ملخصات السنافر

لجنة سنافر البوليتكنك - الاتجاه الإسلامي

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فيزياء ٢

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CH 23: Electric fields

23.1 Proparties of elecrric charge:

→ Electric charge have the following important Properties:

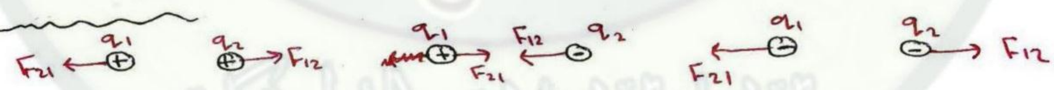
* charge of opposite sign attract one another and charge of the Some sign repal one another.
* Total charge in an isolated system is conserved.
* charge is quantized.

→ we can clussfied the materials to:

* Conductors:
  materials in wich electron move freely.
  ((EX: Iron, copper, gold)).

* Semi conductors:
  their electrical Properties are Somewhere Between Conductors and insulators.
  ((EX: Silicon, germanum)).

* Insulators:
  material in which electron don't move freely.
  ((EX: Rubber, wood)).



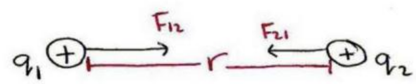
$$q = n * e^-$$

Ex: $q = +1\ \mu.C$

$$n = q/e^- = \frac{1*10^{-6}\ C}{1.6*10^{-19}\ C} = 6.25*10^{12}$$

23.2 Colombs Low :-

➡ Using to find the electrice force exerted by charg (q_1) on a second charge (q_2) ...



- The electric force between two charge is Propotional to the invers square of the distance.

$$F_c = \frac{K \cdot q_1 q_2}{r^2}$$ save

where :-

- K : Coullomb's constant and equal ($8.99 * 10^9$) ...
- q_1, q_2 : value of two charge ...
- r : distace between two charge ...

- The smallest unit of charge (e) is known in Nature is the charge on an electron (-e) or Proton (+e) and has a magnitude ...

23.3 The Electric Field :-

➡ It's defined as the electric force that act's on Small Positive test charge Placed at that Point divided by the magnitude of the test charge ...

- $E = Fe / q_0$

But : $Fe = \frac{K \cdot q \cdot q_0}{r^2}$

$\Rightarrow \frac{K \cdot q \cdot \cancel{q_0}}{r^2 \cdot \cancel{q_0}} \rightsquigarrow \boxed{E = \frac{K \cdot q}{r^2}}$ Save

$E = \frac{k \cdot q}{r^2}$ ...

where :-

- k : Coulomb's constant.
- q : Value of exerted charge.
- r : distance between charge and Point.

- if "q_0" is Positive ⇒ Electric field have a same diriction of electric force ...
- if "q_0" is negative ⇒ Electric field have opposite diriction of electric force...

23.4 Electric field of a cont. charge Distribution :-

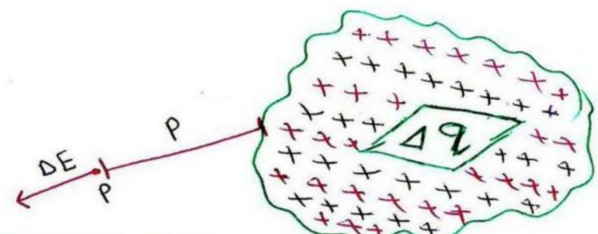
⇒ To evalute the electric field created by cont. charge distribution :-

- Divide the charge distribution into small element's, each of wich contains as mall charge "q" ...
- use the equation ; $E = \frac{k.q}{r^2}$ to Calculate the eletric field due to one of elements out Point "P" ...
- Evaluate the total electrical field of "P" ; By summing the contributions of all charge...

$$\Delta E = \frac{k \cdot \Delta q}{r^2}$$

$$E = k \cdot \sum \frac{\Delta q}{r^2}$$

$$E = E \cdot \lim_{\Delta q \to 0} \sum \frac{\Delta q}{r^2}$$



$$\boxed{E = k \cdot \int \frac{dq}{r^2}}$$

((ممكن يطلب بسؤال كيفية إيجاد هذا القانون))...

- There is three types of charge distribution :
  - Volume charge density :-
    - → charge " Q " is uniformly distributed thoghout a volume.
    - → $\rho = \frac{Q}{V} \Rightarrow (C/m^3)$.
    - → $dq = \rho \cdot dv$
  - surface charge density :-
    - → charge " Q " is uniformly on a surface of Area ((A)).
    - → $\sigma = \frac{Q}{A} \Rightarrow (C/m^2)$.
    - → $dq = \sigma \cdot dA$.
  - linear charge density :-
    - → charge " Q " is uniformly distributed along a line of length (L).
    - → $\lambda = \frac{Q}{L} \Rightarrow (C/m)$.
    - → $dq = \lambda \cdot dL$.

~ " ~ " ~ " ~ " ~ " ~ " ~ " ~ " ~ "

عند حل أي سؤال على التوزيعات المنتظمة نقوم بـ :-

↤ التطبيق على القانون : " $E = K \cdot \int \frac{dq}{r^2}$ "

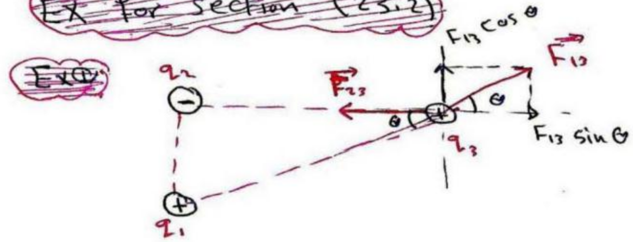
↤ التعويض عن قيمة " dq " بأحد التالية وحسب شكل السطح :

$dq = \rho \cdot dv$; $dq = \sigma \cdot dA$; $dq = \lambda \cdot dL$.

↤ نضع العلاقة المناسبة ثم نكامل العلاقة على الحدود القصوى للتكامل .

Ex for section (23.2)

Ex①



$q_1 = q_2 = 5\ \mu C$

$q_3 = -2\ \mu C$

$\theta = 45°$.

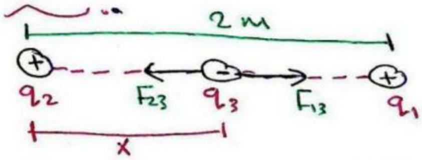
Sol: $F_{13} = (k_e\, q_1 q_3)\backslash r^2 = 1.1\ N$

$F_{23} = (k_e\, q_2 q_3)\backslash r^2 = 9\ N = -9\ \underline{i}\ N$ تدل على الإتجاه

$F_{13x} = F_{13}\sin 45° = 7.9\ N$.

$F_{13y} = F_{13}\cos 45° = 7.9\ N$.

Ex②



$q_1 = 15\ \mu C$.

$q_2 = 6\ \mu C$

على أي بعد توضع الشحنة الثالثة حتى تصبح القوة الثالثة = صفر ؟

Sol: $F_3 = 0$

$F_{13} = \dfrac{K\, q_1 q_3}{(2-x)^2}$; $F_{23} = \dfrac{K\, q_2 q_3}{x^2}$ [ومتى تكون القوة الثالثة تساوي صفر يجب أن تتساوى القوتان]

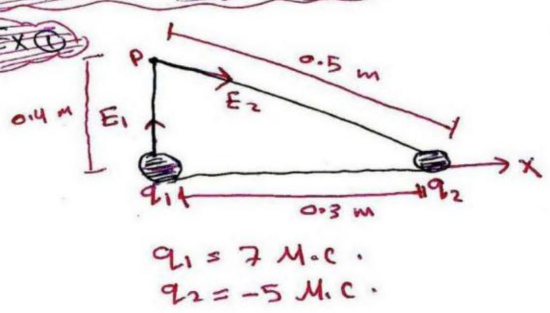
$\dfrac{\cancel{K} q_1 \cancel{q_3}}{(2-x)^2} = \dfrac{\cancel{K} q_2 \cancel{q_3}}{x^2} \Rightarrow \dfrac{15\times\cancel{10^{-6}}}{(2-x)^2} = \dfrac{6\times\cancel{10^{-6}}}{x^2}$

$15x^2 = 6(2-x)^2 \Rightarrow 15x^2 = 6(4-4x+x^2)$.

$3x^2 + 8x - 8 = 0 \Rightarrow \boxed{x_1 = 0.775\ m}$, $x_2 = \cancel{-3.44}\ m$ (لا يوجد مسافة بالسالب)

Ex for section (23.3)

Ex①



$q_1 = 7\ \mu C$.

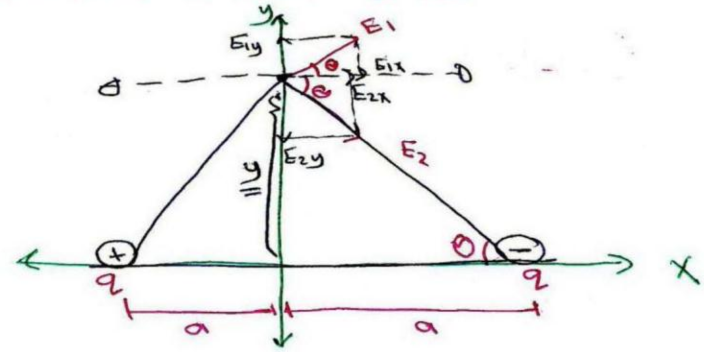
$q_2 = -5\ \mu C$.

Sol:

$E_1 = \dfrac{K\, q_1}{r^2} = \dfrac{9\times10^9 \times 7\times10^{-6}}{(0.4)^2} = 3.9\times10^5\ N/C$

$E_2 = \dfrac{K\, q_2}{r^2} = 1.8\times10^5\ N/C$

EX② «Electric Field of Dipole» ← مهم



Sol: $E_1 = \frac{Kq}{r^2} = \frac{Kq}{(y^2+a^2)}$; $E_2 = \frac{Kq}{r^2} = \frac{Kq}{(y^2+a^2)}$

[$E_2 = E_1$ لكن]

$E = E_{1x} + E_{2x} = E_1 \cos\theta + E_2 \cos\theta = 2 E_1 \cos\theta$

$\Rightarrow = 2 * \frac{Kq}{(y^2+a^2)} * \frac{a}{\sqrt{y^2+a^2}} = K\left[\frac{2qa}{(y^2+\cancel{a^2})^{3/2}}\right]$

ولكن عندما تكون (a) [$y >> a$] أصغر بكثير من (y) نهمل

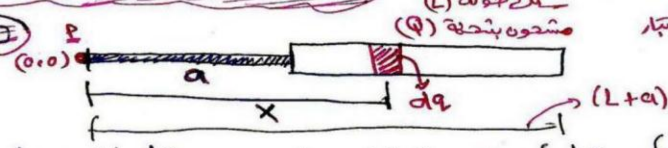
$E = \frac{K\,2qa}{y^3}$ ⇒ المجال الناتج عن «Dipole»

$E = \frac{Kq}{r^2}$; ((Point charge))] ∴ $E_{Dipole} \propto \frac{1}{r^3}$ ...
$E_{point} \propto \frac{1}{r^2}$ ...

Example for section (23.4)

EX④ P عبارة عن شحنة اختبار
إشارتها موجبة

سلك طوله (L)
مشحون بشحنة (Q)



Sol: $dE = \frac{K\,dq}{r^2} \Rightarrow dE = \frac{Kq}{r^2}$ ∴ $\int dE = \int \frac{K \cdot \lambda \cdot dx}{x^2}$ (حدود التكامل تكون عبارة عن الحيز التي توجد فيه الشحنة)

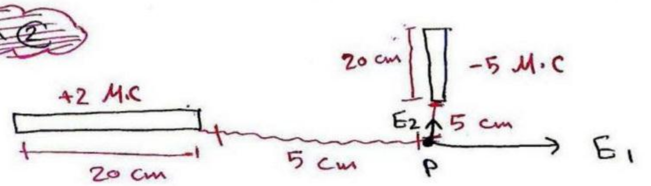
$E = K \int_a^{(L+a)} \frac{\lambda\, dx}{x^2} \Rightarrow E = K * \lambda * \frac{-1}{x}\Big]_a^{L+a} \Rightarrow E = K*\lambda*\left[\frac{1}{a} - \frac{1}{L+a}\right]$

$E = K*\lambda*\left(\frac{L+a-a}{a(L+a)}\right) \Rightarrow E = \frac{K*\lambda*L}{a(L+a)} \Rightarrow E = \frac{K*Q}{a(L+a)}$

وعندما تكون (L) أصغر بكثير من (a) ؛ [$a >> L$]

$\cancel{L}+a = (a) \Rightarrow E = \frac{KQ}{a^2}$ ...

Ex ②



طول السلك = "L"

المسافة بين "P" والسلك = "a"

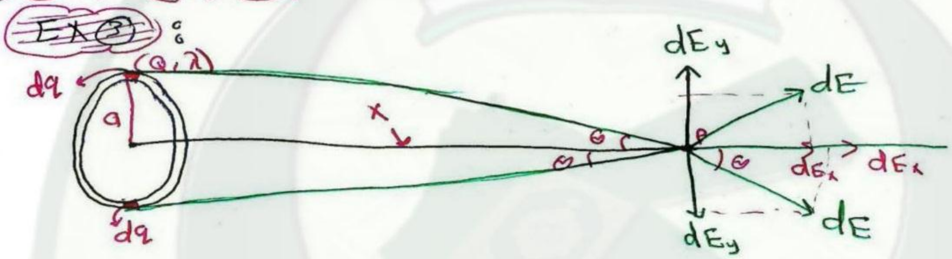
Sol: $E = \dfrac{KQ}{a(L+a)}$ ...

$E_1 = \dfrac{9\times10^9 \times 2\times10^{-6}}{125\times10^{-4}} = 1.4*10^6\ \hat{i}$; $E_2 = 3.6*10^6\ \hat{j}$

$\rightarrow \vec{E}_{net} = (1.4\,\hat{i} + 3.6\,\hat{j})*10^6\ N/C$.

$E_{net} = 3.86*10^6\ N/C$.

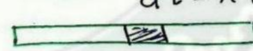
Ex ③ :



Sol: $dE = \dfrac{K\,dq}{r^2} \Rightarrow dE_x = dE\cos\theta$

$[r = \sqrt{x^2+a^2}]$

$dq = \lambda\, dx$



$\cos\theta = \dfrac{x}{r} = \dfrac{x}{\sqrt{x^2+a^2}}$ ...

$dE_x = dE\cos\theta$.

$= \dfrac{K\,dq}{(x^2+a^2)} * \dfrac{x}{\sqrt{x^2+a^2}}$ ...

$\int dE_x = \int \dfrac{K\,x}{(x^2+a^2)^{3/2}}\,dq \Rightarrow E_x = \dfrac{K\,x}{(x^2+a^2)^{3/2}}\int dq$.

$E_x = \dfrac{K\,x}{(x^2+a^2)^{3/2}}\,Q$] $x=0 \rightarrow E_x = 0$.

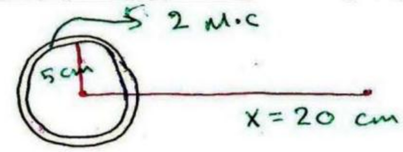
$\rightarrow$ if $x \gg a \rightarrow (x^2+a^2) = x^2$: $\rightarrow E_x = \dfrac{K\,x\,Q}{x^3} = \dfrac{KQ}{x^2}$.

$\rightarrow$ if $a \gg x \rightarrow (x^2+a^2) = a^2$: $\rightarrow E_x = \dfrac{K\,x\,Q}{a^3} = \dfrac{KQ}{a^3}\,x$

$F_x = qE_x \rightarrow F_x = \dfrac{-K\,q\,Q}{a^3}\,x$ ...

إذا كانت الشحنة سالبة ← تكون الحركة اهتزازية مثل النابض.

EX (4)

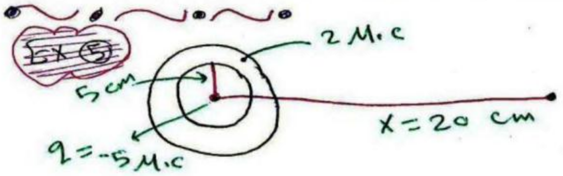


Find The (E)?

Sol: $E = \dfrac{K\,Q\,x}{(x^2+a^2)^{3/2}} = \dfrac{9\times10^9 \times 2\times10^{-6} \times (0.2)}{\left[(0.2)^2+(0.05)^2\right]^{3/2}}$

$E = 4.1 * 10^5 \ N/C$

EX (5)



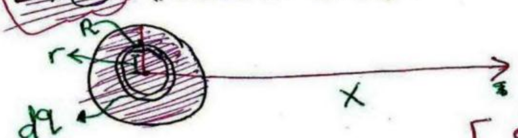
Find the Enet ?

Sol: $\vec{E}_{(1)\ \text{حلقة}} = \dfrac{K\,Q\,x}{(x^2+a^2)^{3/2}}\,\hat{i} = 4.1 * 10^5\,\hat{i} \ N/C$

$\vec{E}_{(2)\ \text{شحنة نقطية}} = \dfrac{-K\,Q}{r^2}\,\hat{i} = \dfrac{9*10^9 \times 5*10^{-6}}{(0.2)^2}\,\hat{i} = -11*10^5\,\hat{i} \ N/C.$

$\vec{E}_{\text{الكلية}} \cong -7*10^5\,\hat{i} \ N/C \ldots$

EX (6) «charged disk» :- قرص مشحون



Sol: $dE = \dfrac{K\,x\,dq}{(x^2+r^2)} \Rightarrow \left[\begin{array}{l} dq = \sigma\,dA \\ dq = \sigma\,(2\pi r)\,dr \ .\ (A = \pi r^2) \\ dA = 2\pi r\,dr \end{array}\right]$

$dE = \dfrac{K\,\sigma\,x\,(2\pi r)\,dr}{(x^2+r^2)^{3/2}} \Rightarrow E = K\,\sigma\,x \displaystyle\int_0^R \dfrac{2r\,dr}{(x^2+r^2)^{3/2}}$

$\rightarrow E_x = 2\pi K \sigma \left(1 - \dfrac{x}{\sqrt{(x^2+R^2)}}\right) \ldots$

$R \gg x \Rightarrow x^2 + R^2 \cong R^2 \ . \ [x/R \xrightarrow{\text{تقترب}} 0]$

$E = 2\pi\,\sigma\,K\left(1 - \dfrac{x}{R}\right).$

$E = 2\pi\sigma K = \cancel{2}\cancel{\pi}\,\sigma\,\dfrac{1}{\cancel{4}_{2}\cancel{\pi}\epsilon_0} = \dfrac{\sigma}{2\epsilon_0}$

23.5 Electric field lines:

- Use to describe an electric field in any Regon on the space ...
- Some Note a boute electric field:

  (A) The lines must begin on a positive Charge and terminate an a negative charge.

  (B) The No. of lines drawn leaving a positive charge or approching a negative charge is Propotional to the magnitude of the charge.

  (C) The electric field "E" is torgout to the electric field lines at each Point.

  (D) No. two field lines Con. cross.

  (E) No of lines per unit Area surface is Proportional to the magnitude of the electric field.

  * close ⇒ electric field is strong.
  * far ⇒ // // // weak.

23.6 Motion in uniform elictric field:

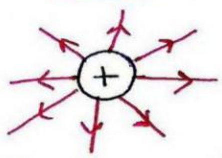
- when a Particle of charge «Q» and mass «m» Placed in an uniform electric field "E":
  - there is an electric force acting an particle.

    ... « $F_e = q \cdot E$ » ...

  - According to 2^{nd} Law.

    ↳ $m \cdot a = q \cdot E$ ⇒ $a = \frac{q \cdot E}{m}$

شرح توضيحي (23.5)



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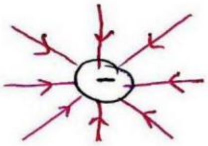

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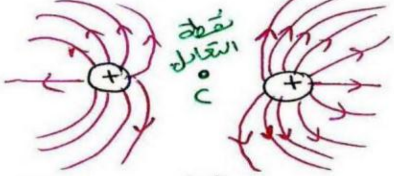
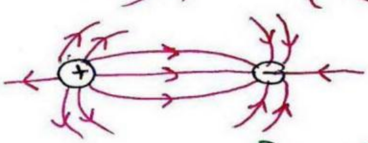
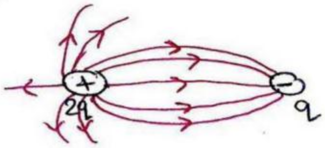
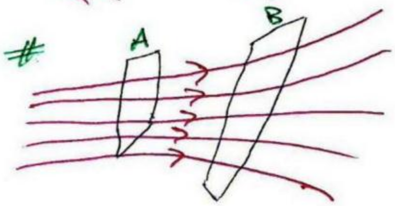


نقطة التعادل: هي النقطة التي يكون عندها المجال المحصل = صفر ...





عدد خطوط المجال تدل على شدة المجال



$((E_A > E_B))$ ...

« لأنه كلما زادت كثافة خطوط المجال كلما زادت شدة المجال »

* 

$E \propto \frac{N}{A}$ عدد خطوط المجال / المساحة $\Rightarrow \boxed{E = \frac{N}{4\pi r^2}}$

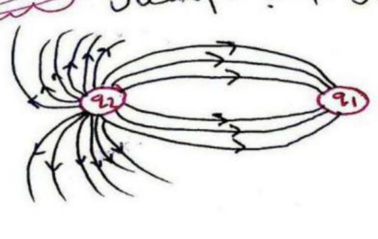
ثابت

$N = C\,q$:

$N_1 = C\,q_1$, $N_2 = C\,q_2$ $\Rightarrow \frac{N_1}{N_2} = \frac{q_1}{q_2}$

« C : constant »

* EX حدد نوع الشحنات والنسبة بين الشحنات



Sol: $q_1 = -ve$; $q_2 = +ve$

$\frac{|q_1|}{q_2} = \frac{6}{18} = \frac{1}{3}$


Some Properaties of the unit :

ملخص القوانين المهمة

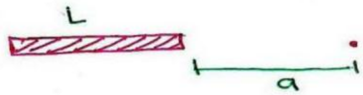
1) $Q = N \cdot e$.

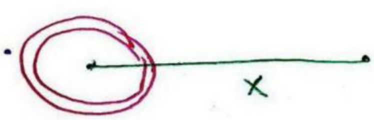
2) $F_e = \dfrac{K q_1 q_2}{r^2}$.

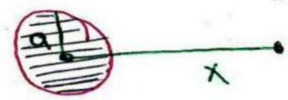
3) $\vec{F} = q \cdot \vec{E}$.

4) $\vec{E} = \dfrac{K \cdot q}{r^2}$.

5) $E = K \int \dfrac{dq}{r^2}$:

- a) $E = \dfrac{K q}{a(L+a)}$. 

- b) $E = \dfrac{K q x}{(x^2+a^2)^{3/2}}$. 

- c) $E = 2\pi \sigma K \left(1 - \dfrac{x}{\sqrt{x^2+R^2}}\right)$. 

ملاحظات على المجال الكهربائي لشحنة نقطية ...

* إذا كانت الشحنة سالبة ⟸ عكس المجال
* إذا كانت الشحنة موجبة ⟸ مع المجال .

6) $E = N/4\pi r^2$; $N = c q$; $\dfrac{N_1}{N_2} = \dfrac{q_1}{q_2}$

7) $a = \dfrac{qE}{m}$ ... [يجب حفظ معادلات الحركة الثلاث أيضاً]

[ويجب مراجعة قوانين المقذوفات]

CH 24 : Gauss's law

24.1 Electric Flux :

* it's No of Line throught out surface.

  " $\Phi = E \cdot A$ "

* Electric flux is Proportional to the No of electric field lines Penefrating some surface.

* Electric flux on closed surface = zero.

24.2 Gauss's law :

* Used to describe a general relationship between the net electric flux through a closed surface and the charge inclosed by the surface.

*

$$\Phi = E \cdot A \cdot \cos\theta . \quad (\text{But} ; \theta = 0)$$

$$\Phi = E \cdot A . \quad (\text{But} ; A = \text{Area of spLear} = 4\pi R^2)$$

$$\Phi = E \cdot 4\pi R^2$$

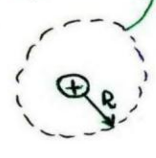
$$E = \frac{K \cdot q}{R^2} \quad \ldots$$

$$\Phi = \frac{K \cdot q}{\cancel{R^2}} \cdot 4\pi \cancel{R^2} \quad \left(K = \frac{1}{4\pi \epsilon_0} \right)$$

$$\Phi = \frac{1}{\cancel{4\pi}\epsilon_0} * q * \cancel{4\pi} \Rightarrow \Phi = \frac{q_{inc.}}{\epsilon_0}$$

$$\oint E \cdot dA = \frac{q_{inc}}{\epsilon_0}$$

سطح غاوسي
Gauss's surface

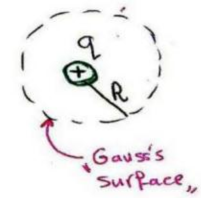


24.3 Application of Gauss's law :

1. electrice field due to an isolated Point charg.

$$\Rightarrow \oint E \cdot dA = \frac{q_{inc.}}{\epsilon_0}$$

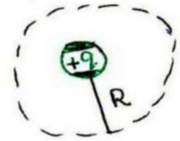
$$E \cdot A = \frac{q}{\epsilon_0} \Rightarrow E \cdot 4\pi R^2 = \frac{q}{\epsilon_0}$$



$$E = \frac{q}{4\pi R^2 \epsilon_0} \Rightarrow E = \frac{K \cdot q}{R^2}$$

2. electric field due to sphere .

$\Rightarrow$ for "$R > a$" :



$$\oint E \cdot dA = \frac{q_{inc.}}{\epsilon_0}$$

$$E \cdot A = \frac{q_{inc.}}{\epsilon_0} \Rightarrow E \cdot \frac{4}{3}\pi R^3 = \frac{q_{inc.}}{\epsilon_0}$$

But $q_{inc.} \neq +Q$

So $\Rightarrow \underbrace{\rho_s}_{\text{Surface}} = \underbrace{\rho_G}_{\text{Gauss}} \Rightarrow \frac{+Q}{\frac{4}{3}\pi a^3} = \frac{q}{\frac{4}{3}\pi r^3}$

$$q = \frac{+Q \cdot r^3}{a^3}$$

$$E \cdot 4\pi \cancel{R^2} = \frac{+Q \cdot R^{\cancel{3}}}{\epsilon \cdot a^3} \Rightarrow E = \frac{Q \cdot K \cdot R}{a^3}$$

$\Rightarrow$ for "$R > a$" :

$$\oint E \cdot dA = \frac{q_{inc.}}{\epsilon_0} \Rightarrow E \cdot A = \frac{q}{\epsilon_0}$$

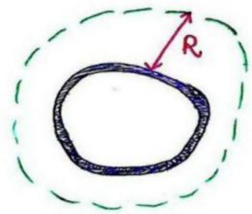
$$E \cdot 4\pi R^2 = \frac{q}{\epsilon_0} \Rightarrow E = \frac{q}{4\pi R^2 \cdot \epsilon_0}$$

$$E = \frac{K \cdot q}{R^2}$$

③ electric field due to thin shell.

A inside shell :- $\boxed{E=0}$

$\Rightarrow q=0$



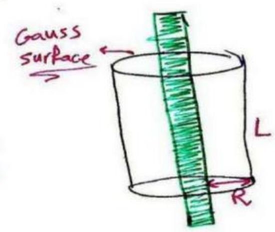
B out side shell :-

$$\oint E \cdot dA = \frac{q}{\epsilon_0}$$

$$E \cdot A = \frac{q}{\epsilon_0} \Rightarrow E \cdot 4\pi R^2 = \frac{q}{\epsilon_0}$$

$$E = \frac{q}{4\pi R^2 \cdot \epsilon_0} \Rightarrow \boxed{E = \frac{k \cdot q}{R^2}}$$

④ electric field due to a cylinder.



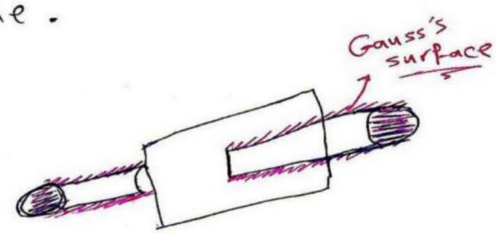
$$\oint E \cdot dA = \frac{q_{inc.}}{\epsilon_0}$$

$$E \cdot A = \frac{q}{\epsilon_0} \Rightarrow E \cdot 2\pi R \cdot L = \frac{q}{\epsilon_0}$$

$$\boxed{E = \frac{2\lambda k}{R}} \ldots$$

5) electric field due to Plane.

$$\oint E\cdot dA = \frac{q_{inc.}}{\epsilon_0}$$



$$E\cdot A = \frac{q_{inc.}}{\epsilon_0}$$

$$E\cdot 2A = \frac{q_{inc.}}{\epsilon_0}$$

$$\Rightarrow E = \frac{q_{inc.}}{2A\cdot\epsilon_0} \rightsquigarrow E = \frac{\delta}{2\epsilon_0}$$

24.4 Conductor's in Electrostatic equliberame:

- conductor's in electrostatic equiliberame has the follwoing:
  1. Electric field is zero any where inside conductor.
  2. The charge resids on the surface.

~~Ex for section (24.1)~~

مثال رقم (24.1) في الكتاب:

Sol: $\cancel{\phi_E = \oint E \cdot dA + \oint E \cdot dA}$

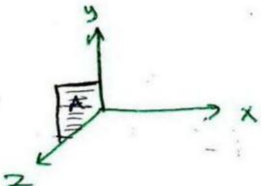
$$E = K\frac{q}{r^2} = (8.99 * 10^9) * \frac{1 * 10^{-6}}{(1)^2} = 8.99 * 10^3 \ N/C.$$

$$A = 4\pi r^2 = 12.6 \ m^2.$$

$$\phi_E = E \cdot A = 8.99 * 10^3 * 12.6 = 1.13 * 10^5 \ N \cdot m^2/C.$$

Ex for section (24.2)

Ex ① $E = a\hat{i} + b\hat{j}$.



*Remark:
$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$
$\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$
$A \cdot B = |A|\cdot|B| \cos\theta$.
$\hat{i}\cdot\hat{i} = |1||1| \cos 0 = 1$

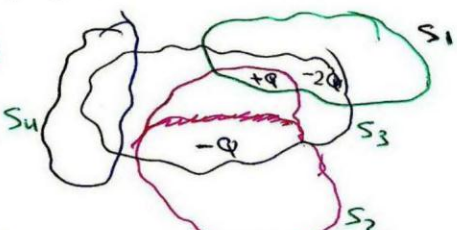
Sol: * ϕ YZ Plane.

$\phi = \vec{E}\cdot\vec{A} = (a\hat{i} + b\hat{j})\cdot(A\hat{i}) = Aa$.

* ϕ XZ Plane $\Rightarrow \phi = (a\hat{i} + b\hat{j})\cdot(A\hat{j}) = bA$.

* ϕ XY Palne $\Rightarrow \phi = (a\hat{i} + b\hat{j})\cdot(A\hat{k}) = 0$.

Ex ②

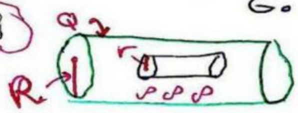


أوجد التدفق على كل سطح؟

Sol: $\phi_{s_1} = \frac{q_{inc}}{\epsilon_0} = \frac{-2Q + Q}{\epsilon_0}$, $\phi_{s_2} = \frac{+Q - Q}{\epsilon_0} = 0$, $\phi_{s_4} = 0$.

$$\phi_{s_3} = \frac{-2Q + \cancel{Q} - \cancel{Q}}{\epsilon_0} = \frac{-2Q}{\epsilon_0}$$

Ex ③



"insulating solid cylinder"

أوجد المجال عندما r<R ؟

Sol: $\oint E \cdot dA = \frac{q_{inc.}}{\epsilon_0} \Rightarrow E \cdot 2\pi r L = \frac{\rho V_{Gauss}}{\epsilon_0}$

$$E * (2\cancel{\pi} \cancel{r} \cancel{L}) = \frac{\rho(\cancel{\pi} r^{\cancel{2}} \cancel{L})}{\epsilon_0}$$

$$\boxed{E_{inside} = \frac{\rho r}{2\epsilon_0}}$$

ملخص قوانين فاصل بـ ((Ch 24))

Summary of laws :

* $\Phi_E = EA\cos\theta$.

* $\Phi_E = \int_{surface} E \cdot dA$.

* Insulating sphere of raduis R ; uniform charge density and total charge Q :

a) $E = \frac{KQ}{r^2}$; $r > R$.

b) $E = K\frac{Q}{R^2}r$; $r < R$.

* Thin spherical shell of raduis «R» and total charge «Q» :

a) $K\frac{Q}{r^2}$; $r > R$.

b) $E = 0$; $r < R$.

* Line charge of infinite length and charge per unit length «λ» :

$E = 2K\frac{\lambda}{r}$; outside the line.

* Infinite charged plane having surface charge density «σ» :

$E = \frac{\sigma}{2\epsilon_0}$; Everywhere outside the plane.

* Conductor having surface charge density «σ» :

a) $E = \frac{\sigma}{\epsilon_0}$; Just outside the conductor.

b) $E = 0$; Inside the conductor.

CH 25 : Electric Potential

25.1 Potential Difference and Electric Potential:

* "The line integral does not depend on the path ~~#~~ taken from "A" to "B" "...

$$\Delta U = U_B - U_A \Rightarrow \Delta U = -q_0 \int_A^B E \cdot ds$$

* The potential energy per unit charge (U/q_0) is independent of the value of (q_0) and has a value at every point in an electric field ; This quantity (U/q_0) is called the electric potential :

$$V = \frac{U}{q_0}$$

$$\Delta V = V_B - V_A \;\leadsto\; \Delta V = \frac{\Delta U}{q_0} = -\int_A^B E \cdot ds$$

* الجهد الكهربائي يقاس :

* $\Delta V = \frac{\Delta U}{q_0} = \frac{Jole}{C} = Volt$

* المجال الكهربائي يقاس بوحدتين :

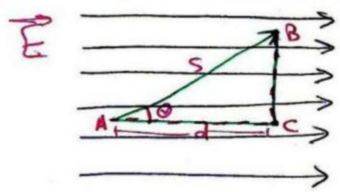
① $E = \frac{F}{q_0} = $ "N/C"

② $\Delta V = E \cdot d \Rightarrow E = \frac{\Delta V}{d} = $ "V/m"

$$1 \frac{N}{C} \equiv 1 \frac{V}{m}$$


25.2 Potential Differences in a Uniform Electric Field

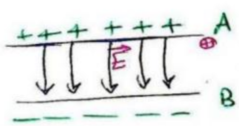
* Electric field lines always point in the direction of decreasing electric potential ...



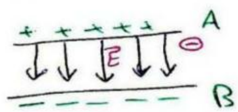
* As the charged particle gains kinetic energy, the charge-field system loses an equal amount of potential energy.

* A system consisting of a negative charge and an electric field gains electric potential energy when the charge moves in the direction of the field.

* The same equipotential surface is given to any surface consisting of a continuous distribution of points having the same electric potential.



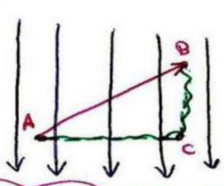
$V_B < V_A$ (يوجد عند Ⓐ شحنة موجبة سوف تسير مع المجال)



$V_B < V_A$ (يوجد عند Ⓐ شحنة سالبة سوف تسير عكس المجال)

$\Delta V = E d \quad ((\theta = 180^\circ))$

Ex:



Sol: $\Delta V = V_B - V_A = \int_A^B \vec{E} \cdot ds$

$[ds = x\hat{i} + y\hat{j}]$

$\Delta V = -\int_A^C E\,dx + \int_C^B E \cdot dy$

$V_{AC} = 0 \rightarrow$ [because ; $\theta = 90^\circ$].

$\therefore V_{AB} = V_{CB}$

الجهد لا يعتمد على المسار الذي تسلكه الشحنة وإنما يعتمد على نقطة البداية والنهاية ...

25.3 Electric Potential and Potential energy due to Point charges.

$$V = k\frac{q}{r}$$ ⇐ في حالة وجود شحنة نقطية واحدة

وفي حالة وجود أكثر من شحنة نقطية:

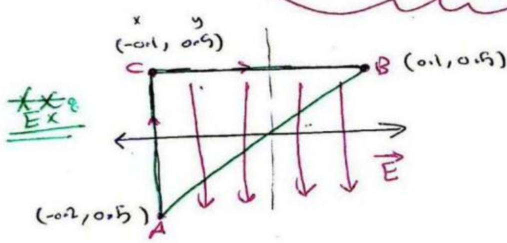
$$V = k \cdot \sum \frac{q}{r}$$

ولإيجاد طاقة الوضع حسب القانون التالي:

في حالة الشحنتين $$U = k\frac{q_1 q_2}{r_{12}}$$

في حالة أكثر من شحنتين ⇐ $$U = k\left(\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right)$$

Ex:



Find the $(V_B - V_A)$?

Sol: $$V_B - V_A = -\int E\cdot ds = -\int_A^C E\cdot ds - \int_C^B E\cdot ds$$

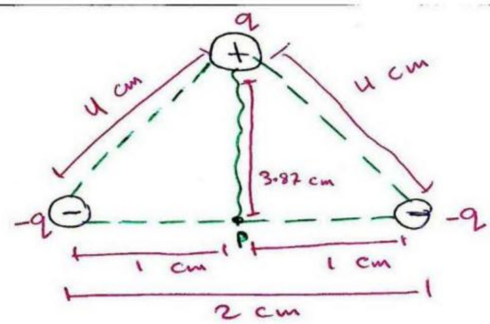
$$= +\int_{-0.3}^{0.5} E\cdot dy\,\cos(180) - \cancel{\int_{-0.2}^{0.4} E\cdot dx\,\cos(90)} = 0$$

$$= |E|\cdot(y)\Big]_{-0.3}^{0.5} = 325(0.8) = +260\ V$$

Ex:

Find V_p??

$\boxed{q = 7\ \mu C}$



Sol: $V_p = Kq\left[\frac{-1}{1*10^{-2}} + \frac{-1}{1*10^{-2}} + \frac{+1}{3.87*10^{-2}}\right] = -1.1*10^{7}\ V$
$= -11\ MV$

25.4 obtaining the value of the electric field from the electric Potential

$$dV = -E_r \cdot dr$$

$$E_x = -\frac{\partial V}{\partial x} \qquad E_y = -\frac{\partial V}{\partial y} \qquad E_z = -\frac{\partial V}{\partial z}$$

عندما نقوم بالاشتقاق بالجهد نحصل على المجال

Ex: find the $|E|\ (1, 0, -2)$; $V = 5x - 3x^2y + 2yz^2$?

Sol:

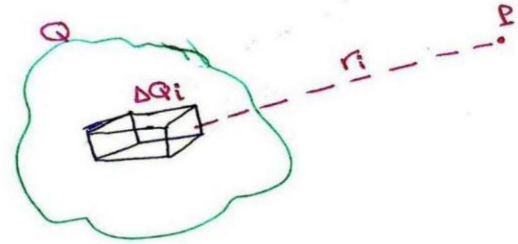
$\rightarrow E_x = -\frac{\partial V}{\partial x} = -5 + 6xy = -5$.

$\rightarrow E_y = -\frac{\partial V}{\partial y} = +3x^2 - 2z^2 = -5$.

$\rightarrow E_z = -\frac{\partial V}{\partial z} = -4yz = 0$.

$|E| = \sqrt{E_x^2 + E_y^2 + E_z^2} = 7.07\ N/C$.

25.5 Electric Potential Due to cont. charge distributions :~

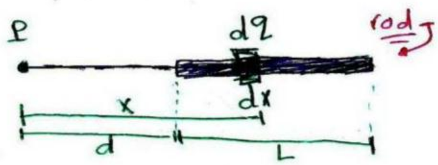


بعد عملية من الإشتقاق نحصل على:

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

* حيث في حل السؤال نأخذ مقطع جزئي من الشكل ...

Ex:



$V_P = ???$

((if $d \gg L \Rightarrow V = 0$)) ← حالة خاصة

Sol:

$$dv = K \cdot \frac{dq}{x} = \frac{K\lambda\,dx}{x} \ldots$$

$$V = \int dv = K\lambda \int_{d}^{d+L} \frac{dx}{x} = K \cdot \lambda \cdot \ln\left(\frac{d+L}{d}\right)$$

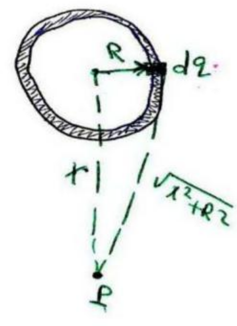
$$V = K \cdot \lambda \cdot \ln\left(\frac{d+L}{d}\right) \ldots$$

"Eletric Potential for a charge Ring" :-

$$dv = \frac{K\,dq}{\sqrt{x^2+R^2}} \rightarrow V = \int dv = \frac{K}{\sqrt{x^2+R^2}} \int dq$$

$$V(x) = \frac{Kq}{\sqrt{x^2+R^2}} \ldots$$

← لكن شدة المجال = شدة الجهد بالنسبة للإزاحة



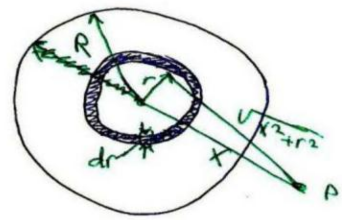
$E_y = E_z = 0$.

$$E_x = -\frac{\partial V}{\partial x} = -\frac{dV}{dx} = -Kq \cdot \frac{d}{dx}(x^2+R^2)^{-1/2}$$

$$= (-Kq)\left(-\frac{1}{2}\right)(x^2+R^2)^{-3/2}(2x)$$

$$E = E_x = \frac{K\,x\,q}{(x^2+R^2)^{3/2}} \#$$


Electric Potential for charge disk :-



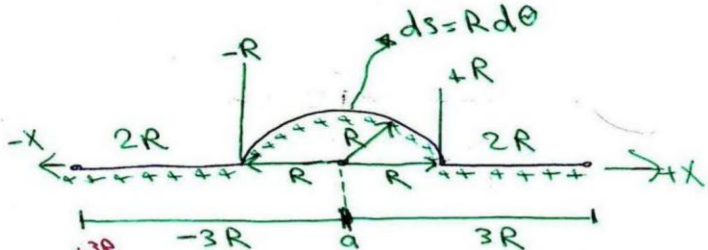
$$dv = \frac{K\,dq}{\sqrt{x^2+r^2}} = \frac{K\sigma 2\pi r\,dr}{\sqrt{x^2+r^2}}$$

$$V = \int dv = \pi K\sigma \int_0^R (x^2+r^2)^{-1/2}\,2r\,dr$$

$$V = 2\pi K\sigma\left[(x^2+r^2)^{1/2} - x\right] .$$

Ex :

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



$$= -\int_{-3R}^{-R} \frac{\lambda\,dx}{-x} + K\int \frac{\lambda\,ds}{R} + K\int_R^{+3R} \frac{\lambda\,dx}{x}$$

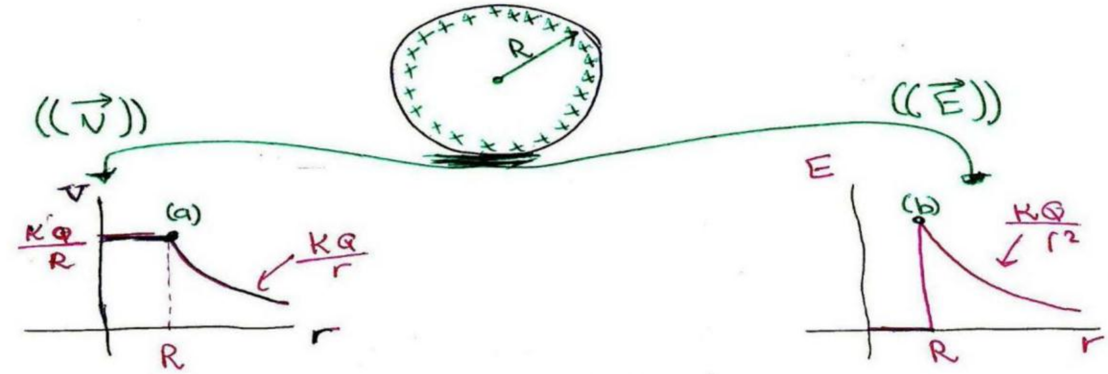
$$K\int \frac{\lambda \cancel{R}\,d\theta}{\cancel{R}}$$

$$\Rightarrow V = K\lambda(\pi + 2\ln 3) \ldots$$

أعد حل المثال هذا أكثر من مرة

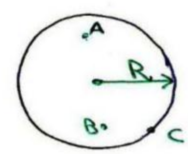
لأنه مهم جداً جداً جداً x (جداً)^{99} :P

26.6 Electric Potential due to a charged Conductor :



((حيث يكون المجال (أ) والجهد أعلى ما يمكن على السطح))
عند النقاط (a) و (b) الممثلة على الرسم البياني

Ex: Find the $V(r) = ??$
a) $r > R$.
b) $r < R$.



Sol:

a) $V(r) = \frac{KQ}{r}$.

b) $\Delta V = V_B - V_A = -\int_A^B \vec{E} \cdot \vec{ds}$ (($V_B - V_A = 0 \rightarrow V_B = V_A$))

$\Delta V = V_B - V_C = -\int \vec{E} \cdot \vec{ds}$ (($V_B - V_C = 0 \rightarrow V_B = V_C$))

$V = \frac{KQ}{R}$ ...

Remark:

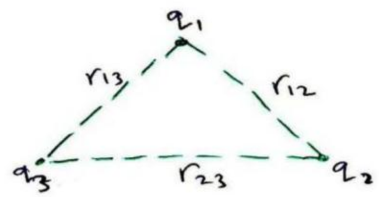
$$\Delta V = \frac{U}{q} \quad \rightarrow \quad U = q \cdot \Delta V$$

Electric potential energy:

$$\therefore \boxed{U = k\frac{q_1 q_2}{r}}$$

^_^

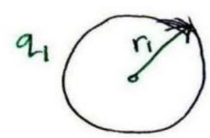
Ex:



$$U = U_{12} + U_{13} + U_{23}$$

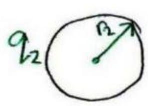
$$= \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$$

Ex: ((Two connected charged spheres)):



$$V = \cancel{k}\frac{q_1}{r_1} = \cancel{k}\frac{q_2}{r_2}$$

$$\frac{q_1}{q_2} = \frac{r_1}{r_2} \quad \text{—\# ①}$$



$$E_1 = k\frac{q_1}{r_1^2} \quad ; \quad E_2 = k\frac{q_2}{r_2^2}$$

$$\frac{E_1}{E_2} = \frac{r_2}{r_1} \quad \text{—\# ②}$$

ملخص قوانين لـ ((CH 25))

SUMMARY:

① $\Delta U = -q_0 \int_A^B E \cdot ds$.

② $\Delta V = \frac{\Delta U}{q_0} = -\int_A^B E \cdot ds$.

③ $\Delta V = -Ed$.

④ $V = K \frac{q}{r}$.

⑤ $U = K \frac{q_1 q_2}{r_{12}}$.

⑥ $E_x = -\frac{dV}{dx}$.

⑦ $V = K \int \frac{dq}{r}$

⑧ uniformly charged ring of raduis (a) : $V = K \cdot \frac{Q}{\sqrt{x^2 + a^2}}$ ...

⑨ uniformly charged disk of raduis (a) : $V = 2\pi K \sigma \left[(x^2 + a^2)^{1/2} - x \right]$ ...

⑩ uniformly charged insulating solid sphere of raduis (R) and total charge (Q):

a) $V = K \frac{Q}{r}$ ... b) $V = \frac{2KQ}{2R} \left(3 - \frac{r^2}{R^2} \right)$.

$(r \geq R)$ $(r < R)$.

⑪ Isolated conducting sphere of raduis (R) and total charge (Q):

a) $V = K \frac{Q}{r}$ ... b) $V = K \frac{Q}{R}$ ...

$(r > R)$. $(r \leq R)$.

CH 26 : Capacitance and Dielectrics

26.1

** Capacitor : Two conductors carying charges equal Magnitude and opposite sign ...

** "Q" on a capacitor is linearly proportional to the Potential difference between conductors. (Plats)...

** Capacitance : The Ratio of the magnitude of the charge on either conductor to the Magnitude of the Potential defference Between the conductors.

$$\boxed{C = \frac{Q}{\Delta V}} \longrightarrow (1)$$

«لا يمكن أن تكون (C) سالبة»

⇒ frome defintion of capacitance we find the capacitore of capacitor is always a positive quantity.

** Remark that the capacitance it's ability of capacitor to store charges.

** Unite of capacitance is colombs per volt wich equal to farad.

$$\boxed{1F = 1C/V}$$

** The farad is very large unite of capacitance.
↳ "we shell use capacitance Rang frame micro farads to picofarads" ...


26.2 Calculating Capacitance :

Capacitance

- General Capacitance ⇓ $C = Q/\Delta V$
- Spherical ⇓ $C = 4\pi\epsilon_0 R$
- Parallel Plate ⇓ $C = \frac{\epsilon_0 A}{d}$
- Cyllinder ⇓ $C = \frac{L}{2K(b-a)}$
- Spherical ⇓ $C = \frac{b-a}{K(b-a)}$

** Capacitance of Spherical Capacetor :

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

where :

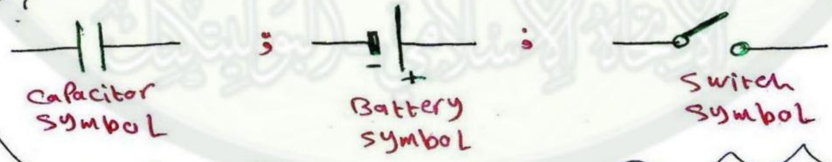
$\Delta V = \frac{K \cdot Q}{R}$ ...

$\therefore C = \frac{Q}{K \cdot Q / R}$.

$\Rightarrow \boxed{C = \frac{1}{K} \cdot R \Leftrightarrow C = 4\pi\epsilon_0 R}$

*** Note that :

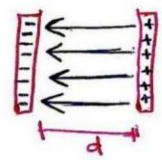
Capacitance of spherical capacitor is proportional to Radius of spheres.



** Capacitance of Parallel-Plate capacitor :-

⇨ we have learned that ; the electric field of two Parallel-Plate is : $E = \frac{\sigma}{\epsilon_0}$ ...

where : $\sigma = \frac{Q}{\lambda}$; So $\Longrightarrow \frac{Q}{\epsilon_0 \cdot A}$ — ①



⇨ And :

$$\Delta V = E \cdot d \Longrightarrow \frac{d \cdot Q}{\epsilon_0 \cdot A} \ \ldots$$

⇨ BY ; $C = Q / \Delta V$ ...

we obtain = $C = \frac{Q}{d \cdot Q / \epsilon_0 \cdot A}$.

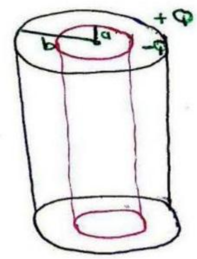
$$C = \frac{\epsilon_0 \cdot A}{d}$$ — ②

A : Area of one plate.   d : distance between plates.

** Note that :

The capacitance of a Parallel-Plate capacitor is Proportional to the area of it's Plates and inversLY Proportional to the Plate seperation .

** capacitance of cylindrical capacitor's :



$\Rightarrow C = Q / \Delta V$ ...

where :

$\Delta V = -\int_a^b E_r \cdot ds$

and ; $E = \frac{2K\lambda}{r}$ ...

$\Rightarrow \Delta V = -\int_a^b \frac{2K\lambda}{r} \, dr$.

$= -2K\lambda \left(\ln|r| \right]_a^b)$

$\Delta V = -2K\lambda \, \ln(b/a)$.

$\Delta V = 2K\lambda \, \ln(b/a)$

$C = Q / \Delta V \Rightarrow Q / 2K\lambda \ln(b/a)$.

$\{ \lambda = Q / L \}$

$C = \frac{\cancel{Q}}{2 \cdot K \cdot \frac{\cancel{Q}}{L} \cdot \ln(b/a)} \Rightarrow C = \frac{L}{2K[\ln(b/a)]}$ — (3)

** Capacitance of spherical capacitors :

"$C = Q / \Delta V$"

$\Delta V = -\int_a^b E \cdot ds \Rightarrow \Delta V = -\int_a^b \frac{KQ}{r^2} \cdot ds$

$\Rightarrow -KQ \int_a^b \frac{1}{r^2} dr$

$-KQ \left(\frac{1}{r} \right]_a^b)$

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

$C = Q / \Delta V \Rightarrow C = \frac{a \cdot b}{K \cdot (b-a)}$ — (4)

26.3 Combination of capacitor.

Combination

Parallel	Series
$C_{eq} = C_1 + C_2 + C_3 + \cdots$	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$
$Q_{eq} = Q_1 + Q_2 + Q_3 + \cdots$	$Q_{eq} = Q_1 = Q_2 = Q_3 = \cdots$
$\Delta V_{eq} = \Delta V_1 = \Delta V_2 = \Delta V_3$	$\Delta V_{eq} = \Delta V_1 = \Delta V_2 = \Delta V_3 = \cdots$

Note that: (Parallel)

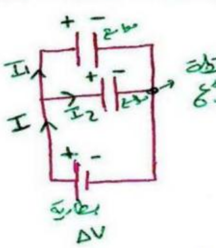
يتم معرفة التوصيل على التوازي من خلال:

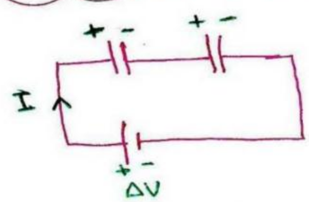
1. إذا وجدت نقطة تفرع بين المواسعات، [لم يمر نفس التيار] ...
2. توصيل نفس أقطاب المواسعات المتشابهة مع بعضها ...

Note that: (Series)

يتم معرفة التوصيل على التوالي من خلال:

1. لم توجد أي نقطة تفرع بين المواسعات [مَرّ فيها نفس التيار] ...
2. توصيل الأقطاب المختلفة مع بعضها البعض ...





26.4 Energy stored in charged capacitor.

$dw = \Delta V \cdot dq$ for instantous charg:

- $w = \Delta V \cdot q \Rightarrow$ for instantous charg: $dw = \Delta V \cdot dq$.

But integrat 2 side $\Rightarrow w = \int \Delta V \cdot dq$.

But $((\Delta V = q/C)) \Rightarrow w = \int \frac{q}{c} \cdot dq \Rightarrow \frac{1}{c} \cdot \int q \cdot dq$.

$w = \frac{Q^2}{2C}$; By ; $C = \frac{Q}{\Delta V} \Rightarrow w = \frac{1}{2} \cdot \Delta V^2 \cdot C$

By ; $C = \frac{Q}{\Delta V} \Rightarrow \frac{1}{2} \cdot \frac{Q}{\Delta V} = \frac{1}{2} Q \cdot \Delta V$

26.5 Capacitors with Dielectrics.

** Dielectric : is a non conducting material, such as : [Rubber, glass or waxed Paper] ...

** when a dielectric is inserted between the Plates of a Capacitors the Capacetance increased by dielectric constant (K).

→ $C = K C_0$.

where :

- → C : is the Capacitance with dielectrics.
- → K : the dielectric constant . « ثابت العزل ».
- → C_0 : is the Capacitance without dielectric.

** Note that :

where « C_0 » is increased By factor « K » ;
U = is decreased BY same factor.

→ $U = \frac{U_0}{K}$ ...

where :

U : energy with dielectrics in Capacitors.

U_0 : energy without dielectrics in Capacitors.

K : dielectrics constant.

26.6 Electric Dipole in an Electric field :-

** The electrical dipole moment is :

"The vector diricted frome "-q" towared "+q" along the line doining the charges" ...

EX 26.5

مش مطلوبة

→ Magnitude of electrical dipole moment :

$$P = 2a \cdot q \longrightarrow (1)$$

** Tourqe on the dipole :-

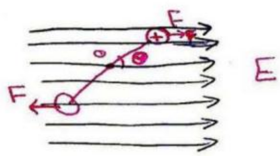
$\tau = F \cdot d$ ...

$F = q \cdot E$; $d = 2a$.

$\therefore \tau = q \cdot E \cdot 2a$

$= 2aq \cdot E$

$\tau = P \cdot E$



τ towards to θ =

$\tau = P \cdot E \cdot \sin\theta$

** Potential energy :-

$\Delta U = \int \tau \cdot d\theta \Rightarrow \int P \cdot E \cdot \sin\theta \, d\theta$

$P \cdot E \cdot \int \sin\theta \, d\theta \Rightarrow -P \cdot E \cdot \cos\theta$

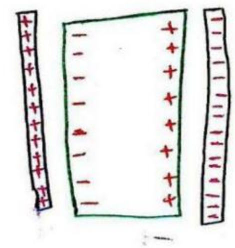
$\tau = P \cdot E \cdot \sin\theta$.

$U = -P \cdot E \cdot \cos\theta$.

26.7 An Atomic Description of Dielectrics :

** When we put the conductor in the electric field ...

→ The conductor have an indused charge and indused Electric field.



$$E = E_0 - E_{ind.}$$

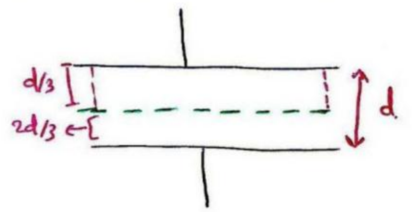
$$E = \frac{E_0}{K} \ldots$$

$$\frac{\sigma}{K \cdot \cancel{\epsilon_0}} = \frac{\sigma}{\cancel{\epsilon_0}} - \frac{\sigma_{ind}}{\cancel{\epsilon_0}}$$

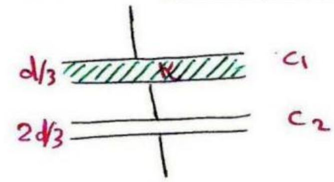
$$\frac{\sigma}{K} = \sigma - \sigma_{ind.}$$

$$\sigma_{ind.} = \sigma - \frac{\sigma}{K}$$

Ex:



تصبح كالتالي



$$C_1 = \frac{\epsilon_0 A K}{(d/3)} \quad ; \quad C_2 = \frac{\epsilon_0 A}{(2d/3)}.$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{\frac{K\epsilon_0 A}{(d/3)}} + \frac{1}{\frac{\epsilon_0 A}{(2d/3)}}$$

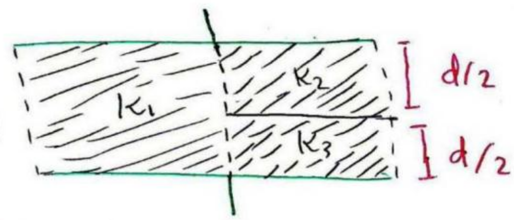
$$\frac{1}{C_{eq}} = \frac{(d/3)}{K\epsilon_0 A} + \frac{(2d/3)}{\epsilon_0 A}$$

Ex:

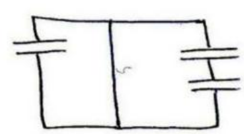
Find the C_{eq} ??

Area $= 1\,cm^2$, $K_1 = 4.9$

distance $= 2\,mm$, $K_2 = 5.6$, $K_3 = 2.1$



Sol: « نقوم برسم الشكل على شكل دائرة تحتوي مواسعات هكذا »



لأن نصف المساحة

$$C_1 = \frac{\epsilon_0 (A/2) K_1}{d}$$ بسبب وجود مادة عازلة

$$C_2 = \frac{K_2 \epsilon_0 (A/2)}{(d/2)} \quad , \quad C_3 = \frac{K_3 \epsilon_0 (A/2)}{(d/2)}.$$

$$\frac{1}{C_{2,3}} = \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{\frac{K_2 \epsilon_0 (A/2)}{d/2}} + \frac{1}{\frac{K_3 \epsilon_0 (A/2)}{d/2}}$$

$$C_{2,3} = \frac{\epsilon_0 A}{d}\left[\frac{K_2 K_3}{K_2 + K_3}\right] \ldots$$

$$C_{eq} = C_1 + C_{2,3} \longrightarrow C_{eq} = \frac{K_1 \epsilon_0 (A/2)}{d} + \frac{\epsilon_0 A}{d}\left[\frac{K_2 K_3}{K_2 + K_3}\right].$$

$$C_{eq} = \frac{\epsilon_0 A}{d}\left[\frac{K_1}{2} + \frac{K_2 K_3}{K_2 + K_3}\right] \longrightarrow C_{eq} = 1.76 * 10^{-6}\,F$$
$$= 1.76\ PF.$$

Ex: "$A = 2\ cm \times 3\ cm$"
"$d = 1\ mm$"

sol:

$$C = \frac{K \cdot \epsilon_o \cdot A}{d} = 20\ P.F$$ "بيكو فاراد"

$$V_{max} = E_{max} \cdot d = 16 * 10^6 (1 * 10^{-3}) = 16 * 10^3\ V.$$

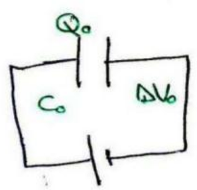
$$Q_{max} = C \cdot \Delta V_{max} = 20 \times 10^{-12} * 16 * 10^3$$
$$= 0.32 * 10^{-6}\ C = 0.32\ \mu C$$

Ex: ((26.6 مثال مرقم في الكتاب)) :⇒ dimensions = 2 cm by 3 cm ; thickness = 1 mm.

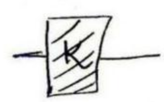
a) Find a capacitance? b) Find the maximum charg

((حلّه في الأعلى))...

Ex:

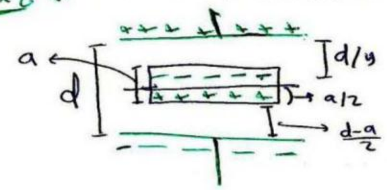


⟹ بعد نزع البطارية نحصل على مادة عازلة (K)



$$V_o = \frac{Q_o^2}{2C_o} \longrightarrow U = \frac{Q_o^2}{2C}$$
$$= \frac{Q_o^2}{2KC_o} = \frac{1}{K}\left(\frac{Q_o^2}{2C_o}\right) \Rightarrow \left(\left(U = \frac{U_o}{K}\right)\right)$$

Ex: ((Effect of a metallic Slab)):



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$
$$= \frac{1}{\frac{\epsilon_o A}{\left(\frac{d-a}{2}\right)}} + \frac{1}{\frac{\epsilon_o A}{\left(\frac{d-a}{2}\right)}} = \frac{\epsilon_o A}{d-a}$$

Summary of laws

ملخص قوانين خاصة ب «CH 26»

** The capacitance of any capacitor :-

"is the ratio between amount of charge (Q) and potential difference (ΔV).

"$C = Q / \Delta V$"

** The capacitance of limited shape of capacitors :-

- Spherical : $C = 4\pi \epsilon_0 R$.
- Parallel-plate : $C = \epsilon_0 A / d$.
- cylindrical : $C = L / 2K \cdot \ln(b-a)$.
- spherical : $C = b \cdot a / k(b-a)$.

** Combination of capacitors :

Series

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots$$

$$Q = Q_1 = Q_2 = Q_3 = \dots$$

$$\Delta V = \Delta V_1 + \Delta V_2 + \Delta V_3 + \dots$$

Parallel

$$C_{eq} = C_1 + C_2 + C_3 + \dots$$

$$Q = Q_1 + Q_2 + Q_3 + \dots$$

$$\Delta V = \Delta V_1 = \Delta V_2 = \Delta V_3 = \dots$$

** Energy stored in capacitors :-

"$U = \frac{1}{2} Q \cdot \Delta V = \frac{1}{2} C \cdot \Delta V^2 = \frac{1}{2} \cdot \frac{Q^2}{C}$"

** when an dielectric insert between Plates of capacitor :

C : increased By factor «K» ⟹ « $C = K \cdot C_o$ ».

U : decreased By factor «K» ⟹ « $U = U_o / K$ ».

E : decreased By factor «K» ⟹ « $E = E_o / K$ »...

** The electric dipole moment (P) :

« $P = 2aq$ »

diriction ⟹ « frome negative charge to positive charge »

** The torque acting on electric dipole :~

$\tau = P * E = +P \cdot E \cdot \sin\theta$.

θ : « Angle between electric field line and line gather two charge » ...

** The Potential energy of system of electric dipole :~

$U = -P \cdot E = -P \cdot E \cdot \cos\theta$.

θ : « Angle between electric field line and Line gather two charge » ...


CH 27 : Current and Risistance :

27.1 : Electric current .

** when ever there is a net flow of charge through Potential difference, an electrical Current is said to exist...

** The current : is the rate at wich charge flows through this surface.

$$I = \frac{\Delta Q}{\Delta t}$$

→ Instantaneous current...

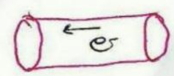
$$I = \frac{dQ}{dt}$$

** The charge Passing through the surface can be Positive or negative.

** Direction of current is the same direction of the flow of Positive charge.

→ direction of current is oppisite of the direction of flow of electrons.

$$I = \frac{\Delta Q}{\Delta t}$$



$$\Delta Q = n \cdot v \cdot Q \Rightarrow \frac{n \cdot v \cdot Q}{t}$$

$$I = \frac{n \cdot v \cdot Q}{t}$$

$$\Rightarrow I = n \cdot v_d \cdot A \cdot Q_e$$

where ; n : No. of electron's .
V_d : drift speed .
A : Cross sectional Area.
Q_e : electron charge .

27.2 Resistance :-

** Current density (J) : The current per unit Area.

$$\boxed{J = I/A = n \cdot q \cdot V_d}$$

we can conclude that the current density is in the same direction of positive charge and in oppisite direction of negative charge.

** In some materials :-

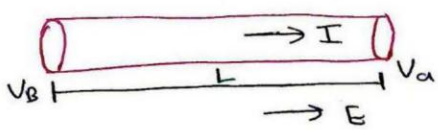
" the current density is proportional to electric field by : $J = \sigma \cdot E$

where:

σ : is the constant of proportional and called the conductivity.

** ohm's low :-

" for many materials the ratio of the current density to the electric field is a constant " σ " ; that is independ of the electric field producting the current.



$\Delta V = E \cdot L \Rightarrow E = \frac{\Delta V}{L}$.

$J = \frac{I}{A} = \sigma \cdot E$.

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

" $\frac{L}{A \cdot \sigma}$: is called the Risestance " R " " ...

$\boxed{\Delta V = I \cdot R} \Rightarrow$ ohm's low.

** Resistance :

"The ratio of the Potential defference a cross a conductor to the current" ...

** The inverse of conductivity is "resistivity".

$$\rho = \frac{1}{\sigma}$$

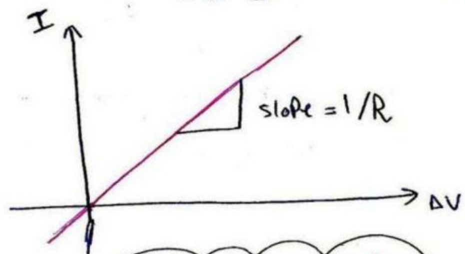
$$\rightarrow \text{"} R = \frac{\rho L}{A} \text{"}$$

** The resistance has SI units of volts per Ampere, wich is called ohm (Ω) :

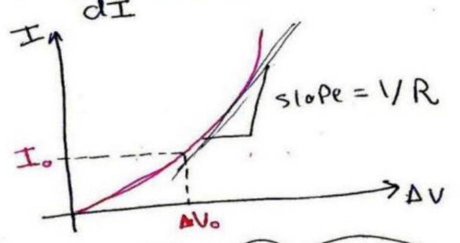
$$\text{"} 1\Omega = \frac{1V}{1A} \text{"}$$

** There is two type of material :

1. ohmic material :-
   - have a Linear ($I - \Delta V$) relationship.
     - slope of Line = $1/R$.
2. No ohmic material :-
   - have a non-linear ($I - \Delta V$) relationship.
     - in this type of materials we have :-
       - A) Statice resistance ; $R = \Delta V / I$.
       - B) dynamic resistance ; $R = \frac{dV}{dI}$ ⇒ (slope of tangent).



ohmic materials

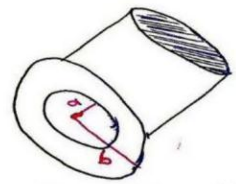


Non-ohmic materials

→ Resistance of coaxial cable:

$$A = 2\pi r L$$

$$dR = \frac{\rho}{2\pi r L}\, dr$$



- To find «R» ; we use Integration from (a) to (b):

$$\int_a^b \frac{\rho}{2\pi r L}\, dr \Longrightarrow \frac{\rho}{2\pi L} * \ln(b/a)$$

«قانون يستخدم لإيجاد مقاومة سلك إسطواني محشو بمادة عازلة» ... ^_^

Where:

ρ : Resistivity of Dielectrial material.

L : thikness of Dielectrial material (b-a).

b : outer raduis.

a : inner raduis.

27.3 A model for electrical Conduction:

** Conduction electrons:

«a collection of free electrons in elements» ...

** The conduction electron move in Random direction through the conductors which avarage speed 10 m/s.

** There is No current in the conductor in the absence of an electric field because the drift speed of free election is zero ...

↳ So: There is No net flow of charge.

** when we applaid electric field :-

↳ we increase the drift speed frome 10^{-4} m/s to 10^{6} typically.

** To find expression for drift velocity :-

we have an electron with charge $(-q)$; and mass m_e.

↳ This electron move under electric field given By:

$$F = E \cdot q$$

By Newton second law:

$$m_e \cdot a = E \cdot q \Rightarrow a = \frac{E \cdot q}{m}$$

* Can electron move in linear :-

$$V_F = V_i + a t$$

But ; $V_i = 0$, $a = \frac{E \cdot q}{m}$.

$$V_F = 0 + \frac{E \cdot q}{m} \cdot t \Rightarrow V_F = \frac{E \cdot q}{m} \cdot t$$

(($V_F = V_d$)) ... (($t = T$ [Avarage time]))

$$V_d = \frac{E \cdot q}{m} T$$

** To relate this equation By electric density:

$$\cancel{J = n.q.v_d} \quad J = n.q.V_d$$

$$J = n.q.\frac{E.q}{m}.T$$

$$J = \frac{n.q^2.E.T}{m}$$

<u>where</u>:

n : No. of electrons Per unit volume.

q : Charge of electrons.

m : mass of electron.

T : Avarage Time.

** To relate this equation to ohms low :

$$J = \sigma . E$$

$$\sigma = \frac{J}{E} \longrightarrow (A).$$

$$\frac{J}{E} = \frac{n.q^2.T}{m} \longrightarrow (B)$$

By: "A = B"

$$\sigma = \frac{n.q^2.T}{m}$$

** T : Avarage time between collissions.

$$T = \frac{L}{V} \quad ; \quad \text{where}$$

L : distance between collisions.

V : Avarage speed

27.4 Resistance with temp. :~

** over a limited temp. range ; the restivity of a conductor varies approximately linearly with temp. according to exprission :~

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

where

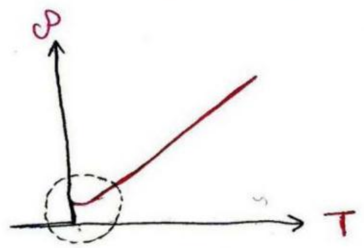
T : Some temp. (°C).

T_0 : reference temp. (°C).

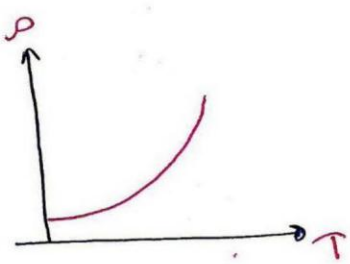
α : temperature coefficient of restivity.

we can use :

$$R = R_0 [1 + \alpha (T - T_0)].$$

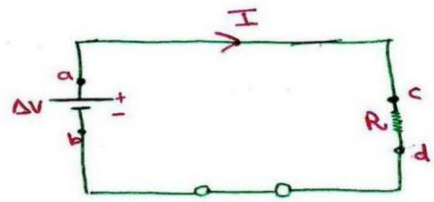


The curve is linear over a wide Range of temp. and "ρ" increase with increasing temp.



As "T" is approches to absolute Zero , the restivity approches to finite ve

27.6 Electrical Power :-



** First : we Imagine energy is being delivered to a resistor ...

** The chimical Potential energy in the Bettery is decressed ; By ~~...~~ Ve ($Q \cdot \Delta V$) while the electrical Potential energy is increased By some a mount .

for . limited a mount of charge

$$\frac{dU}{dt} = \frac{d}{dt}(Q \cdot \Delta V)$$

$$\frac{dU}{dt} = \frac{dQ}{dt} \cdot \Delta V \quad ; \text{But } \frac{dQ}{dt} = I , \ldots$$

$$\frac{dU}{dt} = I \cdot \Delta V \ldots$$

and where ; $\frac{dU}{dt}$ is Power ...

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

By ohm's law By ohm's law .


Summary of low's

ملخص قوانين خاص بـ ((CH 27))

** Avarage electric current :

$$I = \frac{\Delta Q}{\Delta t} = A \cdot n \cdot V_d \cdot q_e$$

** Instantous electric current :

$$I_{ins.} = \frac{dQ}{dt}$$ «first differintial order».

** Magnitude of current density :

$$J = I / A = n \cdot V_d \cdot q$$

«current per unit Area»

** Ohm's low :

« current density in ohmic material (conductor) is proportional to the electric field according to the expression »...

$$J = \sigma \cdot E$$

** The resistance of a conductor :

$$R = \Delta V / I$$

** Resistance for uniform block of material :

$$R = \frac{\rho L}{A} \Rightarrow \Delta V = IR$$

قانون أوم

** Drift velocity when electric field applied :-

$$V_d = \frac{q \cdot E}{m} \cdot \tau$$

** $J = \frac{n \cdot q^2 \cdot E \cdot \tau}{m}$

$$\rightarrow \frac{J}{E} = \frac{n \cdot q^2 \cdot \tau}{m} \quad \left(\left(\sigma = \frac{J}{E}\right)\right)$$

$$\sigma = \frac{n \cdot q^2 \cdot \tau}{m}$$

** The resistivity of conductor vorius with temp. :-

$$\rho = \rho_0 \left[1 + \alpha (T - T_0)\right]$$

** Power :-

$$P = I \cdot \Delta V$$

$$P = I^2 \cdot R$$

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


CH 28 : Direct Current Circuits

28.1 Electromotive force :~

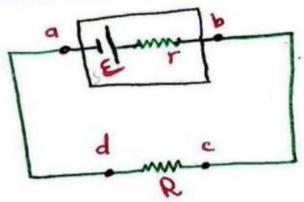
** It's the Max. Possible voltage that the bettery can provide between it's terminds.

أطراف البطارية

Remark :

① * The charges moves from lower Potintial to higher Potintial in terminal voltage.

② * The charges moves from highers to lower Potintial in External voltage.



* There is a resistance to the flow of charge withen the bettery; wich it's called internal resistance (r).

* for a real bettery the terminal voltage is not equal to the , emf, for a bettery in a circuit.

* No move accross the circuit's :-

↳ From a to b : we move from negative to Possitive so the (ΔV) increases by ($+\mathcal{E}$) and decreases by $-Ir$ ...

So ; $\Delta V = \mathcal{E} - Ir$ ...> ①

↳ From b to a : a ccross external load : $\Delta V = IR$ ...> ②

$\Delta V_1 = \Delta V$

$$\mathcal{E} - Ir = IR \rightsquigarrow \mathcal{E} = I(R+r).$$

$$I = \frac{\mathcal{E}}{R+r}$$

28.2 Resistors in Series and Parallel :-
((combination of resistors))

Combination

Parallel توازي

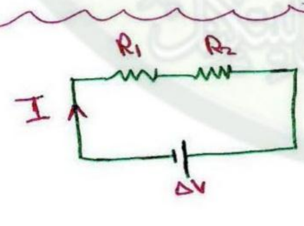
* $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
* $I_{eq} = I_1 + I_2 + I_3 + \dots$
* $\Delta V = \Delta V_1 = \Delta V_2 = \dots$

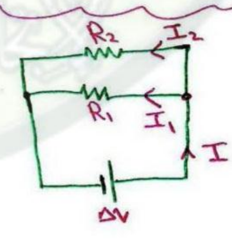
Note that :
اذا وجدت "Junction Point"
يكون التوصيل على التوازي .

Series توالي

* $R_{eq} = R_1 + R_2 + R_3 + \dots$
* $I_{eq} = I_1 = I_2 = I_3 = \dots$
* $\Delta V = \Delta V_1 + \Delta V_2 + \Delta V_3 + \dots$

Note that :
اذا مرّ التيار في جميع المقاومات
يكون التوصيل توالي .





28.3 Kirchoff's Rules :-

* Types of circuit's :-

- Simple Circuit's :-
  - Analayzed By $\Delta V = IR$ "
- Complex circuit's :-
  - Analayzed By Kirchoff's low.

* Kirchoff's Rule :-

1) Junction Rule (K.J.R) :-

"The sum of currents entering any Junction Point must equal the sum of current leaving that Junction".

$$\left(\left(\sum I_{out} = \sum I_{in}\right)\right)$$

2) Loop Rule (K.L.R) :-

"The Sum of the Potential difference a cross all elements arround any closed circuit loop must be zero" ...

$$\sum \Delta V_{\substack{closed \\ loop}} = 0$$

ملاحظات لحل أسئلة كيرتشوف :

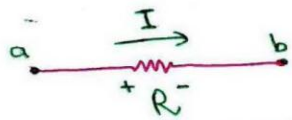
1) يمكن تطبيق قانوني كيرتشوف على جميع الدوائر المغلقة مهما كانت مكوناتها: (مقاومة / بطارية / مواسع)...

2) التيار يسير من الجهد المرتفع إلى الجهد المنخفض: (من الموجب إلى السالب)...

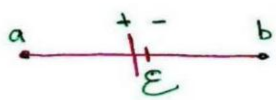
3) إذا لم يحدد السؤال اتجاه التيارات؛ نقوم بوضع اتجاهات افتراضية وذلك حسب اتجاه البطارية الأكبر ...

4) عند عبور المقاومة أو البطارية :

أ) من الموجب إلى السالب ⟸ يقل فرق الجهد ويكون سالب.

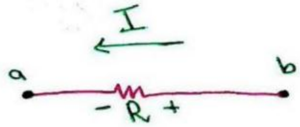


$\Delta V_{ab} = -IR$

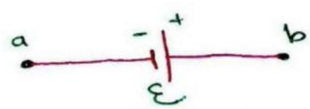


$\Delta V_{ab} = -\varepsilon$

ب) من السالب إلى الموجب ⟸ يزداد فرق الجهد ويكون موجب.



$\Delta V_{ab} = +IR$



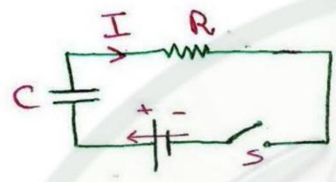
$\Delta V_{ab} = +\varepsilon$

5) المواسع الموجود في أحد فروع الدارة؛ يجعل التيار المار في ذلك الفرع (صفر) بعد مدة من الزمن ...

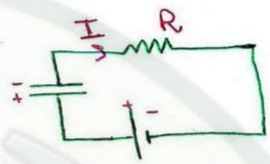

28.4 RC - circuits :-

** In this type of circuits the current is Always in same diriction and very BY time ...

charging capacitors



$t<0$



$t \geq 0$

** For « $t<0$ » : The capacitors is completly uncharged.

** For « $t \geq 0$ » :

↳ $t=0$; the current is the Max ve and the quantity of charge on capacitor is equal zero.

↳ $t>0$; the current is lower ve (zero) and the quantity of charge is Max. on capacitor.

To find the ve's :

Applay the (K.L.R) an circuit :-

$$\overset{\Delta V_{\varepsilon}}{+\varepsilon} - \overset{\Delta V_c}{\frac{q}{C}} - \overset{\Delta V_R}{IR} = 0$$

$t=0$; $q=0$: $I = \frac{\varepsilon}{R}$

$t>0$; $I=0$: $q_{max} = Q = C \cdot \varepsilon$

سعة المواسع

القوة الدافعة

** To find expression for quantity of charge Respect to time :-

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

$$I = \frac{\mathcal{E}}{RC} - \frac{q}{RC} \Rightarrow I = \frac{\mathcal{E}C - q}{RC}$$

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

But Integrating Both side

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

$$-Ln(\mathcal{E} \cdot C - q) + Ln(\mathcal{E} \cdot C) = \frac{t}{RC}$$

$$Ln(\mathcal{E} \cdot C - q) - Ln(\mathcal{E} \cdot C) = \frac{-t}{RC}$$

$$Ln\left(\frac{\mathcal{E} \cdot C - q}{\mathcal{E} \cdot C}\right) = \frac{-t}{RC} \Rightarrow \frac{\mathcal{E} \cdot C - q}{\mathcal{E} \cdot C} = e^{-t/RC}$$

$$1 - \frac{q}{\mathcal{E} \cdot C} = e^{-t/RC}$$

$$q = \underbrace{\mathcal{E} \cdot C}_{\to Q_{max}} \left(1 - e^{-t/RC}\right)$$

$$q(t) = Q_{max}\left(1 - e^{-t/RC}\right)$$ معادلة الشحنة

ولإيجاد قيمة التيار بالنسبة لزمن ← نشتق المعادلة

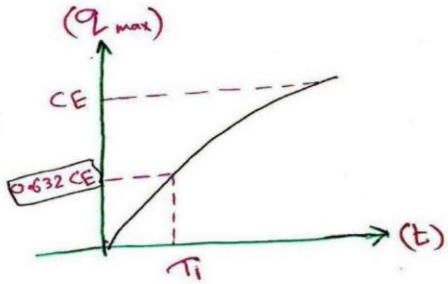
$$I(t) = \frac{\mathcal{E}}{R} \cdot e^{-t/RC}$$ معادلة التيار

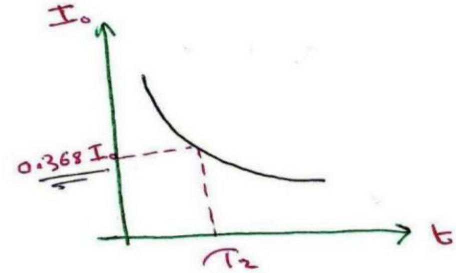
** The quantity ((R C)) is called the :

كمية

((time constant of circuit)) ...

wich - mean : the time during the current decreas to $(e^{-1} I_0)$.





(T_1): الزمن اللازم ليصل التيار إلى (e^{-1}) قيمة العظمى .

(T_2): الزمن اللازم لتصل الشحنة إلى $(1-e^{-1})$ قيمتها العظمى .

Discharging capacitors

** charge respect to (t) :

$$q(t) = Q_{max} \cdot e^{-t/RC} .$$

** currents respect to (t) :

$$I(t) = \frac{-Q}{RC} \cdot e^{-t/RC} .$$

CH 29 : Magnetic fields

Introduction:

* There are a two type of Poles for magnatic field:

  A) North. B) South.

* Sub sequeet experement show that ;

  A) like Poles Repel each other.

  B) opposite Poles attract each other.

* A magnatic Poles are always found in Pairs.

29.1 Magnatic fields and forces :-

Magnatic field : is the magnetic force that exerted on a charged Particle moveing with velocity(v).

Acoording to experements :-

- Magnetude of Magnetic force is ProPortional to ;
  - charge , - speed .

- The magnetude of force is depend on ;
  Magnetude and direction of magnetic field and force.

- when a charged Partial moves Parallel to the magnetic field vector the magnetic force exerted on Partical is zero.

- The magnetic force is Perpendecular to both «V» and «B».

- The diriction of electric force exerted on a Positive charge oppisite to the diriction of force exerted on negative charge.

- The magnitude of magnatic force is ProPortional to $\sin\theta$, where θ is angle Between the $\vec{V}$ and $\vec{B}$.

$$F_B = q * \vec{V} * \vec{B} * \sin\theta$$

ملاحظات [Notes] :

① نستخدم القانون : " $\vec{F_B} = q \cdot \vec{V} \times \vec{B}$ " $\Longleftarrow$ " $\vec{F_B} = q \cdot \vec{V} \cdot \vec{B} \cdot \sin\theta$ "

لإيجاد قيمة القوة المؤثرة على شحنة متحركة .

② لتحديد اتجاه القوة نستخدم قاعدة اليد اليمنى :

* ← يشير الإبهام (Thumb) إلى اتجاه السرعة .
* ← تشير الأصابع إلى اتجاه المجال .
* ← فيكون باطن الكف يشير إلى اتجاه القوة .

[ملاحظة صغيرة جداً اتجاه القوة للشحنة السالبة عكس اتجاه القوة للشحنة الموجبة] .

③ إذا كانت الزاوية بين : $\vec{V}$ و $\vec{B}$ = صفر (Parallel) ؛

أو = 180 (antiparallel) ؛ $\Longleftarrow$ تكون القوة صفر .

④ أكبر قيمة للقوة تكون عندما $\vec{B} \perp \vec{V}$ ؛ " $\theta = 90°$ " ...

There are a several differentation between magetic and electric force :-

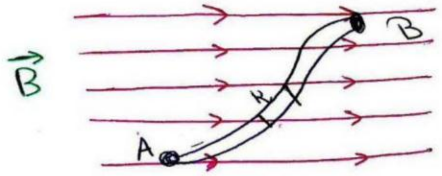
- The electric force act's a long the diriction of the electric field wheras the magnetic force act's perpendecular to magnetic field.

- The electric force act's on a charged Particle regordless of a wetther the Paricle is moving ; where as the magnetic force act's a charged Particle only when the Particle in motion.

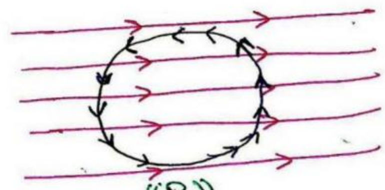
Units of magnatic field in SI unit is :

...((Tesla))...

$$1\,T = 1\,N/(M \cdot C/s) = N/A \cdot m$$



((A))



((B))

Case (A) :

The magnetic force on a curved current-carrying wire in a uniform magnetic field is equal to that on a straight wire connecting the ends point and carrying the same current.

← القوة المغناطيسية المؤثرة على سلك منحني تساوي القوة :- المؤثرة على سلك له مساوي لفرق المسافة بين نقطة بداية السلك ونهايته. ويحمل نفس التيار .

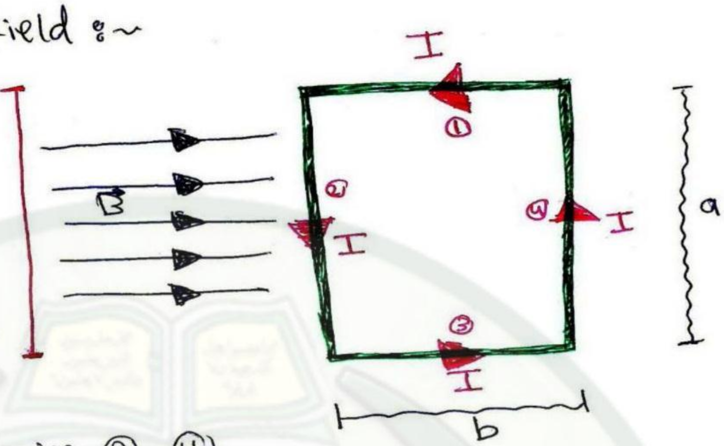
الإزاحة * التيار * المجال المغناطيسي ...

Case (B) :

The magentic force acting on any closed current loop in a uniform magnetic field is zero.

← القوة المحصلة على سلك له شكل حلقة مغلقة = صفر .

29.3 Torque an a current loop in a uniform magnetic field :~



\# Force actining on a wire ①, ③ is Zero because the θ = Zero, and θ = 180 ;

→ $F_1 = I \cdot L \cdot B \cdot \sin(180) = 0$.

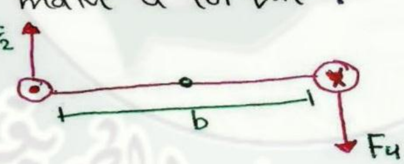
→ $F_3 = I \cdot L \cdot B \cdot \sin(0) = 0$.

\# Force acting on a wire ②, ④ is the MAX "F" ; because the θ = 90 .

→ $F_2 = F_4 = I \cdot L \cdot B \cdot \sin(90) =$ "$I \cdot L \cdot B$"

\# Force acting on wire ② is the oppiset in direction to Force acting on wire ④.

\# This statue make a torque :



$\tau = (F_2 \text{ or } F_4) * b$.

$F_2 = I a \cdot B$.

$\tau = I \cdot B \cdot ab \Longrightarrow \tau = I \cdot A \cdot B$

where : I : current .
A : Area of loop .
B : Magnetic field .

for general : $\tau = I \cdot A \cdot B \cdot \sin\theta$

If the current diriction were reseved the force diriction would Be resève; and the rotational tendency would be reaseave.

$$T = I \cdot A \cdot B \cdot \sin\theta .$$

* $\underline{A}$: The vector wich represent the Area of loop and it's diriction represent the normal to the plane of loop.

* $\underline{\theta}$: is the angle Between $\vec{B}$ and $\vec{A}$.

θ : الزاوية بين $\vec{B}$ ومتجه المساحة (العمودي على المساحة).

* The Torque have a max ve (T_{max}) when; $\vec{A}$ is perpendecular to $\vec{B}$ ($\theta = 90$).

* The Torque have a min. ve (T_{min}) when; $\vec{A}$ is parallel to $\vec{B}$ ($\theta = 0$).

* we can defined the magnetic moment BY:

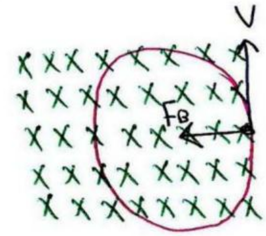
$$\mu = I \cdot A$$

$$* \; T = \mu * B = \vec{\mu} \cdot \vec{B} \sin\theta .$$

$$U = -\mu \cdot B = \vec{\mu} \cdot \vec{B} \cos\theta .$$

((يمكن أن يكون عدد اللفات $\neq 1$ ⟸ ولإيجاد (T) الكلي نضرب بعدد اللفات))...

29.4 Motion of a charged Particle in a uniform magnetic field :-



$$* \sum F = m \cdot a_c$$

$$F_B = m \cdot \frac{v^2}{r}$$

$$q \cdot \cancel{V} \cdot B = \frac{m \cdot v^{\cancel{2}}}{r}$$

$$q \cdot B = \frac{m \cdot v}{r}$$

$$r = \frac{m \cdot v}{q \cdot B}$$ ⟹ raduis of circular Path that the charged Particle moving a long.

Angular speed = $W = \frac{V}{r} = \frac{q \cdot B}{m}$

⟹ frecuancy of cylectron :-

• Period of motion :

" The time interval the Particle requires to Complete on revelution " ...

$$T = \frac{2\pi r}{V} \implies T = \frac{2\pi}{\omega}$$

$$T = \frac{2 \cdot \pi \cdot m}{q \cdot B}$$