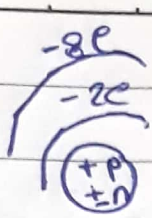
# Physics II

## د. يحيى الرمضانين

إعداد الطالبة: بتول محمد

Atom



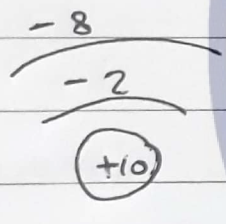

Electricity ( Force
vector quantity )

+p protons
±n newtrons
-e electrons

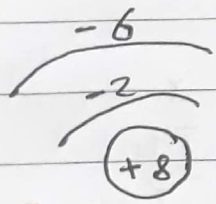
ذرة متعادلة Net charge 0

Insulator مادة عازلة لان مدارها الخارجية ممتلئة
فلا تنتقل $e^-$ بين مداراتها ( مدارات مكتملة )

conductor مواد موصلة لان المدار الأخير مستوعب الكترونات
اضافية (مدارات غير مكتملة )

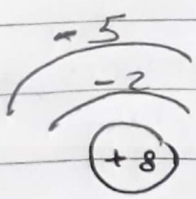



Net = 0




Net = -2 ⇒ negative charge

$2e^-$ أعطيناه




Net = +1 ⇒ positive net charge

* الشحنات الموجبة لا تتحرك ابداً إلا بالتفاعل النووي

Date No.

* The charge is quantized مُكمَّاة

$Q_{net} = n q_{e^-}$

$q_{e^-} = 1.6 * 10^{-19}$ coul

* $q_{e^-} = q_{p^+}$

$q_e = -1.6 * 10^{-19}$ C $e^-$ اذا اكتسب الجسم accept

$q_e = +1.6 * 10^{-19}$ C $e^-$ اذا افقد الجسم lose

n :- عدد الالكترونات المفقودة او المكتسبة

* Type of charge :-

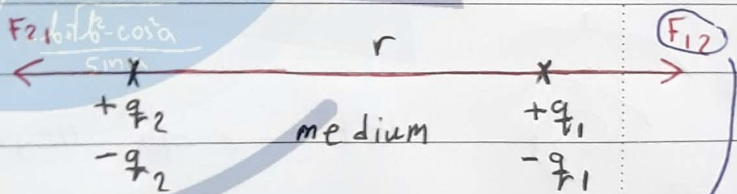
1) positive charge ($+q$)

2) negative charge ($-q$)

* coulomb's charge law : point charges ليس لها ابعاد

$q_1, q_2$, quantity of the charge coul ( C )

Distance meter (m




* Like charges : rebel each other

$F \propto q_1 , q_2$

$F \propto \frac{1}{r^2}$ ⇒ inverse square law

$\overset{r}{\underset{q}{\times}\text{———}\times}$ ⇒ net = zero

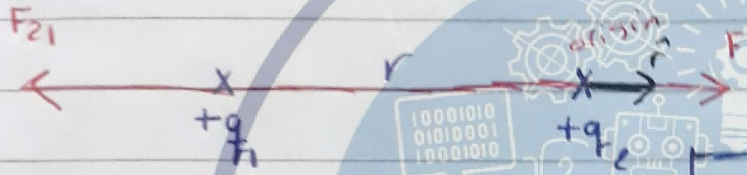
لأن هناك شحنة واحدة فليس لها تأثير

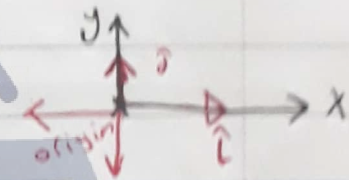
Subject　　　　Date　　　　No.

* $F \propto \frac{q_1 q_2}{r^2} \Rightarrow F = K \frac{q_1 q_2}{r^2} \hat{r}$　　∴ $K = \frac{1}{4\pi\epsilon}$

$\epsilon_0 = 8.85 \times 10^{-12}$　　$K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^{9}$　　permativity

* القوة الكهربائية : حركة الشحنات الكهربائية
* الإشارة السالبة لا تعوض في قانون كولوم




$\Rightarrow \vec{F}_{12} = K \frac{q_1 q_2}{r^2} \hat{r}$

$\vec{F}_{21} = -K \frac{q_1 q_2}{r^2} \hat{r}$

| | | |
|---|---|---|
| $K = 10^3$ كيلو | $M = 10^6$ | $G = 10^9$ |
| $c = 10^{-12}$ سانتي | $m = 10^{-3}$ ملي | $\mu = 10^{-6}$ مايكرو |
| $n = 10^{-9}$ نانو | $P = 10^{-12}$ بيكو | $F = 10^{-15}$ فمتو |

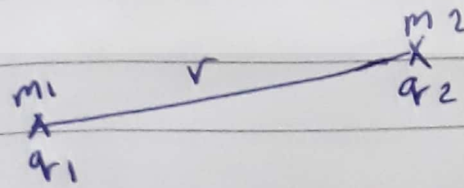
$(a, p)$　　$v_i = 0$ و $t$ و $v_f \neq v_i$ و $\frac{v_p}{v_e} = ??$

Given: $(E, t, v_i)$

$v_f = v_i + at \Rightarrow \Sigma F = ma$

$mg + qE = ma$　　∴ $a = \frac{qE}{m}$

$v = at \Rightarrow v = \frac{qE}{m} t$　　so $\frac{v_p}{v_e} = \frac{m_e}{m_p}$




* قوة الجاذبية الارضية تهمل لصغر حجمها ومقدارها

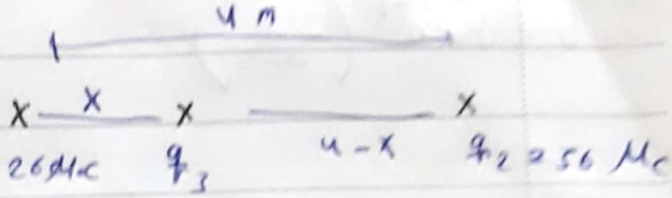
$F_E = \frac{K q_1 q_2}{r^2}$　　$\frac{F_E}{F_G} = \frac{K q_1 q_2}{G m_1 m_2} = \frac{10^{9} \cdot 10^{-38}}{10^{-11} \cdot 10^{-31} \cdot 10^{-27}}$

$F_G = \frac{G m_1 m_2}{r^2}$

ect Date

B 1 $F_G = 1N \longrightarrow F_E = 1 * 10^{40}$

**Example:-** Find the distance if we put a third charge $q_3$ between for the net forces on $q_3$ is zero




$F_{net} = 0$

$F_{13} = F_{23}$

$$\frac{K q_1 q_3}{r^2} = \frac{K q_2 q_3}{r^2} \Rightarrow \frac{25 \times 10^{-3}}{x^2} = \frac{36 \times 10^{-6}}{(4-x)^2}$$

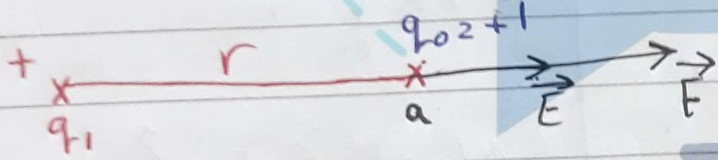
$$\Rightarrow \sqrt{36 x^2} = \sqrt{25(16 - 8x + x^2)}$$

$$6x = 20 - 5x \Rightarrow 11x = 20 \quad \therefore x = \frac{20}{11}\ m$$

## * Electric Field

$$E = \frac{F}{q_0} \quad \therefore E = \frac{K q}{r^2}\hat{r} \quad \Big| \ q_0 : \text{test point charge} = +1$$

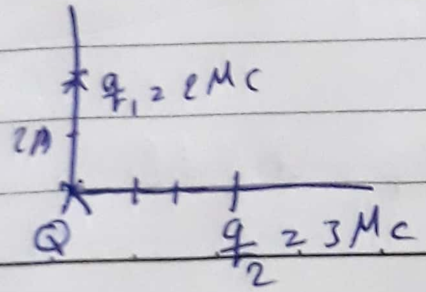
E = the Force per unit positive charge




Find the electric field at point a

$$\vec{F} = \frac{K q_1 q_0}{r^2}\hat{r}\,(N) \qquad \vec{E} = \frac{K q_1}{r^2}\hat{r}\,(N/c)$$

**Example:-** Find the Electric field at the origin



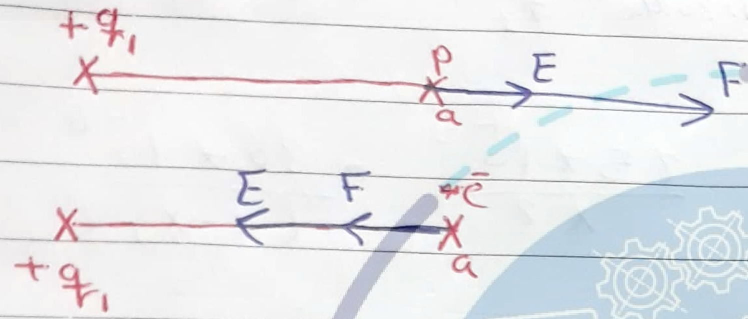

$$E_2 = \frac{9 \times 10^9 \times 3 \times 10^{-6}}{9} = 3 \times 10^3 \ -\hat{i}\ N/c$$

$$E_1 = \frac{9 \times 10^9 \times 2 \times 10^{-6}}{4} = 4.5 \times 10^3 \ -\hat{j}\ N/c$$

$$\therefore \vec{E} = (4.5 \times 10^3 \ -\hat{j} + 3 \times 10^3 \ -\hat{i})\ N/c$$

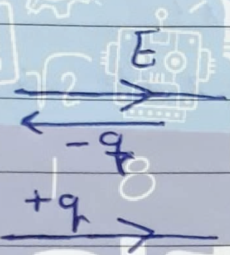
$$|\vec{E}_{net}| = \sqrt{9 + (4.3)^2} \times 10^3$$

$$\theta = \tan^{-1}\left(\frac{3}{4.5}\right)$$

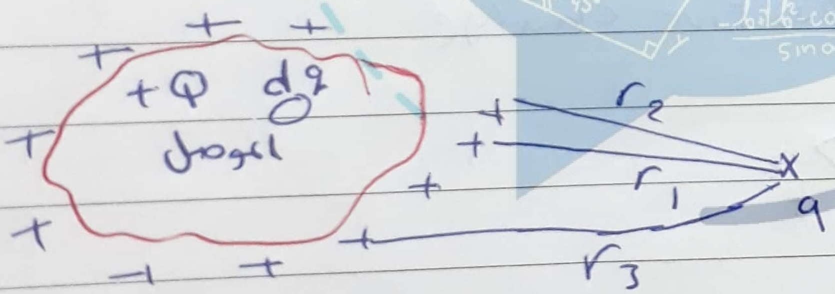



*وجود اي شحنة في مجال كهربائي
يؤدي الى قوة كهربائية

$$* \quad \vec{F} = q\vec{E}$$




continuous charge distribution



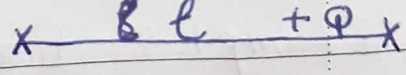

$$\vec{E} = K\frac{q}{r^2}\hat{r}$$

$$\vec{E}_{net} = K\sum\frac{q}{r^2}\hat{r}$$

$$\vec{E} = K\int\frac{dq_i}{r_i^2}\hat{r}_i$$

element of charge

* uniform shape




1) wire :- ($\rightarrow$ 1D) له بعد واحد وهو الطول

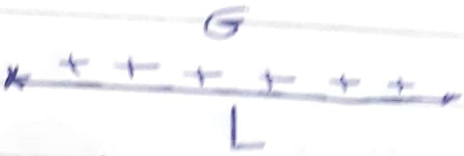
uniform charge distribution

$\lambda \rightarrow$ Linear charge density

$$\lambda = \frac{Q}{L} = \frac{dq}{d\ell} \quad C/m \qquad \therefore dq = \lambda \, d\ell$$

$$\vec{E} = K \int \frac{dq}{r^2} \hat{r} = K \int \frac{\lambda \, dq}{r^2} \hat{r}$$

1) wire (1D)




$\lambda$ = linear charge density

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

Example :- $\vec{E} = K \int \frac{\lambda \, dL}{r^2} \hat{r}$

$$\vec{E} = K \int \frac{\lambda \, dL}{r^2} \hat{r}$$

r :- distance between the source point and the field point $dq = \lambda \, dL = \lambda \, dy$

$\lambda$ = linear charge density

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

Find the electric field at the origin

$$\vec{E} = K \lambda \int \frac{dy}{y^2} (-\hat{j})$$

$\lambda = 2 \times 1$

Date No.

$$K\lambda(-\hat{j})\int_a^{a+L}\frac{dy}{y^2} = K\lambda(-\hat{j})\left[\frac{-1}{y}\right]_a^{a+L}$$

$$= +K\lambda\hat{j}\left[\frac{1}{a+L}-\frac{1}{a}\right]$$

2) surface area (2 Dimention)

surface charge Density ($\sigma$)

$$\sigma = \frac{Q}{A} = \frac{dq}{da} \quad c/m^2$$

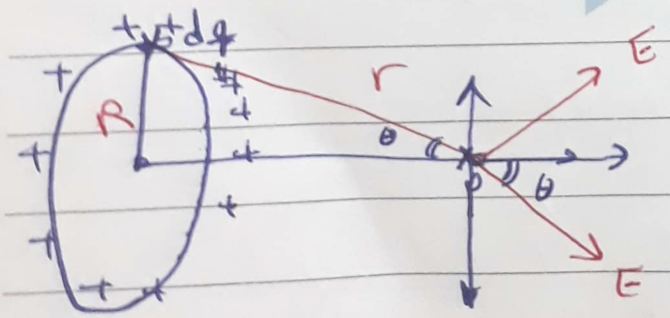
$da$ ← area

$$dq = \sigma\, da$$

$$\Rightarrow \vec{E} = K\int\frac{dq}{r^2}\hat{r} = \sigma K\int\frac{da}{r^2}\hat{r}$$

Example :- charged ring

$$E = K\int\frac{dq}{r^2}\hat{r}$$




$$E = K\int\frac{dq}{(x^2+R^2)}\hat{i}\cos\theta$$

$$\vec{E} = K\hat{i}\int\frac{dq\ x}{[R^2+x^2][R^2+x^2]^{1/2}}$$

N O T E B O O K

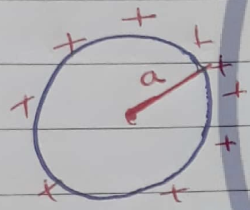
$$\vec{E} = K\hat{\imath}\int \frac{x\, dq}{[x^2+R^2]^{\frac{3}{2}}} = \frac{k\,\hat{\imath}\,x}{[x^2+R^2]^{\frac{3}{2}}}\int dq$$

$$\vec{E} = \frac{K\hat{\imath}\, x\, Q}{[x^2+R^2]^{\frac{3}{2}}}$$

3) charged sphere (3D)

volume charge density

$$\rho = \frac{Q}{V} = \frac{dq}{dv}, \quad Q = 10\,\mu C, \quad a = 20\,cm$$



sphere

$$\rho = \frac{10\times10^{-6}}{\frac{4}{3}\pi(0.2)^3}$$

$dq = \rho\, dv$ ← volume element

$$\sigma = \frac{Q}{4\pi r^2} \longrightarrow \text{سطح الكرة}$$

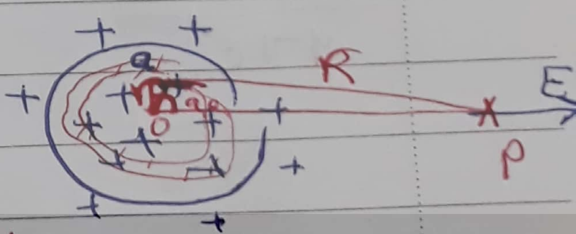
$$\rho = \frac{Q}{\frac{4}{3}\pi r^3}$$

shell

Solid conducting sphere

dielectric sphere

Example :- Charge desk



$$\vec{E} = K\int \frac{dq}{R^2}\,\hat{R}$$

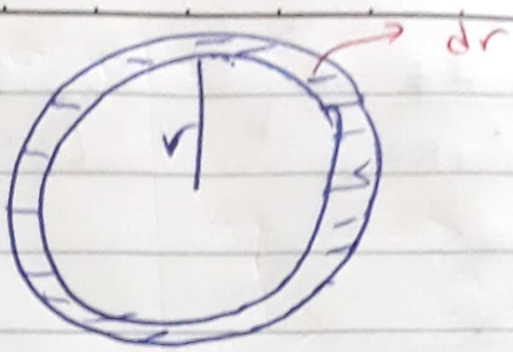
$dq = \sigma\, da$

$dq = \sigma\, da$

$da = 2\pi r\, dr$

$$= K\int_0^a \frac{\sigma\, da}{[x^2+r^2]}\,\hat{\imath} = k\,\sigma\,\hat{\imath}\int \frac{2\pi r\, dr}{[x^2+r^2]}\,\frac{x}{[r^2+x^2]^{\frac{1}{2}}}$$

$$\int_0^a \frac{2r\,dr}{[x^2+r^2]^{\frac{3}{2}}}$$




$2r\,dr = d(r^2)$ $\qquad r^2 = y$

$$\vec{E} = \pi K \sigma \uparrow x \int_0^a d(r^2)\,[r^2+x^2]^{\frac{3}{2}}$$

$$\int dy\,[y+x^2]^{-\frac{3}{2}}$$

$$= 2\pi K \sigma \uparrow x \left. \frac{[r^2+x^2]^{-\frac{1}{2}}}{-1/2} \right|_0^a$$

$$= \pi 2 K x \uparrow \sigma \left[ \frac{1}{[a^2+x^2]^{\frac{1}{2}}} - \frac{1}{x^2} \right]$$

Special case

$a >> x$ [close to the surface]

$$\vec{E} = 2K\uparrow\sigma$$

$$= \frac{2\uparrow\sigma\pi}{4\pi\epsilon_0} = \frac{\sigma}{2\epsilon_0} \uparrow \downarrow$$

عامودي على السطح

# Electric dipole :-

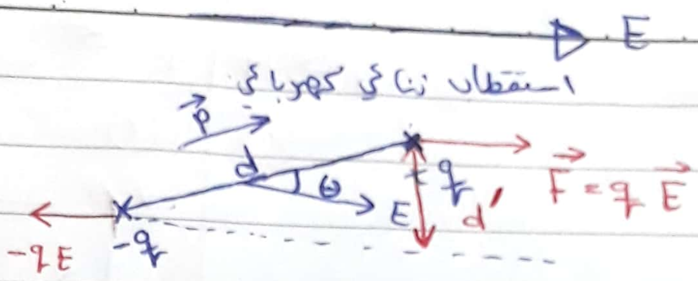
$\vec{P} = q\,\vec{d}$ coulom

اتجاهه من الشحنة الموجبة إلى الشحنة السالبة

كونهن متوازيتين سيخ

مسافة عمودية ← عزم الازدواج

استقطاب ثنائي كهربائي




$d' = d * \sin\theta$

uniform electric field

ثابت

$\vec{F} = +q\vec{E} \Rightarrow$ Electric dipole moment

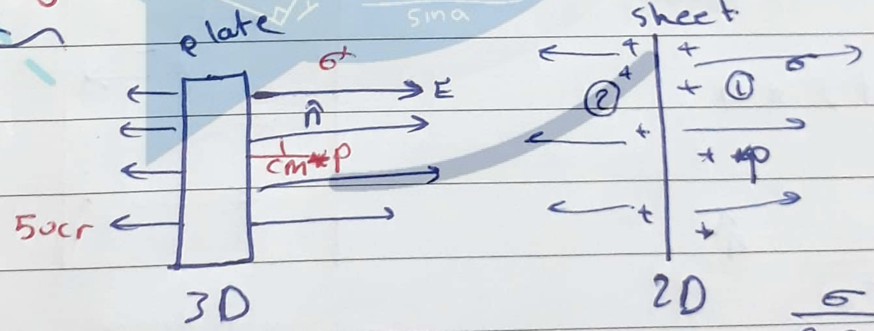
Torque $\Rightarrow$ يجعل الاستقطاب الثنائي الكهربائي يتوازى مع المجال الكهربائي

اذا شد المجال الكهربائي يدور الاستقطاب

$$\tilde{L} = qEd\sin\theta$$
$$= PE\sin\theta = \vec{P} \times \vec{E}$$

potential energy $\Rightarrow$ $U = -\vec{P} \cdot \vec{E}$ Jole } scalare

Desk :-




$\frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0}$

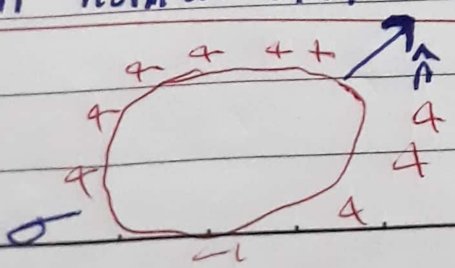
عند النقطة p $\vec{E} = \frac{\sigma}{2\epsilon_0}\hat{n}$

② | ① 

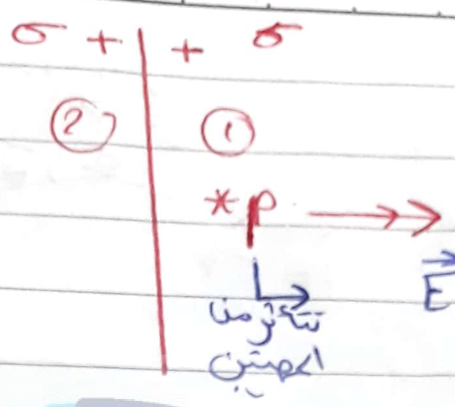
عند النقطة p $\vec{E} = \frac{\sigma}{\epsilon_0}\hat{n}$

$\hat{n}$ normal unit vector

p $\rightarrow E_1 + E_2$



Examples:-

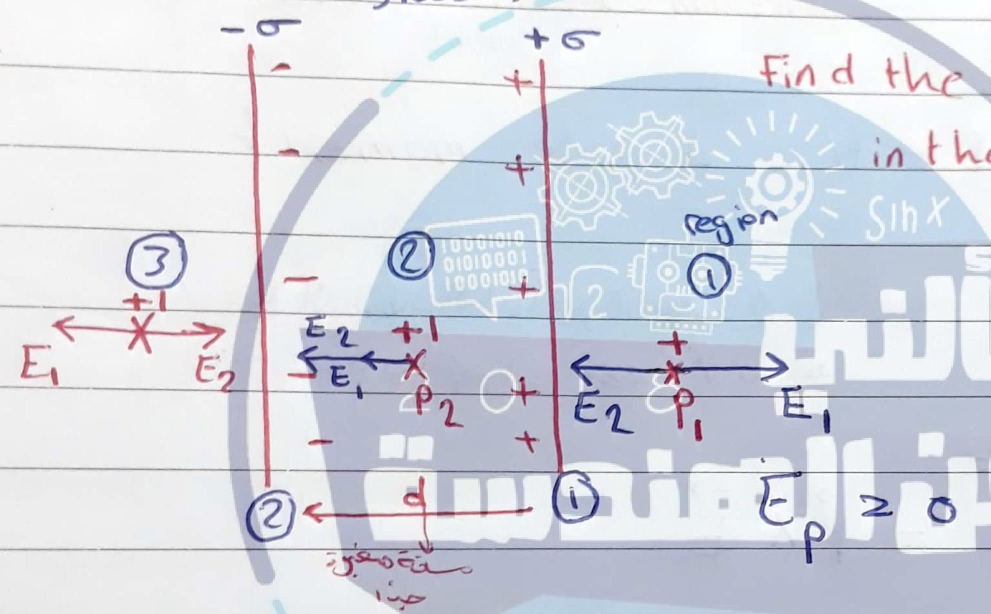


$$\vec{E} = E_1 + E_2 = \frac{\sigma}{\epsilon_0}\hat{n}$$

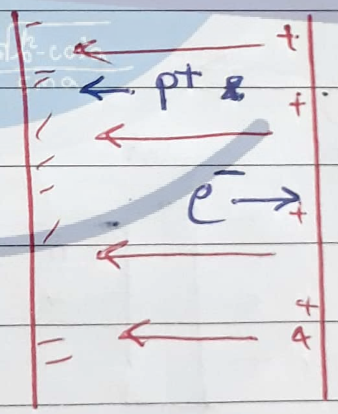
sheets

Ex:-

Find the electric field in the three regions



$\vec{E}_p = 0$

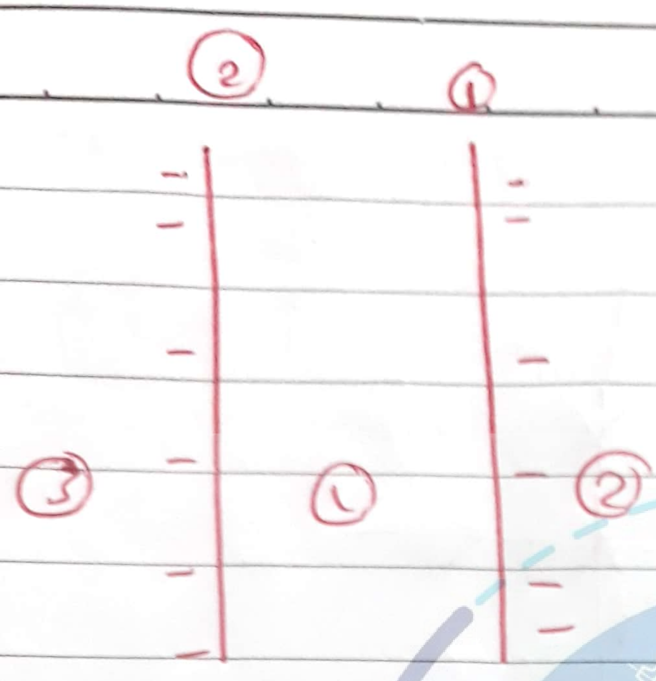


$\vec{E}_1(net) = 0$

$\vec{E}_3(net) = 0$

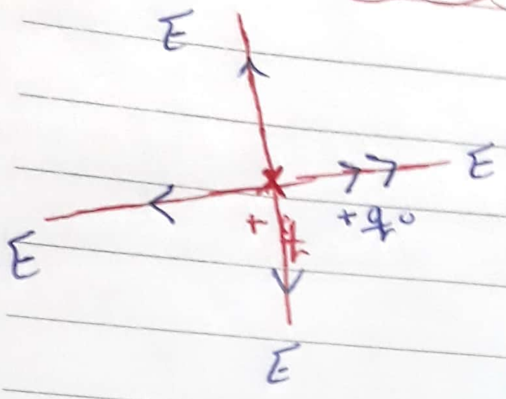
$$\vec{E} = \frac{2\sigma}{\epsilon_0}\hat{n}$$

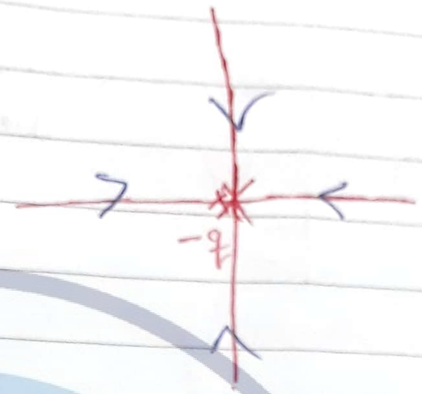
Date



المجال في الداخل 0
ويوجد مجال في الخارج.
فايكون مكثف مثل
لي قبل

## Electric field lines:



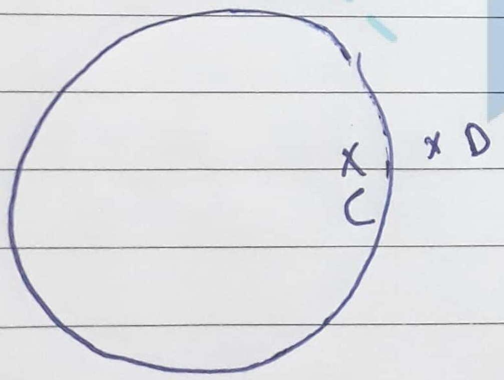





## * ch 23 Gaus's law:-

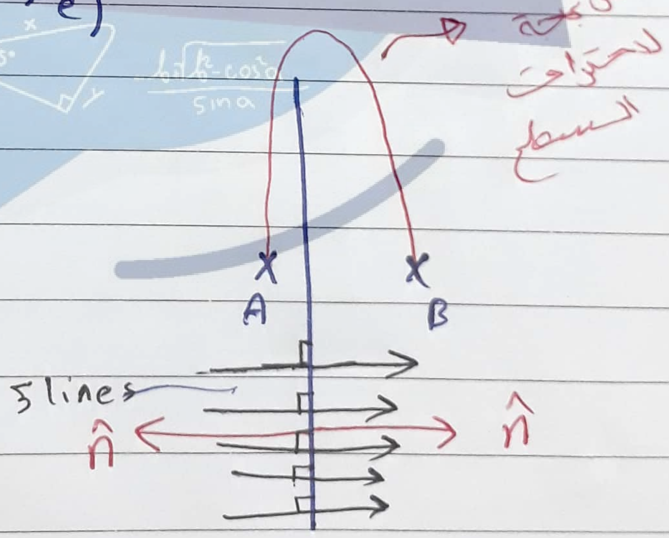
Electric field ( $\vec{E}$ ) مجال كهربائي

Electric flux ( $\phi_e$ ) الفيض الكهربائي




C.S

close surffoce




O.S

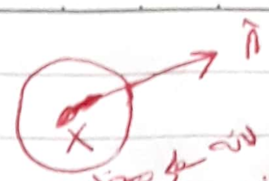
$2m^2 = A$ area

$$\phi_e = 5$$

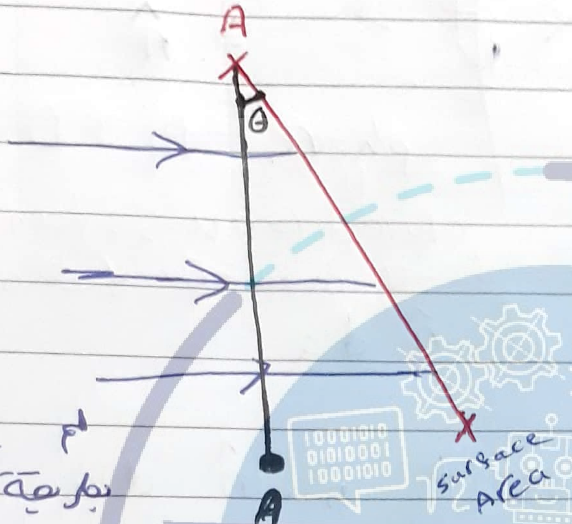
$$\frac{\phi_e}{A} = E = \frac{5}{2} = 2.5 \ N/C$$

Subject Date No.

$$E = \frac{\phi_e}{A} \quad \Big\} \quad \phi_e = EA$$




لأنه سطح مغلق نرسمها باتجاه واحد




لم نخترق بطريقة عامودية لذلك نأخذ المسقط

$$A = A' \cos\theta$$

$$\phi_e = EA'\cos\theta = \vec{E} \cdot \vec{A}$$

area → vector $\vec{A'}$

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

عامودي على السطح خارج منه

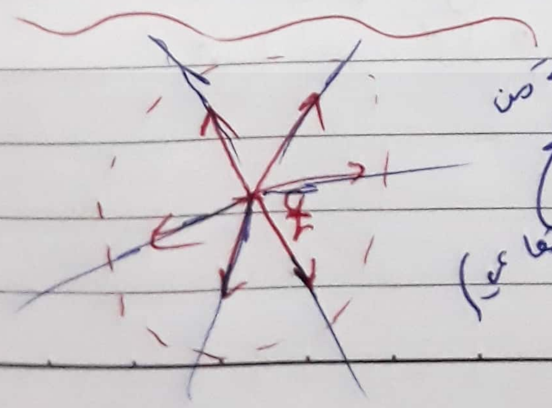
$$\phi_e = \vec{E} \cdot \hat{n} \, A$$

نستخدم هذا القانون لما يكون كلهم ثوابت

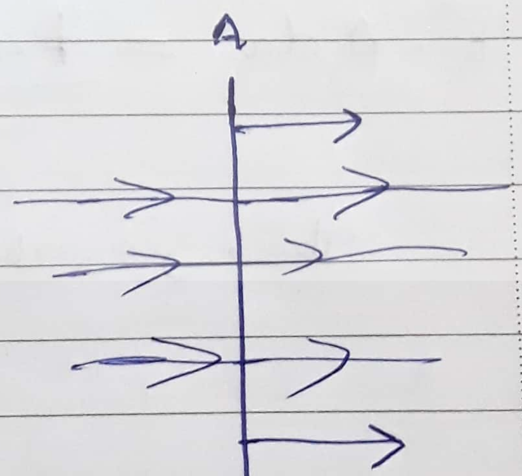
$$\phi_e = \vec{E} \cdot \hat{n} \, A$$

For variable parameters

$$\phi_e = \int_{surface} \vec{E} \cdot \hat{n} \, da$$



خارجة من السطح (خطوط اشعاع)

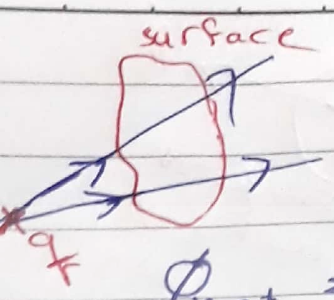



$$\phi_{net} = +5 - 3 = +2$$

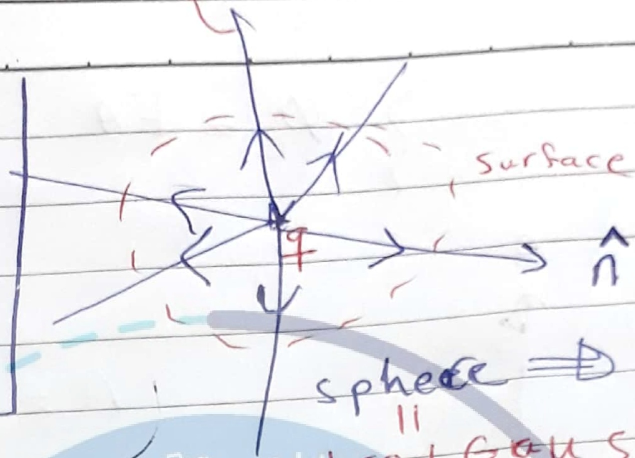
خطوط الشحنة الخارجة [illegible] بعض الخطوط
بدون استمرار

$\hat{n} \cdot \hat{n} = 1$






$\phi_{net} = 0$




sphere $\Rightarrow$ 3D
||
closed Gaussian surface
هو سطح وهمي فيه المجال عليه ثابت

$$A = 4\pi r^2$$

$$\phi_E = \oint \vec{E} \cdot \hat{n}\, da$$

$$= \oint k \frac{q}{r^2}\, \hat{n} \cdot \hat{n}\, da$$

$$\cancel{= k \oint \frac{q}{r^2} = \oint}$$

$$= k \frac{q}{r^2} \oint \underbrace{\hat{n} \cdot \hat{n}}_{1}\, da$$

$$\phi = k \frac{q}{r^2}\, 4\pi r^2 = \frac{1}{4\pi \epsilon_0}\, q\, 4\pi = \frac{q_{enclosed}}{\epsilon_0}$$

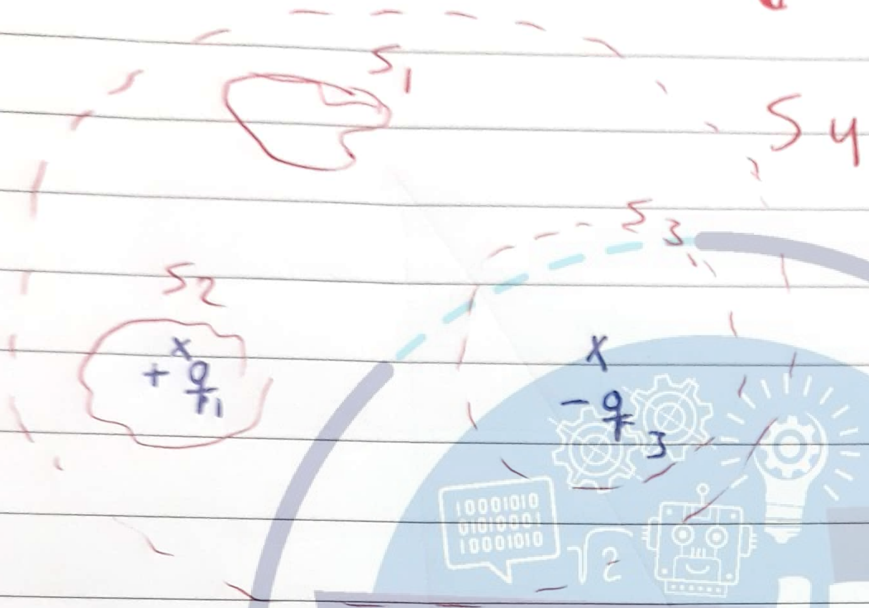
$$\oint_s \vec{E} \cdot A\, da = \frac{q_{enclosed}}{\epsilon_0} \quad \text{Gauss's law}$$

لسطوح غير المنتظم

اما قانون كولوم لسطوح المنتظمة وغير المنتظمة

Subject Date No.

Example :- Find $\phi_e \longrightarrow \Phi_{S_1}$




$\phi_{S_1} = 0$ | $\phi_{S_2} = \dfrac{+q_1}{\epsilon_0}$

$\phi_{S_3} = \dfrac{-q_3}{\epsilon_0}$ | $\phi_{S_4} = \dfrac{+q_1 - q_3}{\epsilon_0}$

## Gauss's law :-

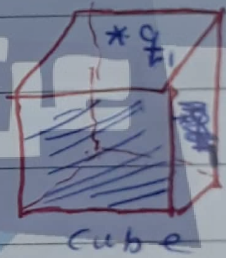
### Electric flux :-

1) $\phi_e = \int_{surf} \vec{E} \cdot \hat{n} \, da = \int_{sur} \vec{E} \cdot \vec{da}$

$\vec{da} = da \, \hat{n}$

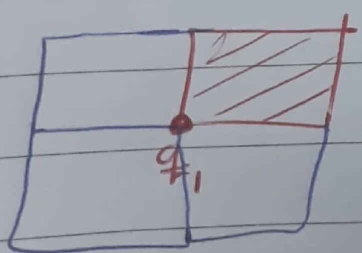
2) $\phi_e = \frac{q_{enc}}{\epsilon_0}$ | $\int_S \vec{E} \cdot \hat{n} \, da = \frac{q_{enc}}{\epsilon_0}$

Examples :- Find the electric flux through the shaded surface :

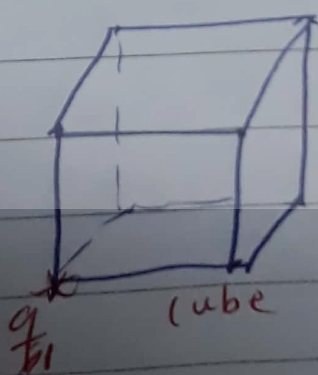



$\phi_e = \frac{q_{enc}}{\epsilon_0}$ | $\phi_{cube} = + \frac{q_1}{\epsilon_0}$

$\phi_{surface} = + \frac{q_1}{6 \epsilon_0}$




2D و 3D



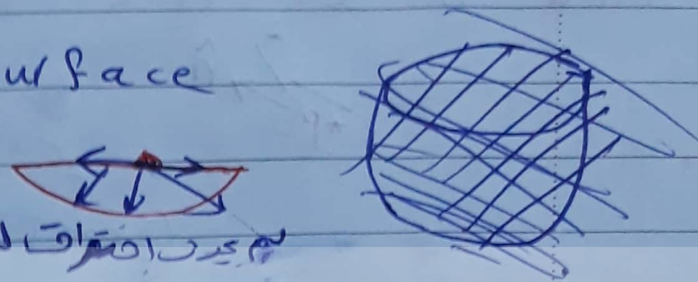

في قانون Guass's يجب ان تقوم

بعمل تماثل

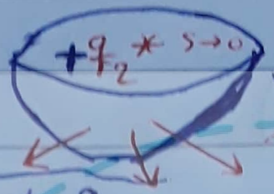
Example 9

hemisphere نصف الكرة

$\phi_e = +\frac{q_2}{2\epsilon_0}$ curved surface



$\boxed{\phi_{e(flat)} = 0}$

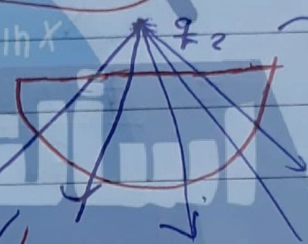


لم يحدث اختراق للأسطح

$\longrightarrow$ الكورة من السطح وحا رجه منه

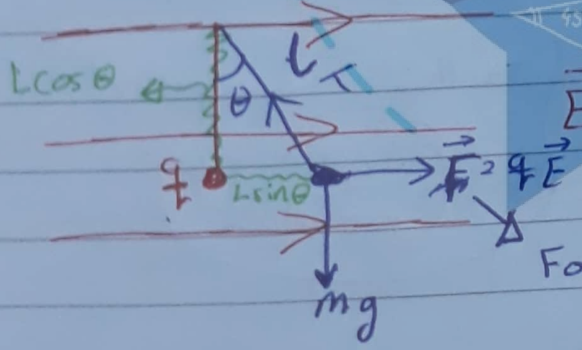
$\boxed{\phi_{e(curved)} = +\frac{q_2}{2\epsilon_0}}$

$\boxed{\phi_e(flat) = \frac{-q_2}{2\epsilon_0}}$



$\longrightarrow$ دخلت السحنة عنا السطح قبل كانت من السطح

L: طول الحبل



$\vec{E} = 2\times10^6\ N/C$

$\vec{F} = q\vec{E}$

~~$\vec{F} = q\vec{E}$~~

Force

EX:- Find the charge on the ball At equilibrium:-

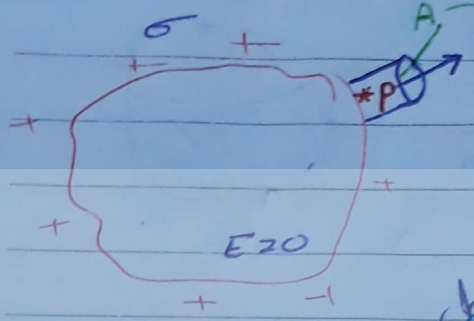
Soln $\longrightarrow$ Torque = 0

$T_{net} = 0 \quad | \quad +qE\,L\cos\theta - mg\,L\sin\theta = 0$

NOTEBOOK

Example :-

Find the electric field at point p




اتجاه $\hat{n}$

غاوسي

(جسم موصل)

(لا يوجد شحنات كهربائية بالداخل لذلك المحصلة تساوي صفر)

$$\oint \vec{E} \cdot \vec{da} = \frac{q_{enc}}{\epsilon_0}$$

$$\int \vec{E} \cdot \hat{n} \, da = \frac{\sigma A}{\epsilon_0}$$

$$E \int da = \frac{\sigma A}{\epsilon_0}$$

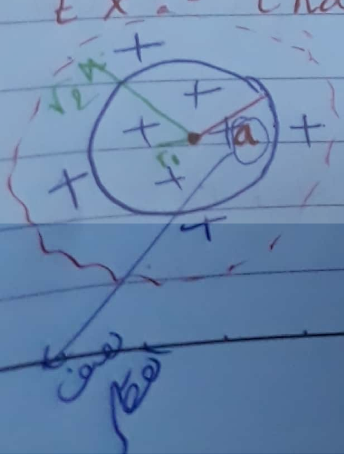
$$E A \, \hat{n} \cdot \hat{n} = \frac{\sigma A}{\epsilon_0}$$

$$\vec{E} = \frac{\sigma}{\epsilon_0} \hat{n}$$

solid :- الشحنات موزعة خارج وداخل الكرة

shell : الشحنات موزعة خارج الكرة على القشرة

Ex :- charged dielectric sphere




Find the electric ~~fee~~ in the region :-

1) $r > a$

2) $r < a$

$$\rho = \frac{+Q}{\frac{4}{3}\pi a^3} \quad coul/m^3$$

$$\oint \vec{E}\cdot\hat{n}\, da = \frac{q_{enc}}{\epsilon_0}$$

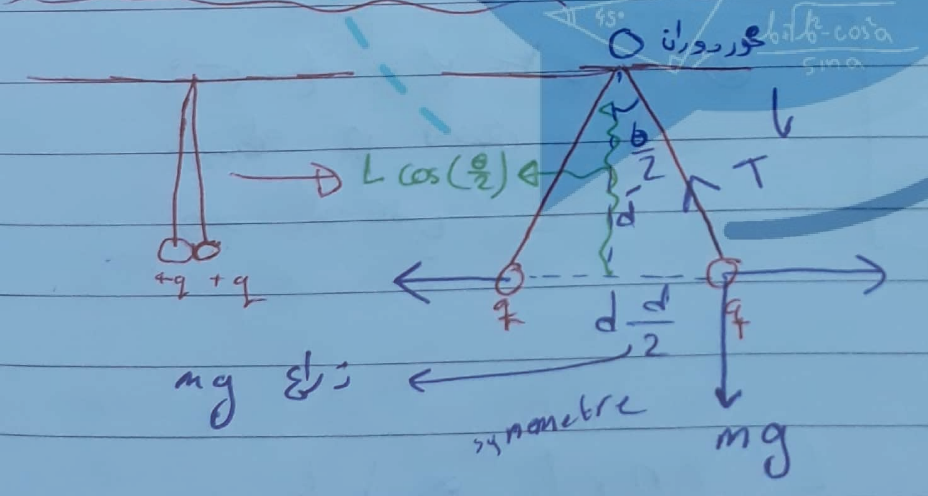
$$E\oint da\,\hat{n}\cdot\hat{n} = \frac{q_{enc}}{\epsilon_0}$$

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

$$E(4\pi r_1^2) = \frac{q_{enc}}{\epsilon_0} = \frac{\rho V_{enc}}{\epsilon_0}$$

$$E(4\pi r_1^2) = \frac{\rho}{\epsilon_0}\left[\frac{4}{3}\pi r_1^3\right]$$

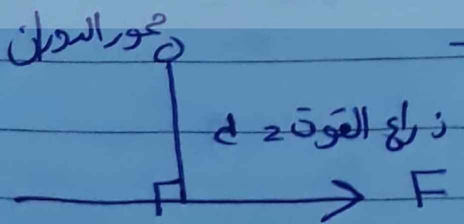
$$\vec{E} = \frac{\rho\, r_1}{3\epsilon_0}\hat{n}$$



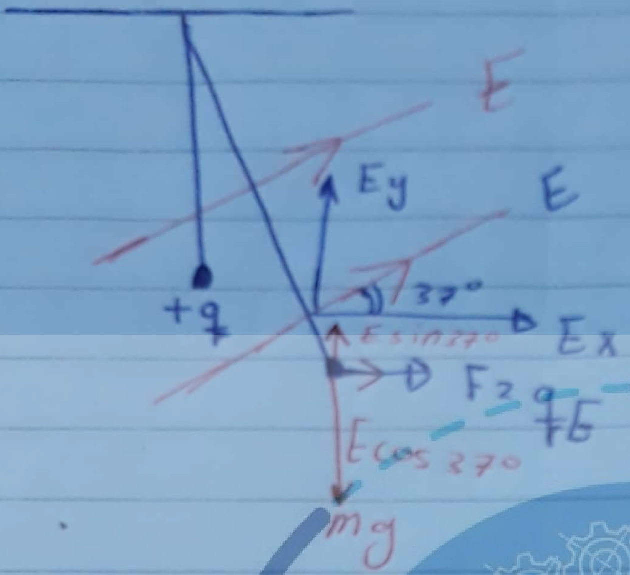

$\sum \tau_{net} = 0$

$$\vec{F} = \frac{Kq^2}{d^2}$$

$$\frac{d}{2} = L\sin\left(\frac{\theta}{2}\right)$$



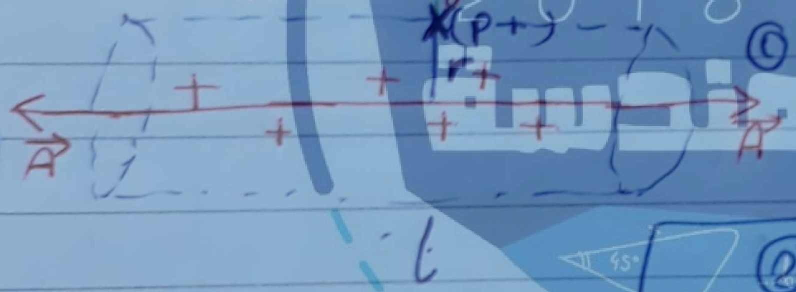

$\tau = Fd$




$\vec{F} = 2\times10^{3}\,\hat{i} + 3\times10^{3}\,\hat{j}$

EX :-

uniforme charged wire



$$\oint_{surface} E\,\hat{n}\cdot da = \frac{q_{enc}}{\epsilon_0}$$

نرسم سطح غاوسي يمر بالنقطة P بيعطي تماثل وهو سطح وهمي

$$= \frac{\lambda l}{\epsilon_0}$$

$$E\,\hat{n}\cdot\hat{r}\oint da = E\,2\pi r l = \frac{\lambda l}{\epsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi\epsilon_0 r}\,\hat{r}$$

ch23:- electric potential :- (V)

electric Force → conservative force $f_c \to w_c \to u$

u potential energy ( J )

V electric potential ( volt )

$$dw = \vec{F} \cdot \vec{dr}$$

$$W = \int \vec{F} \cdot \vec{dr} \quad (1D)$$

*electric force

$$w = \int q \vec{E} \cdot \vec{dr}$$

$$W = q \int \vec{E} \cdot \vec{dr}$$

define $W_C = -\Delta u$

$$\Delta u = -q \int_A^B \vec{E} \cdot \vec{dr}$$

$u_A$ $u_B$

A —— ds or dr —— B

إزاحة صغيرة

$$\Delta u = U_B - U_A$$

$$\frac{\Delta u}{q} = -\int_A^B \vec{E} \cdot \vec{ds}$$

defines:- $\frac{J}{coul} \; \frac{\Delta u}{q} = \Delta V$ potential difference

$$\Delta V = V_B - V_A$$

$$\frac{J}{coul} = volt \qquad \Delta V = \frac{\Delta u}{q}$$

$$\Delta V = -\int_A^B \vec{E}\cdot\vec{ds}$$

$$\underbrace{V_B - V_A}_{\text{جهد كهربائي}} = -\int_A^B \vec{E}\cdot ds$$

$$\Delta V = \frac{\Delta U}{q}$$

$$\Delta U = \Delta V q$$

مجال كهربائي

$\vec{F}$ و $\vec{E}$ و $V$

قوة كهربائية — مجال كهربائي — جهد

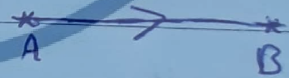
كميات متجهه (المقدار واتجاه)

كمية قياسية (المقدار فقط)

chap 23:- potential (V) 7/2 الخميس

potential difference $\Delta V = V_B - V_A$

$$V_B - V_A = -\int_A^B \vec{E}\cdot\vec{ds}$$

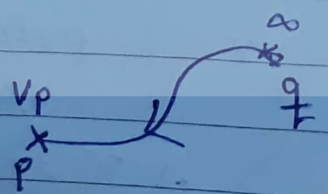



$$\Delta V = \frac{\Delta U}{q} \qquad \frac{J}{coul} = volt$$

energy = work
$W = -\Delta U$

$$\Delta U = q\,\Delta V$$

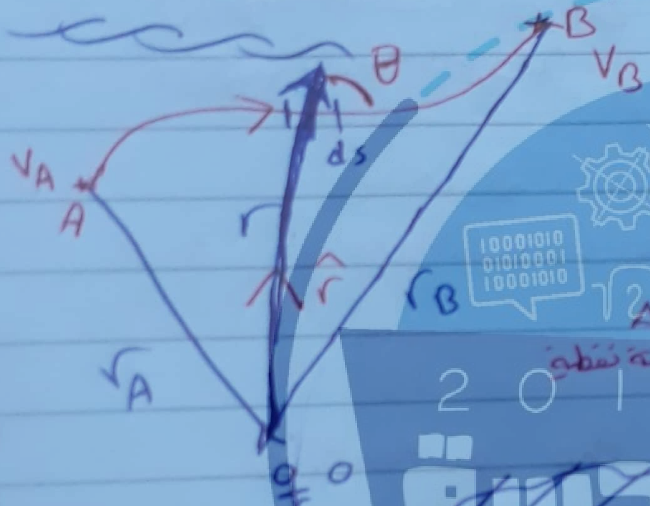
$$U_p = q\,V_p$$



$$V_B - V_A = -\int_A^B \vec{E}\cdot\vec{ds}$$


$V_\infty = 0$

$$V_p = -\int_\infty^p \vec{E}\cdot\vec{ds}$$




$$\Delta V = -\int_A^B K\frac{q}{r^2}\,\hat{r}\cdot\vec{ds}$$

$$\hat{r}\cdot\vec{ds} = |\hat{r}|\, ds\cos\theta$$

$$= ds\cos\theta = dr$$

$$= -Kq\int_{r_A}^{r_B}\frac{dr}{r^2}$$

$$= Kq\,\frac{1}{r}\Big]_{r_A}^{r_B} = \frac{Kq}{r_B} - \frac{Kq}{r_A}$$

$$V_B - V_A = \frac{Kq}{r_B} - \frac{Kq}{r_A}$$

$$V_B = \frac{Kq}{r_B}, \quad V_A = K\frac{q}{r_A}$$

$$V = K\frac{q}{r} \quad \text{volt}$$

$$V = K\sum \frac{q_i}{r_i} \quad \text{Volt}$$

$$\vec{F} = K \frac{q_1 q_2}{r^2} \hat{r}$$

$$\vec{E} = K \frac{q}{r^2} \hat{r}$$

$$V = K \frac{q}{r}$$

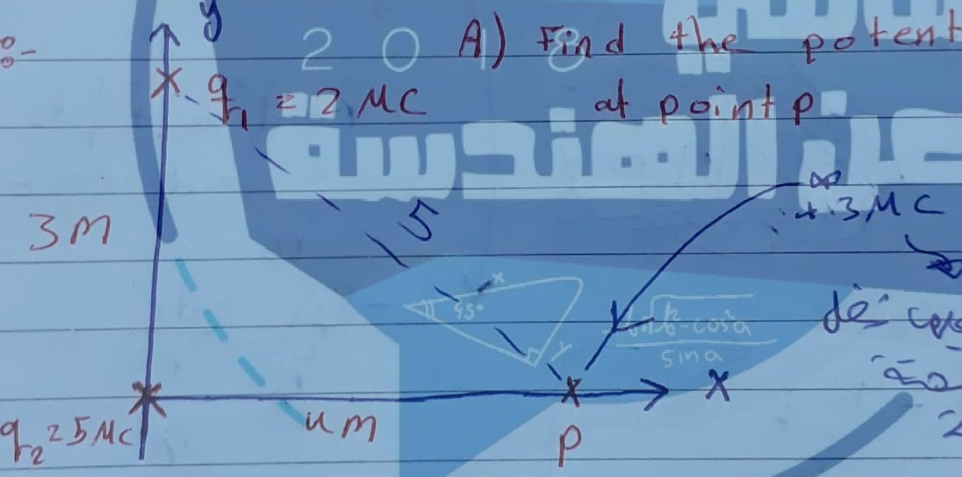
لما تكون الشحنة الكهربائية المعروفة

$$V_p = - \int_{\infty}^{p} \vec{E} \cdot \vec{ds}$$

عندما يكون المجال الكهربائي معروف

Ex:-

A) Find the potential at point P




نبذل عليها شغل لان الشحنة موجبة

$$V_p = V_{q_1} + V_{q_2}$$

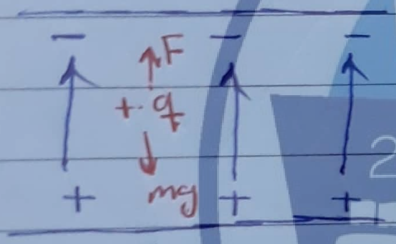
$$= \frac{9 \times 10^9 (-2 \times 10^{-6})}{5} + \frac{9 \times 10^9 (5 \times 10^{-6})}{4}$$

$$= 7.35 \times 10^3 \text{ volt}$$

B) Find the energy to bring a $3\mu$ from infinite to point p

$U = q V_p$

$= 3 * 10^{-6} (7.65 * 10^{3})\ J = 22.95 * 10^{-3}\ J = 22.95\ mJ$

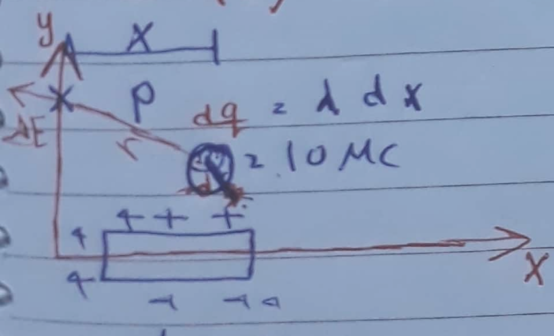



$mg = q\vec{E}$

$\vec{F} = q\vec{E} = m\vec{a}$

$\vec{G} = \frac{q}{m}\vec{E}$

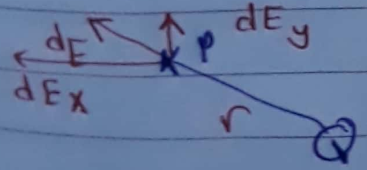
EX(2) a) Find the electric field at point P.




$dq = \lambda\, dx$

$= 10\mu C$

$l = 20cm$




$\lambda = \frac{10 * 10^{-6}}{0.20}$ coul/m

$\vec{E} = k \int \frac{dq}{r^2} = k\lambda \int \frac{dx}{r^2}\ \hat{r}$

$r = \sqrt{x^2 + (0.5)^2}$

$\vec{E} = k\lambda \int \frac{dr}{(x^2 + (0.5)^2)}\ \hat{r}$

$$E_x = K \lambda \int \frac{dx}{(x^2 + (0.5)^2)} \cos\theta \, (-\hat{i})$$

$$= E d \int \frac{dx}{[x^2 + (0.5)^2]} \frac{x}{[x^2 + (0.5)^2]^{1/2}} (-\hat{i})$$

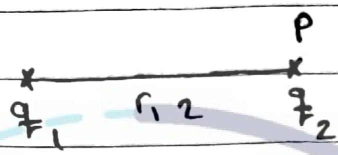
$$E_y = K \lambda \int \frac{dx}{[\ldots]} \sin\theta \, (-\hat{j})$$

10/2 الأحد

Subject | Date | No.

ch23B- potential energy : $U$ $\quad \Delta U = q \Delta V$

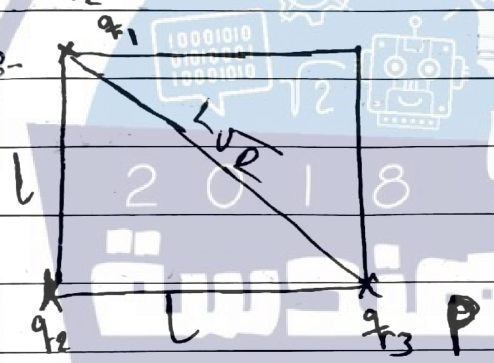
$U = qV$



The potential energy of the system

$V = \frac{K q_1}{r_{12}}$ volt at pcharge $q_2$

Example :-



$$U_{total} = \frac{K q_1 q_2}{L} + \frac{K q_1 q_3}{L\sqrt{2}} + \frac{K q_2 q_3}{L}$$

↳ the total energy of the system

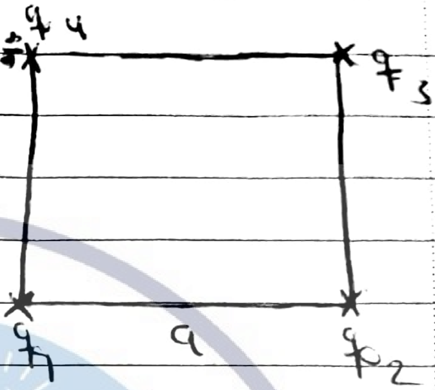
* Find the energy ~~necessary at point p~~ to bring the charge $q_3$ from infinity to point p . or from p to infinity ??

$U_{q_3} = q_3 V_p$ / $V_p = \frac{K q_1}{L\sqrt{2}} + \frac{K q_2}{L}$

$$U_{q_3} = \frac{K q_1 q_3}{L\sqrt{2}} + \frac{K q_2 q_3}{L}$$

Scanned by CamScanner

* Find the energy of the system




$U = K \frac{q q'}{r}$ J

$$U_{system} = \frac{K q_1 q_2}{a} + \frac{K q_1 q_3}{a\sqrt{2}} + \frac{K q_1 q_4}{a} + \frac{K q_2 q_3}{a} + \frac{K q_2 q_4}{a\sqrt{2}} + \frac{K q_2 q_4}{a}$$

⇒ $V_p = -\int_{\infty}^{p} \vec{E} \cdot \vec{ds}$

$\vec{A} \cdot \vec{B} = A_x B_x + A_y d_y + A_z d_z$

$dV = -\vec{E} \cdot \vec{ds}$

* along x-axis ⇒ $dV = -E_x \, dx$ (1D - only)

$$E_x = -\frac{dv}{dx}$$

$$\vec{E} = -\frac{dv}{dx} \hat{i}$$

* along ~~z~~ y-axis ⇒ $\vec{E} = -\frac{dv}{dy} \hat{j}$

* along z-axis ⇒ $\vec{E} = -\frac{dv}{dz} \hat{k}$

in 3D ⇒ $\vec{E} = \boxed{-\frac{\partial v}{\partial x} \hat{i} - \frac{\partial v}{\partial y} \hat{j} - \frac{\partial v}{\partial z} \hat{k}}$

$\frac{\partial v}{\partial x}$ ⇒ partial derivative

$\frac{dv}{dx}$ normal derivative

$\vec{E} = -\text{grad } V = -\nabla V$

bject Date No.

Example 8- A certain potential is given by $V(x,y,z) = 3xyz$ Find $\vec{E}(x,y,z)$

$$\frac{\partial V}{\partial x} = 3yz \;,\; \frac{\partial V}{\partial y} = 3xz \;,\; \frac{\partial V}{\partial z} = 3xy$$

$\Rightarrow$ Find $\vec{E}(1,1,1) \Rightarrow \vec{E} = -3\hat{i} - 3\hat{j} - 3\hat{k}$

Example : Find the energy needed to bring a charge of $2\mu C$ from point B to point C :-

Equipotential lines

$\Delta U = q\,\Delta V$

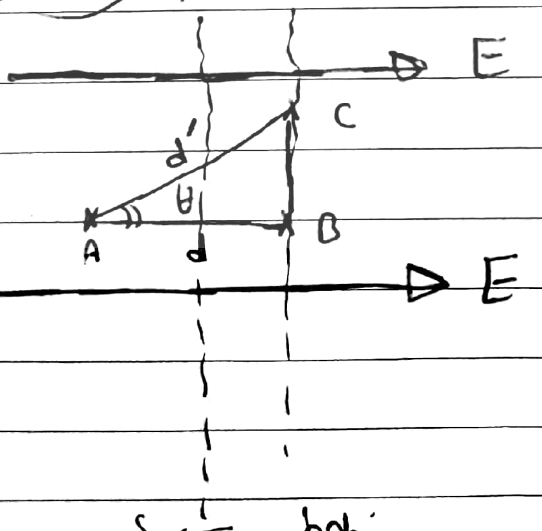
$= 2(10^{-6})[-2]$ J

$\Delta U = -4 \times 10^{-6}$ J → يعني طاقة

→ لأن نقل الشحنة من جهد عالي لأقل

Find $U_{AB} \Rightarrow U_{AB} = 0$

لأن الجسم الموصل جهده متساوي وثابت




uniform electric field

$$V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{s}$$

$$= -\vec{E} \cdot \int ds = -\vec{E} \cdot \vec{d}$$

$= -Ed\cos 0$

$= -Ed$

خطوط تساوي $\therefore V_B - V_A = -Ed$

الجهد عمودي على

خطوط المجال .

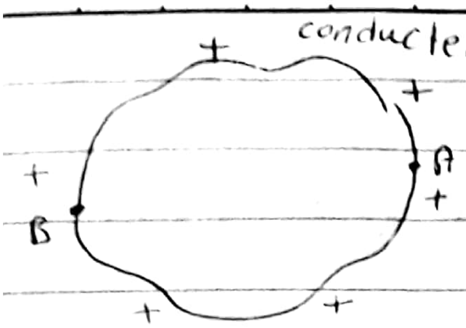
N O T E B O O K

Scanned by CamScanner

$$* \; V_C - V_A = -\int_A^C \vec{E} \cdot \vec{ds} = -\vec{E} \cdot \vec{d}' = -Ed' \cos\theta = -Ed$$

$$V_B - V_A = V_C - V_A \Rightarrow V_C = V_B$$

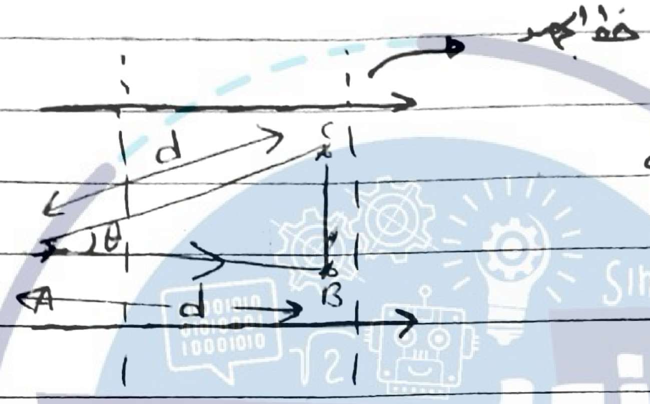
Subject Date No.




$U_{AB} = Zero$

لا تحتاج طاقة لنقل نقطتين على نفس المستوى لان $\Delta V = Zero$

Example




$\cos\theta = \frac{d}{d'}$

uniform electric field

$$V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{s} = -\vec{E} \cdot \int d\vec{s} = -\vec{E} \cdot \vec{d} = -Ed$$

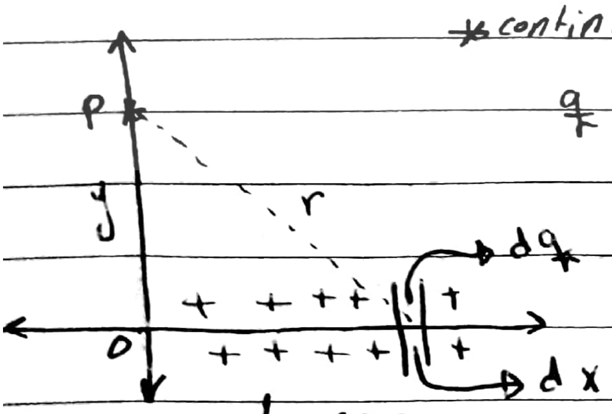
$$V_C - V_A = -\int_A^C \vec{E} \cdot d\vec{s} = -\vec{E} \cdot d' = -Ed'\cos\theta$$

$\therefore V_B - V_A = V_C - V_A \Rightarrow \boxed{V_B = V_C}$

* عندما يكون على خط الجهد = صفر $\Leftarrow$ $V_B - V_C$ أو $V_C - V_B$ = صفر

* continuous charge distribution *

$q = 2\mu C$




$L = 20\,cm$

$\lambda = \frac{q}{L} = \frac{2 \times 10^{-6}}{0.2}\ C/m$

Subject Date No.

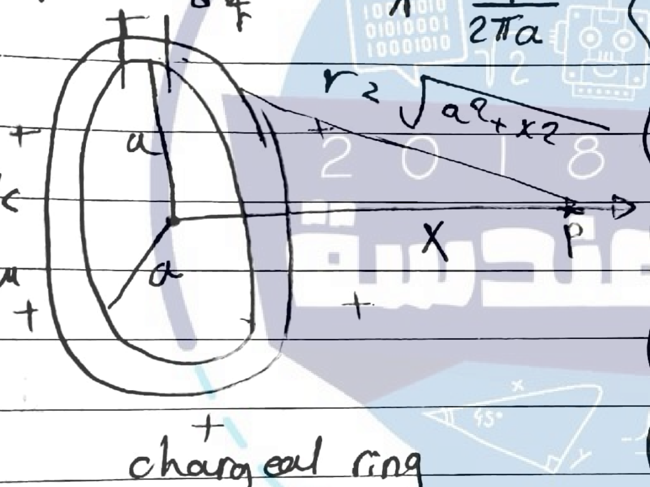
$$dV = K\frac{dq}{r} \qquad \lambda = \frac{dq}{dx}$$

$$V = K\int_0^L \frac{dq}{r} = K\lambda\int_0^L \frac{dx}{\sqrt{x^2+y^2}} = K\lambda \ln\left(x+(x^2+y^2)^{\frac{1}{2}}\right)\Big]_0^L$$

$$= K\lambda\left[\ln\left(L+(L^2+y^2)^{\frac{1}{2}}\right) - \ln y\right]$$

Example :-

$$\lambda = \frac{q}{2\pi a}$$




$q = 10\mu c$

$a = 20\,cm$

$$V = K\int \frac{dq}{r} = K\int_0^q \frac{dq}{\sqrt{a^2+x^2}}$$

$$= \frac{K}{\sqrt{a^2+x^2}}\int_0^q dq = \frac{Kq}{\sqrt{a^2+x^2}}\Big]_0^q$$

$$\vec{E} = K\frac{q}{r^2}\hat{r} \qquad \vec{E} = -\frac{\partial V}{\partial r}\hat{r}$$

$$V = K\frac{q}{r} \qquad \vec{E} = K\int \frac{dq}{r^2}\hat{r}$$

الحل

$$\therefore \vec{E} = -\frac{\partial v}{\partial x}\hat{i} = -\left(\frac{-1}{2}Kq * 2x\left(x^2+a^2\right)^{-\frac{1}{2}}\right) = \frac{Kqx}{\left(\sqrt{a^2+x^2}\right)^3}$$

Example :- uniform charge disk

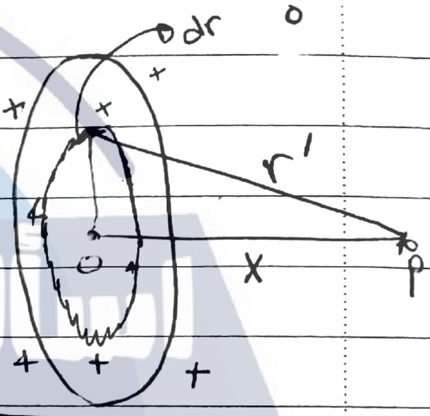
$a = 2\pi r$

$da = 2\pi r\,dr$

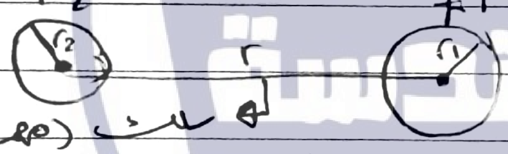
$V = K\int \frac{dq}{r'} = K\sigma \int \frac{da}{r'}$

$= K\sigma \int_0^a \frac{2\pi r\,dr}{\sqrt{r^2+x^2}} = \sigma K\pi \int_0^a \frac{2r\,dr}{\sqrt{r^2+x^2}} = \sigma K\pi * 2\sqrt{r^2+x^2}\Big]_0^a$

$= \sigma 2K\pi\left(\sqrt{a^2+x^2} - x\right)$




Example :- Find the charge on each sphere




(جهد)

$r_1 = 6\,cm$

$r_2 = 2\,cm$

$q = 80\,\mu C$

soln :- $q_1 + q_2 = 80\,\mu C$ —— (1)

$V_1 = K\frac{q_1}{r_1}$

$V_2 = K\frac{q_2}{r_2}$

$V_1 = V_2$

$\Rightarrow \cancel{K}\frac{q_1}{r_1} = \cancel{K}\frac{q_2}{r_2} \Rightarrow \frac{q_1}{r_1} = \frac{q_2}{r_2}$ --- (2)

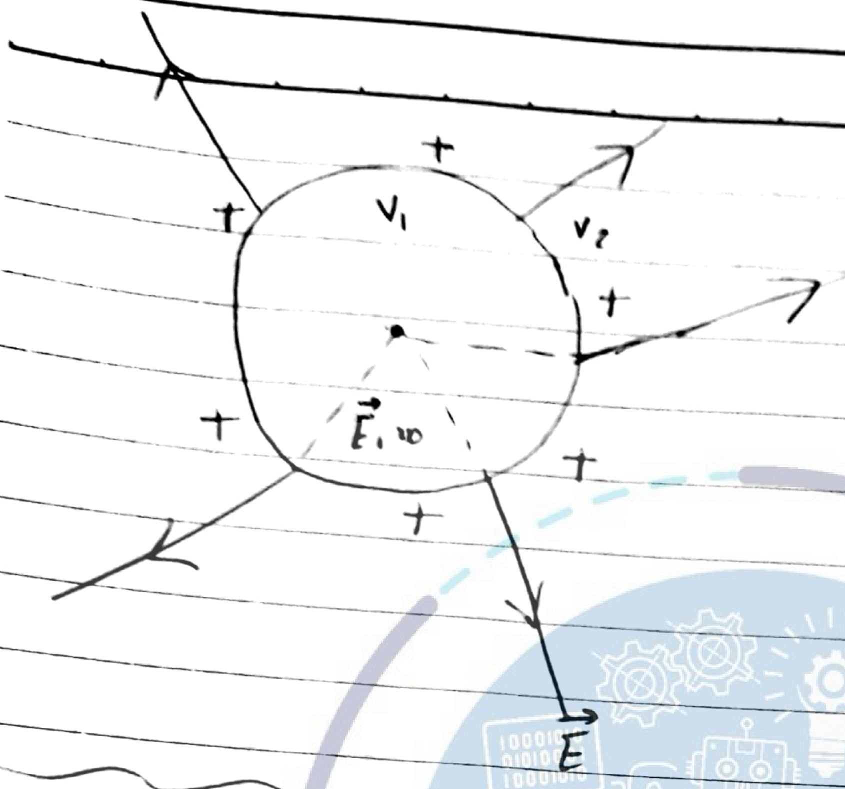
$\Rightarrow \frac{80\,\mu C - q_2}{r_1} = \frac{q_2}{r_2} \Rightarrow r_2(80\,\mu C - q_2) = q_2 r_1$

$\therefore q_2 =$

$\Rightarrow q_1 =$

توزيع الشحنات كيف تصبح جهدهم متساو

Subject　　　Date　　　No.




$V_1 = V_2 \Rightarrow$ سطح متساوي الجهد



Example :- Find the potential of each sphere

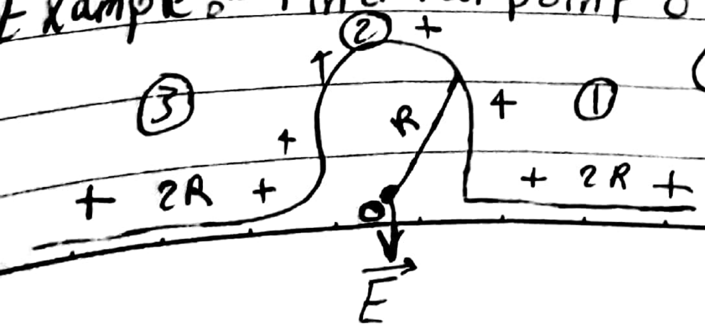

$V_A = \dfrac{Kq_1}{r_1} + \dfrac{Kq_2}{r} \Rightarrow$ تأثير B على A

جهد A

المسافة الواصلة بينهم r

$V_B = \dfrac{Kq_2}{r_2} + \dfrac{Kq_1}{r} \Rightarrow$ تأثير A على B

Example :- Find V at point o




اذا طلب $\vec{E}$ عند o مساهما 1 يلغي 3

وبحسب عند (2) $\Leftarrow$

$\vec{E} = (2) \dfrac{K\lambda}{r}$

نصف دائرة

Subject Date No.

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

Special case:-

$U = q\,V$

جول $J = e^- V \rightarrow$ volt

$= 1.6\times10^{-19} \times 1V = 1.6\times10^{-19}\ eV$

$\Rightarrow 1J = 1.6\times10^{-19}\ eV$

Ch 24:- Capacitance and the dielectric

conducting sphere

كل ال conductors لها capacity

امكانية اضافة شحنات للا نهاية

شحنة الجهد

$1q = V_1$

$2q = 2V_1$

$3q = 3V_1$

$$\frac{q \ (\text{Coul})}{V \ (\text{Volt})} = \text{constant}\ (C) \ \text{Farad}$$

C-capacitance

Farad

$$\Rightarrow 1F = \frac{1C \rightarrow \text{coulomb}}{1V \rightarrow \text{volt}}$$

$mF = 10^{-3} F$

$\mu F = 10^{-6} F$

$nF = 10^{-9} F$

$pF = 10^{-12} F$

NOTEBOOK

Scanned by CamScanner

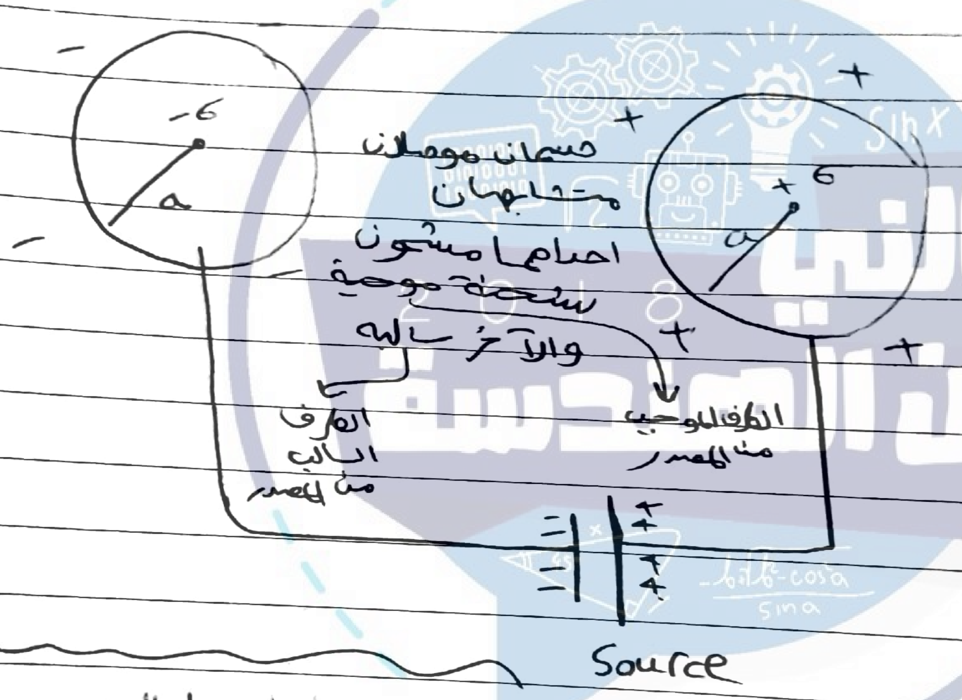
Subject　　　　　Date　　　　　No.

→ dielectric و Insulator

عكف مادة عازلة الى الداخل تحتويها لذا ليس

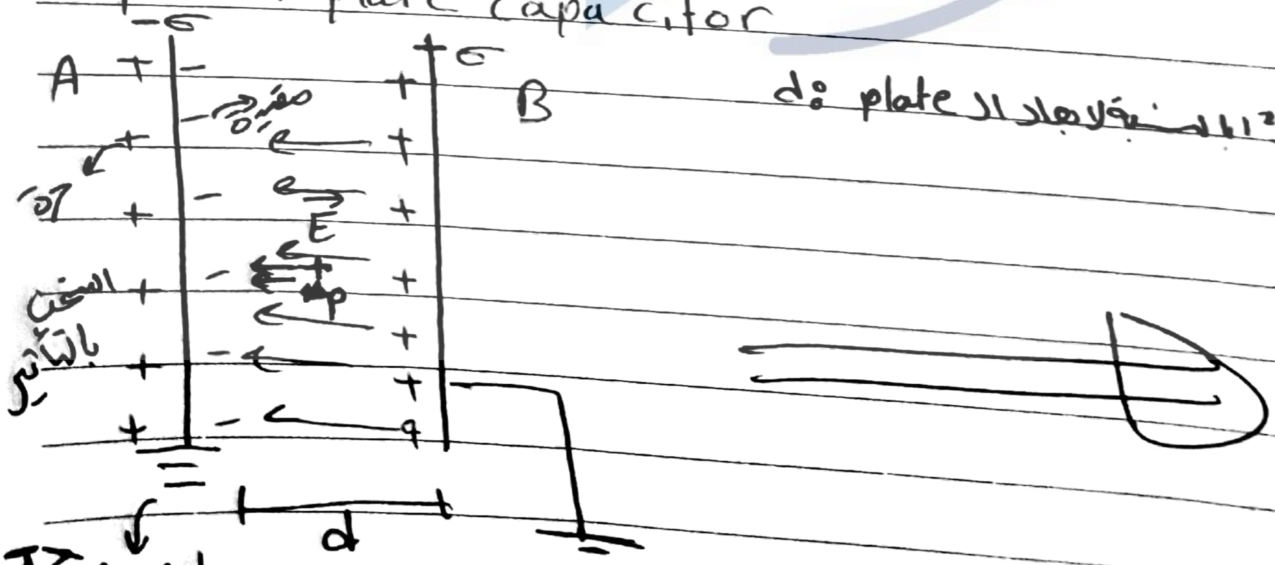
لا شحنة

$$\Rightarrow C = \frac{q}{V} = \frac{q}{K\frac{q}{a}} = \frac{a}{K} = 4\pi\epsilon_0 \cdot a \Rightarrow$$ نصف قطر السطح $\epsilon_0$




Electric Capacitor
المكثف الكهربائي

parallel plate capacitor




d: plate المسافة بين الالواح الـ صغيرة جداً

20
لأنها كبيرة
غطاء

Subject Date No.

$$\vec{E}_1 = \frac{\sigma}{2\epsilon_0}$$

$$\vec{E}_2 = \frac{\sigma}{2\epsilon_0}$$

$$\vec{E}_1 + \vec{E}_2 = \frac{\sigma}{\epsilon_0}\hat{n}$$

في الارض

$E_{out} = 0 \Rightarrow$ في الخارج

$C = \dfrac{q}{\Delta V} \Rightarrow \boxed{\Delta V = E d} \rightarrow E \propto V$ لأن مشتقة

$V = K\dfrac{q}{r}$ $\qquad E = K\dfrac{q}{r^2}$

$\dfrac{V}{E} = r \Rightarrow \Delta V = E\,r$

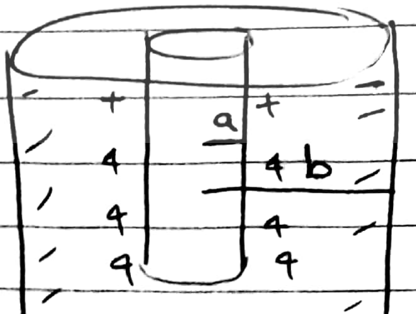
$$\Delta V = \frac{\sigma}{\epsilon_0} d = \frac{q}{A\epsilon_0} d$$

$$\Rightarrow C = \frac{q}{(q/A\epsilon_0)\,d} = \frac{\epsilon_0 A}{d}$$

$\epsilon_0 \rightarrow$ طردية $\quad A \rightarrow$ طردية $\quad d \rightarrow$ عكسية

$$\therefore C = \epsilon_0 \frac{A}{d}$$

cylinderical capacitors




$C = \dfrac{q}{\Delta V} \qquad \Delta V = V_B - V_A$

$$\Delta V = -\int_A^B \vec{E}\cdot\vec{ds}$$

Scanned by CamScanner

السعة لا تعتمد على كمية الشحنة او الجهد.

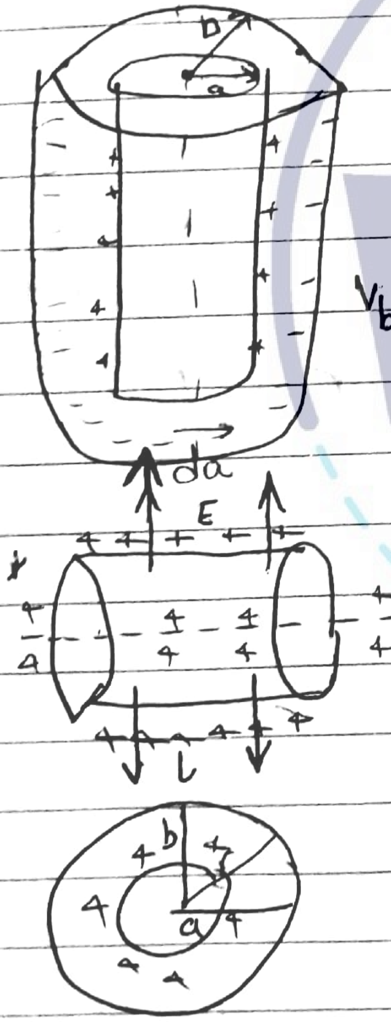
ubject Date No.

## ch 24 :- Capacitance (c)

$$C = \frac{Q}{V} \quad \text{Farad}$$

parallel plate capacitor $\quad C = \frac{\epsilon_0 A}{d}$

* cylinderical capacitor :-




$C = \frac{Q}{\Delta V}$ لانه عبارة عن صفيحتين

مكثف سعته C

متغير السعة

Source مصدر

$$V_b - V_a = -\int_a^b \vec{E} \cdot \vec{dr}$$

$$\Delta V = -\int_a^b E r dr$$

$$= -\int_a^b \frac{2K\lambda}{r} dr$$

$$= -2K\lambda \int_a^b \frac{dr}{r}$$

$$= -2K\lambda (\ln r)_a^b = -2K\lambda(\ln b - \ln a)$$

$$\int_a^b \vec{E} \cdot \vec{da} = \frac{q_{enc}}{\epsilon_0}$$

$$\Delta V = 2K\lambda \ln\left(\frac{a}{b}\right)$$

* concentric cylinedrical

$$E\, 2\pi r L = \frac{1}{\epsilon_0} \lambda l$$

$$E = \frac{\lambda}{2\pi r \epsilon_0} = \frac{2K\lambda}{r}$$

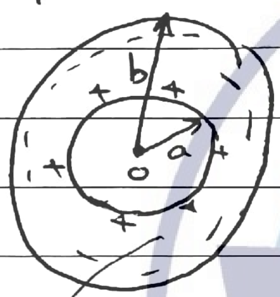
Scanned by CamScanner

Subject Date No.

$$C = \frac{Q}{\Delta V} = \frac{\lambda l}{2k\lambda \ln\left(\frac{a}{b}\right)}$$

$$C = \frac{l}{2k \ln\left(\frac{a}{b}\right)} \Rightarrow \frac{C}{l} = \frac{1}{2k \ln\left(\frac{a}{b}\right)} \quad F/m$$

Spherical capacitor :-




بنسم طاقة عازل المتعمن العد

$$C = \frac{Q}{\Delta V}$$

$$\Delta V = V_B - V_A = -\int_a^b \vec{E} \cdot d\vec{r}$$

$$= -\int_a^b E_r\, dr = -K\int_a^b \frac{Q}{r^2}\, dr$$

$$= -KQ\int_a^b \frac{dr}{r^2}$$

$$= KQ\left[\frac{1}{r}\right]_a^b$$

$$\Delta V = KQ\left[\frac{1}{b} - \frac{1}{a}\right] = QK\left(\frac{a-b}{ab}\right)$$

$$C = \frac{Q}{KQ\left(\frac{a-b}{ab}\right)}$$

$$= 4\pi\epsilon_0 \left(\frac{ab}{a-b}\right)$$

Combination of capacitor

Condesor

condense يكثف

السعات لأنه بخزن الطاقة الكهربائية

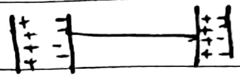
$C_1$

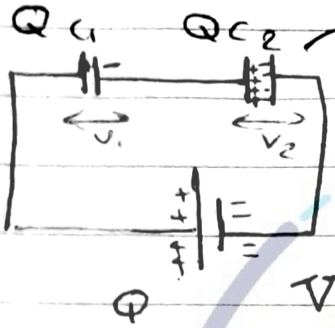
$2 \mu F$

$C_2$

$4 \mu F$

1) In series $\longrightarrow$ هيصاشن الشحنة لكن الجهد بيتجزأ






$$Q = CV$$

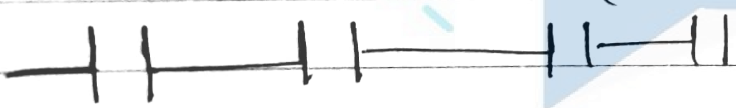
$$\frac{\cancel{Q}}{C_{eq}} = \frac{\cancel{Q}}{C_1} + \frac{\cancel{Q}}{C_2}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$


$$C_{eq} = \frac{2 * 3}{5} = \frac{6}{5} = 1.2\,MF$$

$$C_{eq} = 1.2\,MF$$

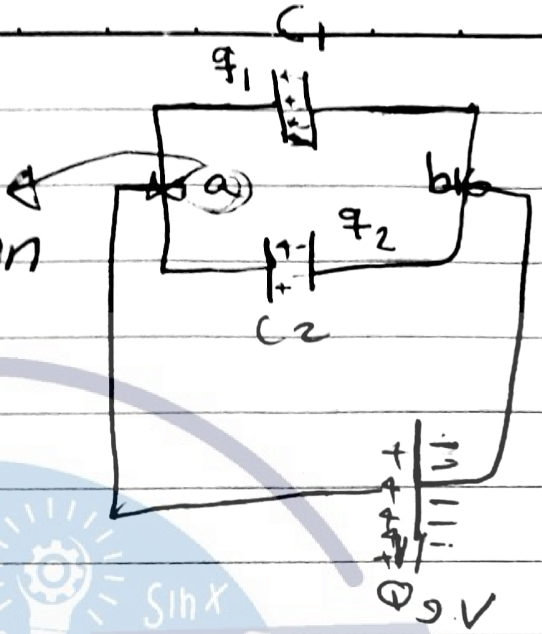



$$\frac{1}{C_{eq}} = \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = 1\,MF$$

$$C_{eq} = \frac{4\,MF}{4} = 1\,MF$$ لانهم متشابهين . $\frac{\text{احدهم}}{\text{عددهم}}$

$$\boxed{C_{eq} = \frac{C}{n}}$$

2) In parallel




$Q = q_1 + q_2$ Junction

$C_{eq} V = C_1 V + C_2 V$

$C_{eq} = C_1 + C_2$

Energy stored in the capacitor

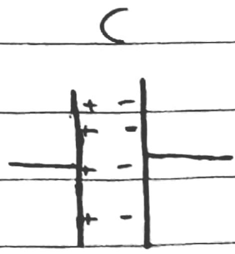
Total energy (Jol)

$V = \frac{U\ (J)}{q\ (coul)}$ volt

$\Delta U = W$

$V = \frac{W}{q} \Rightarrow dW = V\, dq$

$dW = \frac{q}{C}\, dq$




$W = \frac{1}{C} \int_0^Q q\, dq = \frac{1}{2} \frac{q^2}{C}$ J

$W = \frac{1}{2} \frac{C^2 V^2}{C}$

$U = \frac{1}{2} C V^2$

$W = \frac{q^2 V}{2q} = \frac{1}{2} q V$

Energy density

$$\frac{U}{\text{volume}} = u \quad \frac{J}{m^2}$$

$$\frac{V}{d} = E$$

parallel plate capacitor

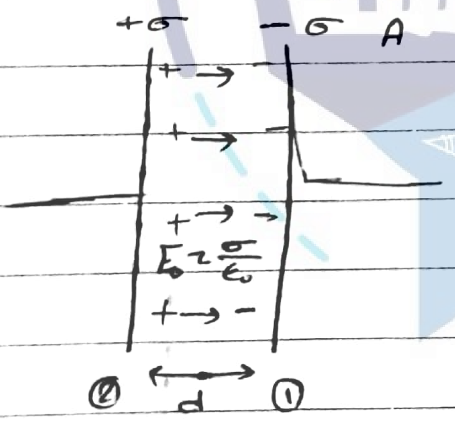
$$u = \frac{\frac{1}{2} C V^2}{Ad} = \frac{\frac{1}{2}\frac{\epsilon_0 A}{d} V^2}{2Ad} = \frac{1}{2}\epsilon_0 \frac{V^2}{d^2} = \frac{1}{2}\epsilon_0 E^2 \ (J/m^3)$$

$U = \int u \, dv$

$dU = du \, dv$ → volume element ⇒ عنصر حجم

$U = u$ volume

$d\tau = dv$

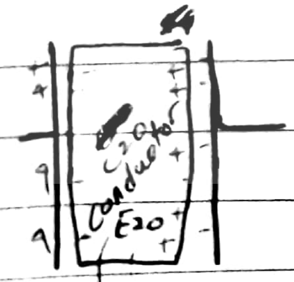



$\vec{E} = \frac{\sigma}{\epsilon_0} \hat{n}$ → المجال الكهربائي عامودي على سطح الصفيحة

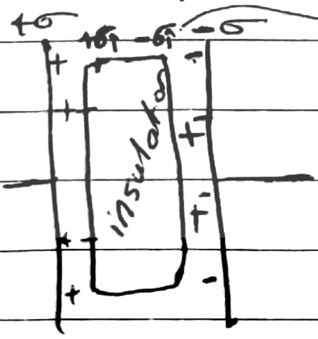
$C_0 = \epsilon_0 \frac{A}{d}$

$F = qE = ma$

$\vec{a} = \frac{q}{m} \vec{E}$




يشحن بالتأثير كليًا




$-\sigma_i$ → induced

$\sigma_i < \sigma$

$\sigma_{net} = \sigma - \sigma_i$

$\vec{E} = \frac{\sigma - \sigma_i}{\epsilon_0}$

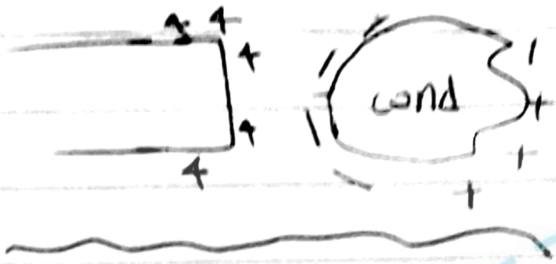
يشحن جزئيًا

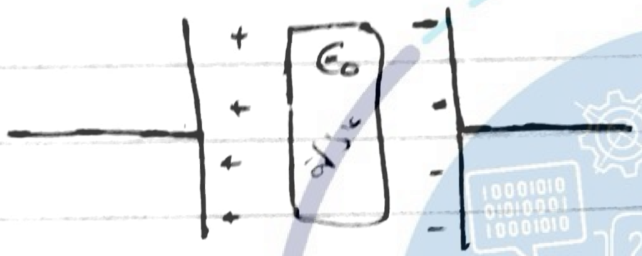
مجال كهربائي بحدود عازلة

$E_0 = \frac{\sigma}{\epsilon_0}$

المتأثر

induced charge density





$V < V_0$

$V = \frac{1}{K} (V_0)$

$E_0 , V_0$

$E = \frac{1}{K} (E_0)$

$K$ :- dieletric constant

$\frac{\sigma - \sigma_{\uparrow}}{\epsilon_0} = \frac{1}{K} \left[ \frac{\sigma}{\epsilon_0} \right]$

$\sigma - \sigma_{\uparrow} = \frac{\sigma}{K}$

$\sigma - \frac{\sigma}{K} = \sigma_{\uparrow}$

$\sigma_{\uparrow} = \sigma \left[ 1 - \frac{1}{K} \right]$

$\sigma_{\uparrow} = \sigma \left( \frac{K-1}{K} \right)$ indused charge

عند وضع مادة عازلة فإن السعة تزيد والجهد والمجال يقل

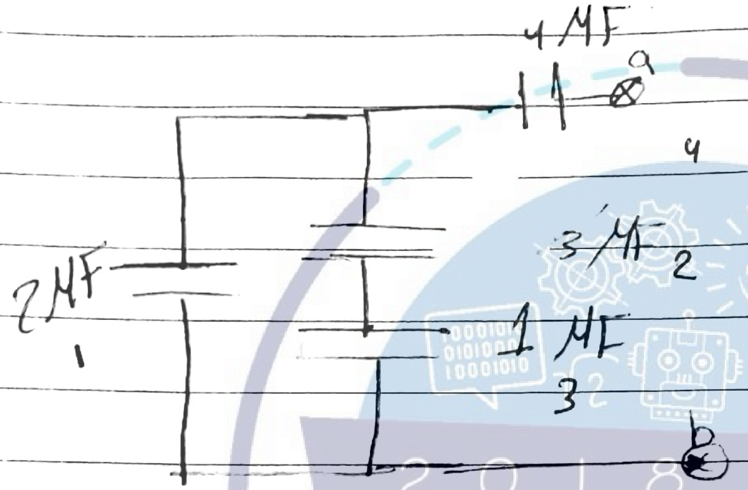
$C_0 = \epsilon_0 \frac{A}{d}$ $\qquad C = \epsilon \frac{A}{d}$

$\therefore \frac{C}{C_0} = \frac{\epsilon}{\epsilon_0} = K$

$\to C = K C_0$ تزداد C

$\to \epsilon = K \epsilon_0$ تزداد ε

Example: Find the equivalent capacitor ($C_{ab}$)
السعة المكافئة من نقطة ab

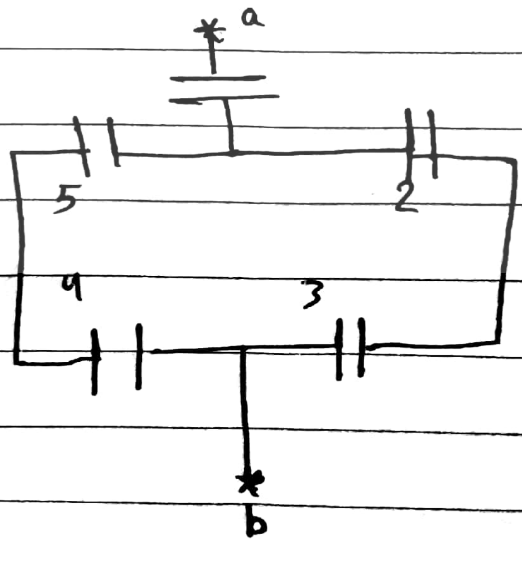


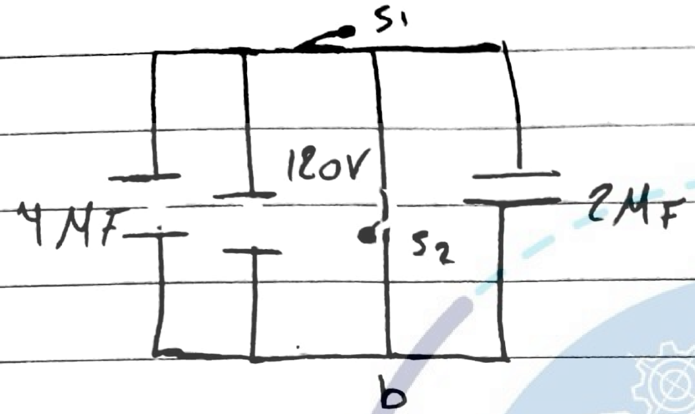

$$C_5 = \frac{C_2 + C_3}{C_2 + C_3} = \frac{3}{4} \mu F = 0.75 \mu F$$

$$C_6 = C_5 + C_1 = 2.75 \mu F$$

$$C_7 = \frac{C_6 C_4}{C_6 + C_4} = \frac{2.75 \times 4}{6.75} = \frac{11}{6.75} \mu F$$

2و3 ⇒ 6 توالي
5و4 ⇒ 7 توالي
6و7 ⇒ 8 توازي
8و1 ⇒ 9 توالي






Find the energy of $C_1$

$q = CV = 4\mu F * 120 = 480 \mu F$

← كالتوالي

2. closed $S_1$ , $S_2$ , Find the energy

← يصير توازي

$W = \frac{1}{2} C V^2 = \frac{1}{2} q V$

(1) $\Rightarrow C_{eq} = C_1 + C_2 = 6 \mu F$

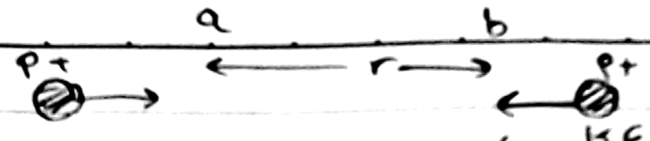
$V_{eq} = \frac{q}{C_{eq}} = \frac{480 \mu C}{6 \mu F} = 8$ Volt

$q_1 = CV \therefore q = 4 * 10^{-6} * 80 C = 320 \mu C$

$q_2 = 2 * 10^{-6} * 80 C = 160 \mu C$

$q_2 = q_{eq} - q_1 = 16 \mu C$

**23 - 7 :




$V = 1500\ m/s$

لما يوصل النقطة b طوله بتصير KE = صفر

1. Find the nearest distance between the two protons

$E_i = E_f$

$KE = \frac{K q q}{r}$ → potential energy

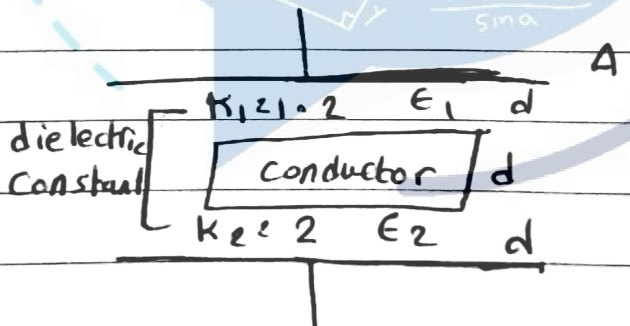
$\frac{1}{2} m v^2 + \frac{1}{2} m v^2 = \frac{K(q_p)^2}{r}$

$\therefore\ r = \frac{9 \times 10^{9} \times (1.6 \times 10^{-19})^2}{(1.67 \times 10^{-27} \times (1500)^2)}$

2. Find the maximum electric force

$F = \frac{K(q_p)^2}{r^2}$

Examples:-




permativity ← $\epsilon = K\epsilon_0$

$C_1 = \epsilon_1 \frac{A}{d}$

$C_2 = \epsilon_2 \frac{A}{d}$

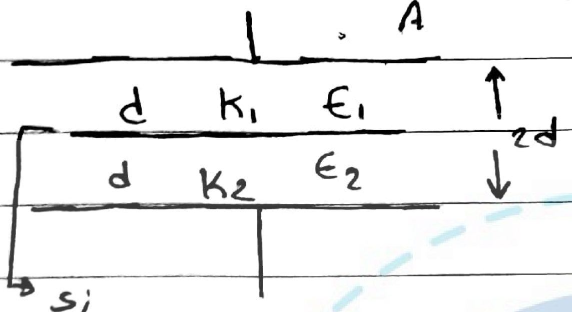
$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$

$\Rightarrow \epsilon_1 = K\epsilon_0 = 1.2 \times 8.85 \times 10^{-12}$

$\epsilon_2 = K\epsilon_0 = 2 \times 8.85 \times 10^{-12}$

Subject Date No.

Example :- Find the equivalent capacitor




زر البطارية الموازنة

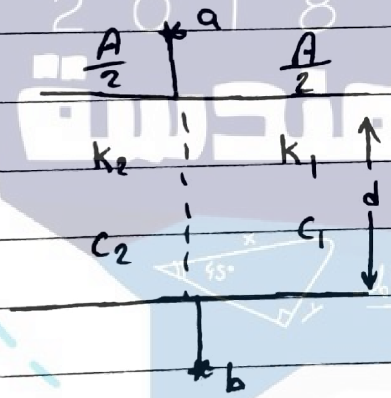
$$C_1 = \epsilon_1 \frac{A}{d}$$

$$C_2 = \epsilon_2 \frac{A}{d}$$

$$\therefore C_0 = \epsilon_0 \frac{A}{2d}$$

$$\therefore C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

Example

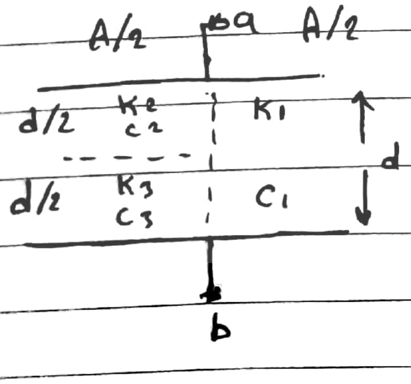



$$C_1 = k_1 \epsilon_0 \frac{A/2}{d}$$

$$C_2 = k_2 \epsilon_0 \frac{A/2}{d}$$

$$C_{eq} = C_1 + C_2$$

Example




$$C_1 = k_1 \epsilon_0 \frac{A/2}{d}$$

$$C_2 = \epsilon_2 \frac{A/2}{d/2}$$

$$C_3 = \epsilon_3 \frac{A/2}{d/2}$$

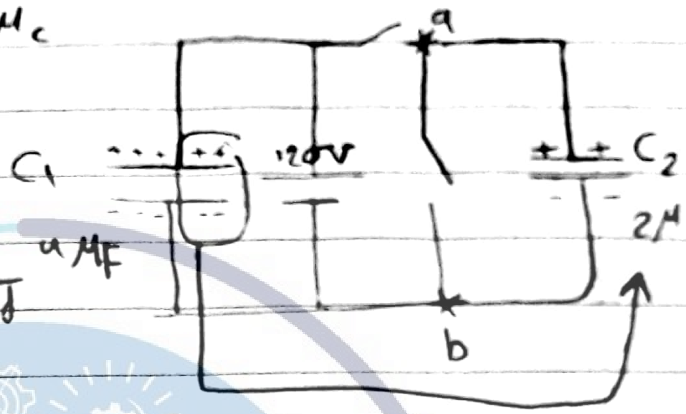
$$C_{eq} = C_4 + C_1$$

$$\therefore C_4 = \frac{C_2 C_3}{C_2 + C_3}$$

Subject Date No.

Example :- Find the charge of c

$q_1 = CV = 4\times10^{-6} * 120 = 480\ \mu c$




Find the energy stored in $C_1$

$U = \frac{1}{2} C V^2 = \frac{1}{2} * 4\mu F * (120)^2 J$

$V_a = V_b$

(3.) $q_{eq} = q_1 + q_2 = 480\ \mu C$

$\frac{q_1}{c_1} = \frac{q_2}{c_2} \Rightarrow V_a = V_b$

* Find the Final pot energy

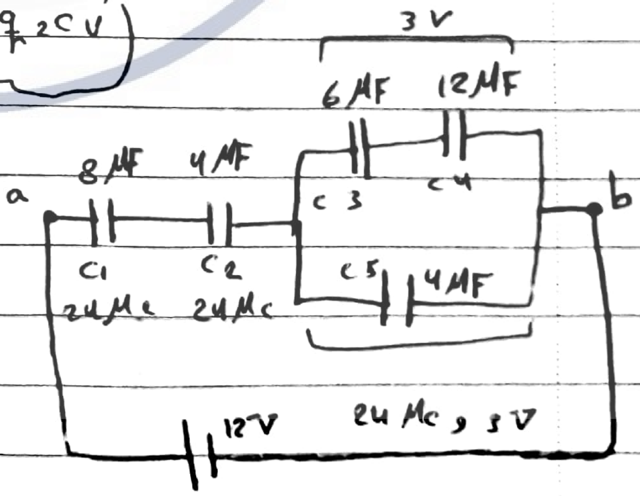
$U_f = \frac{1}{2} C_1 V^2 + \frac{1}{2} C_2 V^2$

$\therefore V = \frac{480\ \mu F}{C_1 + C_2}$ parallel $q = CV$

Example :- 24 - 51 $\therefore V_{ab} = 12\ V$

1) Find the initial energy of the system

2) Find the energy stored in $C_2$




(1) $\therefore C_6 = \frac{C_3 C_4}{C_3 + C_4} = \frac{6*12}{18} = 4\ MF$

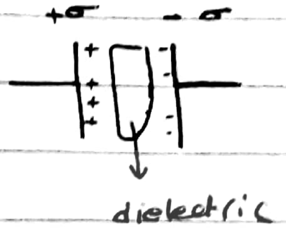
$C_7 = C_6 + C_5 = 8\ MF$

N O T E B O O K

Scanned by CamScanner

Subject Date No.

$U_1 = \frac{1}{2} C_{eq} V^2 = \frac{1}{2} * 2 * 144 * 10^{-6} = 144 \mu J.$




$V = \frac{1}{K} V_0$ $E = \frac{1}{K} E_0$

وجود العازل وعدم وجوده لا يؤثر لكن تتغير المجال الكهربائي والجهد الكهربائي

$q_{eq} = 2 \mu F * 12 = 24 \mu C$

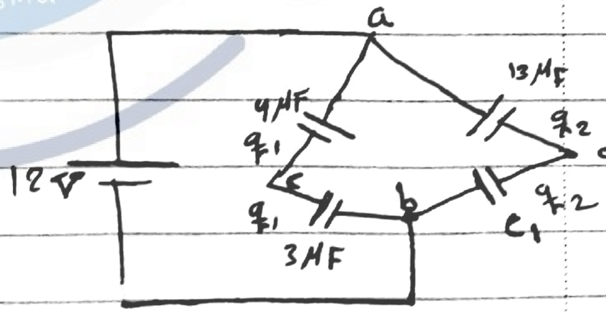
$\therefore q = CV \Rightarrow V_1 = \frac{12 * 10^{-6}}{8 * 10^{-6}} = 3 V \Rightarrow V_1 = V_2$

$\Rightarrow q_6 + q_5 = 24 \mu C \quad \therefore q_6 = q_5 = 12 \mu C$

$V_3 = 2 V$ و $V_4 = 1 V \Rightarrow V_3 + V_4 = 3 V$

(2) $U = \frac{1}{2} C V^2 = \frac{1}{2} * 4 * 10^{-6} * 6 = 12 \mu J$

Example :- Find $C_1$ if $V_{cd} = 0$




Soln:- $V_{ac} = V_{ad}$ --- (1)

$V_c - V_d = 0 \therefore V_{bc} = V_{bd}$

$q = CV$

$\Rightarrow \frac{q_1}{4} = \frac{q_2}{8}$ --- ① $\frac{q_1}{3} = \frac{q_2}{C}$ --- ②

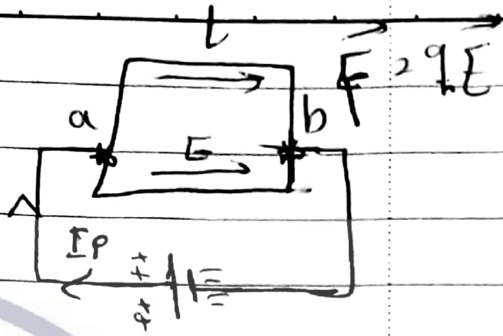
$\Rightarrow q_2 = 2 q_1 \Rightarrow \frac{q_1}{3} = \frac{2 q_1}{C_1} \Rightarrow C_1 = 6 \mu F$

$4 C = 8 * 3$
عند نقطة الاتزان كل
طرفين متقابلين
متساويين

N O T E S

Subject ch25 Date No.

Current and Risistence




$V_{ab} = E\,l$

$\Delta V = V_{ab} = V_a - V_b$

$\Rightarrow \vec{F} = q\vec{E} = m\vec{a}$

$V_a > V_b$

$\therefore \vec{a} = \frac{q\vec{E}}{m}$

البروتون لا يخضع للقانون
لانه غير مشحون

$I_p$ تيار بروتونات

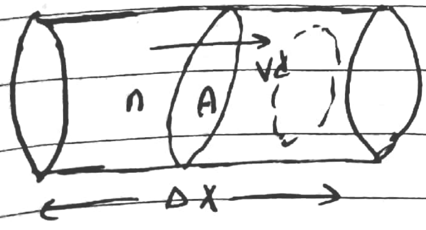
$I_e$ تيار الكترونات

$|I_p| = |I_e|$

الشحنات تسير من الجهد
الاعلى إلى الجهد الأقل

$$V_b - V_a = -\int_b^a \vec{E} \cdot d\vec{r}$$

Drift velocity حركة فوضوية ($V_d$)




n: number density carrier

$n = \frac{\text{number of total carge}}{\text{unit volume}}$

I( average electric current) $\Rightarrow I_{avg} = \frac{\Delta q}{\Delta t}$

volume $= A \cdot \Delta x = A \cdot V_d \cdot \Delta t$

$\therefore$ total number of carriers $\Rightarrow N = A \cdot V_d\, \Delta t\, n$

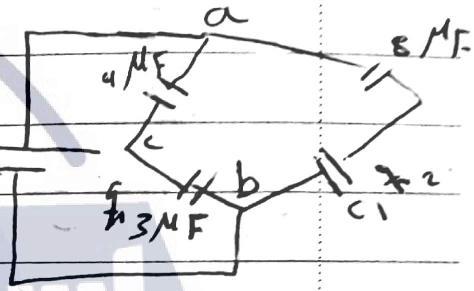
NOTEBOOK

Scanned by CamScanner

$\Delta Q = A \cdot d \cdot \Delta t \; n \cdot q$

$$\boxed{I_{avg} = \frac{\Delta q}{\Delta t} = \frac{A \cdot V_d \cdot n \cdot \Delta t \cdot q}{\Delta t} = V_d \cdot n \cdot q \cdot A}$$

$I_{avg} = \frac{\Delta q}{\Delta t}$   C/s = Ampere




Example : Find $C_1$ if $V_{cd} = 0$

soln: - $V_{ac} = V_{ad}$ —— (1)

$q = CV$

$V_c - V_d = 0$

$\Rightarrow \frac{q_1}{4} = \frac{q_2}{8}$ —— (1)    $\frac{q_1}{3} = \frac{q_2}{C_1}$ —— (2)

$\Rightarrow q_2 = 2q_1 \Rightarrow \frac{q_1}{3} = \frac{2q_1}{C_1} \Rightarrow C_1 = 6\,\mu F$

$C_2 * 4 = 8 * 3$

عند نقطة
الاتزان لأن كلا مكثفين
متصلين مشترك وبين

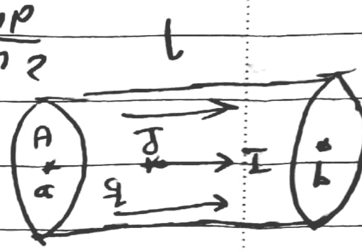
** Resistance and current

$V_{ab} = E\,l \Rightarrow V_{ab} = V_a - V_b$

$\sigma \rightarrow$ conductivity

$J \rightarrow$ current density

$J = \frac{I}{A}$   $\frac{Amp}{m^2}$




$J \propto E$   $\boxed{J = \sigma \vec{E}}$   ohm's law

$\cancel{J = \frac{V}{\sigma}}$   $J = \frac{1}{\rho}\vec{E} \Rightarrow \rho = \frac{1}{\sigma} \rightarrow$ resistivity

$J = \sigma E$

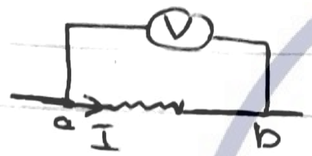
$$\frac{I}{A} = \sigma \frac{V}{L} \Rightarrow \frac{V}{I} = \frac{1}{\sigma}\,\frac{1}{A} = \boxed{\frac{\rho L}{A} = R}$$

define $\frac{\Delta V}{I} = R$ → resistance

$V = IR$ ohm's law

$V_a > V_b$

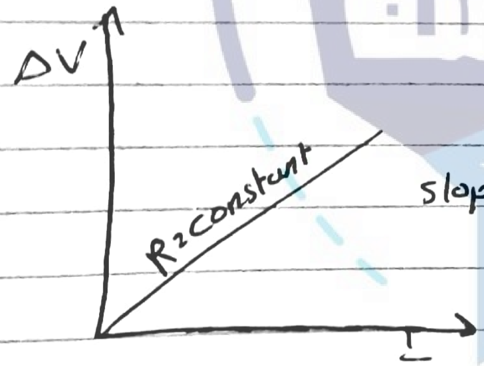
R ⇒




$V_{ab} = IR$

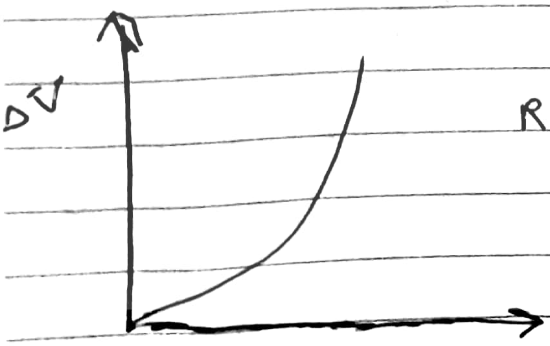
Example 10V —— 6V Find potential drop

$V_{ab} = V_a - V_b = 4\ V$




ohmic resistance

slope $= \frac{\Delta V}{I} = R$




$R \neq$ constant

$R_2 = R_1(1 + \alpha \Delta T)$

$\Delta T$ → $T_2 - T_1$

$\alpha$ → Temprature coefficient of resistance

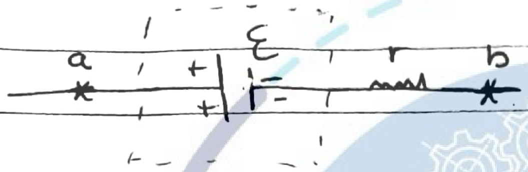
$\rho_2 = \rho_1(1 + \alpha \Delta T)$

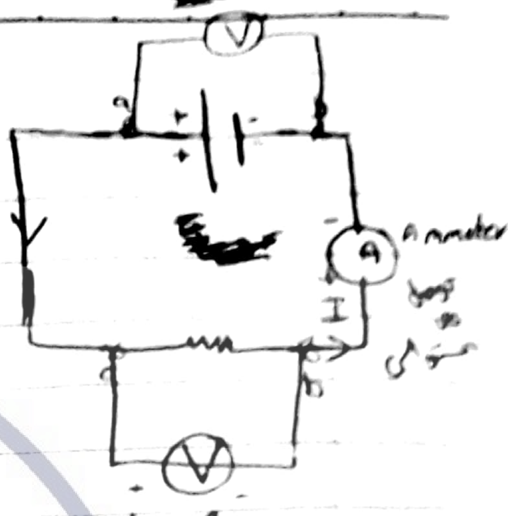
Subject Date No

emf $\mathcal{E} \rightarrow$ electromotive

$r \rightarrow$ internal resistance

Ideal source $(r=0)$




$V_{ab} \rightarrow$ external potential فرق جهد خارجي

$\mathcal{E} = IR - Ir$ ; $I = \frac{\mathcal{E}}{R+r}$

ohm's law
$V = IR$
$P = I^2 R$
$P = \frac{V^2}{R}$

* electric power :-

Energy $\Delta U = \Delta q \, \Delta V$

define the power $P = \frac{\Delta W}{\Delta t}$ J/sec = watt

* $P = \frac{\Delta q}{\Delta t} \Delta V$

مقدار الشغل المبذول خلال فترة زمنية معينة

$P = I \Delta V \Rightarrow P = \frac{V}{R}(V) = \frac{V^2}{R}$

$P = I(IR) = I^2 R$

Example :- A proton beam is strike a target. How many proton strike the target in 23 sec. If the current is 125 $\mu A$

$I = \frac{\Delta q}{\Delta t} \Rightarrow \Delta q = 125 \times 10^{-6} \times 23$

$\Delta q = n \cdot q_p \Rightarrow n = \frac{125 \times 23 \times 10^{-6}}{1.6 \times 10^{-19}}$

NOTEBOOK

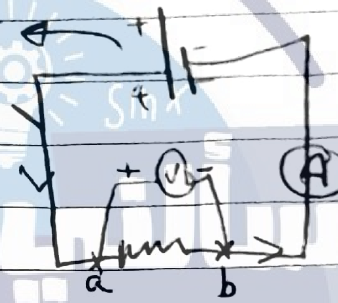
Scanned by CamScanner

Subject Date No.

Example:- A potential of 120 Volt is applied to a wire of length 150 cm with the across section area of 0.6 $mm^2$, Find the current in the copper wire of $\sigma_{cu} = 1.5 * 10^7$

Soln:- $V = IR \Rightarrow I = \frac{V}{R}$ $\therefore R = \frac{1}{\sigma} * \frac{L}{A} = \frac{1.5}{1.5*10^7 * 0.6 * 10^{-3}}$ ohm =

$I = \frac{120}{R}$

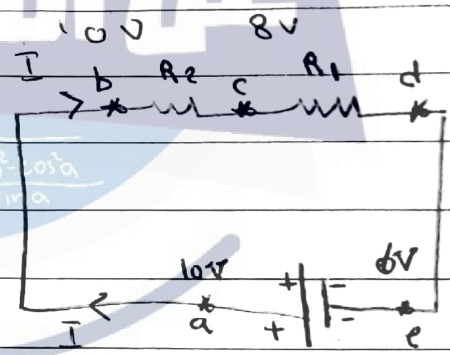



** emf $\varepsilon$

External potential $V_{ab}$

** Ressitance combination

1) Series combination




$V_b > V_c > V_d$

$V_b = V_a$ , $V_d = V_e$ بسبب عدم وجود مقاومة

$V = 120$

* الجهد يتجزأ بين المقاومات المختلفة في الدارة

$V = IR_1 + IR_2$ $IR_{eq} = IR_1 + IR_2$

$R_{eq} = R_1 + R_2$

$I_{eq} = I_1 + I_2$ | $R_{eq} = R_1 + R_2$

$V_{eq} = V_1 + V_2$

$R_{eq} \longrightarrow$ أكبر من أكبر مقاومة موجودة

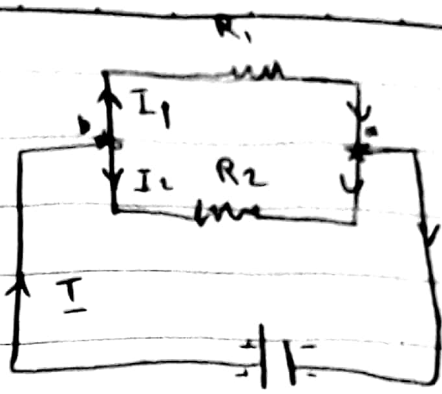
NOTEBOOK

2) parallel combination

$I = I_1 + I_2$

$V = V_1 = V_2$

$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} \quad \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$




V, r=0

$R_{eq} = \frac{R_1 R_2}{R_1+R_2} = \frac{18}{9} = 2 \ \Omega$

Example:- Find the current in the circuit


10 V , 1 Ω = r

$I = \frac{\mathcal{E}}{R_{eq}+r} = \frac{10}{5+1} = \frac{10}{6} = \frac{5}{3}$ Amp

Example:- Find the potential drop across R = 1 Ω

$V = IR = 1.66 * 1 = 1.66 \ V$

مقاومة داخلية للبسر ←

Example:- Find the internal pot. drop

$V_{internal} = IR = 1.66 * 1 = 1.66 \ V$

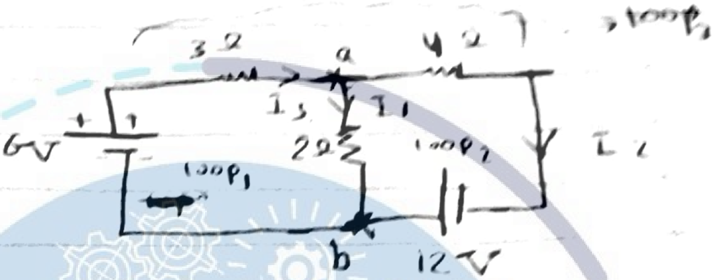
Ideal source ⇒ $V_{internal} = 0$ , Because $r = 0$

NOTEBOOK

** Kirchiff's laws

$I = \frac{\varepsilon}{R_{eq}}$ نطبق بالدارات البسيطة     branch = 3

loop = 3




1) $\Sigma I = 0$ at a junction $\boxed{a}$ OR $\boxed{b}$

at junction $\boxed{a}$ $\quad I_3 - I_2 - I_1 = 0$ --- (1)

2) $\Sigma V = 0$ over loop$_1$


$\therefore -2I_1 - 3I_3 + 6 = 0$

$(I_3 - I_2 - I_1 = 0) \times 3$

$6 - 3I_3 - 2I_1 = 0$

$3I_3 - 3I_2 - 3I_1 = 0$

$-3I_3 + 6 - 2I_1 = 0$

$(6 - 3I_2 - 5I_1 = 0) \times 4$

$(-12 - 2I_1 + 4I_2 = 0) \times 3$

$24 - 12I_2 - 20I_1 = 0$

$-36 + 12I_2 - 6I_1 = 0$

$-12 - 26I_1 = 0 \quad \therefore I_1 = \frac{-12}{26}$

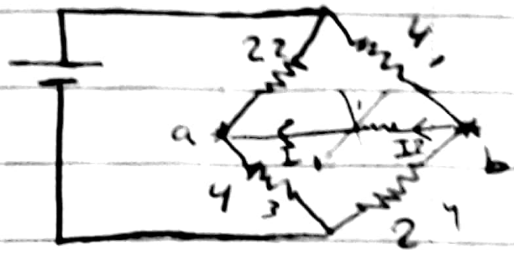
Example :-

$V_a = V_b$

1+ 2 ⇒ توازي

3 + 4 ⇒ توازي

5 + 6 ⇒ توالي




حقط مفتوحة Ω ا تلغى لكن

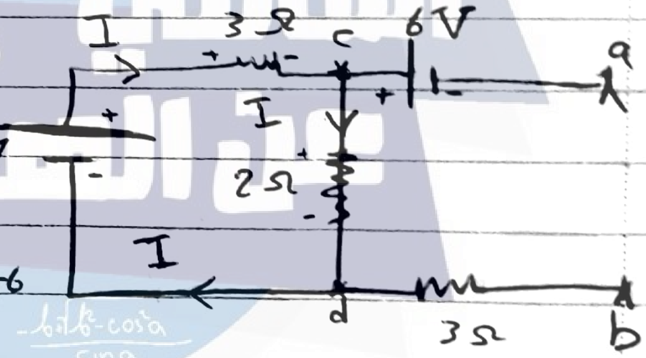
السلك نبقى $V_a = V_b$

في حال عدم التماثل نحل

بطريقة كيرشوف

* اذا أزيل السلك لسبب او لآخر فإن $V_a \neq V_b$

Example: Find $V_{ab}$




$I = \frac{\mathcal{E}}{R_{eq}+r} = \frac{12}{5} = 2.4$ Amp

$V_{ab} = V_a - V_b = (+2 * 2.4 - 6) = 4.8 - 6$

$= -1.2\ V$

لا يمر تيار في مقاومة 3Ω لانها دارة مفتوحة

* جهد b أعلى من جهد a

بسبب عدم وجود تيار بين a و b

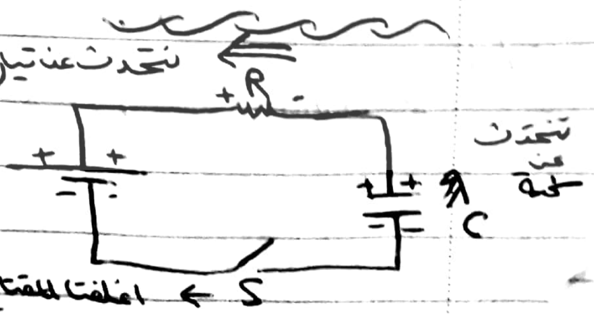
$V_{ba} = 1.2\ V = V_d$

* RC - Series combination

$\Sigma V = 0 = + \mathcal{E} - RI - \frac{q}{c} = 0$

$V_R = IR \qquad V_c = \frac{q}{c}$

$q_{max}$ الشحنة الكلية على المكثف



$q_{max}$ = الشحنة الكلية على المصدر

at $t = (0^+)$ = $+\mathcal{E} - IR - 0 = 0$

$\therefore I_{max} = \dfrac{\mathcal{E}}{R} = I_0 \longrightarrow$ at $t = 0$

بعد فترة من الزمن عند شحن المواسع كاملاً من البطارية $(I=0)$ at a large time

$$\mathcal{E} - \frac{q_{max}}{C} = 0 \qquad \therefore q_{max} = C\mathcal{E}$$

$$\mathcal{E} - IR - \frac{q}{C} = 0$$

$$\mathcal{E} - \frac{dq}{dt}R - \frac{q}{C} = 0$$

$$\mathcal{E} = \frac{dq}{dt}R + \frac{q}{C} = 0 \quad \therefore \frac{\mathcal{E}C - q}{CR} = \frac{dq}{dt}$$

$$\Rightarrow \int_0^q \frac{dq}{\mathcal{E}C - q} = \int_0^t \frac{dt}{CR} \Rightarrow -\ln(\mathcal{E}C - q)\Big]_0^q = \frac{t}{RC}$$

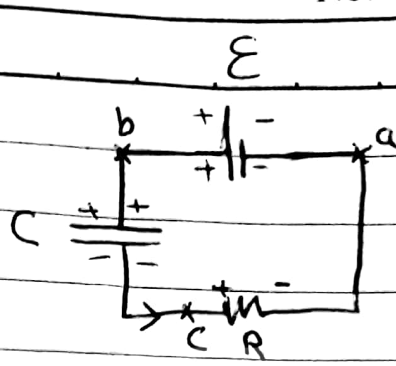
$$\therefore \frac{-t}{RC} = \ln|\mathcal{E}C - q| - \ln|\mathcal{E}C| = \ln\frac{\mathcal{E}C - q}{\mathcal{E}C}$$

$$\therefore \frac{\mathcal{E}C - q}{\mathcal{E}C} = e^{-t/RC} \Rightarrow e^{-t/RC} = \frac{q_{max} - q}{q_{max}}$$

$$e^{-t/RC} * q_{max} = q_{max} - q \qquad \therefore q = q_{max}\left(1 - e^{-t/RC}\right)$$

Scanned by CamScanner

R-C - series ~~ckt~~ circuit




$\sum V = 0$

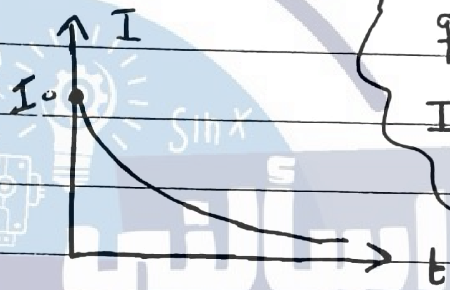
~~$+\mathcal{E} = -$~~

$+\mathcal{E} - \frac{q}{c} - IR = 0$

for a long time

$q = q_{max} \left[1 - e^{-t/Rc}\right]$

$I = I_o e^{-t/Rc}$




$q_{max} = C\mathcal{E}$

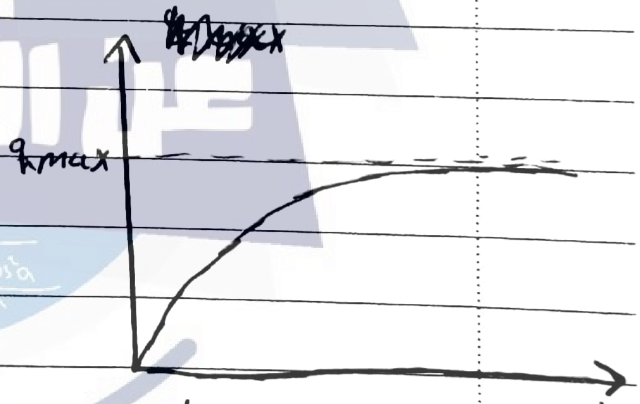
$I_o = \frac{\mathcal{E}}{R}$

$t = 0$

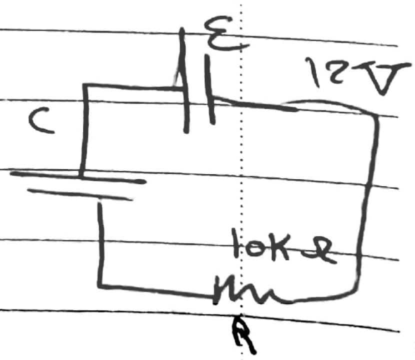
$I = I_o e^{-t/RC} \Rightarrow I = I_o e^{-t/\tau}$

$\frac{t\,(sec)}{RC}$

RC $\Rightarrow$ Time constant $= \tau$




along tim $= 4\tau$ or $5\tau$




Example :- If $I_o = 100$ A , Find I

$\tau = RC = 10 * 10^3 * 10^{-6} * 6 = 60 * 10^{-3} = 60ms$

$I = I_o e^{-t/\tau} \Rightarrow t = \tau \quad \therefore I = I_o e^{-1}$

اختيار

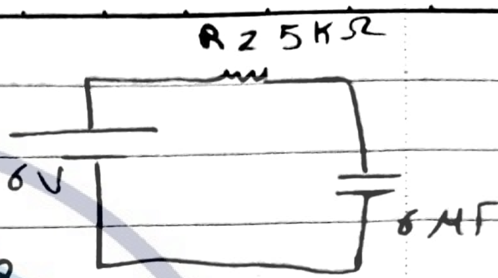
$I = \frac{I_o}{e} = \frac{I_o}{2.7} \simeq 0.36 I_o = 36A$

$\therefore 4\tau = 240mS = 0.24S$

Scanned by CamScanner

1. Find the $\tau$

$\tau = 30 * 10^{-3} = 30\ ms$

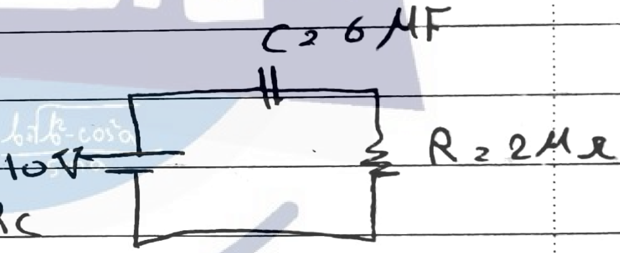



2. Find the current after 10 ms in the R

$I = I_{max}\ e^{-t/RC}$

$I_{max} = \frac{\varepsilon}{R} = 1.2\ mA$

Example:- Find the time for the resister to have a current of $\frac{I_0}{10}$



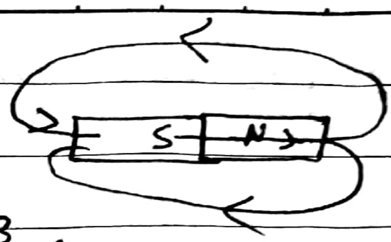

$I = I_0\ e^{-t/RC}$

$\frac{\cancel{I_0}}{10} = \cancel{I_0}\ e^{-t/RC} \rightarrow -\ln 10 = -t/RC$

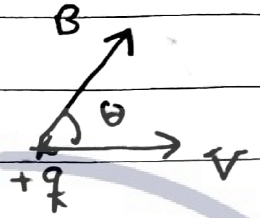
$\therefore t = RC \ln 10$

Ch 27

* Magnetism




$\vec{F}_B = q(\vec{V} \times \vec{B})$




$\vec{F}_B = qVB\sin\theta$

** Magnetic flux

$\phi_e = \int_{surface} \vec{E} \cdot d\vec{a} = \frac{q_{enc}}{\epsilon_0}$

$\phi_m = \int_{sur} \vec{B} \cdot d\vec{a}$

*** Gauss's law :-

$\phi_m = \int_{sur} \vec{B} \cdot d\vec{a} = 0$

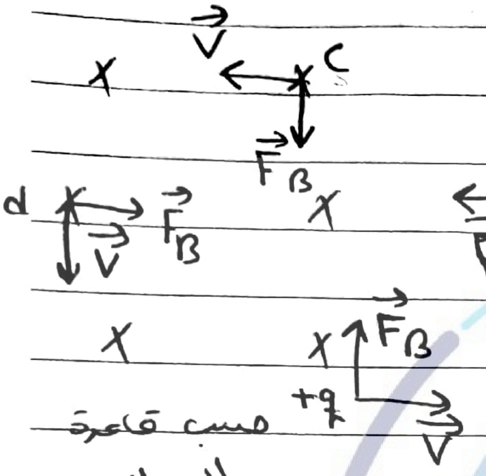
**** Magnetic field + Electric field

$\vec{F}_{net} = q[\vec{E} + \vec{V} \times \vec{B}]$ ⇒ Lorentz Force

$\vec{F}_B = q(\vec{V} \times \vec{B}) = qVB\sin\theta$

$N = C\frac{m}{s}B \rightarrow B = \frac{N.S}{C.m} =$ Tesla (T)

* charged particle in a magnetic field.




$\vec{B} = 10\hat{k}$ Tesla

$\Rightarrow F_B = q(\vec{V} \times \vec{B})$

$= qVB\sin\theta$

$= qVB$

حسب قاعدة اليد اليمنى

$\rightarrow \frac{mV^2}{R} = qVB \quad \therefore \frac{mV}{R} = qB$

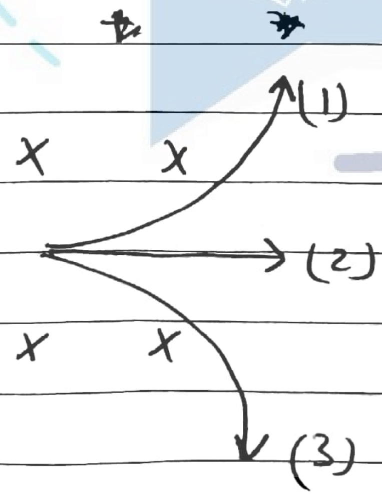
$\rightarrow \boxed{V = \frac{qBR}{m}}$ m/s

Example

$\pm n \rightarrow (2)$

$+p \rightarrow (1)$

$-e \rightarrow 3$




V linear velocity m/s

$\omega$ angular velocity Rad/s

$V = \omega R$

$\boxed{\therefore \omega = \frac{qB}{m}}$

$V = \frac{2\pi R}{T}$ $\quad T$ زمن الدورة الواحدة

$T = \frac{2\pi R}{V}$

$$F = ma = qE$$

$+q$

$$\therefore a = \frac{qE}{m}$$

لانه القوة المغناطيسية لا تؤثر

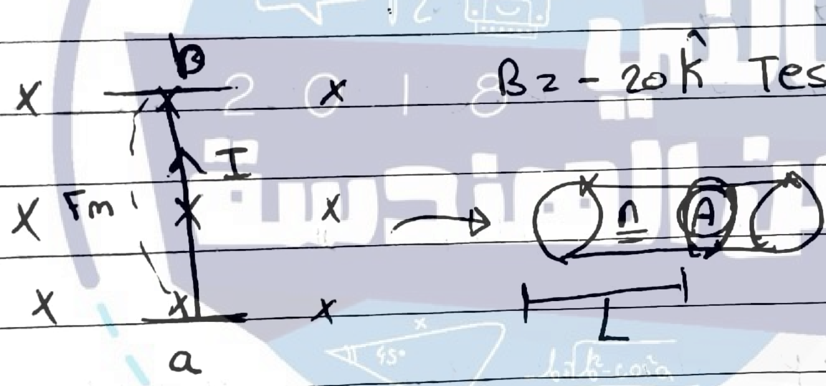
في السرعة فقط تؤثر في الاتجاه

$\Rightarrow$ The magnetic work $= 0$

$$W = \Delta KE = \frac{1}{2} m V^2 \longrightarrow W = 0$$

*** conducting wire in a magnetic field carrying a current

$B = -20\hat{k}$ Tesla




~~V = A~~ $V = AL$

no. of charges $nAL$

$$F_{total} = nALq(\vec{V}_d \times \vec{B})$$

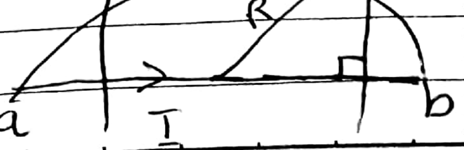
$$= nALq V_d B \sin\theta \longrightarrow I = nAV_d q$$

$$= I(\vec{L} \times \vec{B})$$

* Example:- semi circle in a uniform magnetic field $\vec{B} = B_0 \hat{j}$

* Find the magnetic force

1) Force on a streight wire ab




$\rightarrow \vec{F} = I(\vec{I} \times \vec{B})$

$\vec{F} = I \cdot 2R \cdot B \; \hat{k} \; (N)$

$$\vec{F}_{mag} = q(\vec{V} \times \vec{B}) = I(\vec{L} \times \vec{B}) \Rightarrow I = AnV_d q$$

Subject Date No.

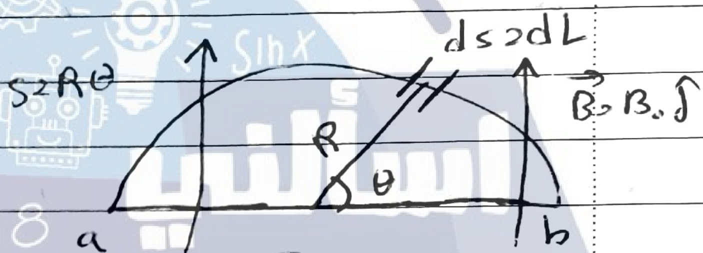
$\vec{F}_{mag} = I(\vec{L} \times \vec{B})$

$\vec{F}_B = \int I(dL \times B)$

$F_B = I \int dL \times B = I \int dL \sin\theta = IB \int \sin\theta \, dL$

Example

$\vec{F}_B$ (wire)

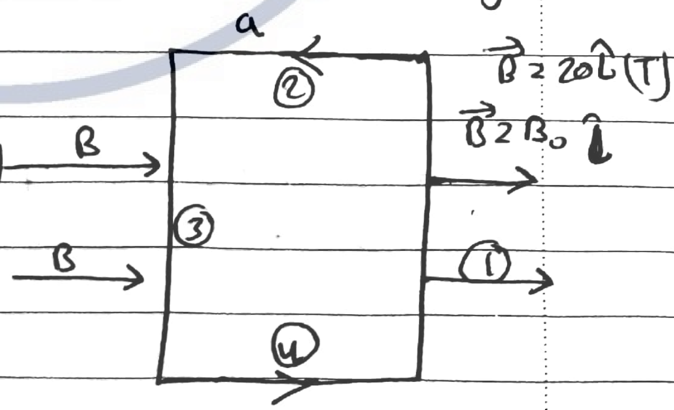



$F_B = IB \int R \, d\theta \sin\theta$

$= IBR \int_0^{\pi} \sin\theta \, d\theta = IBR(-\cos\theta)\Big|_0^{\pi} = 2IBR(-\hat{k})$

$\therefore \vec{F}_{net} = 0$ القوة المغناطيسية لل loop (الجسم المغلق) بساوي صفر

** A conducting loop carring a current in a uniform magnetic field.




القوة المغناطيسية المؤثرة على حلقة = صفر لأنه مغلق

part 1 :- $\vec{F}_1 = I(\vec{L} \times \vec{B}) = ILB(-k)$

part 2 ; $\vec{F}_2 = 0$

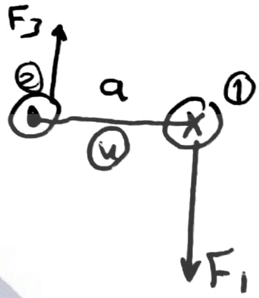
part 3 ; $\vec{F}_3 = ILB(k)$

part (4) ; $\vec{F}_4 = 0$

$\rightarrow \vec{F}_{eq} = ILB(-\hat{k}) + ILB(\hat{k}) = 0$

قوتين متساويتين مقدارًا ومتعاكستين اتجاهًا

( Torque )




$\tau = F \cdot d = I L B a = I A B$

define $= I A = \mu$ magnetic dipole moment

( استقطاب ثنائي مغناطيسي

$\vec{P} = q d$ استقطاب ثنائي كهربائي

$\tau = \mu B$ single loop

$\mu = N I A$ $\therefore \tau = N \mu B$ لو كان اكثر من لفة

$\Rightarrow \tau = \vec{\mu} \times \vec{B}$ مغناطيسي

$\tau = \vec{P} \times \vec{E}$ كهربائي

$U = -\vec{\mu} \cdot \vec{B} = -\mu B \cos\theta$ (Joul)

Subject Date No.

Example :- A proton with velocity $\vec{V} = 2i - 4j + \hat{k}$ m/s in a region of magnetic field $\vec{B} = \hat{i} + 2\hat{j} - \hat{k}$ Tesla, Find the magnetic force

$\vec{F} = q(\vec{V} \times \vec{B})$

$= 1.6 * 10^{-19} \left( (2\hat{i} - 4\hat{j} + \hat{k}) \times (\hat{i} + 2\hat{j} - \hat{k}) \right)$

$= 1.6 * 10^{-19} \left( 4\hat{k} + 2\hat{j} - 4(-\hat{k}) + 4\hat{i} + \hat{j} - 2\hat{k} \right)$

$= 1.6 * 10^{-19} ( 2\hat{i} + 3\hat{j} + 8\hat{k})$

اتجاه $F_g$ باتجاه ال $\hat{i}$

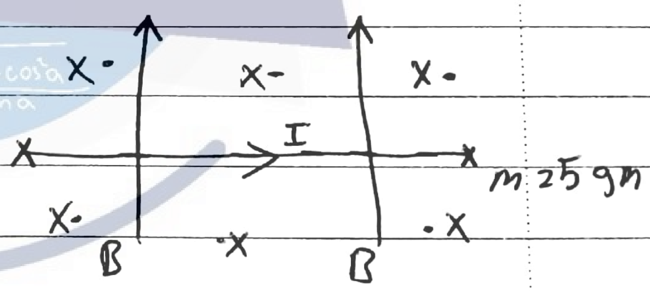
$\vec{F} = 2\hat{i} + 3\hat{j} + 3\hat{k}$

$\cos\theta = \frac{2}{\sqrt{4+9+64}}$ او $\sin\theta = \frac{3}{\sqrt{\ }}$

$\vec{A} = 2\hat{i} + 3\hat{j}$

الاتجاه

$\tan\theta = \left(\frac{3}{2}\right) \rightarrow \theta = \tan^{-1}\left(\frac{3}{2}\right)$




Example :- $B = B_0 \hat{k}$

$\vec{F}_m = I \ell B (\hat{k})$

$\vec{F}_m = I \ell B(-\hat{j})$

$\vec{F}_{net} = mg + I \ell B(-\hat{j})$

$\vec{F}_m = I \ell B(\hat{j})$

$\vec{F}_{net} = I \ell B - mg$

Example :- Electron beam are accelerated from rest throught a pot. diff of 250 Volt. The electrion travell in a circular path with a radius 1.5 cm. Find the magnetic field if it is normal to the beam.

$\frac{1}{2} m V^2 = q \Delta V$

$\frac{1}{2} * 9.1 * 10^{-31} V^2 = 1.6 * 10^{-19} * 250 \quad \therefore V = 1.11 * 10^{-1}$ m/s

~~$\frac{1}{2} * 9.1 * 10^{-31} V^2 = 1.$~~

$\longrightarrow q V B = \frac{m V^2}{R} \quad \therefore B = \frac{m V}{q R} = \frac{9.1 * 10^{-31} * 1.11 * 10^{-1}}{7.5 * 10^{-2} * 1.6 * 10^{-19}} = 8.4 * 10^{-9}$ Tesla

*Example :- A rectangular coil of dimension $5.4 * 8.5$ cm consists of 25 turns and carries a current of 15mA, A 0.35 T magnetic field is applied parallel to the plane of the loop

a) calculate the magnetic dipole moment

$\vec{\mu} = N I A = 25 * 15 * 10^{-3} * (8.5 * 5.4) * 10^{-4} = 1.7 * 10^{-3}$ A.m²

b) The magnitude of the torque

$\vec{\tau} = \vec{\mu} \times \vec{B} = \mu B \sin\theta = 1.7 * 10^{-3} * 0.35$ N.m

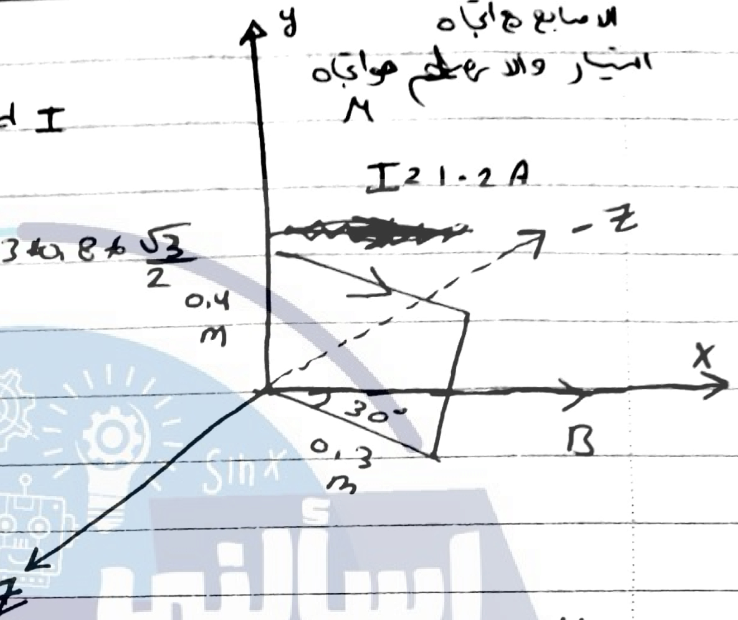
Subject Date No.

$\theta < M$ $\quad A \perp M$

Example :- If $\vec{B} = 0.8\hat{i}$ Tesla, Find $I$

$\tau = MB\sin\theta \rightarrow \sin 60$

$= IAB \frac{\sqrt{3}}{2} = 1.2 * 0.4 * 0.3 * 0.8 * \frac{\sqrt{3}}{2}$




* ch 28 :-

sources of the magnetic fied

** Biot - Savart law :-

* pormeability $M_0$

$F_e = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r}\hat{r}$ $\qquad$ $\vec{d}B$ ~~$F_m$~~ $= \frac{M_0}{4\pi} \cdot \frac{I\vec{ds} \times \hat{r}}{r^2}$

I موجه
الممانعة

$\rightarrow B = \frac{M_0}{4\pi}\int \frac{I\,\vec{ds} \times \hat{r}}{r^2} = \frac{M_0 I}{4\pi}\int \frac{\vec{ds} \times \hat{r}}{r^2}$

~~Ex~~

Scanned by CamScanner

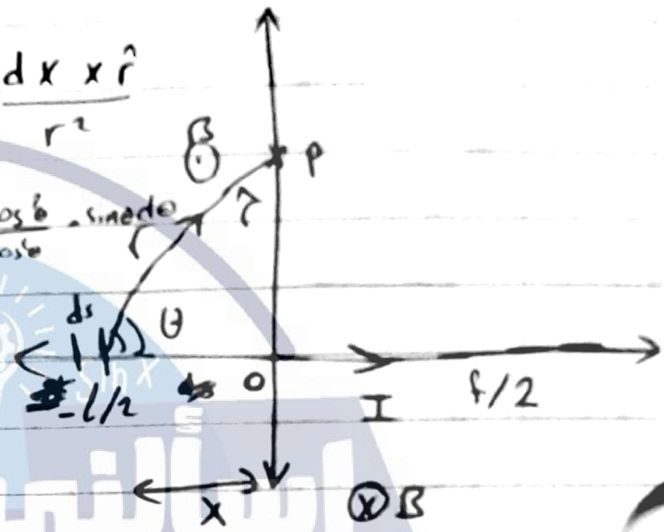
Subject Date No

Example:- Find the magnetic field at point p

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

$$= \frac{\mu_0 I \hat{k}}{4\pi}\int \frac{dx \sin\theta}{r^2} = \frac{\mu_0 I \hat{k}}{4\pi}\int_{\theta_1}^{\theta_2} \frac{a\cos\theta}{a^2\cos\theta}\,.\sin\theta d\theta$$

$$= \frac{\mu_0 I \hat{k}}{4\pi}\left[\frac{-\cos\theta}{a}\right]_{\theta_1}^{\theta_2}$$




$$= \frac{-\mu_0 I \hat{k}}{4\pi a}(\cos\theta_2 - \cos\theta_1)$$

$r = \frac{a}{\sin\theta} = a\csc\theta$

لو كان طول السلك عدد

** المجال المغناطيسي على امتداد السلك يساوي صفر دائماً

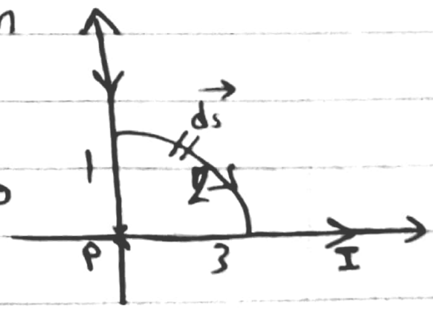
** Very long wire $\vec{B} = \frac{\mu_0 I \hat{k}}{4\pi a} = \frac{\mu_0 I \hat{k}}{2\pi a}$ Tesla


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

Example :- Find the magnetic field at the origin

$B_1 = B_3 = 0$ $\quad s = R\theta \rightarrow ds = R d\theta$

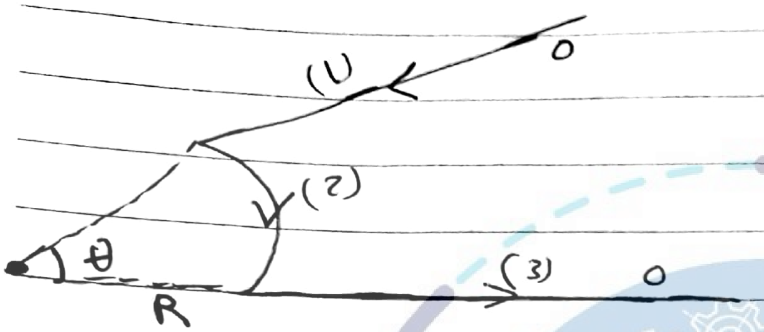
$$B_2 = \frac{\mu_0 I}{4\pi}\int \frac{\vec{ds}\times\hat{r}}{r^2} = \frac{\mu_0 I R}{4\pi R^2}\int_0^{\pi/2} \sin\theta d\theta$$

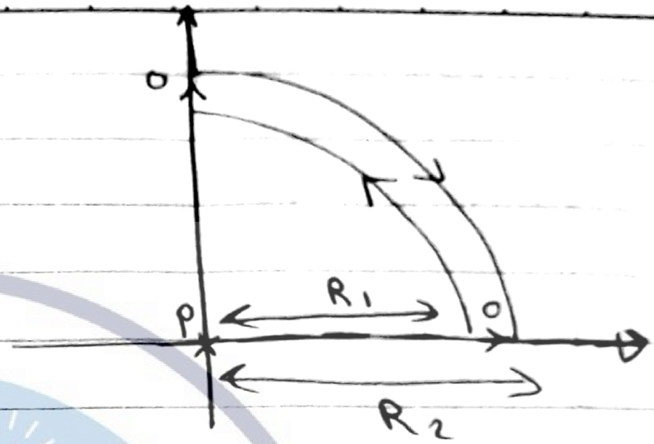



$$= \frac{\mu_0 I}{4\pi R}\left[-\cos\theta\right]_0^{\pi/2} = \frac{-\hat{k}\mu_0 I}{4\pi R}$$

$$= \frac{-\mu_0 I \hat{k}}{4\pi R} \text{ Tesla}$$

Subject Date No.



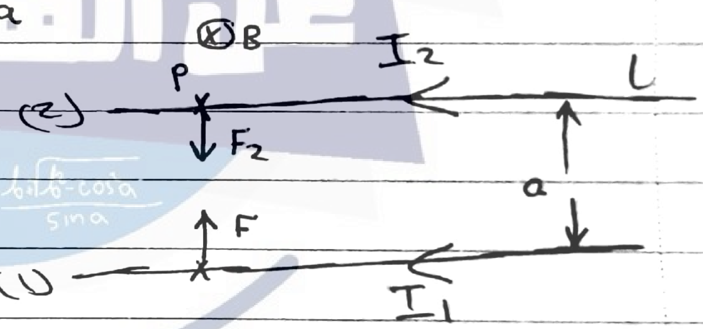




** magnetic force between two parallel wire

$$F_{mag} = I(\vec{L} \times \vec{B})$$

$$\vec{F}_2 = I = L B_1 = \frac{I_2 \, l \, I_1 \mu_0}{2\pi a}$$

$$\vec{F}_1 = \frac{I_1 I_2 \, l \, \mu_0}{2\pi a}$$



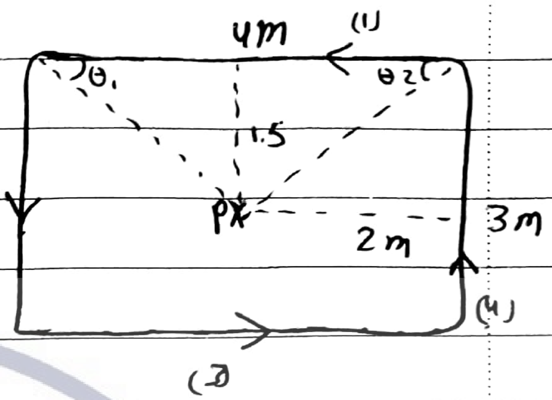

اتجاه التيار نفسه ⇐ تجاذب بين السلكين
متعاكس ⇐ تنافر
] عكس الكهربا

$$F = \frac{\mu_0 I_1 I_2 \, l}{2\pi a}$$

اتجاه F يعتمد على اتجاه التيارين في الأسلاك

Force perunit length $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi a}$ (N/m) لا تعتمد على طول السلك

Example:- Find the magnetic field at the center of the rectangle




$$B_1 = \frac{-\mu_0 I}{4\pi a}\left[\cos\theta_2 - \cos\theta_1\right)\cdot\hat{K}$$

$B_1 = B_2$ , $B_2 = B_4$

$B_{net} = B_1 + B_2 + B_3 + B_4 = 2B_1 + 2B_2$

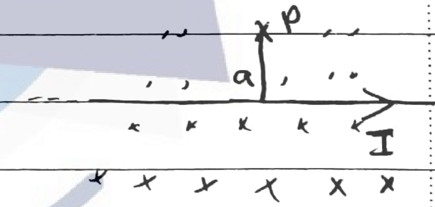
** magnetic flux:-

$\oint_m = \int_S \vec{B}\cdot d\vec{a}$ $\qquad \Phi_m = \oint \vec{B}\cdot d\vec{a} = 0$ Gusse's law magnetic

→ close loop

$$\Rightarrow \Phi_E = \int \vec{E}\cdot d\vec{a} = \frac{q_{enc}}{\epsilon_0}$$

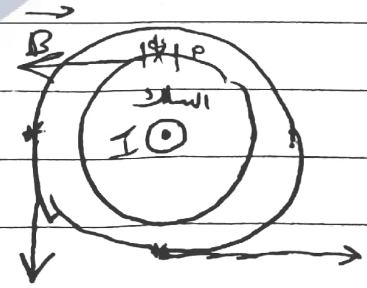
** Amper's law:-




$$B = \frac{\mu_0 I}{2\pi a}\hat{K}$$

$\int \vec{B}\cdot d\vec{s} = \int B\, ds$

Amperian loop




المجال عمودي على نصف القطر
خط وهي مغلقة قيمة المجال
المغناطيسي ثابتة عند اي نقطة عليه

$$\Rightarrow B\int ds = BS = 2B\pi K = \frac{\mu_0 I}{2KR} \rightarrow B = \mu_0 I$$

$$\therefore \int \vec{B}\cdot d\vec{s} = \mu_0 I$$