kN}{C}$$

$$\vec{E}_2 = \frac{9\times10^{9} \times 12\times10^{-9}}{(10\times10^{-2})^2}\left(-\overset{\frac{6}{10}}{\sin}\varphi\, i - \overset{\frac{8}{10}}{\cos}\varphi\, j\right) = \frac{9\times12\times10^{4}}{1000}\times10^{4}\,(6i-8j)$$

$$= -6.5\,i - 8.6\,j\ \frac{kN}{C}$$



$$\vec{E}_3 = \frac{9\times10^{9} \times 9\times10^{-9}}{(6\times10^{-2})^2} = \frac{81}{36}\times10^{4}\,i\ \frac{kN}{C}$$

$$\vec{E}_p = 16\,i + 12.4\,j\ \frac{kN}{C}$$

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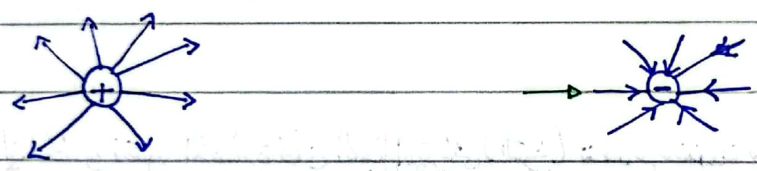
B] Find the electric force on a point charge $Q = -5nC$ locted at P.

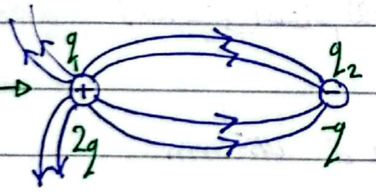
* $\vec{F}_p = -q\,\vec{E}_p = 5\times10^{-9}\,[-16i - 12.4j]\times10^{3} = -80i - 62\ \mu N$

* The electric feild lines propectios خواص

• The electric feild lines emerge from +ve charge and end (termiatted) in -ve change

.. The electric feild lines number is proportional طردياً to the charge

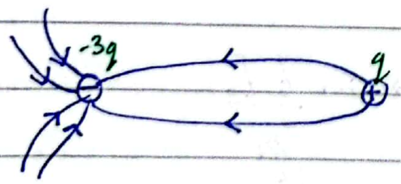


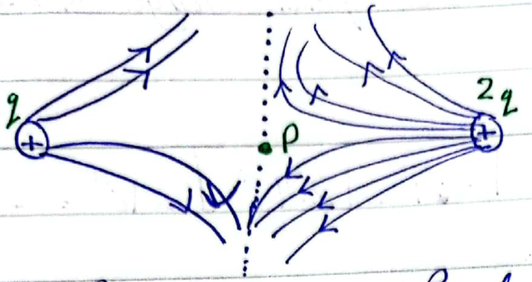


* Find the ratio of $\frac{q_1}{q_2}$

$\frac{q_1}{q_2} = \frac{N_1}{N_2} = \frac{8}{4} = 2 \quad \therefore q_1 = 2q_2$

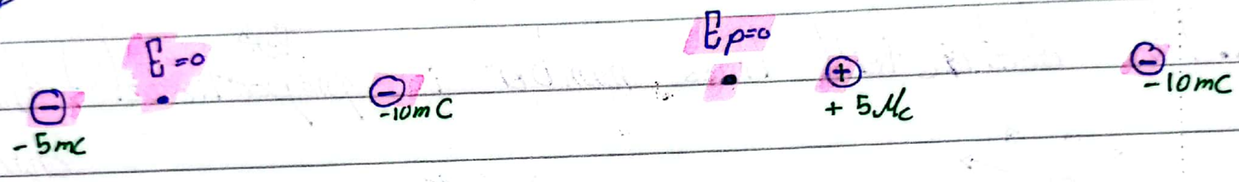
*





→ Point "P" of vanishing of electric feild where a point charge
يتلاشى

* Equilbrium ($\Sigma \vec{F} = zero$)



Remark:- إذا كانوا نفس الاشارة فإن المجال الكهربائي (القوة) تنعدم مقتربة من صغرهم
(من غير اهتمام للاشارة عند تحديد الاصغر)

* The motion of charged particle in a uniform electric feild

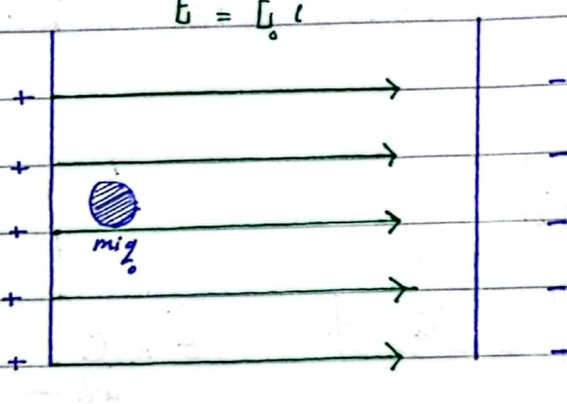
* $F_e = ma = q_0 E_0$ * $a = \frac{q_0 E_0}{m}$

1] $v = v_0 + at$ 2] $x(t) = v_0 t + \frac{1}{2} a t^2$

3] $v^2 = v_0^2 + 2a \Delta x$

تكون طاقة وضع عالية بينما طاقة حركية اقرب للصفر (اقل من طاقة الوضع)

$\vec{E} = E_0 i$



تكون طاقة حركية اكبر من طاقة الوضع

* $E = P.E + K.E = \text{Constant}$

Remark: ... كلغ / م³ = غم / سم³ = الكتلة / الحجم = الكثافة

* The $\vec{E}$-field of continous charge distribution

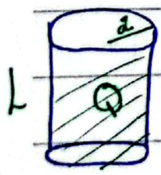
→ Charge distribution charge density

* 3D (rho ρ)

Examples :- A] charged sphere (كرة)

r: radius → $\rho = \frac{Q}{\frac{4}{3}\pi R^3}$ ← حجم الكرة

B] Cylinder اسطوانة



$\rho = \frac{Q}{\pi a^2 L}$ → حجم اسطوانة

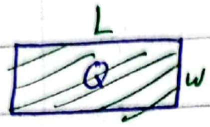
a: radius

L: height

* D: Diamter قطر

$\therefore \rho = \frac{\text{charge}}{\text{volume}}$ (3D) roh ⟶ volume charge density

* 2D (sigma "σ")

Examples :- A]  $\sigma = \frac{Q}{wL}$ ⟶ مساحة مستطيل

B] Charge Disk (قرص)  $\sigma = \frac{Q}{\pi R^2}$ ⟶ مساحة دائرة

$\therefore \sigma = \frac{\text{charge}}{\text{Area}}$ (2D) sigma ⟶ surface charge density

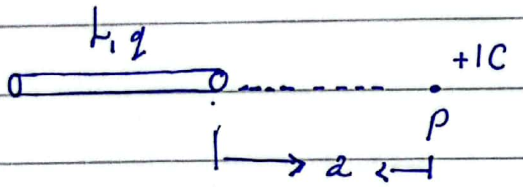
* 1D (Lamda λ)

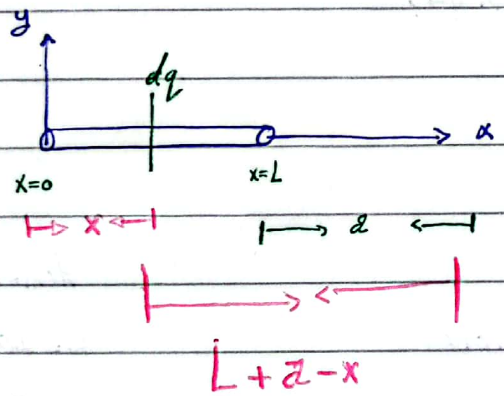
$\lambda = \frac{\text{Charge}}{\text{length}}$

Examples :- A] Rod, wire ↓ $\frac{L, q}{\lambda = \frac{q}{L}}$ B] Ring ↓ $\lambda = \frac{Q}{2\pi R}$ 

* $E = \int_{charge} \frac{k_e \, dq}{r^2}$ → تكامل بالنسبة للشحنة

Example: The electric field of a finit rod of charge q of length L along its axis





يكون سؤال معطي $q, L, a, \lambda = \frac{q}{L}$

$dE = k_e \frac{q}{(L+a-x)^2}$ → $E_p = \int_{charge} \frac{k_e \, dq}{(L+a-x)^2}$

* $E_p = k_e \int_{x=0}^{L} \frac{\lambda \, dx}{(x+L-a)^2}$

$\lambda = \frac{q}{x} \rightarrow q(x) = \lambda x$

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

$$= K_e \int_0^L \frac{\lambda \, dx}{(x-L-a)^2} = K_e \frac{-\lambda}{(x-L-a)}\Bigg|_0^L =$$

ثابت ثابت

$$-K_e \lambda \left[\frac{-1}{a} + \frac{1}{L+a}\right] \Rightarrow E_p = \frac{K_e \lambda L}{a(a+L)} = \frac{K_e q}{a(a+L)} \quad *$$

$\lambda L = q$

بعد توحيد مقامات

* يوجد حالة اخرى وهي :- *

* $\lambda = \lambda(x)$ يعني λ تعتمد على (x) وليس الشحنة

$$E_p = K_e \int_0^L \frac{\lambda(x)\, dx}{(x-L-a)^2} =$$

مثلاً

$\lambda(x) = 0.1x$

$L = 20\,cm \rightarrow 0.2$

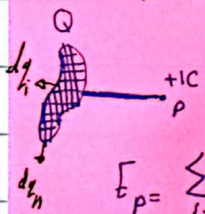
$x = 5\,cm \Rightarrow 0.05$

$a = 1\,cm \Rightarrow 0.1$

$$0.1\, K_e \int_0^L \frac{x}{(x-L-a)^2}\, dx = 0.016$$

الحاسبة

* كيف أشتق قانون $E = \int K_e \frac{dq}{r^2}$



* $dE_i = \frac{q_i}{r_i^2}$

$$E_p = \sum_{i=1} dE_i = \sum K_e \frac{dq_i}{r_i^2}$$

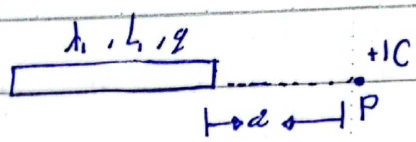
لأنها صغيرة

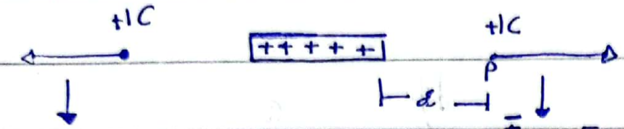
مجموع نأخذ مجموع (vectors)

* ونستطيع حساب المجموع (مساحة تحت منحنى) من خلال تكامل

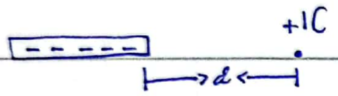
$$E = \int_{charge} \frac{K_e\, dq}{r^2} \quad *$$

$*\ E = \frac{K_e \lambda L}{d(d+L)}$, $\lambda L = Q$

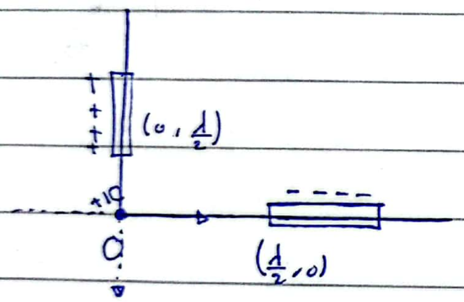


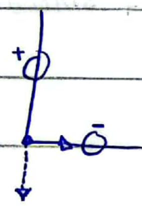
$*$ 

$*\ \vec{E} = E_0(-\hat{i})$ $\qquad \vec{E} = E_0\,\hat{i}$ "outwards" مبتعدة



$\vec{E} = E_0(-\hat{i})$ "inwards" مقتربة



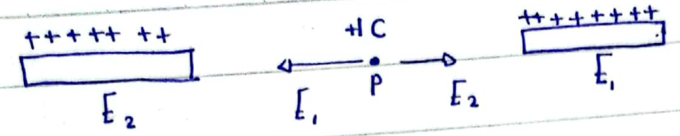


$*$ Find the electric field $\vec{E}$ at the Origin O.

a] $\frac{4K_e d}{3}(\hat{i}+\hat{j})$ $\qquad$ b] $\frac{4K_e d}{3}(-\hat{i}-\hat{j})$

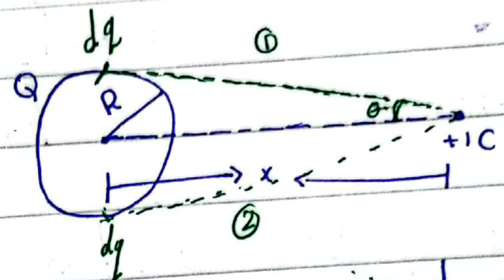
c] $\frac{4K_e d}{3}(-\hat{i}+\hat{j})$ $\qquad$ d] $\frac{4K_e d}{3}(\hat{i}-\hat{j})$

Subject



$$\vec{E}_p = E_2\hat{i} - E_1\hat{i}$$

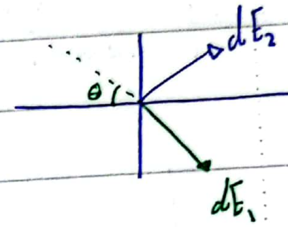
* Example :- Charged Ring



* $\lambda = \dfrac{Q}{2\pi R}$

$$d\vec{E}_1 = K_e \frac{dq}{x^2+R^2}(\cos\theta\,\hat{i} - \sin\theta\,\hat{j})$$

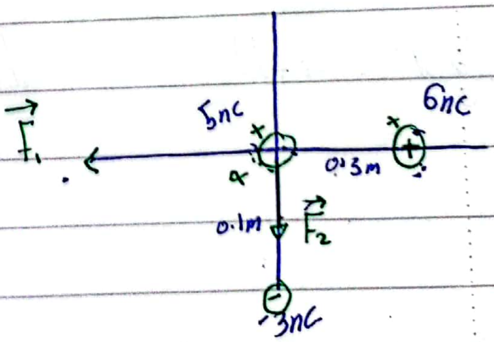
$$d\vec{E}_2 = K_e \frac{dq}{x^2+R^2}(\cos\theta\,\hat{i} + \sin\theta\,\hat{j})$$



$$\therefore E_{Ring} = \frac{K_e Q x}{(R^2+x^2)^{3/2}}$$

* When x is the perpendicular distance on the axis of the ring from It's center.

Example 11 (Book)



* $\vec{F}_1 = \dfrac{9\times10^9 \times 6\times10^{-9} \times 5\times10^{-9}}{0{,}3^2}(-\hat{i})$

$= 0{,}3\ mN(-\hat{i})$

* $\vec{F}_2 = 1.3\ mN(-\hat{j}) = 135\times10^{-5}(-\hat{j})$

* $F_o = \sqrt{(0.3)^2 + 1.3^2} = \boxed{}\ mN$ * $\tan\alpha = \dfrac{F_2}{F_1} = \dfrac{1.3}{0.3}$

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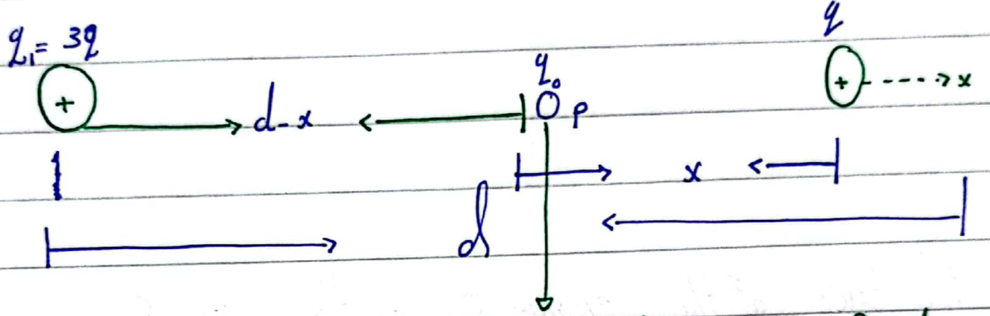

$d = 1.5m$

* Where the electric field vanishes يتلاشى

$\rightsquigarrow \vec{E}_p = zero$

* The 3^{rd} charge in Equilibrium

$\rightsquigarrow \vec{F}_{q_0} = zero$

Solu: $|E_1| = |E_2|$ بدون اشارة $\qquad |F_1| = |F_2|$

$$\frac{\cancel{k_e}\, 3\cancel{q}}{(1.5-x)^2} = \frac{\cancel{k_e}\, \cancel{q}}{x^2} \rightarrow 3x^2 = (1.5-x)^2 \rightsquigarrow \pm\sqrt{3}\, x = 1.5 - x$$

$$\therefore \quad x = \frac{1.5}{1 \pm \sqrt{3}} \longrightarrow \frac{1.5}{1+\sqrt{3}}$$

لأنه لا يوجد
حلول بالسالب

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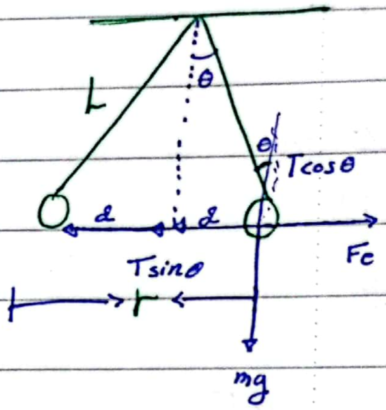
$m = 0.2g$ $\quad$ $\theta = 5^\circ$

$q = 7.2nC$



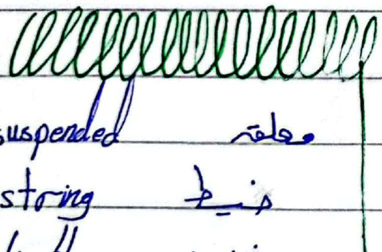
$\sum F = zero \rightarrow \sum F_x = 0 \; , \; \sum F_y = 0$

$T\sin\theta = F_e \quad \rightarrow T\tan\theta = \frac{F_e}{mg}$

$T\cos\theta = mg$

$* \sin\theta = \frac{d}{L} \rightarrow d = L\sin\theta$ $\quad$ $* F_e = \frac{K_e q^2}{(2L\sin\theta)^2} \rightarrow \frac{K_e q^2}{(2L\sin\theta)^2} = mg\tan\theta$

$L = \sqrt{\frac{K_e q^2}{4mg\sin^2\theta\tan\theta}}$ *



suspended معلقة
string خيط
ligth خفيف

Remark:

الانتباه إلى وحدة الكتلة

$g \rightarrow 10^{-3} \rightarrow kg$

$mg \rightarrow 10^{-6} kg$, $Mg = 10^{-9} kg$

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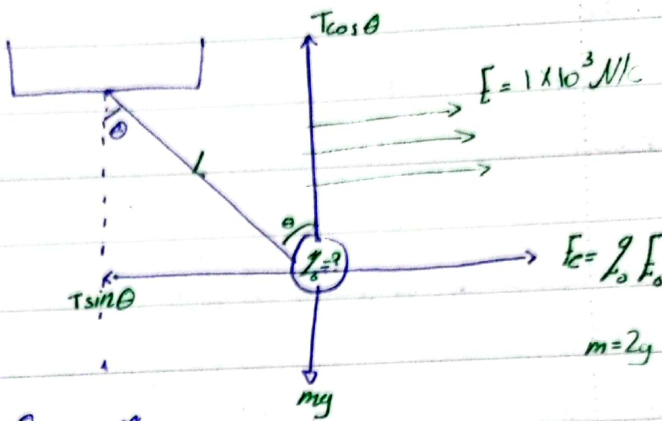

$L = 20\ cm$

$\theta = 15°$

$m = 2g$

* $T\sin\theta = q_0 E_0$ $\rightarrow q_0 = \frac{mg\tan\theta}{E_0}$ *
* $T\cos\theta = mg$

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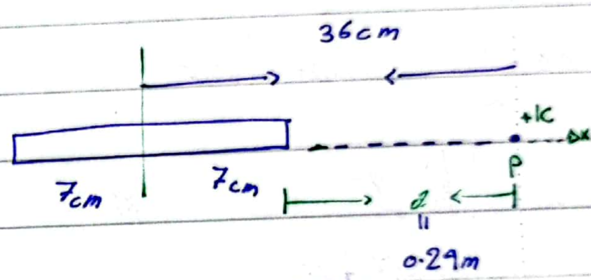


$L = 14\ cm$

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

$q = -22\ \mu C$ * $E_q = k_e \frac{q}{d(d+L)}$

* $E_p = \frac{9\times10^9 \times 22\times10^{-6}}{0.29(0.29+0.14)}$ $\boxed{}$ $(-\hat{i})$ inward *

* $Q_0 = -5\mu C$ $+1C$ P $\rightarrow E_p = \boxed{}\ (\hat{i})$

$F_{Q_0} = Q_0 E_p (-\hat{i})$ [Repulsive outwards]

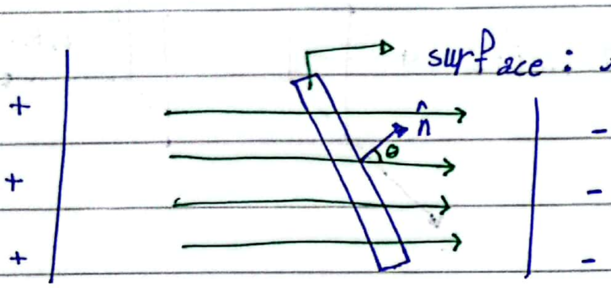
N O T E B O O K

Date 26. oct

Chapter: 24 Gauss's Law

1] The electric flux

تدفق الكهربائي



$\vec{E} = E_0 \hat{\imath}$

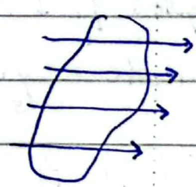
$* \hat{n} = \begin{cases} \hat{\imath}, & -\hat{\imath} \\ \hat{\jmath}, & -\hat{\jmath} \\ \hat{k}, & -\hat{k} \end{cases}$ normal unit vector

* We define the electric flux $\Phi_E = E_0 A \cos\theta_{\hat{n} E_0} =$

$\vec{E} \cdot \vec{A}$, $\vec{A} = A\hat{n}$

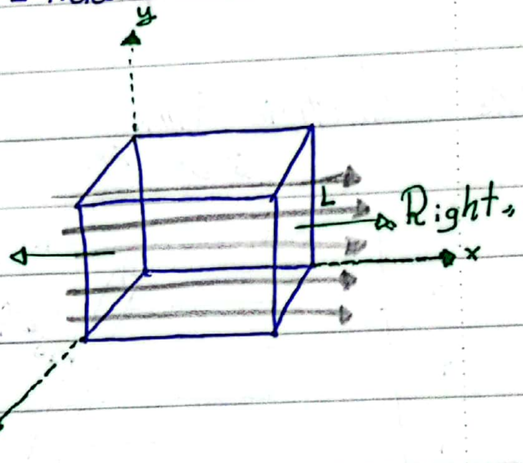
$$\Phi_E = \int_{Area} \vec{E} \cdot d\vec{A}$$

$* \Phi_E \rightarrow \left[\text{Scaler}, \frac{Nm^2}{C} \right]$



N O T E B O O K

Exercise: 1. Cubic shape in $\vec{E}_0$ - field

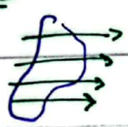


* $\Phi_{right} = E_0 A = E_0 L^2 \cos(0) = 1$

* $\Phi_{left} = -E_0 A = -E_0 L^2 \cos(\pi) = -1$ left.

Remark: immersed: مغموس، مغمور

* Conclusion: The total flux of uncharged object immersed in a uniform electric field is zero



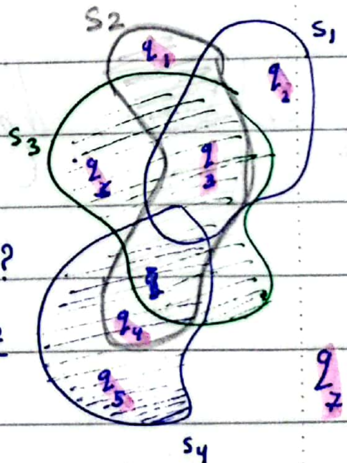
$\Phi_T = zero$

* Gaussian surfac (q_{in}) $= \oint \vec{E} \cdot d\vec{a} = \frac{q_{in}}{\epsilon_0}$ → الاشارة.

Area → Φ_E

Example: $q_1 = 1\ \mu C$ $q_2 = -2\ \mu C$ $q_3 = 5\ \mu C$

$q_4 = -10\ \mu C$ $q_5 = -5\ \mu C$ $q_6 = 7\ \mu C$ $q_7 = 3\ \mu C$



* Find the flux throughout each Gaussiesian surface?

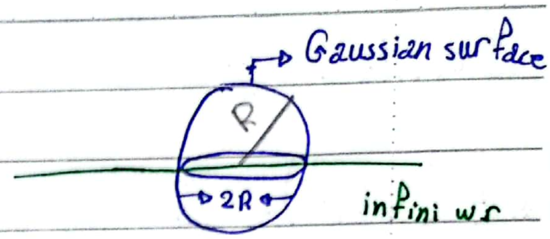
→ $\Phi_1 = \frac{q_2 + q_1}{\epsilon_0} = \frac{-2+5}{8.85 \times 10^{-12}} \times 10^{-6} = \frac{3}{8.85} \times 10^{6} = \frac{3}{8.85}\ M\ \frac{N.m^2}{C}$

→ spherical symmetr

→ $\Phi_2 = \frac{1+5-10}{8.85} \times 10^{6} = \frac{-4}{8.85}\ M\ \frac{N.m^2}{C}$

→ $\Phi_3 = \frac{12}{8.85}\ M\ \frac{N.m^2}{C}$

Example 2:- $R = 15cm$ $\lambda = 27 \frac{nC}{m}$

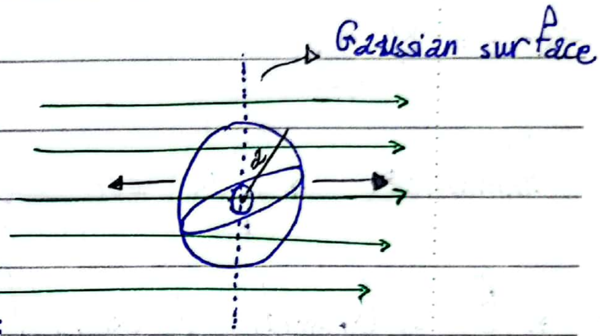


$\Phi = \frac{q_{in}}{\epsilon_0}$, $\lambda = \frac{q}{L} = \frac{q}{2R}$ $\Rightarrow q = (\lambda)(2R)$

$\frac{\lambda(2R)}{\epsilon_0}$ $\ast$

Example 3:- $E = 600 \frac{N}{C}$

$a = 10\ cm$ $Q = 7nC$



. The total flux throughout Gaussian surface:

$$\Phi_T = \Phi_E + \Phi_q = 0 + \frac{Q}{\epsilon_0}$$

. $\Phi_{\text{hemi-sphere right}} = \Phi_E + \Phi_q$ $\rightarrow$ $\Phi_{h.S.R} = E\left(\frac{4\pi a^2}{2}\right) + \frac{q}{2\epsilon_0}$ مساحة سطح كرة

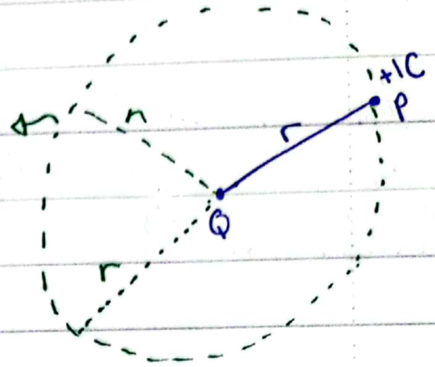
. $\Phi_{h.S.L} = -E_0\left(\frac{4\pi a^2}{2}\right) + \frac{q}{2\epsilon_0}$

. Find the electric field using Gauss's law $\int E \cdot da = \frac{q_{in}}{\epsilon_0}$

1] Find the electric field of a point charge?

$$\oint \vec{E} \cdot d\vec{a} = \frac{q_{in}}{\epsilon}$$

* $E(4\pi r^2) = \dfrac{Q}{\epsilon_0}$



$\rightarrow E = \dfrac{Q}{4\pi\epsilon_0 r^2}$ ※

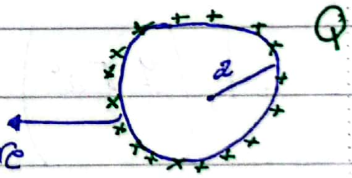
* $E = K_e \dfrac{Q}{r^2}$

Remark: * q is +ve → +1 * q is -ve → -1

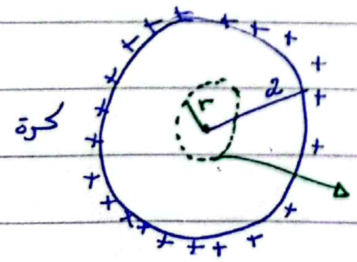
* θ → Geometry لا يعتمد على

* Spherecal Symmetry

A] The conducting Sphere :: metalic, copper, Alumimum



• Find the electric field inside the sphere $r < a$ → الكرة الداخلية



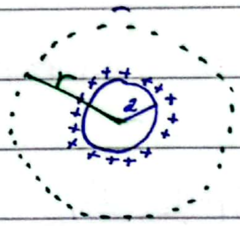
* Surface charge density $\sigma = \dfrac{Q}{4\pi a^2}$

* $E(4\pi r^2) = \frac{q_{in}}{\epsilon_0} = \boxed{zero} \rightarrow$ لأنه داخل السطح لا يوجد شحنة (هي فقط على سطح)

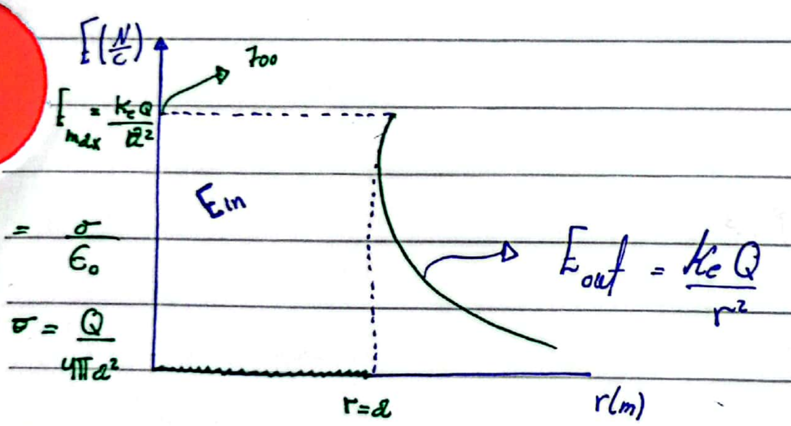
$E_{in} = zero$ if $r < a \rightsquigarrow$ Conductor

B] Find the E - field outside A sphere? $r \geq a$

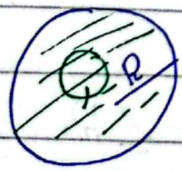
* $E(4\pi r^2) = \frac{q_{in}}{\epsilon_0} = \frac{Q}{\epsilon_0}$



$E_{out} = \frac{K_e Q}{r^2}$, $r \geq a$

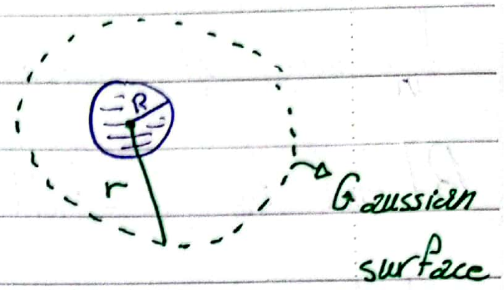


* Non-conducting sphere insulating sphere .. plastic, Rubber,...



$\rho = \frac{Q}{\frac{4\pi}{3} R^3}$

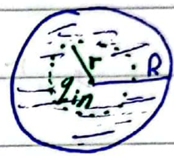
$* \; \vec{E}_{out} = ?$ $\qquad r > R$ → الكرة اللاموصلية



$\rightarrow E(4\pi r^2) = \dfrac{q_{in}}{\epsilon_0} = \dfrac{Q}{\epsilon_0}$

$E_{out} = \dfrac{k_e Q}{r^2} \qquad r \geq R$

$* \; E_{in} = ? \qquad r \leq R$



$\rightarrow E(4\pi r^2) = \dfrac{q_{in}}{\epsilon_0} \quad , \quad r \leq R$

$\rho = \dfrac{Q}{\frac{4\pi}{3} R^3} = \dfrac{q_{in}}{\frac{4\pi}{3} r^3}$

$\rightarrow \rho$ is Given $\rightarrow q_{in} = \dfrac{4\pi}{3} \rho r^3$

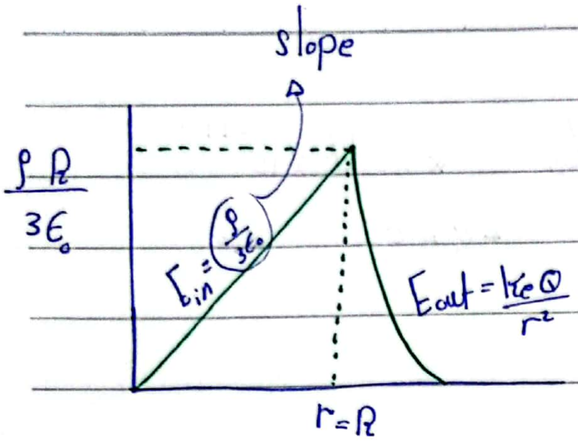
$\rightarrow Q$ is Given $\rightarrow q_{in} = \dfrac{r^3}{R^3} Q$

$* \; E(\cancel{4\pi} \cancel{r^2}) = \dfrac{\cancel{4\pi}}{3} \dfrac{\rho \cancel{r^3}}{\epsilon_0} \Rightarrow E_{in} = \dfrac{\rho r}{3\epsilon_0} \quad , \quad r \leq R$

oR

$E(4\pi r^2) = \dfrac{r^3}{R^3} \dfrac{Q}{\epsilon_0} \rightarrow E_{in} = \dfrac{k_e Q}{R^3} r \quad , \quad r \leq R$

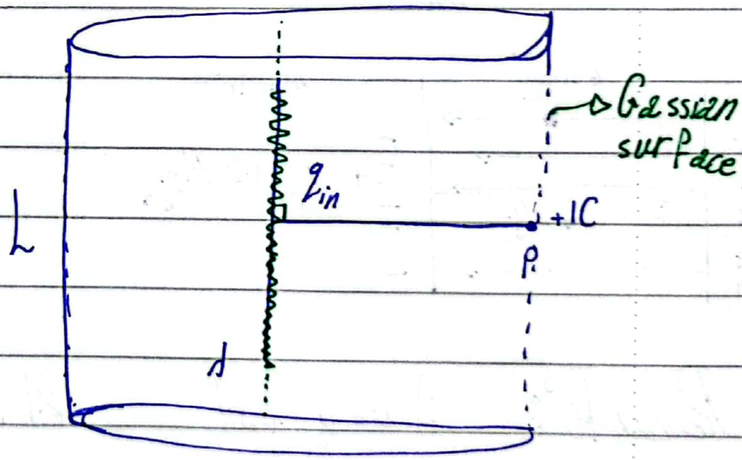
Subject Date 31. oct No.



* find the electric field of an infinite wire at a perpendicular distance "r" from its axis.

.. Cylinderical symmetry

1] Infinty wire



$\rightarrow \lambda = \frac{q_{in}}{L}$

$\rightarrow \int E \, da = \frac{q_{in}}{\epsilon}$

$\hookrightarrow$ ثابتة

$E(2\pi r \cancel{L}) = \frac{\lambda \cancel{L}}{\epsilon_0}$

لمساحة سطح
الاسطوانة

* $E_{\text{wire Rod}} = \frac{\lambda}{2\pi\epsilon_0 r} = \frac{2k_e\lambda}{r}$ ✻

"Review"

Q 51/720 → proton → $* m_e = 1.67 \times 10^{-27}\ kg$ $* e = 1.6 \times 10^{-19}\ C$

$* E = 640\ \frac{N}{C}$ $* v_0 = 0$ *

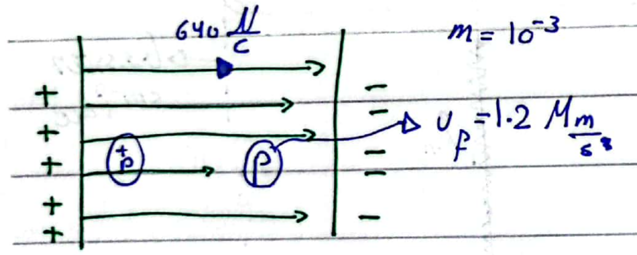
1] The acclelartion : $F_e = m_p a = q_0 E_0$

$1.67 \times 10^{-27} a = 1.6 \times 10^{-19} \times 640$ → $a = 613 * 10^{m}\ ms^{-2}$

2] The time : $t = \frac{v_f}{a} = \frac{1.2 \times 10^{6}}{613 \times 10^{3}} = 19.6 \times 10^{-6} s = 19.6\ \mu s$

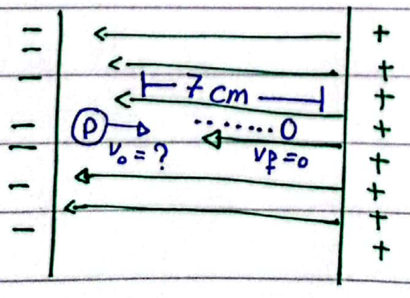
3] How far : $\Delta x = v_0 t + 0.5 a t^2 = 0.11.8\ m$

zero



Remark : 1] $v = v_0 + at$ 2] $\Delta x = v_0 t + \frac{1}{2} a t^2$ 3] $v^2 = v_0^2 + 2a\Delta x$

Q 52 : $\vec{E} = -6 \times 10^{5}\ (\hat{i})$



Subject Gauss's law Date 1.11 No.

$\rightarrow \vec{a} = \frac{q_o E_o}{m_p} = \frac{-1.6 \times 10^{-19} \times 6 \times 10^{5}}{1.67 \times 10^{-27}} \hat{i}$ $\vec{a} = -a_o \hat{i}$

$= -5.75 \times 10^{13} \hat{i}$ direction $(-\hat{i}) \rightarrow 5.75 \times 10^{+13}\ ms^{-2}$

deacceleration $= 5.75 \times 10^{13}\ ms^{-2}$

$\rightarrow v_f^2 = v_o^2 + 2a\Delta x \Rightarrow 0 = v_o^2 + 2(-5.75 \times 10^{13})(0.07)$

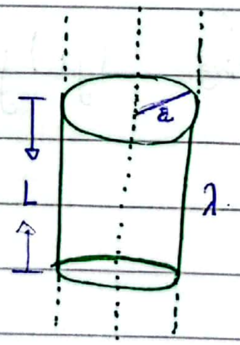
$v_o^2 = 2(5.7)(0.07) \times 10^{3} \rightarrow v_o = \sqrt{8.1 \times 10^{12}} = 2.8 \times 10^{6}\ m/s$

$\rightarrow t = \frac{-v_o}{a} = \frac{-2.8 \times 10^{6}}{-5.75 \times 10^{3}} = 50 \times 10^{-9}\ sec \rightarrow 50\ ns$

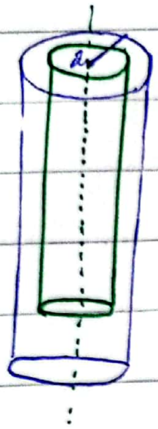
$\rightarrow v = v^o + at \Rightarrow 0 = v_o + at$

* Charge Cylinder

$\rightarrow$ conducing Cylinder

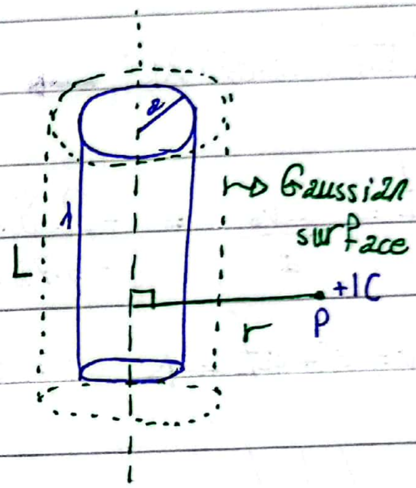


* $\vec{E}_{in} = ?$ $\qquad r < a$



$E_{in} = \text{zero}\ , \quad r < a$

* $E_{out} = ?$ $\qquad r > a$

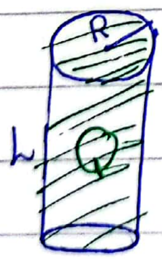


$$E(2\pi r L) = \frac{q_{in}}{\epsilon_0} = \frac{\lambda L}{\epsilon_0}$$

$$E_{out} = \frac{2 k_e \lambda}{r} \ , \quad r \geq a$$

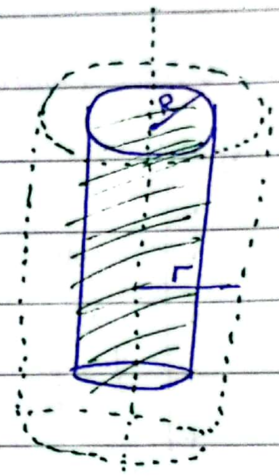
* Non-conducing Cylinder insulating غير موصل (عازل)

$\rightarrow \rho = \dfrac{Q}{\pi R^2 L}$



Subject　　　　Date　　　　No.

1] $E_{out} = ?$ $\quad r \geq R$



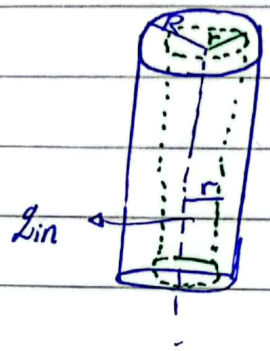
$\rightarrow \int E\, da = \frac{q_{in}}{\epsilon_0}$

$E(2\pi r L) = \frac{q_{in}}{\epsilon_0} = \frac{Q}{\epsilon_0}$

$E_{out} = \frac{Q}{2\pi\epsilon_0 L r}$ $\quad \rightarrow Q = \rho \pi R^2 L$ *

$\rightarrow E_{out} = \frac{\rho \cancel{\pi} R^2 \cancel{L}}{2\cancel{\pi}\epsilon_0 \cancel{L} r} = \frac{\rho R^2}{2\epsilon_0 r}$, $\quad r \geq R$

2] $E_{in} = ?$ $\quad r \leq R$



$E(2\pi r L) = \frac{q_{in}}{\epsilon_0}$

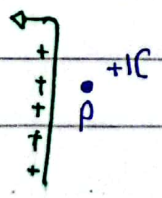
$\rho = \frac{Q}{\pi R^2 L} = \frac{q_{in}}{\pi r^2 L} \longrightarrow q_{in} = \pi r^2 L \rho$

$q_{in} = \frac{r^2}{R^2} Q$ $\quad * \; E(2\cancel{\pi} \cancel{r} \cancel{L}) = \frac{\cancel{\pi} r^{\cancel{2}} \rho \cancel{L}}{\epsilon_0} \rightarrow E_{in} = \frac{\rho}{2\epsilon_0} r$, $\; r \leq R$

* Infinite sheet, plane, Disk, wall, very large

conductor $\frac{\sigma}{\epsilon_0}$ $\qquad$ non conducter $\frac{\sigma}{2\epsilon_0}$

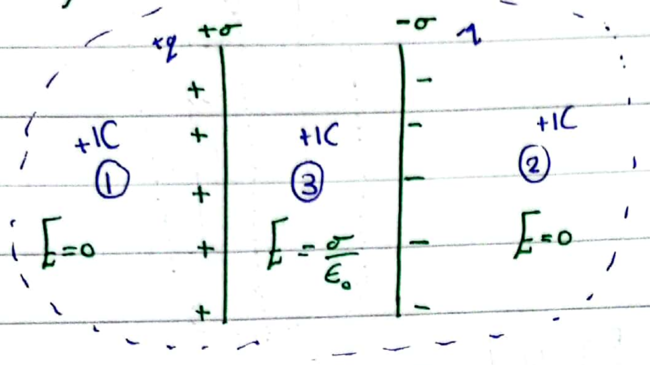
Q, A



$\sigma = \frac{Q}{A}$

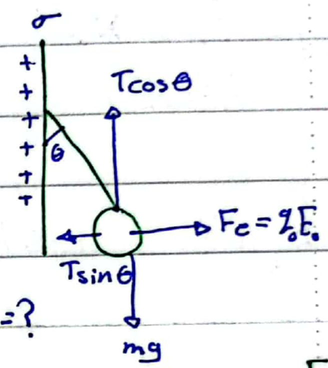
NOTEBOOK

Example:- Non-conducing infinit sheet



$Q = \Sigma A$

Example:- Infinit wall: Conductor



$T\sin\theta = q_0 \frac{\sigma}{\epsilon_0}$

$L = 20\,cm$

$\theta = 15°$

$T\cos\theta = mg$

$m = 2mg$ $\quad \sigma = 50 \frac{mC}{m^2}$ $\quad q = ?$

$E = \frac{\sigma}{\epsilon_0}$

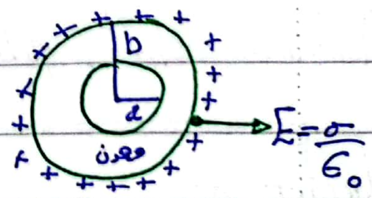
$\tan\theta = \frac{q_0 \sigma}{\epsilon_0 mg}$

$q_0 = \frac{\epsilon_0 mg \tan\theta}{\sigma}$

* Conducing spherical shell قشرة كروية معدنية

a: inner radius = 5cm

b: outer radius = 10cm

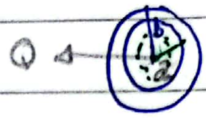


→ The conducting shell has a net charge 10mc

→ located in it's center a charge $Q = -5\,\mu C$

Subject Date 5.Dec No.

A] Find the $\vec{E}$ feild at $r = 2\,cm$ from the center



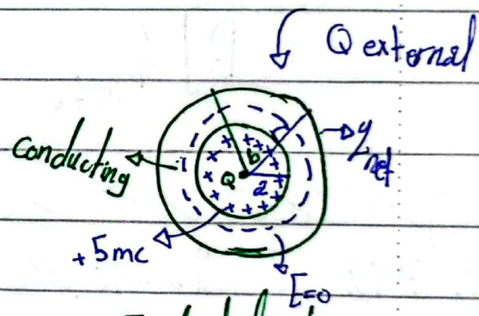
$\rightarrow E = \frac{k_e Q}{r^2} = \frac{9\times10^9 \times 5\times10^{-6}}{(0.02)^2} \frac{N}{C}$ "in words"

B] $\vec{E} = ?$, $r = 15\,cm$

الإشارة

$E = \frac{k_e (Q_{ext} + Q)}{r^2}$, $r > b$ $= \frac{9\times10^9 (10-5)10^{-6}}{0.15^2} \frac{N}{C}$ "outwords"

Example: Find the value of $Q_{external}$?

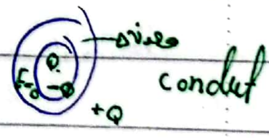


$Q = -5\,mc$ $q_{net} = 10\,\mu c$ $a = 5\,cm$ $b = 10\,cm$

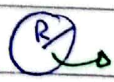
$Q + Q_{external} = Q_{net}$

$-5 + ? = 10 \rightarrow Q_{external} = 15\,\mu C$

Inducted charge



1/ 740 $E = 6.2\times10^5\ N/C$



1] $\Phi = ?$ surface $\perp$ electric field $\rightarrow \Phi = E A \cos\theta_{in}$, $\theta = 0$

$6.2\times10^5 \times 3.2\ \frac{N m^2}{C}$ *

N O T E B O O K

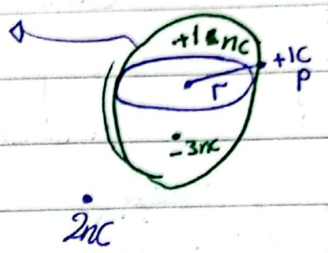
Subject Date 5. Dec No.

2] $\phi = ?$ surface // electric field ϕ = zero

8/740

$$\phi = \frac{q_{in}}{\epsilon_0} = \frac{(1-3) * 10^{-9}}{8.85 * 10^{-12}} \frac{N.m^2}{C}$$

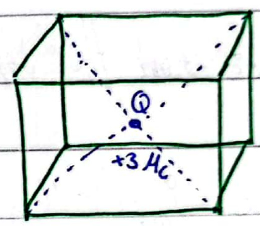
Gaussian surface



15/741

A] $\phi_T = \frac{q_{in}}{\epsilon_0} = \frac{3 * 10^{-6}}{8.85 * 10^{-12}} \frac{N m^2}{C}$

B] $\phi_{surface} = \frac{\phi_T}{6}$ #

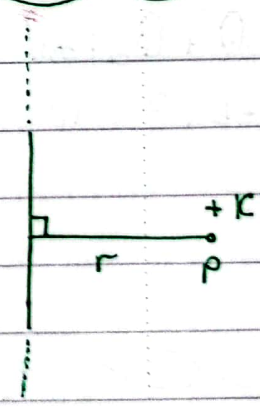


24/742 $\lambda = -90 \frac{\mu C}{m}$ $E_{Rod} = \frac{2 K_e \lambda}{r}$

r = 10, 20, 100cm

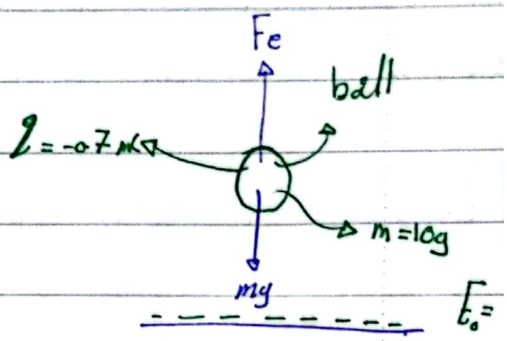
$E|_{r=20cm}$ $\frac{2 * 9 * 10^9 * 90 * 10^{-6}}{0.2} \frac{N}{C}$ in words $(-\hat{i})$

#



Subject Date 5.Dec No.

25/742 $F_e = mg = qE_0$

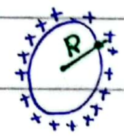


$$E_0 = \frac{mg}{q} = \frac{10 * 10^{-5} * 10}{0.7 * 10^{-6}} \frac{N}{C} \downarrow$$

24/742 spherical shell

$R = 14\ cm$

$Q = 32\ \mu C$



$\rightarrow$ surface $\rightarrow$ معدنية $\rightarrow$ $\sigma = \frac{Q}{4\pi R^2}$

A] $E_{r=10cm} = zero$ B] $E_{r=20cm} = \frac{K_e Q}{r^2} = \frac{9 * 10^9 * 32 * 10^{-6}}{(0.2)^2} \frac{N}{C}$

C] Surface charge density $\Rightarrow \frac{Q}{4\pi R^2} = \frac{32 * 10^{-6}}{(4\pi)(0.14)^2}$

Remarks:

* suspended in Equilibrium: معلقة ساكن
* volume $\rightarrow$ عازل $\rightarrow$ $\rho = \frac{Q}{\frac{4\pi}{3} R^3}$

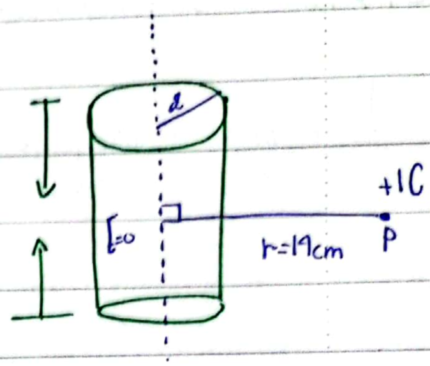
30/742 Non-conducting wall

$\sigma = 8.6 \frac{\mu c}{cm^2}$ $\rightarrow$ $E|_{r=7 or\ 10, 11, 5\ cm} = \frac{\sigma}{2\epsilon_0} = \frac{\frac{8.6 * 10^{-6}}{10^{-4}}}{2 * (8.85 * 10^{-12})}$

$F = qE$ ② حال طلب عند ~~شحنة~~ (قوة) معينة نضرب المجال ب الشحنة

Subject Date 5. Dec No.

34/742 $a = 7cm$ $L = 2.4m$ $E = 36 \frac{kN}{C}$



A] $E = \frac{2k\lambda}{r}$ $= 36000 = \frac{2 \times 9 \times 10^9 \times \lambda}{0.19}$

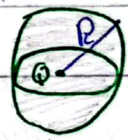
$\lambda = \frac{36000 \times 0.19}{18 \times 10^9} \frac{C}{m}$

$q = \lambda L = \boxed{} \times 2.4 \ C$ ✻

B] $E|_{r=4cm} = zero$ $r < a$ معدنية داخلها لايوجد مجال ✻

35/742 Non-conducting عازلة

$R = 40 \ cm$ $Q = 26 \mu c$



A] $E|_{r=0cm} \frac{\rho}{3\epsilon_0} r = zero$

B] $E|_{r=10cm} \frac{\rho r}{3\epsilon_0}$ ∴ $\rho = \frac{Q}{volume} = \frac{26 \times 10^{-6}}{\frac{4\pi}{3}(0.4)^3}$ $\rho = 97 \times 10^{-6} = 97 \frac{\mu C}{m^3}$

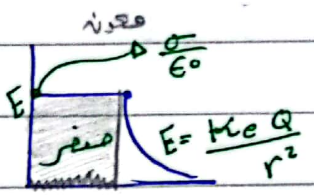
Remark: * $E_{out} = \frac{kQ}{r^2}$

* $E_{in} = \frac{\rho r}{3\epsilon_0}$

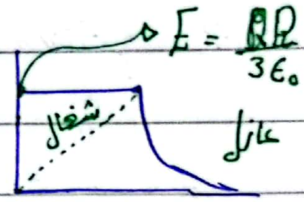
Date 5. Nov

$$*E\big|_{r=10} = \frac{97 \times 10^{-6}}{3 \times 8.85 \times 10^{-12}} \times 0.1$$

To Remember :: [A]



[B]



$$*E\text{“out”} = \frac{K_e Q}{r^2} = \frac{9 \times 10^{9} \times 26 \times 10^{-6}}{0.4^2}$$

$$*E\big|_{r=50m} = 9 \times 10^{9} \times \frac{26 \times 10^{-6}}{0.5^2}$$

*Chapter 25 : The electric potential

“7. Nov

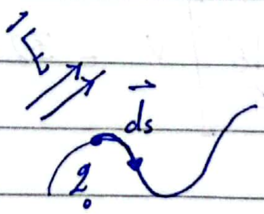
• The electric potential energy

Work $= -\Delta U$, U = Potential energy

$\rightarrow W = \int \vec{F} \cdot \vec{ds}$

$*\, ds = \hat{i}dx , -\hat{i}dx$
$\hat{j}dy , -\hat{j}dy$
$\pm \hat{i}dx \pm \hat{j}dy$

$$\rightarrow \Delta U_{e\,A\to B} = -\int_A^B \vec{F_e} \cdot \vec{ds}$$



$F = q_0 \vec{E}$

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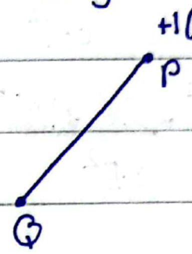
$$* \Delta U_{A\to B} = -\int_A^B q_0 \vec{E}\cdot d\vec{s} \rightarrow U_B - U_A = -q \int_A^B \vec{E}\cdot d\vec{s}$$

* The electric potianal diffience : ΔV

$$\Delta V = \frac{\Delta U}{q_0} = -\int_A^B \vec{E}\cdot d\vec{r}$$

→ Example : The electric potential at a point charge

$$* \Delta V = -\int \frac{k_e Q}{r^2} dr \rightarrow V_P = \frac{k_e Q}{r}$$



$$E = \frac{k_e Q}{r^2}$$

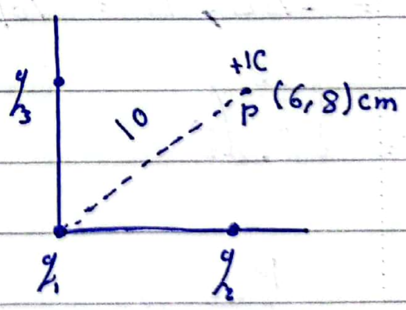
→ 1] + → +1 → 2] - → -1

$$* V_p = \sum_{i=1} V_i = \frac{k_e q_1}{r_1} + \frac{k_e q_2}{r_2} + \frac{k_e q_3}{r_3} + \frac{k_e q_4}{r_4}$$

نعوض بـ "q" بإشارة

Example : $q_1 = 10\,\mu C$ $q_2 = 15\,\mu C$ $q_3 = 16\,\mu C$

A] The electrice poteanial at the point P.



$$V_p = V_1 + V_2 + V_3 , \quad V = \frac{k_e q}{r}$$

$$= \frac{9\times10^9 \times 10^{-6}}{10^{-2}} \left[\frac{-10}{10} + \frac{15}{8} + \frac{16}{6} \right] V = 32\times10^5$$

N O T E B O O K

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B] Find the work required to bring a charge $Q = -20nC$ from infinty to the point P

$*\ W_{A\to B,\ \infty\to P} = -\Delta U_{A\to B,\ \infty\to P}$, $\Delta V = \frac{\Delta U}{q_o}$ الشحنة المتأثرة

$= -q_o \Delta V_{\infty\to P} = -Q\left[V_P - \cancel{V_\infty}\right]^{\to\ zero} = +20\times10^{-9}\,(32\times10^{5}) = 640\times10^{-4}$

$\Delta U_{\infty\to P} = -W = -0.064\ J$ ※

∴ Obtaining the electric feild from electic potential

$*\ V(x) = -\int E\,dx$ $*\ E(x) = \frac{-\partial V}{\partial x}$ $*\ E(y) = \frac{-\partial V}{\partial y}$ $*\ E(z) = \frac{-\partial V}{\partial z}$

∴ $V = V(x,y,z)$

$\vec{E}(x,y,z) = \frac{-\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

Example: Given $V(x) = \frac{-1}{x}$ Find $E(x = 0.1m) = ?$

$E(x) = -\frac{\partial V}{\partial x} = \frac{-1}{x^2} \Rightarrow E(0.1) = \frac{-1}{0.1^2} = -100\ V$

N O T E B O O K

Example: Given $v(x,y,z) = 5xyz$ Find $\vec{E}(-1,0,1)m$

$\rightarrow -\frac{\partial V}{\partial x} = -(5yz) = -\text{zero}$ $\rightarrow -\frac{\partial V}{\partial y} = -(5xz) + 5$

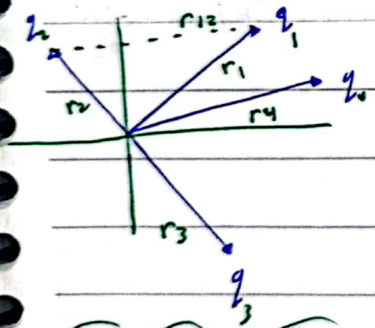
$\rightarrow -\frac{\partial V}{\partial z} = -[5xy] = 0$ $\ast\ \vec{E}(-1,0,1) = 5\hat{j}$ $\rightarrow |\vec{E}| = 5\frac{v}{c}$

* Find the work required to assamble the shown chargs from infinty

or

* Find the electric static energy required to assemble the shown charges from infinty

$\rightarrow U = \frac{k_e q_1 q_2}{r_{12}} + \frac{k_e q_1 q_3}{r_{13}} + \frac{k_e q_2 q_3}{r_{23}} + \frac{k_e q_1 q_4}{r_{14}} + \frac{k_e q_2 q_4}{r_{24}} + \frac{k_e q_3 q_4}{r_{34}}$



$U = \frac{k_e Q_1 Q_2}{r_{12}}$

Subject Date No.

Example: Given $v(x,y,z) = 5xyz$ Find $\vec{E}(-1,0,1)$ m

$\rightarrow -\frac{\partial V}{\partial x} = -(5yz) = -$ zero $\rightarrow -\frac{\partial V}{\partial y} = -(5xz) + 5$

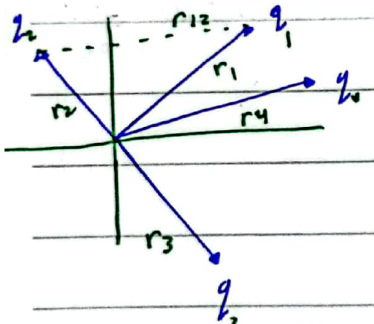
$\rightarrow -\frac{\partial V}{\partial z} = -[5xy] = 0$ $* \vec{E}(-1,0,1) = 5\hat{j}$ $\rightarrow |\vec{E}| = 5\frac{V}{C}$

* Find the work required to assemble the shown chargs from infinty

or

* Find the electric static energy required to assemble the shown charges from infinty

$\rightarrow U = \frac{k_e q_1 q_2}{r_{12}} + \frac{k_e q_1 q_3}{r_{13}} + \frac{k_e q_2 q_3}{r_{23}} + \frac{k_e q_1 q_4}{r_{14}} + \frac{k_e q_2 q_4}{r_{24}} + \frac{k_e q_3 q_4}{r_{34}}$



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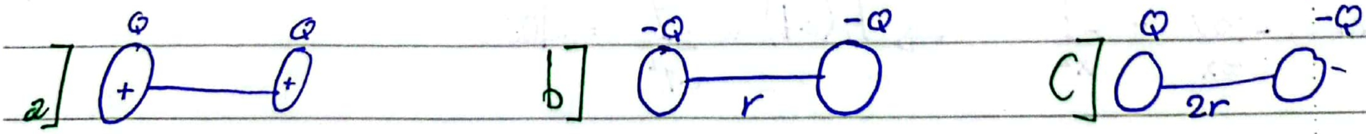
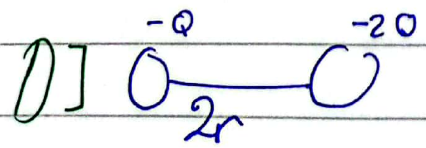


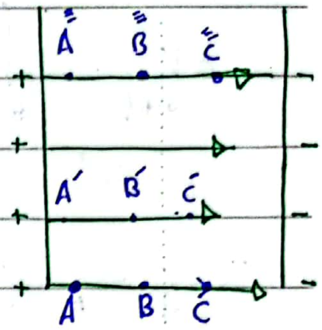


: $U_a = \frac{k_e Q^2}{r}$ $U_b = \frac{k_e Q^2}{r}$ $U_c = -\frac{k_e Q^2}{2r}$ $U_d = \frac{k_e}{r}$

~~$U_b = U_a > U_c > U_d$~~ $U_A = U_B = U_D > U_C$

[1] The Equi-potential Surface سطوح تساوي الجهد

$\Delta V_{AC} = V_{C'''} - V_A = -\int_A^{C'''} \vec{E}\cdot d\vec{s}$, $d\vec{s}$ $\begin{cases} i\,dx , -i\,dx \\ y\,dy , -y\,dy \end{cases}$



$\int_A^{C''} E\cdot(dx\,i) - \int_C^{C'''} E\cdot(+dy\,j) = -\int_A^{C} E_0\,\hat{i}\cdot dx\,i - \int_C^{C'''} E\,\hat{i}\,(dy\,j)$

$\Delta V_{A\to C} = -\int E_0\,dx - 0 \rightarrow V_C - V_A = -Ed = -ve$ *

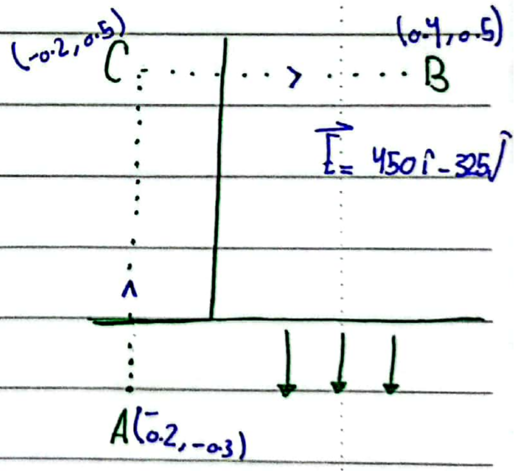
$E = \frac{\sigma}{\epsilon}\hat{i} = E_0\hat{i}$

~~* $\Delta V_{A\to C} = -\int E_0\,dx$~~

* $\Delta K.E + \Delta U = 0 \rightarrow K.E = 0.5mv^2$

* $U = q_0 V$ —— * $W_{A\to C} = -\Delta U_{A\to C} = -q_0 \Delta V_{A\to C} = +|e|(V_C - V_A) = -100|e|$ سالب

5.769 $E_0 = 325\ v/m$ Find $V_B - V_A$



$\Delta V_{AB} = V_B - V_A = -\int_A^B \vec{E}\cdot d\vec{s} = -\int_A^C \vec{E}\cdot d\vec{s} - \int_C^B \vec{E}\cdot d\vec{s}$

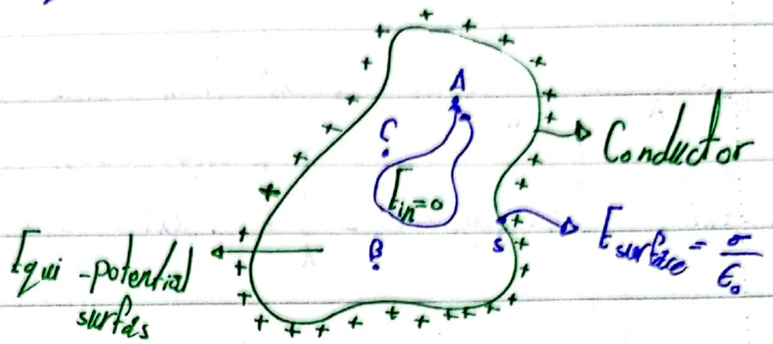
$= -\int_{0.3}^{0.5} 325(-j)\cdot(+dy\,\hat{j}) - \int_{0.2}^{0.4} \cancel{325 \times -\hat{i}\cdot(+dx\,i)}$ 260

$(325)(0.8) = 260\,v = V_B - V_A$

* Condutors in electrostatic Equilibrium

→ $\Delta V_{S\to A} = -\int_S^A \vec{E}_{in}\cdot d\vec{s}$ = zero

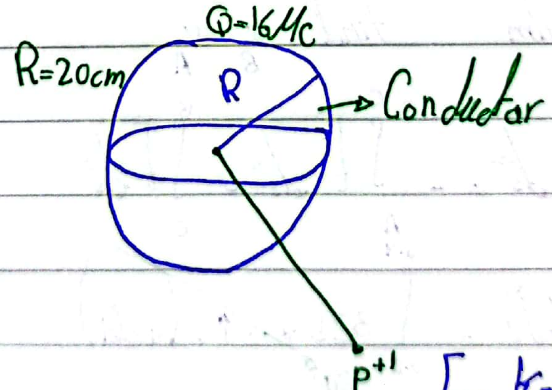
$V_S = V_A = V_B = V_C$



Example: Find electrostatic and Find V:

A] $E\big|_{r=R} = \frac{9\times10^{9}\times16\times10^{-6}}{0.2^2}$ * $V = \frac{9\times10^{9}\times16\times10^{-6}}{0.2}$ v

B] $E\big|_{10cm}$ = zero * $V\big|_{10cm} = \frac{k_e Q}{r}\Big|_{r=R} \rightarrow V_R = \frac{9\times10^{9}\times16\times10^{-6}}{0.2}$



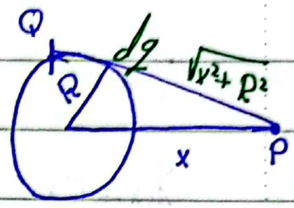
$E = \frac{k_e Q}{r^2}$

$V = \frac{k_e Q}{r}$

* The electric potential of Cts charged distribution

* $V_P = \int \frac{k_e \, dq}{r}$

1] Charged Ring

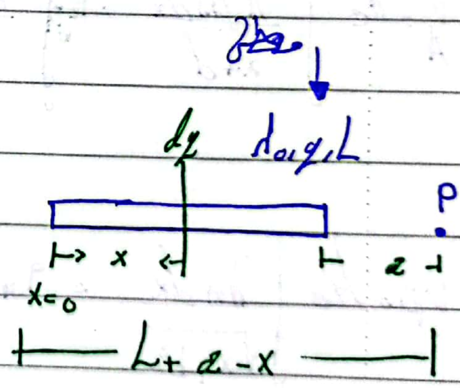


$$V_P = \int \frac{k_e \, dq}{\sqrt{R^2+x^2}} = \frac{k_e Q}{\sqrt{R^2+x^2}}$$

$$E_{Ring} = \frac{-\partial V}{\partial x} = \frac{k_e Q x}{(R^2+x^2)^{3/2}}$$

2] Finite wire (Rod)

a) Along the wire «rod»

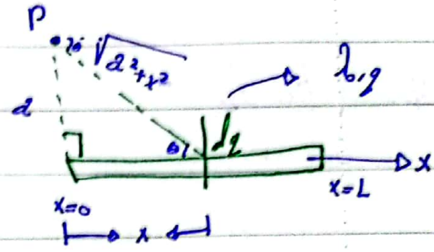


$$V_P = \int \frac{k_e \, dq}{(L+a-x)} \qquad dq = \lambda(x)\, dx$$

$$= \int_0^L \frac{k_e \lambda_0 \, dx}{(L+a-x)} = k_e \lambda_0 \ln |L+a-x|$$

b) The potenial at the corner of the rod.

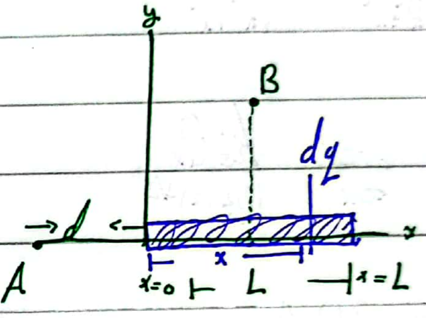
$V_p = k_e \int \frac{\lambda(x)\,dx}{\sqrt{d^2+x^2}} \rightarrow k_e \lambda \int_{x=0}^{L} \frac{dx}{\sqrt{x^2+d^2}}$ الواسطة



$45.772 \quad \lambda(x)=Cx \quad C=0.1\frac{nC}{m^2} \quad d=20cm \quad L=50cm$

1] $[\lambda]=[C][x]$

$[C]=\frac{[\lambda]}{[x]}=\frac{C/m}{m}=C/m^2$



2] $V_A = k_e\int_0^L \frac{\lambda(x)\,dx}{x+d} = k_e\times10^{-9}\int_0^L \frac{0.1\,x\,dx}{x+d} = 9\times10^9\times10^{-9}\int\frac{0.1\,x\,dx}{x+0.2}$

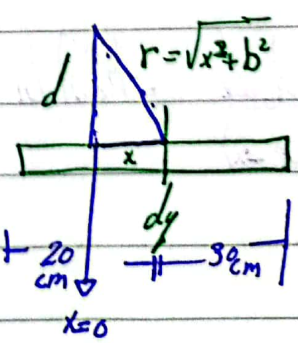
الواسطة

3] $V_P = k_e\int\frac{\lambda(x)\,dx}{\sqrt{x^2+b^2}} = 9\times10^9\int_{-0.2}^{0.3}\frac{0.1\times10^{-9}\,x\,dx}{\sqrt{x^2+0.1^2}}$

$L=50cm$

$b=10cm$

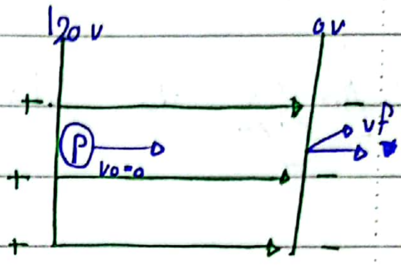
$0.9\int_{-0.2}^{0.2}\frac{x\,dx}{\sqrt{x^2+0.1^2}}$ الواسطة



أخذ 20 سالبة لأنه اعتبر هي بعد 20

3.769 proton $m_p = 1.67\times10^{-27}$ kg $\quad +e = 1.6\times10^{-19}$ C

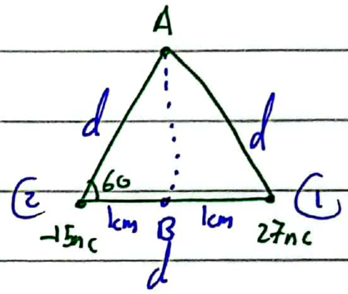
$\Delta U + \Delta K = 0 \rightarrow \Delta K = -\Delta U =$



$0.5 m v_f^2 - \underbrace{\cancel{0.5 m v_0^2}}_{zero} = -q\Delta V \rightarrow V_P = \sqrt{\frac{2q\Delta V}{m_p}}$ $\quad (\Delta V = -120)$

14.770 Equi Lateral triangle $d = 2$

مثلث متساوي الاضلاع



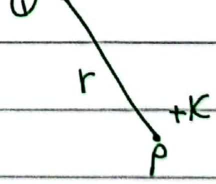
A) $V_A = V_1 + V_2 \rightarrow \frac{9\times10^9\times10^{-9}}{0.02}(27-15)$ V

$V_B = \frac{9\times10^9\times10^{-9}}{0.01}(27-15)$ V

B) $W_{A\to B}$ eletron $= -\Delta U_{A\to B} \rightarrow W_{A\to B} = -q\Delta V_{A\to B} = -(-1.6\times10^{-19})[V_B - V_A]$ J

20.771 $\quad V_p = -3K$ V $\quad E_p = 500$ V/m $\quad$ Find Q and r

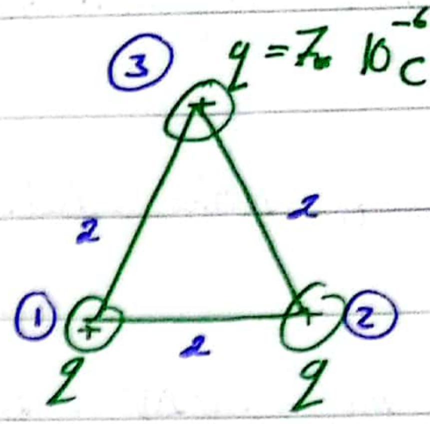
$\rightarrow E_p = \frac{K_e Q}{r^2} = 500$



$\rightarrow V = \frac{K_e Q}{r} = 3000 \quad * \; r = \frac{3000}{500} = 6$ cm

$* \; \frac{K_e Q}{6} = 3000 \rightarrow Q = \frac{6\times3000}{K_e}$

28.771 $q = 7\times 10^{-6} C$ $a = 10 cm$



$$U = \sum k_e \frac{q_1 q_2}{r} \Rightarrow U = k_e \frac{q_1 q_2}{r}$$

$$U = \frac{k_e q^2}{a} + \frac{k_e q^2}{a} + \frac{k_e q^2}{a} = \frac{3 k_e q^2}{a} = \frac{3\times 10^{9}\times 9\times 49\times 10^{-12}}{0.1} J$$

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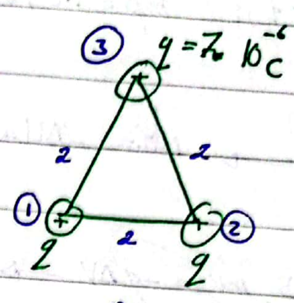
28.771 $q = 7\times 10^{-6}C$ $2 = 10cm$

$U = \sum k_e \frac{q_1 q_2}{r} \Rightarrow U = k_e \frac{q_1 q_2}{r}$



$U = \frac{k_e q^2}{2} + \frac{k_e q^2}{2} + \frac{k_e q^2}{2} = \frac{3 k_e q^2}{2} = \frac{3\times 10^9 \times 9 \times 49 \times 10^{-12}}{0.1} J$

7.769 electron

$\ast \Delta k + \Delta U = 0$

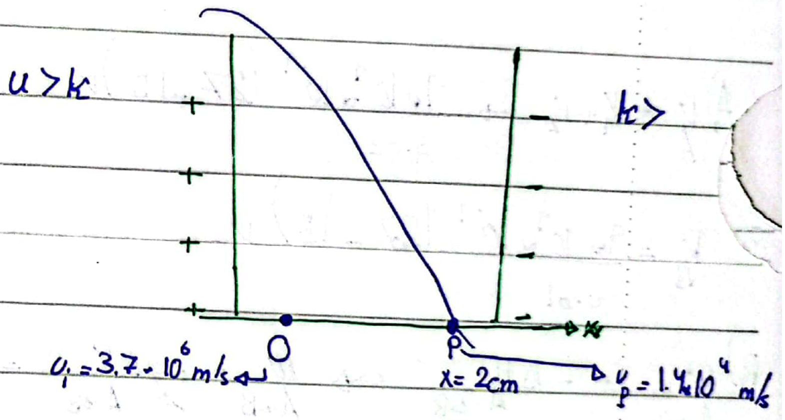
$\ast \Delta U = -\Delta k = -(k_f - k_i)$

$q_o \Delta V_{o \to p} = 0.5\, m_e (v_p - v_i)$

$= 0.5\,(9.11\times 10^{-31})\left((3.7\times 10^6)^2 - (1.4\times 10^5)^2\right)$

$q_o \Delta V = 6.23\times 10^{-18}$

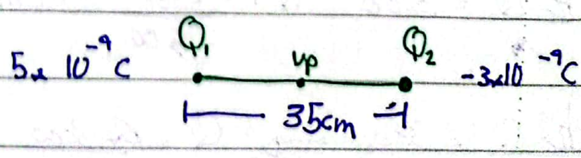
$\ast \Delta V = \frac{6.23\times 10^{-11}}{-1.6\times 10^{-19}} = -38.91 V$



$\therefore V_o > V_p$

16/770

بالأشارة



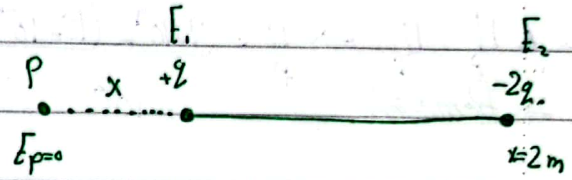
$V_p = V_1 + V_2 = \frac{9\times 10^9 \times 10^{-9}}{0.175} [5 - 3] V$

electric potinal (V_p) [illegible] $= V_1 + V_2 = \frac{k_e q}{r}$

b] electric potential energy

$$U = k_e \frac{q_1 q_2}{r} = 9\times10^9 \frac{(5\times10^{-9})(-3\times10^{-9})}{0.35} J$$

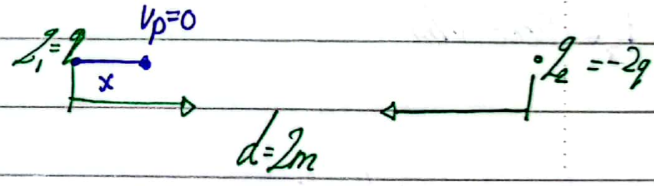
23/771



A] $|E_1| = |E_2|$

$$\frac{k_e q_1}{x^2} = \frac{k_e 2q}{(2+x)^2} \rightarrow 2x^2 = (2+x)^2$$

B] Where the electric potential is zero



بالإشارة

$$V_p = V_1 + V_2 = 0 \Rightarrow \frac{k_e q_1}{x} = -\frac{k_e q_2}{2-x}$$

$$= \frac{q}{x} = \frac{2q}{2-x} \rightarrow x = 2/3$$

39: $v(x,y,z) = 5x - 3x^2y + 2yz^2$

$E_x = -(5 - 6xy)$ $\quad E_y = -(-3x^2 + 2z^2)$ $\quad E_z = -(4yz)$

$E(1,0,-2) = -5\hat{i} - 5\hat{j} + 0\hat{k}$ $\quad \times |E| = 5\sqrt{2}$ v/m

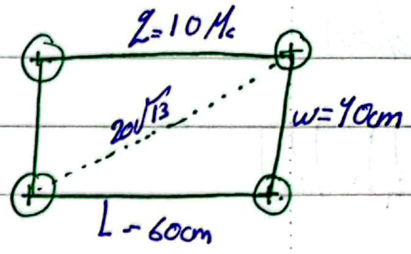
27/771

بالإشارة

A] $U = \frac{9\times10^{9} \times (10\times10^{-6})^{2}}{10^{-2}} \left[\frac{1}{60} + \frac{1}{20\sqrt{13}} + \frac{1}{40} + \frac{1}{40} + \frac{1}{20\sqrt{3}} + \frac{1}{60}\right]$

B] $\Delta U = \Delta U_p - U_f \Rightarrow U_p = \frac{9\times10^{9} \times (10\times10^{-6})^{2}}{10^{-2}} \left[\frac{1}{60} + \frac{1}{40} + \frac{1}{20\sqrt{13}}\right]$

↳ $q_3 \Rightarrow$ Removed

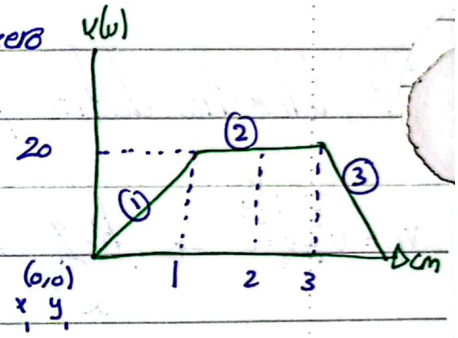


36.772 $E = -\frac{\Delta V}{\Delta X} = -\left(\frac{V_2-V_1}{x_2-x_1}\right)$

$*E_1 = -\frac{20-0}{0.01-0} = -2000$ v/m

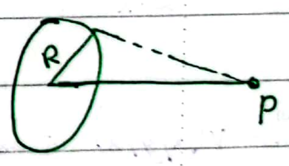
$*E_2 =$ zero

$*E_3 = 2000$ v/m



43/772 Charged Ring

$E_p = \frac{k_e Q}{(x^2+R^2)^{3/2}}$, $V_p = \frac{k_e Q}{\sqrt{x^2+R^2}}$

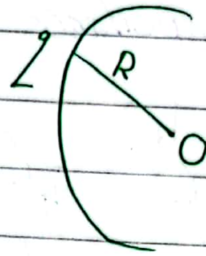


$\Delta V_{0\to 2R} = V(2R) - V(0) \Rightarrow \frac{k_e Q}{\sqrt{5}R} - \frac{k_e Q}{R} \Rightarrow \frac{k_e Q}{R}\left(-1 + \frac{1}{\sqrt{5}}\right)$

"44" Semi_circl

$$*E_0 = \frac{2k_e \lambda \sin\left(\frac{\alpha}{2}\right)}{R}$$

$$*V_0 = \frac{k_e Q}{R}$$



L = Length = 14cm

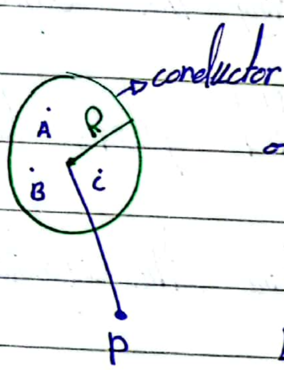
$q = 7.5\ \mu C$

$$\Rightarrow L = \frac{\cancel{2}\pi R}{\cancel{2}} \qquad R = \frac{L}{\pi} = \frac{0.14}{3.14}$$

$$\Rightarrow V_0 = \frac{9*10^9 * (-7.5) * 10^{-6}}{0.14/3.14}$$

60.773 Conducing spherical shell

$$V_A = V_B = V_C = V_s = \frac{k_e Q}{R}$$



$$\sigma = \frac{Q}{4\pi R^2}$$

$$E = \frac{\sigma}{\epsilon}$$

$$E = \frac{k_e Q}{R^2}$$

$$V_P = \frac{k_e Q}{r}$$

A] $E\big|_{r=10cm} = zero$

B] $V\big|_{r=10cm} = \cancel{\frac{9*10^9 * 26 * 10^{-6}}{0.10}}$

$Q = 26\ \mu C$

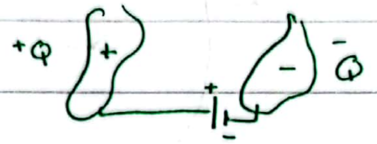
$R = 14$ cm

$$\Rightarrow \frac{9*10^9 * 26 * 10^{-6}}{0.14}$$

Subject Date 19. Nov No.

* Chapter-26 The Capacitance موسوعة

1] Defintion of capcitance



⇒ We define, the capacitance as $C = \frac{\text{charge}}{\text{potential difference}}$

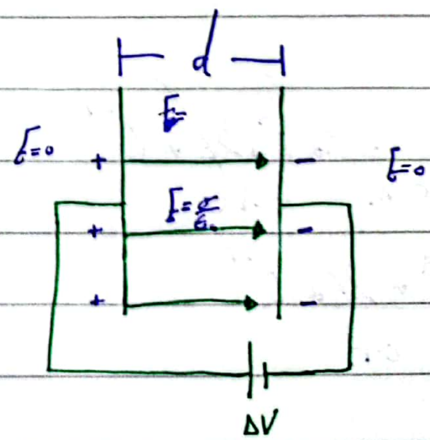
* $C = \frac{Q}{\Delta V} = \frac{C}{V}$ = farad = F *

• Caculating the Capacitance :-

1] parallel plate Capacitort :-

* We define, the capacitance as $C = \frac{Q}{\Delta V}$

d :- separtion betwteel two plates



$* \; C = \dfrac{Q}{\Delta V} \Rightarrow C = \dfrac{Q}{\frac{\sigma d}{\epsilon_0}}$

$\Rightarrow C = \dfrac{\epsilon_0 A}{d}$ مهم

$* \; \Delta V = -\int E \, dx = -\int \frac{\sigma}{\epsilon} dx$

$* \; \sigma = \dfrac{Q}{A}$

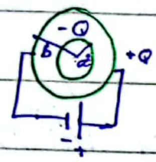
$* \; C = \dfrac{\epsilon_0 Q}{\frac{Q}{A} d} = \dfrac{\epsilon_0 A}{d}$

$* \; \Delta V = \dfrac{\sigma}{\epsilon_0} d$

2] Spherical Capacitor مواسعة كروية

$$\Rightarrow \Delta V_{ab} = -\int E \, dr = +\int_a^b \frac{k_e Q}{r^2} dr = k_e Q \left(\frac{-1}{r}\right)\Big|_a^b = -k_e Q \left(\frac{1}{b} - \frac{1}{a}\right) = -k_e Q \left(\frac{a-b}{ab}\right)$$

$$= \frac{k_e Q (b-a)}{ab}$$ مهم

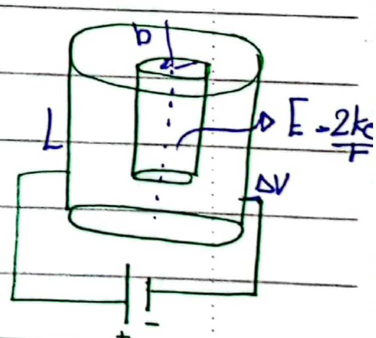


$$\Rightarrow C = \frac{Q}{\Delta V} = \frac{Q \, ab}{k_e Q (b-a)} \Rightarrow C = \frac{4\pi \epsilon_0 \, ab}{b-a}$$ مهم

3] Cylinderical Capacitor مواسعة إسطوانية

$$\Rightarrow \Delta V_{ab} = -\int_a^b \frac{2k_e \lambda}{r} dr = -2k_e \lambda \ln r \Big|_a^b \Rightarrow$$

$$\Delta V = -2k_e \lambda \ln\left|\frac{b}{a}\right| \Rightarrow |V| = 2k_e \lambda \ln\left|\frac{b}{a}\right|$$ مهم



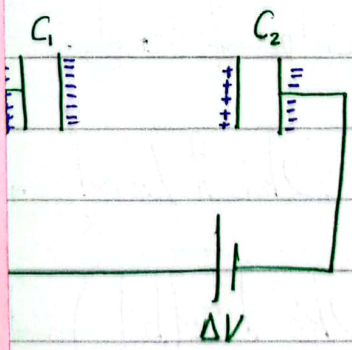
$$\Rightarrow C = \frac{Q}{\Delta V} = \frac{Q}{2k_e \lambda \ln\left|\frac{b}{a}\right|} \Rightarrow \frac{L}{2k_e \ln\left|\frac{b}{a}\right|} = \frac{2\pi \epsilon_0 L}{\ln\left|\frac{b}{a}\right|} \quad ※$$

$\Rightarrow$ Capacitance per unit length $\frac{C}{L} = \frac{2\pi \epsilon_0}{\ln\left|\frac{b}{a}\right|}$

2] "Combinations of Capactance"
" توصيل المواسعات "

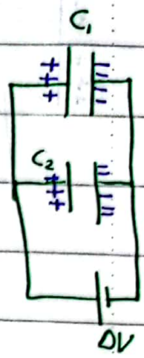
A] Series Combination توصيل التوالي

- The Charge on each Capaction $Q_1 = Q_2 = Q_{eq}$ — equivillent المكافئ
- .. Potential difference across each capatere $\Delta V = \Delta V_1 + \Delta V_2$
- ... The equiveivellent capactace $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$



B] Parallel Combination توصيل التوازي

• $Q_{eq} = Q_1 + Q_2$ •• $\Delta V = V_1 = V_2$ ••• $C_{eq} = C_1 + C_2$

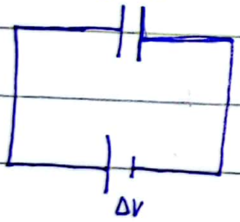


⇒ The energy stored in a Capacitor

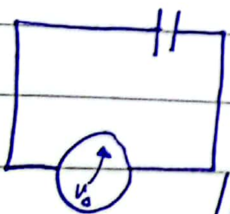
$* \; U = \frac{1}{2} Q \Delta V$ $\quad * \; C = \frac{Q}{\Delta V} \rightarrow Q = C \Delta V = 0.5\, C (\Delta V)^2 = \frac{Q^2}{2C}$

3] Capacitance and Dielectric مواد ثنائية القطبية (التكهرب)

Charging the capacitor while filled with Air :-



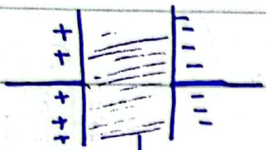
Disconnecting the capacitor from the battary



voltmeter

Date No.

Inserting a dielectric Meterial inside the capacitor



$Q = Q_0$ $\qquad * \; \epsilon_0 = \epsilon_0 K$

↳ Dielectric Material

$* \; \Delta V = \dfrac{\Delta V_0}{K}$ ← بدونه مادة Dielectric

$\Rightarrow K$: dielectric constant

له يقصد مادة $\quad K \geq 1$

$\Rightarrow C = K C_0$ جزيئه

* Charge is the same before and after inserting Dielectric

* The work needed to insert the dielectric material

$\Rightarrow W = -\Delta U = -(U_f - U_i) \qquad \Rightarrow U = 0.5\, Q\, \Delta V \Leftarrow$

$W = U_i - U_f = 0.5\, Q_0 \Delta V_0 - 0.5\, Q\, \Delta V = 0.5\, Q_0 \Delta V_0 - 0.5\, Q_0 \dfrac{\Delta V_0}{K}$

$= 0.5\, Q_0 \Delta V_0 \left(1 - \dfrac{1}{K}\right) \Rightarrow U_0 \left(1 - \dfrac{1}{K}\right)$ ※

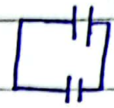
Energy stored before and after

$U_0 = \dfrac{Q^2}{2C_0} \Rightarrow U = \dfrac{Q^2}{2C} \Rightarrow U = \dfrac{Q^2}{2KC_0}$

$\dfrac{1}{K} \dfrac{Q^2}{2C_0} \Rightarrow U = \dfrac{1}{K} U_0$ ※

"Solving problems:-"

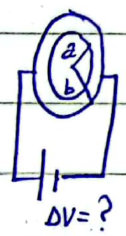
⇒ 1. 801 $\Delta V = ?$ $C = 3\,\mu F$; $Q = 27\,\mu C$



$$\Delta V = \frac{Q}{C} = 9V \quad *$$

⇒ 2. 801 spherical Capacitor $a = 7cm$ $b = 14cm$ $Q = 4\,\mu C$

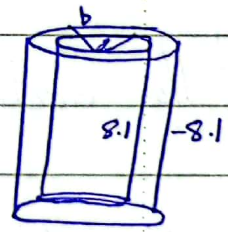
A] $C = \frac{4\pi\epsilon_0 ab}{b-a} = \frac{4\pi(8.85\times10^{-12})\,0.07\times0.14}{0.14-0.07} = \boxed{}\,F$



B] $\Delta V = \frac{Q}{C} = \frac{4\times10^{-6}}{\boxed{}}\,V \quad *$

⇒ 5. 801 $L = 50m$ diameter $2b = 7.27mm$, $2a = 2.58mm$, $Q = 8.1\,\mu C$

$$C = \frac{2\pi\epsilon_0 L}{\ln\left|\frac{b}{a}\right|} = \frac{2\pi(8.85\times10^{-12})(50)}{\ln\left|\frac{7.27}{2.58}\right|} = \boxed{}\,F$$



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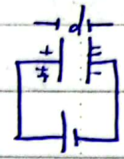
⇒ 7.801 $\sigma = \frac{30 nC}{cm^2} = 30\times10^{-5}\frac{C}{m^2}$ $\Delta V = 150v$ (separation)

المسافة ← ←

والمطلوب ↑

* $C = \frac{\epsilon_0 A}{d}$ * $Q = C\Delta V$ * $\sigma = \frac{Q}{Area}$



$\sigma \cancel{A} = \frac{\epsilon_0 \cancel{A}}{d}\Delta V \Rightarrow d = \frac{\epsilon_0 \Delta V}{\sigma} = \frac{8.85\times10^{-12}\times150}{30\times10^{-5}} = \square m$ *

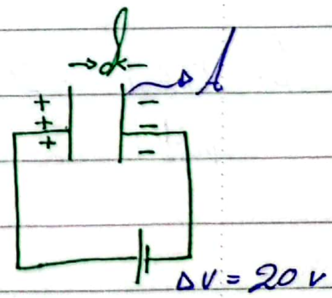
⇒ 8.801 $A = 2.3\ cm^2$ $d = 1.5\ mm$ $\Delta V = 12v$

A] $C = \frac{\epsilon_0 A}{d} = \frac{8.85\times10^{-12}\times2.3\times10^{-4}}{1.5\times10^{-3}} = \boxed{\ } F$

B] ⇒ $E = \frac{\sigma}{\epsilon_0} = \frac{\Delta V}{d} = \square \Rightarrow \Delta V = Ed$ ← final

9.801 $A = 2.30\ cm^2$ $d = 1.8mm$

a] The electri field $\Delta V = Ed$



$E = \frac{\Delta V}{d} = \frac{20}{1.8\times10^{-3}} = 11111\ v/m$

b] $E = \frac{\sigma}{\epsilon_0} = \sigma = \epsilon_0 E = 8.85\times10^{-12}\cdot 11111 = 9.833\times10^{-8}\ c/m^2$

c] $C = \frac{Q}{\Delta V} = \frac{\epsilon_0 A}{d} = \frac{8.85\times10^{-12}\times2.3\times10^{-4}}{1.8\times10^{-3}} F$

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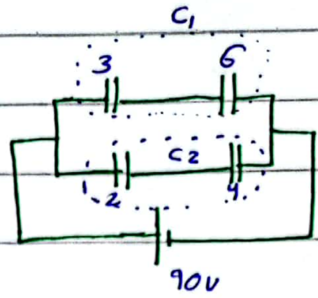


19.802 $C = 2\mu F$

$$* \frac{1}{C_1} = \frac{1}{3} + \frac{1}{6} = \frac{3}{6} \Rightarrow C_1 = 2\mu F$$

$$* \frac{1}{C_2} = \frac{1}{2} + \frac{1}{4} = \frac{3}{4} \Rightarrow C_2 = \frac{4}{3} \mu F$$

$$* C_{eq} = 2 + \frac{4}{3} = \frac{10}{3} \mu F$$

$$Q_{eq} = C_{eq} \Delta V = \frac{10}{3} * 90 = 300 \mu C$$

بما أنها في حالة توازي

$\Delta V_{C_1} = \Delta V_{C_2} = 90V$ $* Q_{eq(1)} = C_1 \Delta V_1 = 2 * 90 = 180 \mu C$

بما أنها في حالة توالي

$* Q_{eq(2)} = \frac{4}{3} * 90 = 120 \mu C$ $* Q_3 = Q_6 = 180 \mu C$ $* Q_2 = Q_4 = 120 \mu C$

$* \Delta V_3 = \frac{Q_3}{C_3} = \frac{180}{3} = 60V$ $* \Delta V_6 = \frac{Q_6}{C_6} = \frac{180}{6} = 30V$

• What is the energy stored in the system?

$$U = 0.5\, Q_{eq} \Delta V = \frac{300}{2} * 10^{-6} * 90 = 13.5 mJ$$

Questions: $Q_2 = 120 \mu C$ $\Delta V = ?$ ← في حال طلب ΔV وأعطى Q_2

$Q_2 = 120 \mu C$ $U = 150 \mu J$ $\Delta V = ?$ ← في حال أعطى U وطلب ΔV

N O T E B O O K

21.802 $\underbrace{C_1, C_1, C_1 \dots C}_{n}$ Find $\underline{\underline{n}}$

C_s (توالي) = ? $C_p = 100 C_s$

* $\frac{1}{C_s} = \underbrace{\frac{1}{C} + \frac{1}{C} + \dots + \frac{1}{C}}_{n}$

* $C_p = \underbrace{C_1 + C_1 + \dots + C}_{n}$

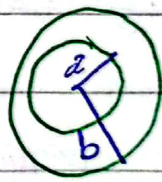
$= \frac{n}{C}$

$= nC$

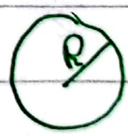
$\therefore n\cancel{C} = 100 \frac{\cancel{C}}{n} \Rightarrow n^2 = 100 \Rightarrow n = 10$ *

11. Speial Case: spherical Capactior

$C = \frac{4\pi\epsilon_0 ab}{b-a}$



Isolated sphere, drop of water



$\Rightarrow C = \lim_{b\to\infty} \frac{4\pi\epsilon_0 ab}{b-a} = \frac{4\pi\epsilon_0 a\cancel{b}}{\cancel{b}}$

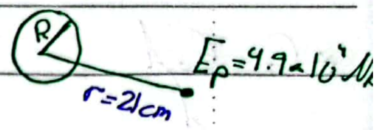
حالة خاصة
(مهم)

* $C_{isoted} = 4\pi\epsilon_0 R$

N O T E B O O K

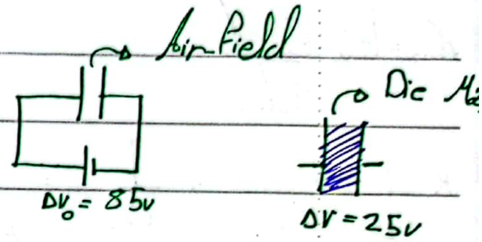
$* \; E = \frac{k_e Q}{r^2} \Rightarrow Q = E r^2 / k_e \Rightarrow \frac{4.9 \times 10^4 \times (0.21)^2}{9 \times 10^9} \; C$

$\Rightarrow \sigma = \frac{Q}{4\pi R^2}$ ⊲ [illegible]



If R = 12cm find C $\Rightarrow 4 \times 3.14 \times 8.85 \times 10^{-12} \times 0.12 \; F$ ※

44. 8o4



1] $k = \frac{\Delta V_0}{\Delta V} = \frac{85}{25} = 3.4$

* before insering the dielectric

1] $C_0 = \frac{\epsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \times 2.3 \times 10^{-4}}{1.8 \times 10^{-3}} = 1.13 \; pF$

2] $Q_0 = C_0 \Delta V_0 = 1.13 \times 85 = 96.1 \; pC$

3] $U_0 = 0.5 \, Q_0 \Delta V_0 = \frac{96.1 \times 85}{2} = 4048.3 \; pJ$

* After inserting the dieletric

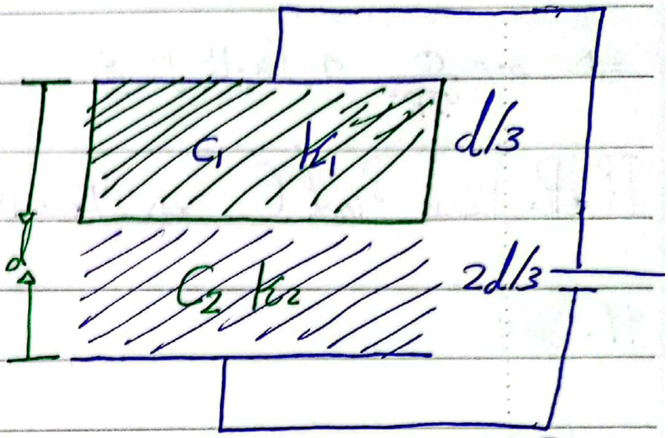
1] $C = C_0 k = 3.4 \times 1.13 = 3.8 \; pF$

2] $Q = C_0 \Delta V_0 = 96.1 \; pc$

3] $U = \frac{U_0}{k} = \frac{4048.3}{3.4} \; pJ = 1201.2 \; pJ$

* energy = w = $|\Delta U|$ = $4048.3 - 1201.2 = \; pJ$

Example: What is the Equillent Capacitace :



$* \; C_0 = \frac{\epsilon_0 A}{d}$ $\qquad * \; C = K C_0$

$* \; C_1 = K_1 \frac{\epsilon_0 A}{d/3}$

$* \; C_2 = K_2 \frac{\epsilon_0 A}{2d/3}$

$* \; \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d/3}{K_1 \epsilon_0 A} + \frac{2d/3}{K_2 \epsilon_0 A}$

$\frac{1}{C_{eq}} = \frac{d}{3\epsilon_0 A}\left(\frac{1}{K_1} + \frac{2}{K_2}\right) \Rightarrow \frac{d}{3\epsilon_0 A} \; \frac{K_2 + 2K_1}{K_1 K_2}$

$C_{eq} = \frac{3\epsilon_0 A K_1 K_2}{d(K_2 + 2K_1)}$

$K_1 = 1$ للتحقق من الجواب
$K_2 = 1$

HomeWork :- $K_1 = 2.3$ $\quad K_2 = 1.7$ $\quad A = 2.3\,cm^2$ $\quad d = 1.8\,mm$ Find Equillent Capa

$* \; C_1 = K_1 \frac{\epsilon_0 A}{d/3} \Rightarrow 2.3 * \frac{8.85*10^{-12} * 2.3*10^{-4+3}}{\frac{1.8*10^{-3}}{3}}$ $\qquad * \; C_2 = 1.7 * \frac{8.85*10^{-12} * 2.3*10^{-4}}{\frac{2*1.8}{3} * 10^{-3}}$

$\frac{1}{C_{eq}} = \frac{1}{78.02} * 10^{+13} + \frac{1}{28.83} * 10^{13} = 0.047*10^{13} \rightarrow C_{eq} = 21.2*10^{-13} F$ *

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$\ast C_1 = k_1 \dfrac{\epsilon_0 A/3}{d}$

$C_2 = k_2 \dfrac{\epsilon_0 \, 2A/3}{d}$

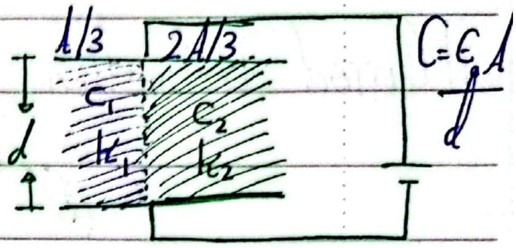
$\Rightarrow C_{eq} = C_1 + C_2 \Rightarrow \dfrac{\epsilon_0 A}{3d}(k_1 + 2k_2)$

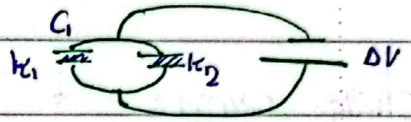
$\ast C_0 = \dfrac{\epsilon_0 A}{d} = 12 \, \mu F$

* Dielectric material

$\boxed{1}$ $k_1 = 4.9$ Baklite

$\boxed{2}$ $k_2 = 3.7$ paper



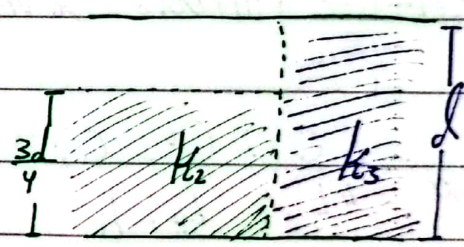


* C_1 and C_2 in series

C_{12} and C_3 in paralle

$C_1 = k_1 \epsilon_0 \dfrac{A/2}{d/4}$ $C_2 = k_2 \epsilon_0 \dfrac{A/2}{3d/4}$

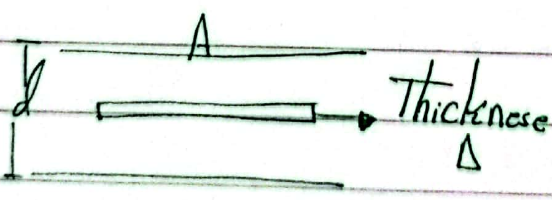
$C_3 = k_3 \epsilon_0 \dfrac{A/2}{d}$



Note: Metalic Slab $\Delta = 1mm$ $d = 1cm$

$C = \dfrac{\epsilon_0 A}{d - \Delta}$

0.9cm $\Rightarrow$ d

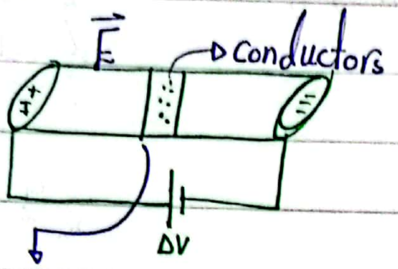


Subject   Date   No.

Chapter 27 The electric Current

Q / $I \mid t$

1] Current Defination



charge carriers
حاملات الشحنة

2] Electric Current: Average current   التيار المتوسط

$* \; I_{av} = \frac{\Delta Q}{\Delta t} = \frac{Q_f - Q_i}{t_f - t_i} = \frac{C}{sec}$ $* \; [I_{av}] = $ Amper : A

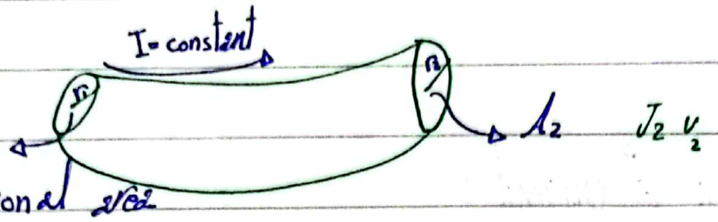
.. The instantious current   اللحظي

$I = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t} = \frac{dq}{dt}$

Examples:- $q(t) = 3t^2 - t + 1 \Rightarrow I(t = 1sec) = \frac{dq}{dt}\Big|_{t=1} = 6t - 1\Big|_{t=1} = 5A$

2] The current Density of a non_uniform conductor :

I = constant



A: cross-sectional area

* $J_1 > J_2$
* $v_1 > v_2$

* We define, the current density $(\vec{J})$

$\rightarrow J = \frac{I}{Area}$ $\rightarrow J_1 = \frac{I}{A_1} = \frac{I}{\pi r_1^2}$ $\rightarrow J_2 = \frac{I}{\pi r_2^2}$ A/m^2

* $I \Rightarrow$ scalar * current density : vector
* I : is constant any where
* $J = n q v_d$
* $\vec{J} = \sigma \vec{E}$
* $[\sigma] = A/m.V$
* $[\rho] = m.V/A$ ($= \Omega.m$)

3] Ohm's Law :

* $\vec{J} = \sigma \vec{E}$

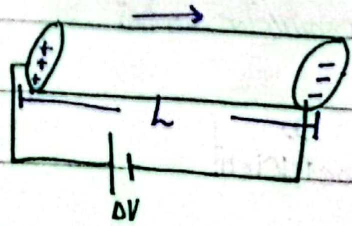
σ : conductivity (الموصلية)

$\rho : \frac{1}{\sigma}$: resistivity (المقاومية)

but $\Delta V = Ed$

* $\frac{I}{A} = \sigma . \frac{\Delta V}{L} \Rightarrow \Delta V = \frac{L}{\sigma A} I$

$I, \vec{J}, \vec{E}$



Ohm's Law $\leftarrow$ $\boxed{\vec{J} \propto \vec{E}}$

مقاومة

* $\Delta V = \left(\frac{\rho L}{A}\right) I$ * $\Delta V = RI$ * $R = \frac{\rho L}{A}\ \Omega$

* The Microscopic picture of current :

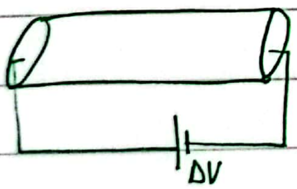
→ $I = n q v_d A$ Example 27.1

→ تعطى في الامتحان

v_d :- drift speed A :- area n :- electron's density $\left(\frac{e}{m^3}\right)$

4] Tempeiture - dependent resistance اعتماد المقاومة على الحرارة

$T_0 = 20°C$  $R(T_0) = R_0$

$T > T_0$ 

$R(T) = ?$

* $R(T) = R_0 \left(1 + \alpha (T - T_0)\right)$

→ resistance مقاومة

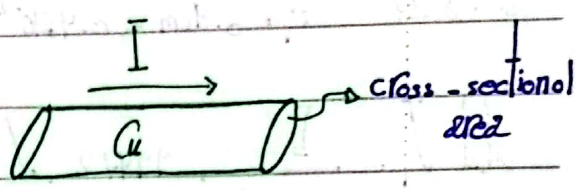
→ when the conductor is hot

→ when the conductor is cold

α : Thermal coefficient * $[\alpha] = \frac{1}{C} = C^{-1}$

* Resistiviy المقاومية

$\rho(T) = \rho_0 (1+\alpha (T - T_0))$

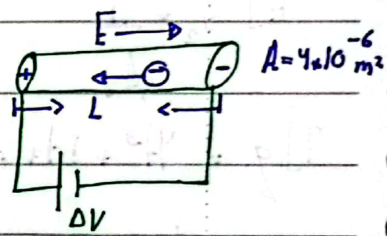


3.826 $A = 4\times10^{-6}\,m^2$ $I = 5A$ $n = 8.49\times10^{28}\,\frac{e}{m^3}$

drift speed

S:- $I = nqAv_d \Rightarrow v_d = \frac{I}{nqA} = \frac{5}{8.49\times10^{28}\times 1.6\times10^{-19}\times 4\times10^{-7}} = [\ ]\,m/s$

B] The resistance of the Cu-wire



$L = 25cm$, $\rho = 1.7\times10^{-8}\,\Omega.m$

$\Rightarrow R = \frac{\rho L}{A} = \frac{1.7\times10^{-8}\times 0.25}{4\times10^{-6}} = 1.06\times10^{-2}\,\Omega = 1.06m\Omega$

c] Find the Potential difference

$\Rightarrow \Delta V = RI \Rightarrow 5\times1.06\times10^{-3} = 5.3\times10^{-3}\,V$

d] Find the electric field establishedin wire

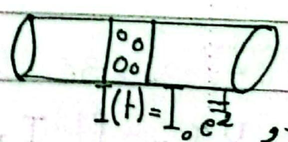
$\Rightarrow \Delta V = EL \Rightarrow E = \frac{\Delta V}{L} = \frac{5.3\times10^{-3}}{0.25} = 0.0212\,V/m$

e] What is the power delevired by the battary قدرة $\Rightarrow P = I\Delta V$ [watt] $= 5\times(5.3\times10^{-3}) = 26.5mW$

7.826 A] ΔQ: $0 \le t \le 2$ $I(t) = \frac{dq}{dt} \Rightarrow dq = I(t)dt \Rightarrow \Delta Q = \int I(t)\,dt$

$\Delta Q = I_0 \int_0^2 e^{-\frac{t}{2}}\,dt = -I_0 2 \left[e^{-\frac{t}{2}}\right]_0^2 \Rightarrow I_0 2 \left[1 - \frac{1}{e}\right] = //e$

(عوض الباقي بنفسك بشطارة)



0.270

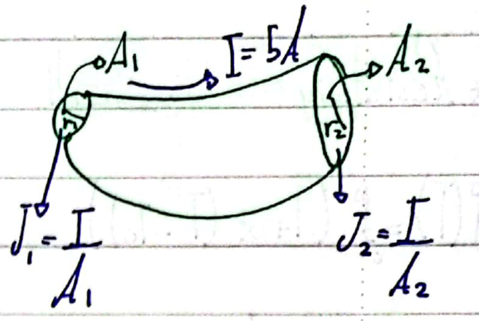
B] $\Delta Q = ?$ $0 \le t \le 10\,2$

$\Delta Q = I_0 2 \left[1 - \frac{1}{e^{10}}\right]$ -

c] $\Delta Q = ?$ $0 \le t \le \infty$ $\Delta Q = I_0 2 \left[1 - \frac{1}{e^{\infty}}\right] = I_0 2$

Subject Date No.

8.826 $r_1 = 0.4cm = 0.4\times10^{-2} = 4\times10^{-3}m$



A] $J_1 = \frac{5}{\pi(4\times10^{-3})^2} = 99472 \frac{A}{m^2}$

B] $I|_{A_2} = I|_{A_1} = 5A$

C] $J_1 > J_2$ $v_{d(1)} > v_{d(2)}$ D] $A_2 = 2A_1 \rightarrow \pi r_2^2 = 2\pi(4\times10^{-3})^2 \rightarrow r_2 = 4\sqrt{2}\ mm$

E] $J_2 = \frac{I}{A_2} \rightarrow \frac{I}{2A_1} = \frac{J_1}{2}$

9] $q = 4t^3 + 5t + 6$, $A = 2cm^2$

A] Average current $t=0 \rightarrow t=5sec$

$I_{av} = \frac{Q_f - Q_i}{\Delta t} = \frac{Q(5)-Q(0)}{5-0} = \frac{531-6}{5} A$

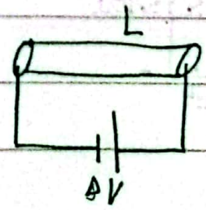
B] The instaninous curent $I_{(t=1)} = \frac{dq}{dt} = 12t^2 + 5 = 17A$

14/827 $\Delta V = 120v$, $R = 240\Omega$ A] $\Delta V = RI \rightarrow I = \frac{\Delta V}{R} = \frac{120}{240} = 0.5A$

B] power $\rightarrow I\Delta V = p \rightarrow 0.5\times120 = 60W$

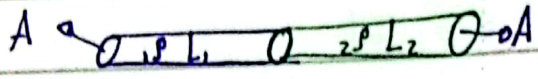
15/827 $I = 36$ $2R = 2mm$ $\Delta V = 9.11v$ $L = 50m$ $\rho = ?$

$\Delta V = RI = \frac{\rho L}{A} I \rightarrow \rho = \frac{\Delta V(A)}{LI} = \frac{9.11\times\pi\times(1\times10^{-3})^2}{50(36)} = \boxed{}\ \Omega.m$



N O T E B O O K

.1 Find the equivalent resistance



$A = 2mm^2$ $\rho_1 = 1.59 \times 10^{-8}\ \Omega.m$ $L_1 = 50cm$ $L_2 = 75cm$ $\rho_2 = 2.82 \times 10^{-8}\ \Omega.m$

$$R_T = R_1 + R_2 = \frac{\rho_1 L_1}{A} + \frac{\rho_2 L_2}{A} \Rightarrow \frac{10^{-8}}{2 \times 10^{-6}}\left[1.59 \times 0.5 + 2.82 \times 0.75\right] = \boxed{}\ \Omega$$

Ex.2

$$R_N = ?\ R_0 \Rightarrow R_0 = \frac{\rho L}{A} \Rightarrow R_N = \frac{\rho\, L/3}{3A}$$

$$R_N = \frac{\rho L}{9A} \Rightarrow \frac{R_0}{N^2}$$, N ⇒ of parts $$\Rightarrow \frac{R_N}{R_0} = \frac{1}{N^2}$$

26.827 R(T) $\Rightarrow R(T) = R_0\left[1 + \alpha \Delta T\right] \Rightarrow \Delta T = T - T_0\ ;\ T > T_0$

Tungest : W $R_0 = 19\ \Omega$ when cold $T_0 = 20c°$

$R = 140\ \Omega$ when hot $T > T_0$ $\alpha = 4.5 \times 10^{-3}\ c^{-1}$

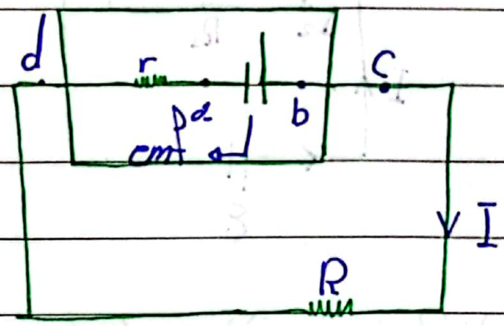
$$Sol:- \left[\frac{R(T)}{R_0} - 1\right] \Big/ \alpha = \Delta T \Rightarrow \frac{\frac{140}{19} - 1}{4.5 \times 10^{-3}} = \Delta T = T - 20$$

$T - 20 = 1415 \Rightarrow T = 1435\ c°$ ✗

*Chapter-28 Direct Current

⇒ The electromotive force emf القوة الدافعة الكهربائية

r :- Internal restance
R :- load resistance external
$\mathcal{E}$: Electromotive force



$* \Delta V_{ab} = \mathcal{E}mf = (R+r)I$ $\quad * \mathcal{E} = IR + rI$

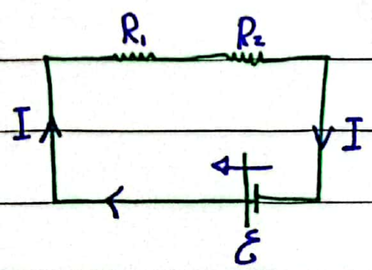
$* IR = \mathcal{E} - Ir$ $\quad * \Delta V_{cd} = \mathcal{E} - Ir = IR$

⇒ ΔV_{cd} :- Terminal valtage

.. Combinations of Resistors توصيل المقاومات

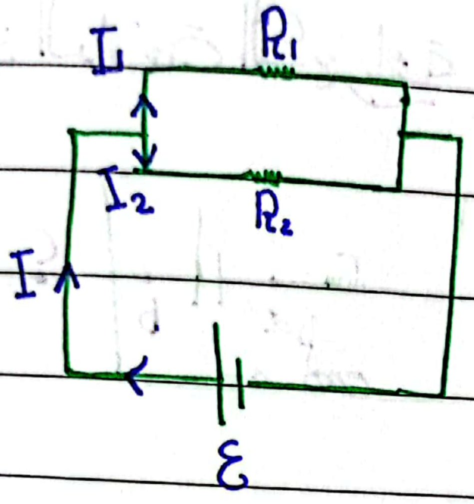
A] Series Combinations :- 1] The current in each resistor $I = I_1 = I_2 = I_{eq}$

2] Potential diff difference across each resistance $\mathcal{E} = \Delta V_1 + \Delta V_2$



3] Equivillent Resistance $R_{eq} = R_1 + R_2$

B] parallel Combination :-



1] $I = I_1 + I_2$

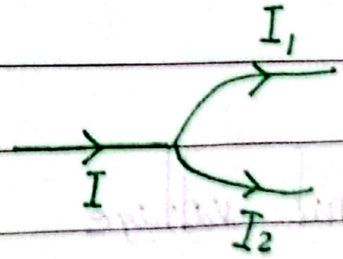
2] $\Delta V_1 = \Delta V_2 = \Delta V$

3] $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

* Kirchoff's Rules :

• The conservation of charge

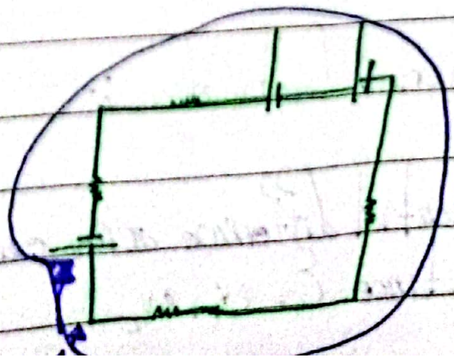
$\sum I_{in} = \sum I_{out}$



$I = I_1 + I_2$

•• Conservation of energy

$\sum \Delta V = 0$
closed loop

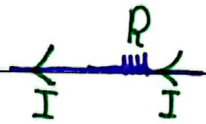


.. Kirchoff's Convention :-

⇒ Resistance [→ + →]

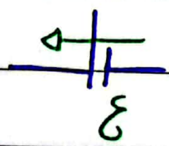
A] $\Delta V = -IR$

B] $\Delta V = IR$

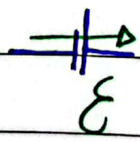


⇒ Battery [→ + →]

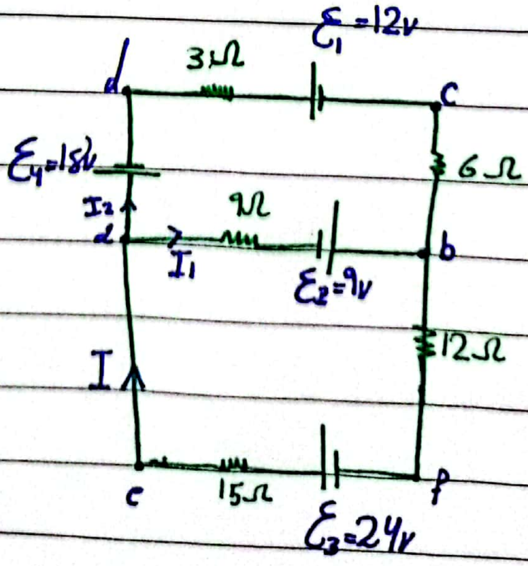
A] $\Delta V = -\mathcal{E}$



B] $\Delta V = \mathcal{E}$



Example:-



$* \ \sum I_{in} = \sum I_{out}$ $\quad * \Rightarrow I = I_1 + I_2 \ldots \boxed{1}$

$* \ \sum \Delta V_{abcda} = 0$ loop 1n

closed loop

$= -9I_1 + (+9) + (+6I_2) + (+12) + (+3I_2) + (+18) = 0$

$= -9I_1 + 9I_2 + 39 = 0 \Rightarrow -3I_1 + 3I_2 + 13 = 0 \ldots \boxed{2}$

$* \ \sum \Delta V_{efbce} = 0$

closed loop

$= +(15+12)I + (-24) + (-9) + (+9I_1) = 0$

$= 27I + 9I_1 - 33 = 0 \Rightarrow 9I + 3I_1 - 11 = 0 \ldots \boxed{3}$

للحل على الالة الحاسبة يجب ترتيب :

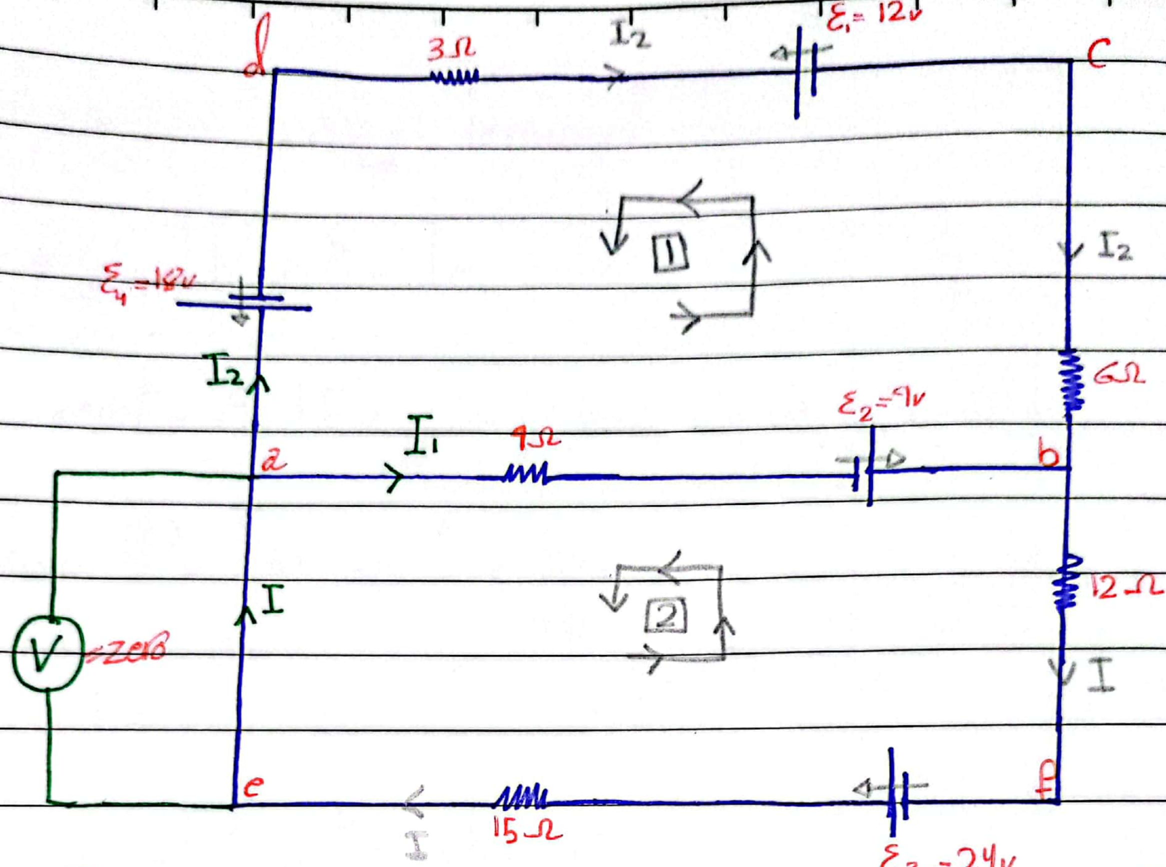
$I - I_1 - I_2 = 0 \ldots \boxed{1}$ $\quad 0I - 3I_1 + 3I_2 = -13 \ldots \boxed{2}$ $\quad 9I + 3I_1 + 0I_2 =$

$\Rightarrow I = \frac{3}{7}$ $\quad \Rightarrow I_1 = \frac{50}{21}$ $\quad \Rightarrow I_2 = -\frac{41}{21}$

*عندما يطلب فرق الجهد بين نقطتين :-
دائمًا أخذ مع مسار حتى لو طلب العكس

*الانتباه إلى إشارة التيار إذا كانت
نعوضها سالبة ولكن في حال طلب
الاتجاه نعكس ما فرضناه .

Chapter 28



* Find $V_a - V_e = ?$

$$V_e + \dots = V_a \Rightarrow V_e + \left(+15 \times \frac{3}{7}\right) + (-24) + (-9) + \left(+9 \times \frac{50}{21}\right) = V_a$$

$$\therefore V_e - V_a = \text{zero} \equiv V_a - V_e = \text{zero}$$

* Find $V_d - V_a = ?$

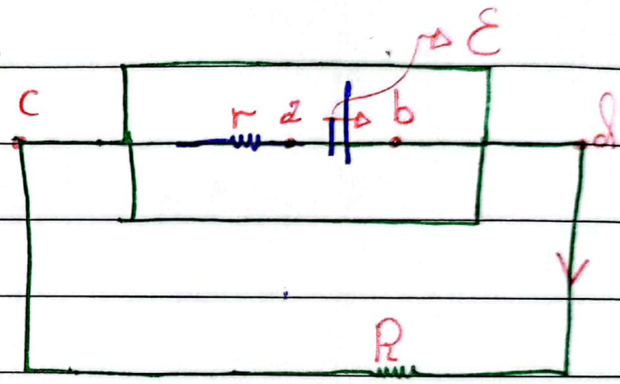
$$V_a + \dots = V_d \Rightarrow V_a + \left(-9 \times \frac{50}{21}\right) + (+9) + \left(+9\left(\frac{-41}{21}\right)\right) + 12 = V_d$$

Reminder :: ΔV_{cd} : Terminal Voltage

$\Rightarrow \Delta V_{cd} = IR = \mathcal{E} - Ir$

$*emf = \mathcal{E} = 15v$ $* P = 20W$ $* \Delta V_{cd} = 11.6v = \Delta V_R$

Solution: A] $P = I\Delta V \Rightarrow I = \frac{P_R}{\Delta V_R} =$



$\frac{20}{11.6} = 1.72A$

B] $\Delta V_R = RI \Rightarrow 11.6 = R(1.72)$

$\Delta V_{ab} = IR + Ir$
$= (R+r)I$

$R = \frac{11.6}{1.72} = 6.74\,\Omega$

C] $\mathcal{E} = (r+R)I \Rightarrow r+R = \frac{\mathcal{E}}{I} = \frac{15}{1.72}$

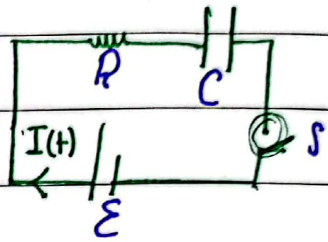
$r = \frac{15}{1.72} - 6.74 = 1.98\,\Omega$

5 / Dec / 2023

* RC - Circuit

→ R: resistance $\Omega, K\Omega, m\Omega$ / → C: Capacitor [μF, nF]

1] Charging RC - Circuit



→ Key «1» : R, C, $\mathcal{E}$

→ Key «2» : The capacitor is intially uncharged

$$\Rightarrow \mathcal{E} = \Delta V_R(t) + \Delta V_C(t) = R I(t) + \frac{q(t)}{C} \text{ but } I(t) = \frac{dq}{dt}$$

$$\mathcal{E} = R\frac{dq}{dt} + \frac{q}{C} \Rightarrow \frac{dq}{dt} + \frac{q}{RC} = \frac{\mathcal{E}}{R}$$

$\tau = RC$ (sec) : Time-constant

$$* \frac{dq}{dt} + \frac{q}{\tau} = \frac{\mathcal{E}}{R}$$

* Solution → Key «3»

$$q(t) = Q_{max}\left(1 - e^{-\frac{t}{\tau}}\right)$$

$$\Rightarrow Q_{max} = \mathcal{E}C$$

$$\Rightarrow I(t) = \frac{dq}{dt} = \frac{Q_{max}}{\tau} e^{-\frac{t}{\tau}} = I_{max}\, e^{-\frac{t}{RC}}$$

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• The P.d a cross the Capacitor :

$$\Delta V_c(t) = \frac{q(t)}{C} = \mathcal{E}(1 - e^{\frac{-t}{\tau}})$$

•• The P.d a cross the resistance

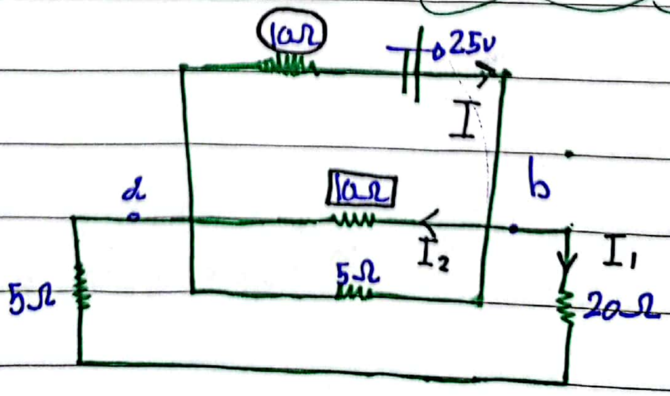
$$\Delta V_R(t) = R\,I(t) = \mathcal{E}\,e^{\frac{-t}{\tau}}$$

∴ The energy stored in the Capacitor

$$U_c(t) = \frac{q^2(t)}{2C} = 0.5\,C\,\mathcal{E}(1 - e^{\frac{-t}{\tau}})^2$$

∷ The power dissipated in the resistor

$$P_R(t) = R\,I^2(t) \Rightarrow \frac{\mathcal{E}^2}{R}\,e^{\frac{-2t}{RC}}$$



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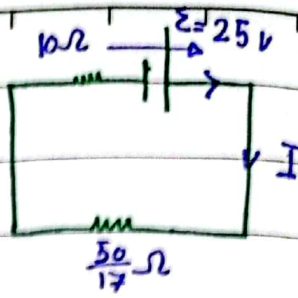
Chapter 28



$\Rightarrow R_1 = 20 + 5 = 25\,\Omega$

$\Rightarrow \frac{1}{R_2} = \frac{1}{25} + \frac{1}{5} + \frac{1}{10} \Rightarrow R_2 = \frac{50}{17}\,\Omega$

$* R_{eq} = \frac{50}{17} + 10 = \frac{220}{17}\,\Omega$

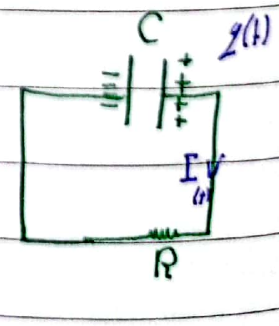
$* I = \frac{\varepsilon}{R_{eq}} = \frac{25 \times 17}{220} = \frac{85}{44} = 1.93\,A$

$* \Delta V_{\frac{50}{17}} = \left(\frac{50}{17}\right)\left(\frac{85}{44}\right) = \frac{125}{22} = 5.68\,V$

$* \Delta V_{10} = 10\left(\frac{85}{44}\right) = \frac{850}{44} = 19.32\,V$

~~*~~ $* I_1 = \frac{\Delta V_{ab}}{25} = \frac{5.68}{25}\,A$

* Discharging RC - Circuit



Key 1: C, R

Key 2: The capacitor is initially charged Q_0

$\Delta V_c(t) + \Delta V_R(t) = 0$

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$* \frac{q_{(t)}}{C} + R I_{(t)} = 0 \Rightarrow \frac{q_{(t)}}{C} + R \frac{dq}{dt} = 0$

$\frac{dq}{dt} + \frac{1}{RC} q(t) = 0$, Time constant $\tau = RC$

$\frac{dq}{dt} + \frac{q_{(t)}}{\tau} = zero$ $\quad * q(t) = Q_0 e^{\frac{-t}{\tau}}$

$\Rightarrow I = \frac{dq}{dt} = -\frac{Q_0}{\tau} e^{-t/RC}$ $\quad * I_{(t)} = -I_0 e^{-t/RC}$, $I_0 = \frac{Q_0}{RC}$

(I_0 max current in the circuit) $\therefore q(t) = Q_{max} (1 - e^{\frac{-t}{\tau}})$

27.860 $I_A = 2A = I$

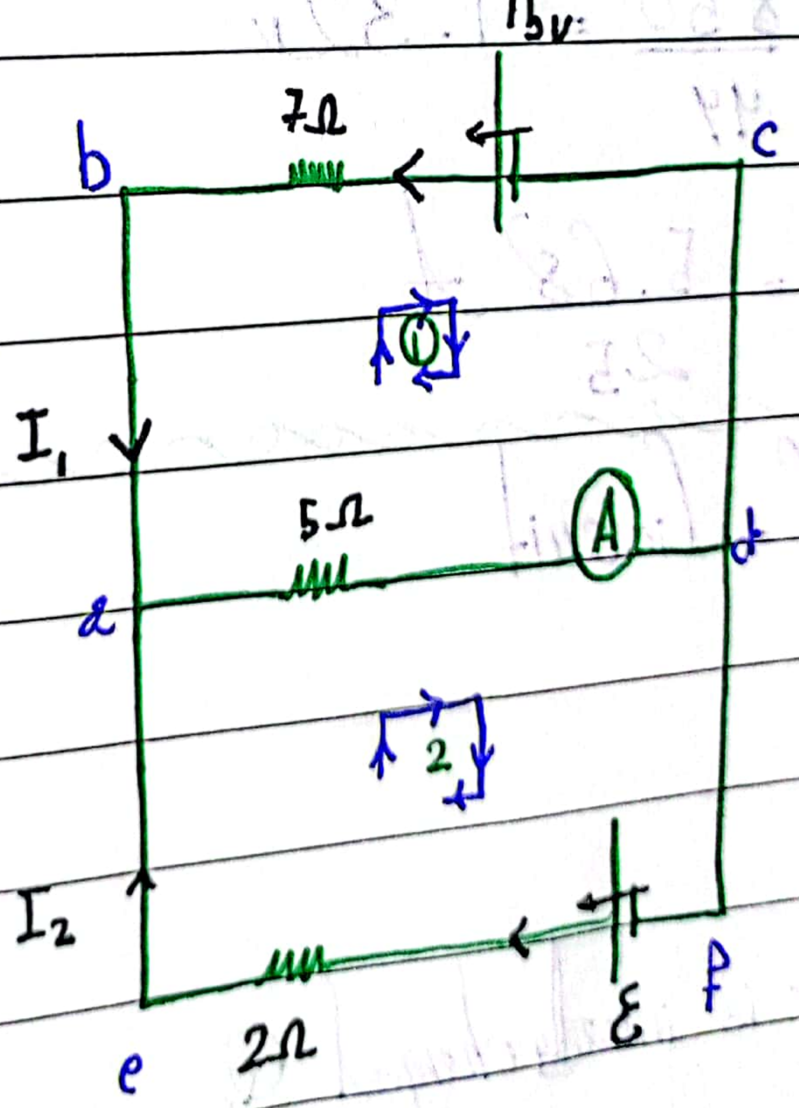
$\Rightarrow I = I_1 + I_2 = 2$

$\boxed{A}$ $\sum \Delta V_{abcda} = 0 \Rightarrow 7 I_1 + (-15) + 5 \times 2 = 0$

$I_1 = \frac{5}{7} A \therefore I_2 = 2 - 5/7 = \frac{9}{7} A$

B] $\sum \Delta V_{edfe} = 0 \Rightarrow -5 \times 2 + (+\mathcal{E}) + -2 \times \frac{9}{7} = 0 \Rightarrow \mathcal{E} = \frac{88}{7} V$

29.8760]



RC-circuit

Charging

- The capacitor is intially uncharge

$Q(0)=0$

∴ $R, C, \mathcal{E}$

∴ $q(0), I(0) \to I_{max}$

∴ $\underbrace{Q_{max} = \mathcal{E}C \quad I(t) \to 0}_{t \to \infty}$

Discharging

- Charged: Q_0

$q(0) = Q_0$, $I(0) = I_{max} = \frac{Q_0}{\tau}$

∴ RC

∴ $\underbrace{q(t) \to 0 \quad I(t) \to 0}_{t \to \infty}$

37/861 Charge $q(t) = Q_{max}\left(1 - e^{-\frac{t}{\tau}}\right)$, $\tau = RC$, $Q_{max} = \mathcal{E}C$

$\mathcal{E} = 9V$ $\quad C = 20\mu F$ $\quad R = 100\Omega$

A] Time constant $\tau = RC = 2 \times 10^{-3} = 2 m\,sec$ ※

B] $Q_{max} = \mathcal{E}C = 9 \times 20 = 180 \mu C$

C] $q(t)\big|_{t=1\tau} = 180\left(1 - e^{-\frac{t}{\tau}}\right) = 180\left(1 - e^{-1}\right) = 113.8 \mu C$

D] Find the time at which the Capacitor is charged at 70% of It's maxm value?

Ratio like $\frac{3}{4}$, $\frac{1}{2}$, %

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$q(t) = Q_{max}(1 - e^{-\frac{t}{\tau}}) \Rightarrow \frac{q(t)}{Q_{max}} = 0.7 = 1 - e^{-\frac{t}{\tau}} \Rightarrow e^{-\frac{t}{\tau}} = 0.3 \Rightarrow -\frac{t}{\tau} = \ln 0.3$

$t = -\ln(0.3)\tau$

[E] Find the time at which the energy stored in the capacitor is $\frac{3}{4}$ It's maxm value?

$$U_c(t) = \frac{q^2(t)}{2C} = \underbrace{0.5\,\mathcal{E}^2 C}_{U_{max}}\left(1 - e^{-\frac{t}{\tau}}\right)^2$$

$$\frac{U_c(t)}{U_{max}} = \frac{3}{4} = \left(1 - e^{-\frac{t}{\tau}}\right)^2 \Rightarrow 1 - e^{-\frac{t}{\tau}} = \pm\sqrt{0.75} \Rightarrow e^{-\frac{t}{\tau}} = 1 \mp \sqrt{0.75}$$

$$-\frac{t}{\tau} = \ln(1 \mp \sqrt{0.75}) \xrightarrow[\text{بالسالب}]{\text{لا يوجد ln}} t = -\tau \ln(1 - \sqrt{0.75})$$ ※

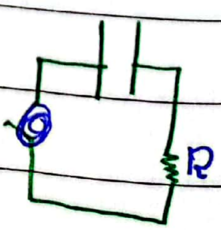
※ ناتج سالب ويوجد سالب اصلي إذا صحيحة ※

39.862 Discharing
- → R
- → C
- → Capacitor initially charge

$q(t) = Q_0 e^{-\frac{t}{\tau}} \Rightarrow \tau = RC$ $C = 2nF$, $Q_0 = 5.1\mu C$ $R = 1.3k\Omega$

1] Time constant:-

$\tau = RC = 1300 \times 2 \times 10^{-9} = 2.6\mu sec$



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2] Find the charge, at the current at time $9\mu_c$ after the swich is closed

$$q(t) = Q_0 e^{-\frac{t}{\tau}} = 5.1 e^{-\frac{9}{2.6}} \mu C$$

$$I_{(t)} = -\frac{Q_0}{\tau} e^{-\frac{t}{\tau}} = -\frac{5.1 \times 10^{-6}}{2.6 \times 10^{-6}} e^{-\frac{9}{2.6}} A$$

3] The maxm current I_{max}

$$I_{max} = I_{(t)}\Big|_{t=0} = \frac{Q_0}{\tau} = \frac{5.1}{2.6} A$$

4] Find the time at which the potential differential across the capacitor where reachs 30% of It's maxm value?

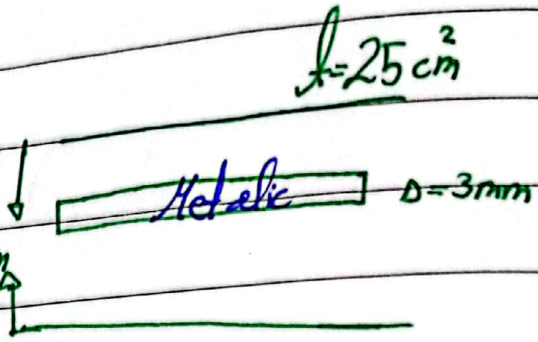
$$Cq(t) = CQ_0 e^{-\frac{t}{\tau}} \Rightarrow V_c(t) = V_0 e^{-\frac{t}{\tau}} \Rightarrow \frac{V_c(t)}{V_0} = 0.3 = e^{-\frac{t}{\tau}} \Rightarrow t = -\tau \ln(0.3)$$

5] Find the time at when the energy stored in the capacitor is 70% of It's maxm value?

$$U_c(t) = \frac{Q^2}{2C} = \frac{Q_0^2}{2C} e^{-\frac{2t}{\tau}} \Rightarrow U_{(t)} = U_0 e^{-\frac{2t}{\tau}} \Rightarrow 0.7 = e^{-\frac{2t}{\tau}}$$

$$t = -\frac{1}{2} \tau \ln(0.7)$$

Metalic Slab

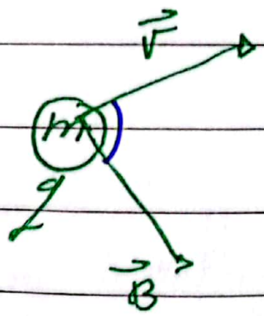


$$C = \frac{\varepsilon_0 A}{d-\Delta} = \frac{8.85\times10^{-12}\times 25\times10^{-4}}{1.7\times10^{-2}}$$

Chapter 29 The Magnetic Force

particles: Mass, charge, veclocity

Magnetic field: $\vec{B}$ (Tesla)



Then, the magnetic force is given by

$\vec{F}_m = qvB\sin\theta_{\vec{v},\vec{B}}$, $\vec{F}_e = \vec{E}q$

$\vec{F}_M = 0$ → $v = 0$; → $\theta = 0, \pi$ → parallel ($\theta = 0$) ; opposite $\theta = \pi$

$\Rightarrow \vec{F}_M = q\vec{v}\times\vec{B}$

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<u>Rew</u>

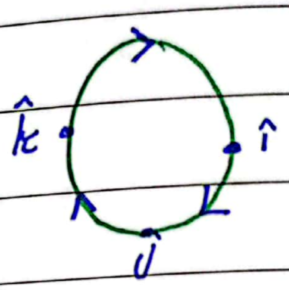
- $\vec{C} = \vec{A} \times \vec{B}$, $\vec{C} \perp B$ and $\vec{C} \perp \vec{A}$

$\therefore \boxed{-}\,\vec{C} = \vec{B} \times \vec{A}$

$\Rightarrow \hat{i} \times \hat{j} = \hat{k}$ $\qquad \Rightarrow \hat{j} \times \hat{i} = -\hat{k}$

$\hat{j} \times \hat{k} = \hat{i}$ $\qquad \hat{k} \times \hat{j} = -\hat{i}$

$\hat{k} \times \hat{i} = \hat{j}$ $\qquad \hat{i} \times \hat{k} = -\hat{j}$



$* \; \hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0$

Example: Find the magnetic force on a proton travelling at $\vec{v} = 3\hat{i} - \hat{j} + 7\hat{k}$ m/s in magnetic field $\vec{B} = -\hat{k} + 3\hat{j}\ \mu T = 0\hat{i} + 3\hat{j} - \hat{k}$

$$\Rightarrow \vec{F} = q\vec{v} \times \vec{B} = q \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & -1 & 7 \\ 0 & 3 & -1 \end{vmatrix}$$

$\vec{F} = q\,[-20\hat{i} + 3\hat{j} + 9\hat{k}]$ $\leftarrow$ مهما كانت ج سالبة غير اشارة ما داخل القوس

$|F| = q\sqrt{20^2 + 3^2 + 9^2}$ ⋇

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* Right - hand Rule [+ve charges]

→ $\vec{v}$ → الاصابع

→ $\vec{B}$ → باطن اليد

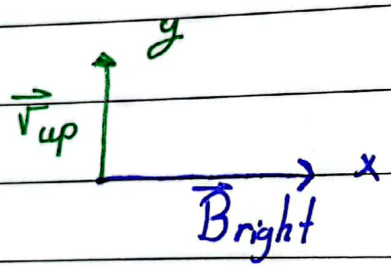
→ $\vec{F}$ → الابهام

⊙ out of page

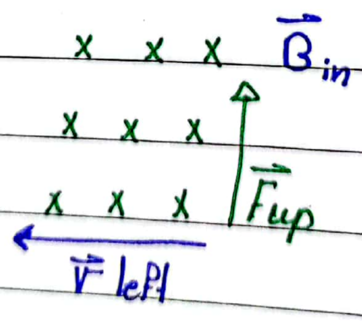
⊛ into page

Example: Proton

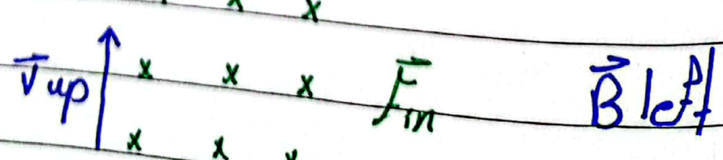
$\vec{F}$ ⊗ $(-\hat{k})$



Example: -ve charge electron



Example: electron



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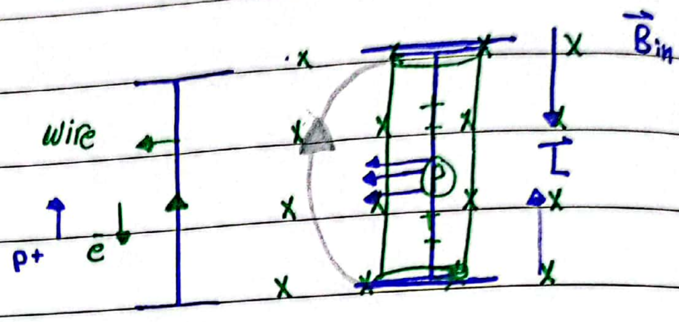
2] The Manget force on a wire carrying current:

* $\vec{F}_q = q\vec{v} \times \vec{B}$ * $I = nqv_d A$

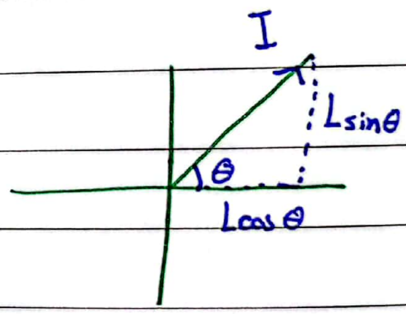
$\rightarrow \vec{F}_I = \sum_N q\vec{v} \times \vec{B}$

$= N q\vec{v} \times \vec{B}$



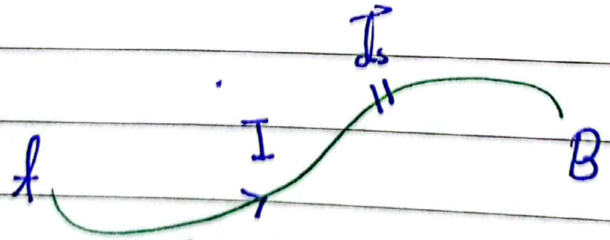
$n = \frac{N}{volume} = \frac{N}{AL}$ $\therefore F = nqAL\vec{v} \times \vec{B}$

$\vec{F} = (\underbrace{nq\vec{v}A}_{\equiv I})\vec{L} \times \vec{B} \Rightarrow I\vec{L} \times \vec{B}$



$|\vec{F}_I| = ILB\sin\theta_{\vec{L},\vec{B}}$ ※

* General Case:



$\vec{F}_I = I\int_A^B \vec{ds} \times \vec{B}$

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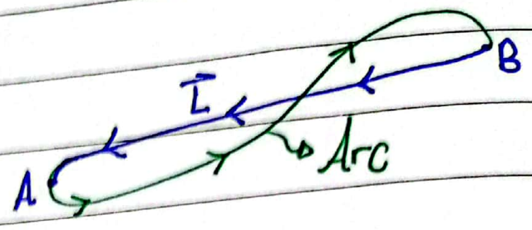
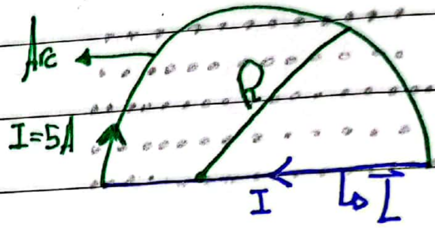
$\rightarrow \vec{F}_{arc} + \vec{F}_{I} = zero$



$* \ \vec{F}_{arc} = -\vec{F}_{I}$

Example.1 «Semi-circle» What is the magnetic force on the semi-circle?

$\vec{B}_{out} = 200\,\mu T \quad R = 20\,cm$



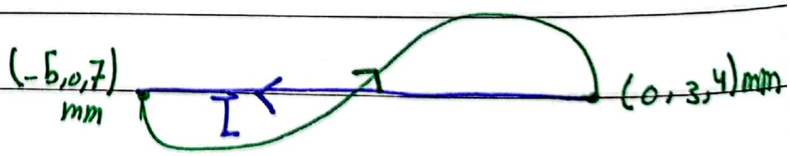
$\vec{F}_{arc} + \vec{F}_{L} = 0 \rightarrow \vec{F}_{L} = ILB \sin\theta_{I,\vec{B}}$

$I(2R)B = 5(2 * 0.2) * 200 * 10^{-6} = 0.4\,mN\ (Up)$

$\therefore \vec{F}_{arc} = 0.4\,mN\ (down)$ ※

Example.2 Find the Magnetic on the wire?

$I = 10A \quad \vec{B}_{in} = 2mT$



$L = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2} \rightarrow L = \sqrt{25 + 9 + 9} = \sqrt{43}\ mm$

$F_{I} = ILB \sin\theta \rightarrow 10(\sqrt{43}) * 10^{-3} * 2 * 10^{-3} * 1 = 131.14\,\mu N\ (down)$

$\therefore \vec{F}_{Arc} = 131.14\,\mu N\ (Up)$ ※

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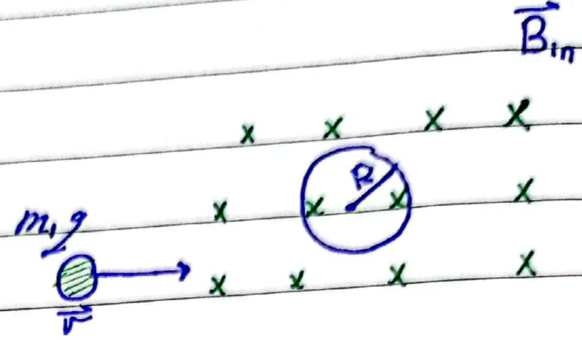
* The Motion a charge particle in a uniform $\vec{B}$ _ field :-

انحراف

direction of deflection

اتجاه القوة



. $\vec{B} \perp \vec{v}$: Circular path ○

.. $\vec{B} \not\perp \vec{v}$: Helix « helical path » لولبي

تسارع مركزي

* $\vec{F}_m = q v B \sin\theta_{\vec{v}, \vec{B}} \Rightarrow q v B = m \frac{v^2}{R} \Rightarrow q v B = m \frac{v^2}{R}$

$R = \frac{m v}{q B}$ حفظ

دورات

. R: radis of Revulation (circular path)

.. perodic time: T * $v = \frac{\pi R 2}{T} \Rightarrow T = \frac{2\pi R}{v} = 2\pi \frac{m v}{v q B}$

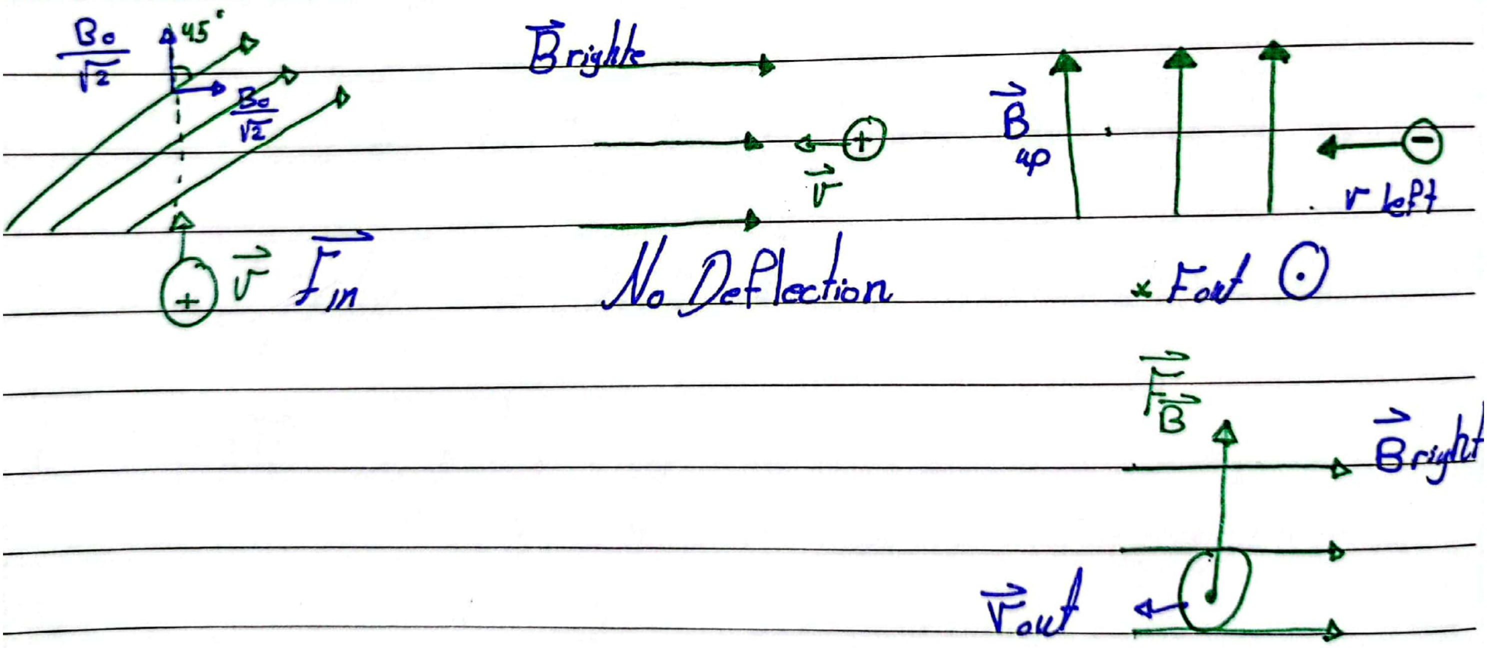
$T = 2\pi \frac{m}{q B}$ حفظ

∴ The angular speed frequency

$$\omega = \frac{2\pi}{T} = \frac{qB}{m}$$ حفظ

Solving problems:

2. 895 / Deflection: اتجاه الانحراف

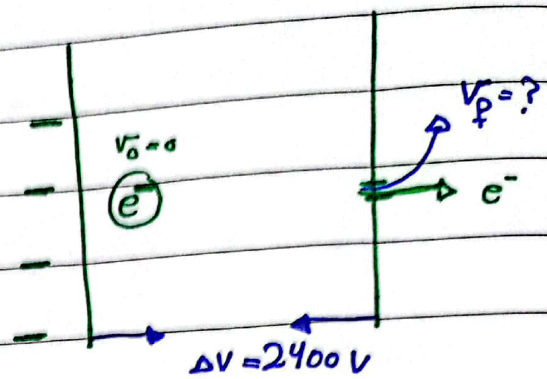


6. 895 proton $\vec{v} = 4\times10^{6}\ m/s$ $B = 1.7\ T$ $F = 8.2\times10^{-3}\ N$

$$F = qvB\sin\theta \rightarrow \sin\theta = \frac{F}{qvB} = \frac{8.2\times10^{-13}}{1.6\times10^{-19}\times4\times10^{6}\times1.7}$$

/ /

7.845 electron



A] $\Delta K + \Delta U = 0$

$\frac{1}{2} m_e v_f^2 - 0 = -q_0 \Delta V$

$v_f = \sqrt{\frac{2 q_0 \Delta V}{m_e}} = \sqrt{\frac{2 * 1.6 * 10^{-19} * 2400}{9.11 * 10^{-31}}}$

B] Minm force : force = 0 , $\theta = 0, \pi$

C] Maxm force : $\theta = \frac{\pi}{2} = 1$ or $\frac{3\pi}{2} = -1$ $f_{max} = q v B$

8.895/ proton $\bar{v} = 2\hat{i} - 4\hat{j} + \hat{k}$ m/s $\vec{B} = \hat{i} + 2\hat{j} - \hat{k}$ T

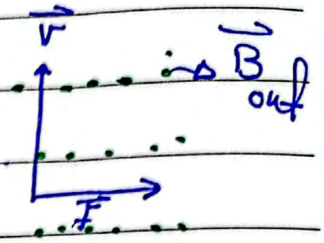
$\vec{F} = q \vec{v} \times \vec{B} \Rightarrow q \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -4 & 1 \\ 1 & 2 & -1 \end{vmatrix} \Rightarrow \vec{F} = q\left[2\hat{i} + 3\hat{j} + 8\hat{k}\right] =$

$1.6 * 10^{-19} (2\hat{i} + 3\hat{j} + 8\hat{k}) \Rightarrow |\vec{F}| = 1.6 * 10^{-19} \sqrt{4 + 9 + 64}$ N *

14.89 5 proton perpendicular : $\perp$

$\vec{B} \perp \vec{v}$ $\quad$ $* v = 1 \times 10^{7}$ m/s $\quad$ $* a = 2 \times 10^{13} \frac{m}{s^2}$ $\quad$ (+ x اتجاه)

$F = qvB = ma \Rightarrow B = \frac{m_p a}{vq} = \frac{1.67 \times 10^{-27} \times 2 \times 10^{13}}{1 \times 10^{7} \times 1.6 \times 10^{-19}}$ $\quad$ $\vec{v}$ $\vec{B}$ out $\vec{F}$



Remark :

ممكن يكون السؤال كالآتي

$\vec{v} = 2\hat{i} - 4\hat{j} + \hat{k}$

ويكون معطي اتجاه تيار على wire

$\vec{I} = 2\hat{i} - 4\hat{j} + 1\hat{k}$

$\divideontimes$ $\vec{F} = I \, L \times B$ $\quad$ طريقة حل :-

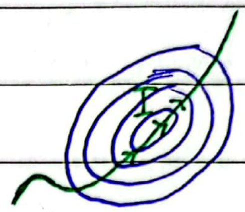
13.89 5 $\quad$ $B = 2mT$ $\quad$ $v = 1.5 \times 10^{7}$ m/s

A] $qvB = \frac{mv^2}{R} \Rightarrow R = \frac{mv}{qB} = \frac{9.11 \times 10^{-31} \times 1.5 \times 10^{7}}{1.6 \times 10^{-19} \times 2 \times 10^{-3}}$ $\quad$ R

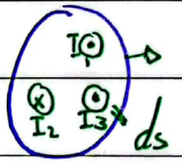
B] $v = \frac{2\pi R}{T} \Rightarrow T = \frac{2\pi R}{v} = \frac{2\pi}{v} \cdot \frac{mv}{qB} = \frac{2\pi m}{qB} = \square$ s $\divideontimes$

Chapter.30 Sources of Magnetic Field

• Amper's Law



• $B \sim \sum I$



⇒ Amper's Law

$$\oint_C \vec{B}\cdot d\vec{s} = \mu_0 I \qquad \mu_0 = 4\pi \times 10^{-7}\ \frac{T.m}{A}$$

$2\pi r$

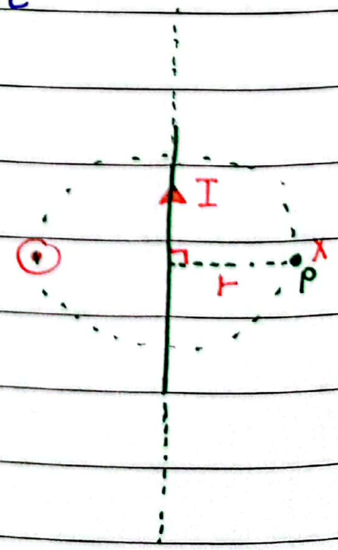
Free space permeability

Example.1 The Magnetic of an inifinty wire

$$\oint \vec{B}\cdot\vec{ds} = \mu_0 I$$

↓

$$B(2\pi r) = \mu_0 I \Rightarrow B = \frac{\mu_0 I}{2\pi r}$$



Example.2 $I_1 = 5A$ $I_2 = 15A$ $I_3 = 10A$

$B = \frac{\mu_0 I}{2\pi r}$ Find the magnetic field the point(s)?

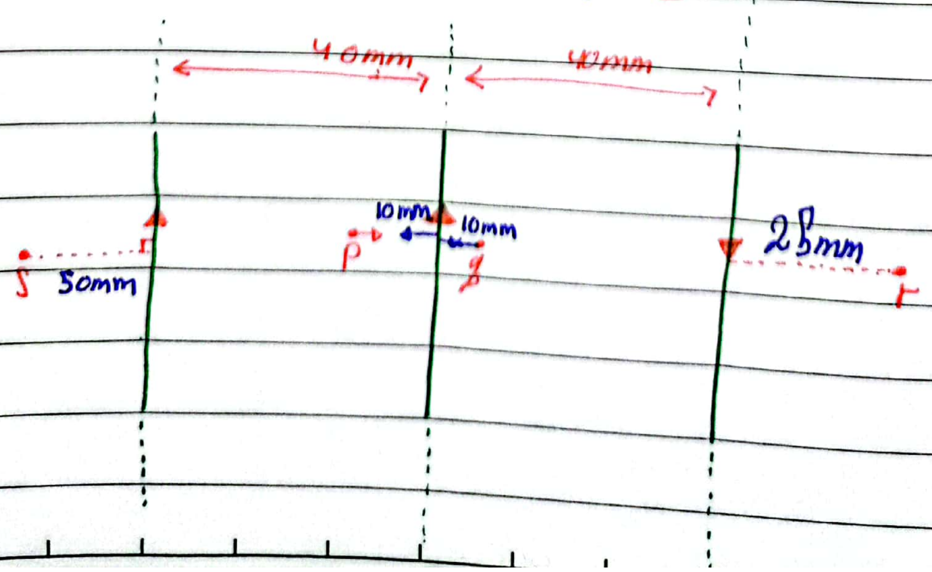
$\vec{B}_s = \vec{B}_1 + \vec{B}_2 + \vec{B}_3$

$\Rightarrow B_1 = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi(50 \times 10^{-3})} = \frac{1}{5} \times 10^{-4} = 0.2 \times 10^{-4} = 20\,\mu T \odot$

$\Rightarrow B_2 = \frac{4\pi \times 10^{-7} \times 15}{2\pi(40 \times 10^{-3})} = \frac{100}{3} \times 10^{-4} = 33.3\,\mu T \odot$

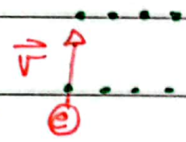
$\Rightarrow B_3 = \frac{4\pi \times 10^{-7} \times 10}{2\pi \times 130 \times 10^{-3}} = \frac{20}{130} \times 10^{-4} = \frac{200}{13}\,\mu T \otimes = 15.4\,\mu T \otimes$

$\therefore B_s = 20 + 33.3 - 15.4 = 37.9\,\mu T \odot$



6. An electron moving at $6*10^{7}$ m/s passing the point S perpendular to the Magnetic field. Find the net magnetic force on the electron?

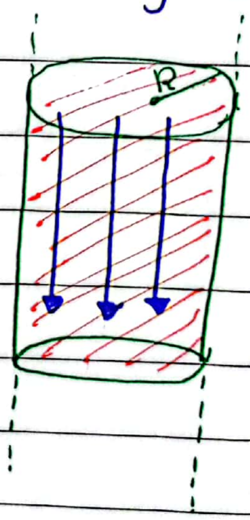
$\vec{F} = q v B \sin\theta_{v,B}$ $\theta = 90$



$\vec{F} = 1.6*10^{-19}*6*10^{7}*39*7*10^{-6}\,N = 262.08\,pN$

Defletion left

Example: 3 Consider an infinite wire of radius "R" cariying a current I uniformly distribution throught it

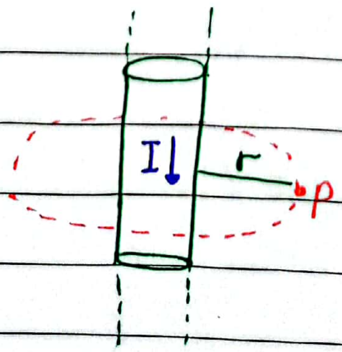


A] Find $\vec{B}_{out} = ?$ $r > R$

* $B_{out} = \frac{\mu_0 I}{2\pi r}$, $r > R$

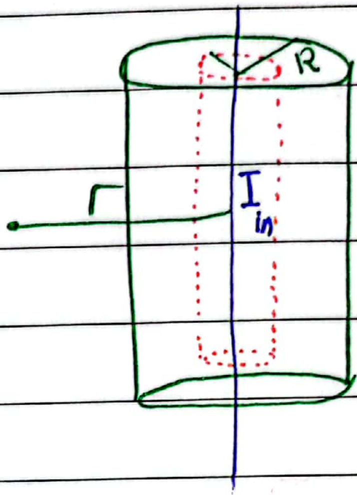
$\Downarrow$

$\oint B\,ds = \mu_0 I \Rightarrow B\,2\pi r = \mu_0 I$



B] Find $\vec{B}_{in} = ?$ $r < R$

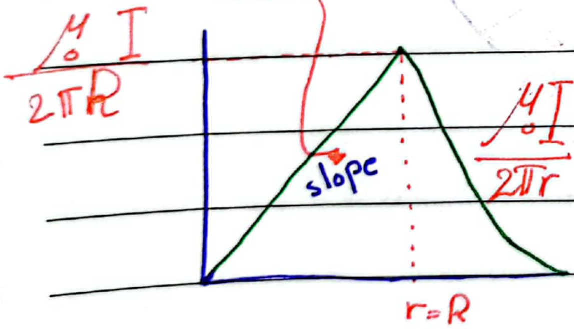
$\oint B_{in} ds = \mu_0 I_{in}$



$\rightarrow J = \frac{current}{Area} = \frac{I}{\pi R^2} = \frac{I_{in}}{\pi r^2}$

$I_{in} = \frac{r^2}{R^2} I \quad \therefore B(2\pi r) = \mu_0 \frac{r^2}{R^2} I$

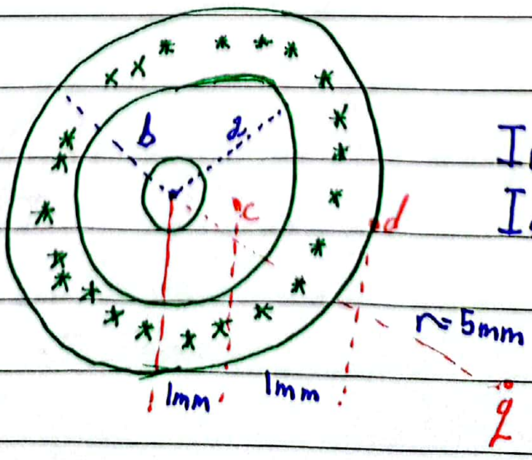
$B_{in} = \frac{\mu_0 I}{2\pi R^2} r \qquad r < R$



$$B_{out} = \frac{\mu_0 I}{2\pi r}$$

Q31.

innerradius: a
outer radius: b



$I_1 = 1A$
$I_2 = 3A$

* $\oint B\,ds = \mu_0 I_{in}$ $\quad B_c = ?$ $\quad 0 \le r \le a$

$B = \dfrac{\mu_0 I_1}{2\pi r}$ $\quad 0 \le r \le a$

$B_c\Big|_{r=1mm} = \dfrac{4\pi \times 10^{-7} \times 1}{2\pi (1\times10^{-3})} = 2\times10^{-4}\, T$ up

2] $B\Big|_{r=5mm} = ?$ $\quad r > b$

* $B_g = \dfrac{\mu_0}{2\pi r}(I_1 + I_2) = \dfrac{4\pi\times10^{-7}(3-1)}{2\pi(5\times10^{-3})}$ down ⇐ بالاتجاه الاكبر (تيار)

↑
التعويض بالاشارة

* (I_2) $\quad \oint B\,ds = \mu_0 I_{in} \Rightarrow B(2\pi r) = \mu_0 I_{in} \Rightarrow$ جزء من I_2

* $J = \dfrac{I_2}{\pi b^2 - \pi a^2} = \dfrac{I_{in}}{\pi(r^2 - a^2)} \Rightarrow I_{in} = \left(\dfrac{r^2 - a^2}{b^2 - a^2}\right) I_2$

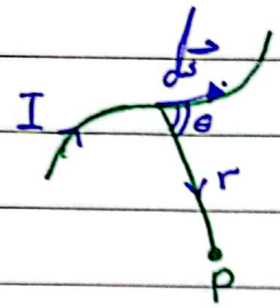
* $B_g = B_{I_1} + B_{I_2} = \dfrac{\mu_0 I_1}{2\pi r} - \left(\dfrac{r^2 - a^2}{b^2 - a^2}\right)\dfrac{\mu_0 I_2}{2\pi r}$

$\dfrac{\mu_0}{2\pi r}\left[I_1 + \left(\dfrac{r^2 - a^2}{b^2 - a^2}\right) I_2\right] = \dfrac{4\pi\times10^{-7}}{2\pi(1.75\times10^{-3})}\left[1 + \left(\dfrac{1.75^2 - 1.5^2}{2^2 - 1.5^2}\right)\times 3\right] =$

$2.53\times10^{-4}\, T$

2] Biot and Savart law

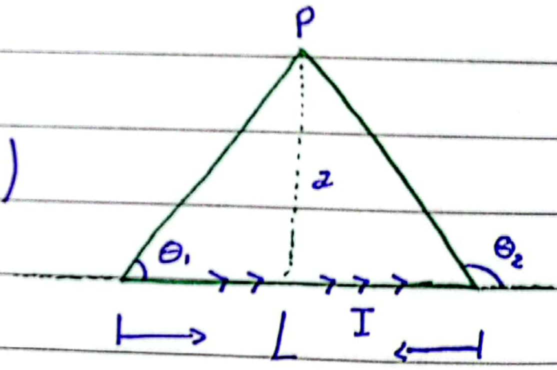
$$B = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{s} \times \hat{r}}{r^2}$$



* Special cases:

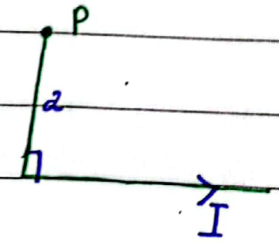
A] Finite wire

$$B_{\text{"finite wire"}} = \frac{\mu_0 I}{4\pi a} (\cos\theta_1 - \cos\theta_2)$$



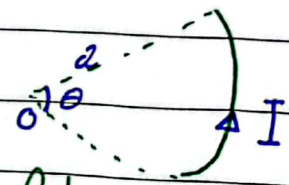
→ Infinite wire $B = \frac{\mu_0 I}{2\pi r}$

B] Semi-infinite wire



→ $B = \frac{\mu_0 I}{4\pi r}$

C] Current Arc



→ $B_0 = N \frac{\mu_0 I \theta}{4\pi a} \odot$ N: number of turns

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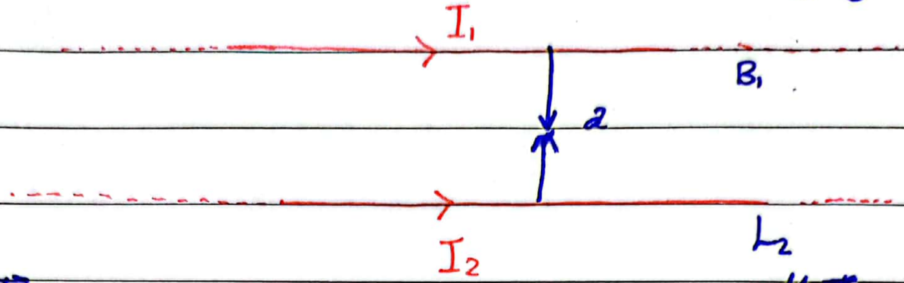
4] The Magnetic force between two wires carrying current.



* $F_{1\to 2} = I_2 L_2 \times \vec{B}_1 =$ * $B_1 = \frac{\mu_0 I_1}{2\pi a}$ ⊗

$\Rightarrow F_{1\to 2} = I_2 L_2 \frac{\mu_0 I_1}{2\pi a} = \frac{\mu_0 I_1 I_2 L_2}{2\pi a}$

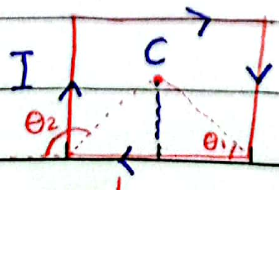
$\frac{F_{1\to 2}}{L_2} = \frac{\mu_0 I_1 I_2}{2\pi a} \; N/m$

* The force: • If the two currents are parallel (same direction) then the force is attractive

•• If the two currents are opposite then the force between them is repulsive

Solving problems:

E. 926 $L = 0.4m$ $I = 10A$ $\frac{L}{2} = 0.2$ $\theta_1 = 45°$ $\theta_2 = 135°$

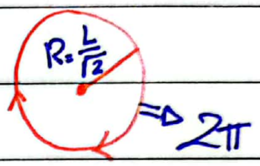


$$B_1 = \frac{4\pi \times 10^{-7} \times 10}{4\pi(0.2)} \left(\cos(45) - \cos(135)\right) \Rightarrow B_1 = \frac{10}{\sqrt{2}} \mu T \quad (x)$$

$$B_C = 4\left(\frac{10}{\sqrt{2}}\right) \mu T = \frac{40}{\sqrt{2}} \mu T$$

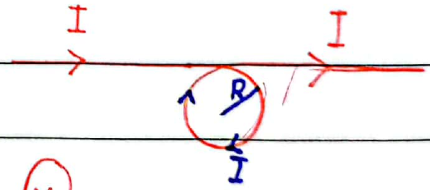
↳ 4 لأنو عدد الاسلاك

b] $B_{loop} = N \frac{\mu_0 I \theta}{4\pi R}$



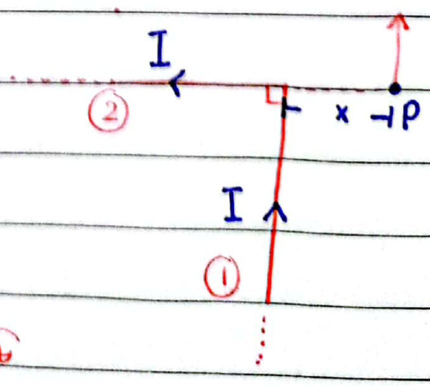
$$B = \frac{(1)(4\pi \times 10^{-7})(10)(2\pi)}{4\pi \times (0.4/\sqrt{2})} = 2.22 \times 10^{-5} \quad (x)$$

7] $R = 0.1m$ $I = 7$



$$B_0 = \frac{\mu_0 I}{2\pi R} + \frac{\mu_0 N I (2\pi)}{4\pi R} \Rightarrow \frac{\mu_0 I}{2\pi R}(1+\pi) \quad (x)$$

10.926 $x = 100mm$ $I = 7A$

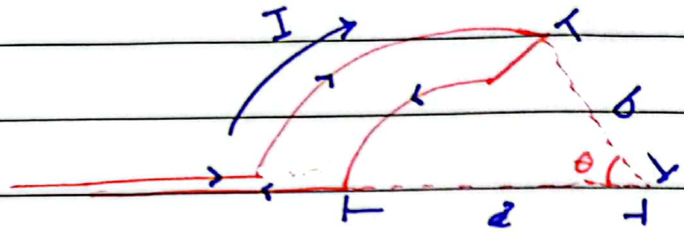


$$B_{sime\text{-}inferit\ wire} = \frac{\mu_0 I}{4\pi R} = \frac{4\pi \times 10^{-7} \times 7}{4\pi \times 100 \times 10^{-3}} \quad (x)$$

* إذا وضعنا إلكترون عند نقطة P نستخدم قانون

$F = qvB$ (right) بدو يعطي ٣

13.926 $\theta = 60$ $a = 2cm$ $b = 4cm$ $I = 10A$



$$B_{loop} = \frac{N \mu_0 I \theta}{4\pi R}$$

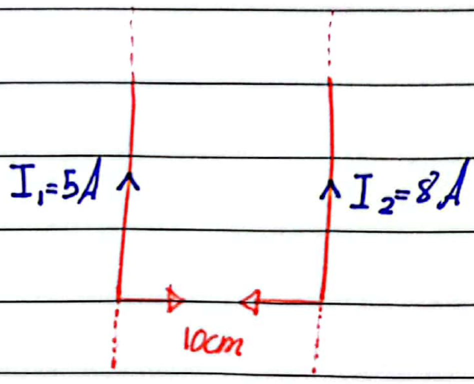
$$* B_a = \frac{1 * 4\pi * 10^{-7} * 10 * \pi/3}{4\pi (2 * 10^{-2})} \odot$$

$$* B_b = \frac{1 * 4\pi * 10^{-7} * 10 * \pi/3}{4\pi (4 * 10^{-2})} \otimes$$

$$\therefore B_p = B_a - B_b \odot$$

كلما كان اقرب من نقطة
كان الأكبر

21.927



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

$$* B_1 = \frac{4\pi * 10^{-7} * 5}{2\pi (0.1)} \otimes \qquad * B_2 = \frac{4\pi * 10^{-7} * 8}{2\pi (0.1)} \odot$$

$$* F_{\substack{1 \to 2 \\ 2 \to 1}} = \frac{\mu_0 I_1 I_2}{2\pi r} = \frac{4\pi * 10^{-7} * 5 * 7}{2\pi (0.1)} = \boxed{} N/m$$

B_1

25/ $I_1=5A$ $I_2=10A$ $c=0.1m$ $a=0.15m$ $L=0.45m$

$F_{net}=F_{left}+F_{right}$

$\to F_{left}=\frac{\mu_0 I_1 I_2 L}{r} = \frac{4\pi\times10^{-7}(5)(10)(0.45)^2}{0.1} = 4\pi\times10^{-7}\times225 = 9\pi\times10^{-5}$ attractive (left)

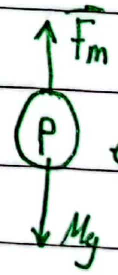
$\to F=\frac{\mu_0 I_1 I_2 L}{r} = \frac{4\pi\times10^{-7}(5)(1000)(0.45)}{25} = 360\pi\times10^{-7} = 3.6\pi\times10^{-5}$ right

$F_{net}=5.4\pi\times10^{-5}$ (left)

33/ $v=2.3\times10^4 m/s$ = const

*proton: $\vec{v} \not\parallel I$ electron: $v \parallel I$

$\Sigma F=0 \to qvB\sin\theta=mg$



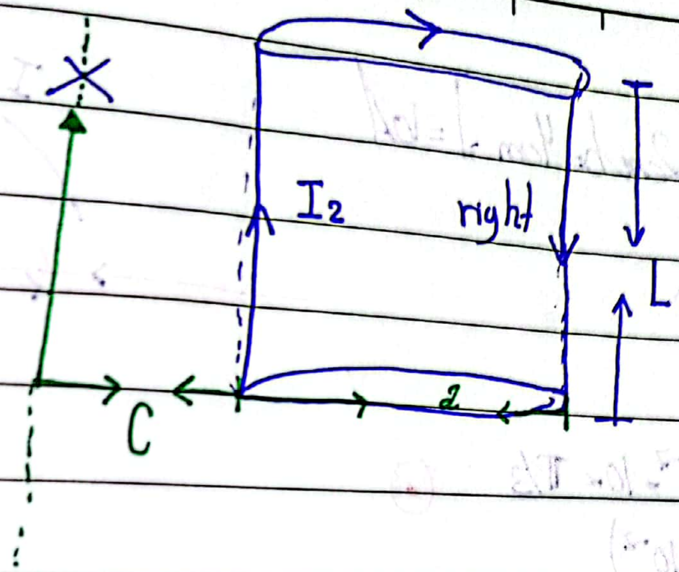
$\theta=\pi/2$

$B=\frac{m_p g}{qv} = \frac{1.67\times10^{-27}\times10}{1.6\times10^{-19}\times2.3\times10^4}$ T

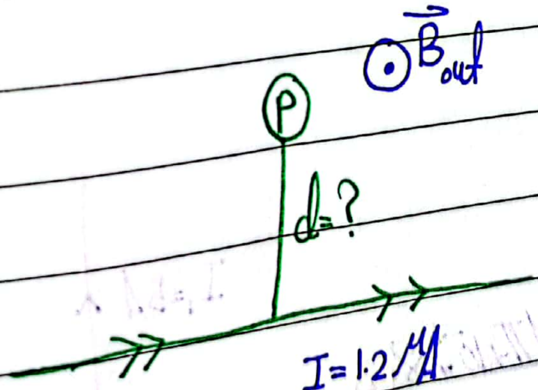
$\frac{\mu_0 I}{2\pi d}=\boxed{\ }$

$\frac{4\pi\times10^{-7}\times1.2\times10^{-6}}{2\pi d}=\boxed{\ }$

25]

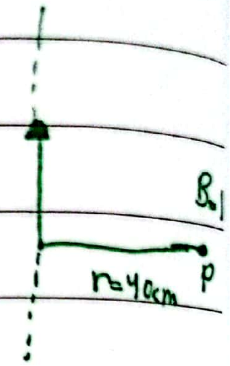


33]



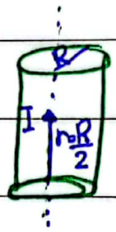
35/ $B_p = 1\mu T$ $\quad I = 2A$ $\quad r = 40cm$

$B = 0.1\mu T \longleftrightarrow r = ?$ $\quad B = \frac{\mu_0 I}{2\pi r} = 0.1\times10^{-6} = \frac{4\pi\times10^{-7}(2)}{2\pi(r)}$

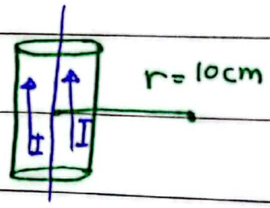


36/ $R = 2.5cm$ $\quad I = 2.5A$

* $J = \frac{I}{A} = \frac{2.5}{\pi(2.5\times10^{-2})^2}$



$B_{out} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi\times10^{-7}\times2.5}{2\pi(0.1)}$ ⊗



* $J = \frac{I}{\pi R^2} = \frac{I_{in}}{\pi(\frac{R}{2})^2} \Rightarrow I_{in} = \frac{1}{4}I \Rightarrow \oint B\,ds = \mu_0 I_{in}$

$B(2\pi r) = \mu_0 \frac{I}{4}$

$B\Big]_{r=R/2} = \frac{\mu_0 I}{4(2\pi r)}\Big|_{r=R/2} \Rightarrow \frac{4\pi\times10^{-7}\times2.5}{4(2\pi\times1.25\times10^{-2})} = \boxed{\quad} T$