فيزياء 2

Menna Tullah Jayousi

طريقة دراسة المادة :

١- متابعة للمحاضرات أول بأول وعدم المراكمة ضروررررريييييي.

٢- حل الاوتلاين كل نهاية تشابتر وإذا اجى الفاينال أو الميد ومش حالينهم ما تضيعوا وقت عليهم وحلوا فورمات كتير ضروري.

٣- فورمات ثم فورمات ثم فورمات ثم فورمات حرفياً إذا درستوا فورمات هتزبطوا.

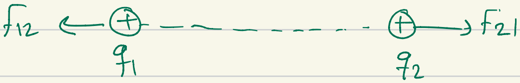
٤- وتوكلوا على الله واعطوها حقها سهلة بس بدها تركيز وان شاء الله موفقين.

Chapter 21:

$q = \mp ne.$, $n = 1, 2, 3, \dots$

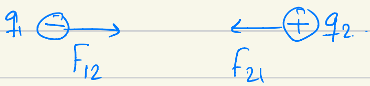
$e = 1.6 \times 10^{-19}$ c.
$q_e = -1.6 \times 10^{-19}$ c.
$q_p = 1.6 \times 10^{-19}$ c.
$m_e = 9.11 \times 10^{-31}$ kg.

Repulsive force:



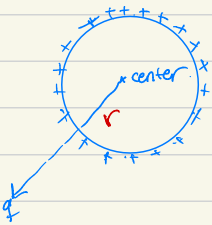
قوى التنافر.

Attractive force: ⇒ قوى التجاذب

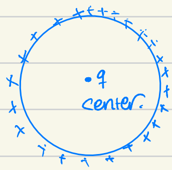


Electric force: $\Rightarrow F = \dfrac{k\,q_1\,q_2}{r^2}$

K depends on :
1- medium between q1&q2.
2- units in the air (vacume)=$k = 9 \times 10^{9}\ N.m^2/C^2$.
$\hookrightarrow k = \dfrac{1}{4\pi\varepsilon_0}$, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$.
$\hookrightarrow$ permitivity constant for air (vacume).



$E = \dfrac{kq}{r^2}$.



$F_{net} = 0$.

$E = 0$.

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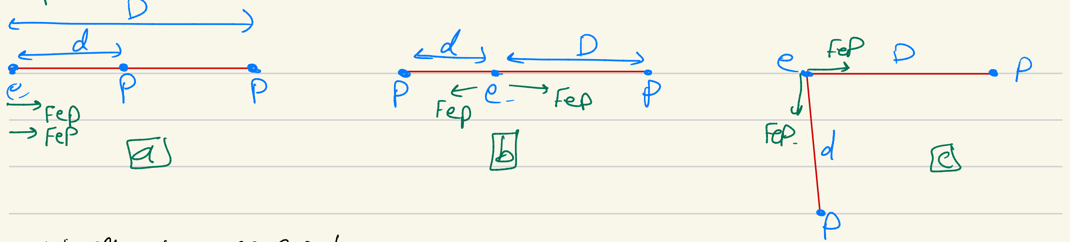
Example:-

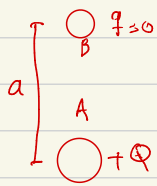


⇒ largest ⇒ a > c > b.

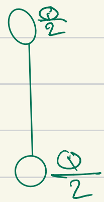
⇒ In the situation c, is the angle between the net force and line d less than or more than 45°? ⇒ less than 45°

↳ $\phi = 0$ because $F_{ep_d} > F_{ep_D}$.

Example ⇒



بعد التلاس



⇒ So $F = \frac{k q_1 q_2}{r^2} = \frac{k \frac{Q}{2} \frac{Q}{2}}{a^2} = \frac{k Q^2}{4a^2}$

Gravitational force : ⇒ $F = G \frac{m_p^2}{r^2}$

$G = 6.67 \times 10^{-11}\ N.m^2/kg^2$

If we change proton → into neutron so we will have a positron, e^+.

If we change neutron → into proton so we will have an electron, e^-.

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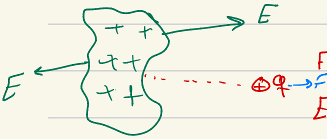
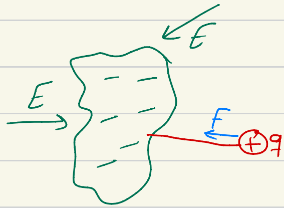
Chapter 22:



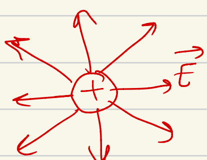
$$F = \frac{k q_1 q_0}{r^2}$$

$$E = \frac{F}{q_0} = \frac{kq}{r^2} \; N/C$$

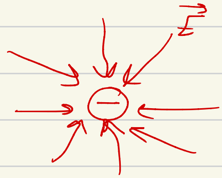


$$F = \frac{k q_1 q_0}{r^2}$$

$$E = \frac{kq}{r^2}$$



دائماً E خارجة من الشحنة الموجبة.



دائماً المجال داخل إلى الشحنة السالبة.

حالات التعادل :

١- عندي شحنتان متماثلتان (موجبتين أو سالبتين) : خارج الخط الواصل بينهما بعيداً عن الشحنة الأصغر غالباً.

٢- عندي شحنتان مختلفتين: داخل المسافة بينهما على الخط الواصل بينهما أقرب إلى الشحنة الأصغر.

٣- عندي شحنتان مختلفتين ومتساويتين : منتصف المسافة بينهما مباشرة.

Electric dipole:

$P = q\,d.$

$V_f = v_i + at$

$V_f^2 = v_i^2 + 2ad$

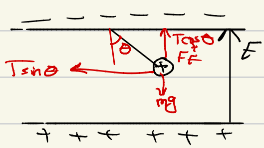
$d = v_i t + 0.5\, a t^2$

$W = F.d = F\, d \cos\theta$

$W = q\,(E.d)$

$W_{net} = K.$

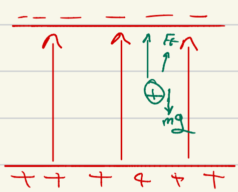
$W = 0.5\, m(V_f^2 - V_i^2)$

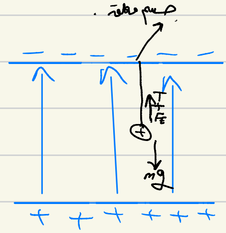


$F = m\,a$

$E\,q = m\,a$

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





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Potential energy:

$U = -P \cdot E$

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

Torque:

$\tau = P \times E$

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

example ⇒ $\vec{P} = 2\hat{i} + 3\hat{j}$.

$E = 2\hat{i} + \hat{j}$.

$$\Rightarrow \tau = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 0 \\ 2 & 1 & 0 \end{vmatrix} = (\text{zero})\hat{i} - (\text{zero})\hat{j} + (-4)\hat{k} = -4\hat{k}.$$

1- linear charge density : $\lambda = \dfrac{q}{L}$

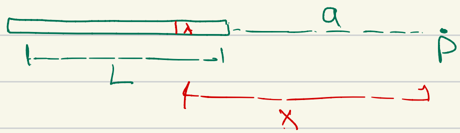
2- surface charge density : $\sigma = \dfrac{q}{A}$.

⇒ إذا كانت ال q سالبة بنعوضها بالسالب.

3- volume charge density : $\rho = \dfrac{q}{V}$ ⇒ دائماً بعوضها موجب.

Rod : ⇒ على جنب

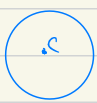
من المهم فهم طريقة الاشتقاق.



$dq = \lambda\, dx$.

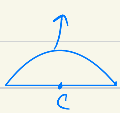
$$E = \frac{K \lambda L}{a(L+a)}.$$

Ring :

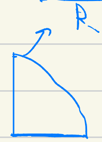


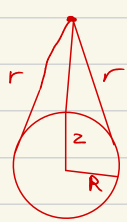
$E = 0$

$$E = \frac{2 K \lambda}{R}.$$



$$E = \frac{K \lambda}{R}$$





$$E = \frac{2\pi R K \lambda z}{(R^2 + z^2)^{3/2}}.$$

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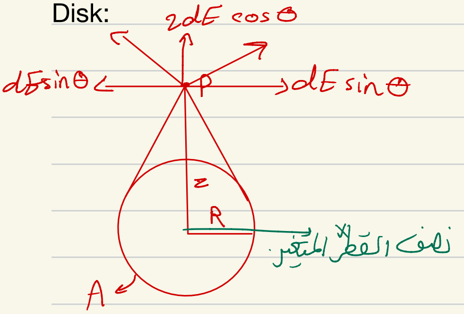
Disk:



$dq = \sigma \, dA$

$\cos\theta = \frac{z}{r}$

$\therefore E = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right].$

* if $z >>>> R \Rightarrow E = 0.$
* if $R >>>> z \Rightarrow E = \frac{\sigma}{2\varepsilon_0}.$

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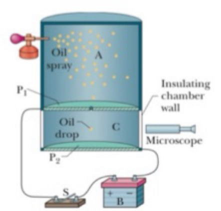
33 In Millikan's experiment, an oil drop of radius 1.64 μm and density 0.851 g/cm^3 is suspended in chamber C (Fig. 22-16) when a downward electric field of 3.20×10^5 N/C is applied. (a) Find the charge on the drop, in terms of e. (b) If the drop had an additional electron, would it move upward or downward?



$r = 1.64 \times 10^{-4}$ m , $\rho = 0.851$ g/cm^3 , $E = 3.2 \times 10^5$.

851 = تيسير

* The drop in equilibrium $\Rightarrow \Sigma F = 0.$
* The mass of the drop $= V\rho = \frac{4}{3}\pi R^3 \rho.$

الحجم

$F_E = mg$

$Eq = mg.$

$3.2 \times 10^5 \, q = \frac{4}{3}\pi (1.64 \times 10^{-6})^3 \times 851 \times 10.$

$q = 4.91 \times 10^{-19}.$

$q = ne$

$n = \frac{-4.91 \times 10^{-19}}{1.6 \times 10^{-19}} = -3$

$q = -3e.$

(b) If it had an additional e so

$q = -4e.$

$F_E > mg.$ more upward.

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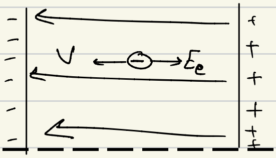
38 An electron enters a region of uniform electric field with an initial velocity of 30 km/s in the same direction as the electric field, which has magnitude $E = 50$ N/C. (a) What is the speed of the electron 1.5 ns after entering this region? (b) How far does the electron travel during the 1.5 ns interval?



$V_i = 30\,km/s = 3000\,m/s.$

$E = 50\,N/C.$

$t = 1.5 \times 10^{-9}\,s$ $\quad V_f = ??$ $\quad \Delta X = ??$

$m = 9.11 \times 10^{-31}.$

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11 In Fig. 22-27, two curved plastic rods, one of charge $+q$ and the other of charge $-q$, form a circle of radius $R = 4.25$ cm in an xy plane. The x axis passes through both of the connecting points, and the charge is distributed uniformly on both rods. If $q = 15.0$ pC, what are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the electric field $\vec{E}$ produced at P, the center of the circle?

Figure 22-26 Problem 10.

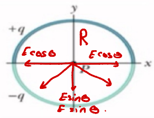

Figure 22-27 Problem 11.

14 In Fig. 22-29, a thin glass rod forms a semicircle of radius $r = 3.00$ cm. Charge is uniformly distributed along the rod, with $+q = 4.50$ pC in the upper half and $-q = -4.50$ pC in the lower half. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the electric field $\vec{E}$ at P, the center of the semicircle?

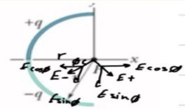

Figure 22-29 Problem 14.

الفرق بينهم.

$\boxed{1}$ $dE_y = dE \sin\theta$ $\qquad \lambda = \frac{q}{s} = \frac{q}{\theta R}$

$dE_y = \frac{-k\,dq}{r^2}\sin\theta \quad , \quad \lambda R\,d\theta = dq$

$= \frac{-k\lambda R\,d\theta}{R^2}\sin\theta$

$E_y = \frac{k\lambda}{R}\int_0^{\pi}\sin\theta\,d\theta = \frac{-k\lambda}{R}\left[-\cos\theta\right]_0^{\pi}$

$= \frac{-k\lambda}{R} - \frac{k\lambda}{R} = \frac{-2k\lambda}{R}.$

$= \frac{-2 \times 9 \times 10^{9} \times 1.12 \times 10^{-10}}{4.25 \times 10^{-2}} = -47.43\,\hat{j}.$

$\theta = 90\,(-\hat{j}).$

$\lambda = \frac{q}{s} = \frac{15 \times 10^{-12}}{4.25 \times 10^{-2} \times \frac{\pi}{180} \times 180}$

$\lambda = 1.12 \times 10^{-10}.$

$dE_y = -dE\sin\theta.$ $\qquad s = \theta r$

$= \frac{-k\,dq}{r^2}\sin\theta$ $\qquad ds = r\,d\theta, \ \sigma = \frac{q}{s}$

$= \frac{-k\sigma r\,d\theta\,\sin\theta}{r^2}$ $\qquad \sigma\,ds = dq.$

$\sigma r\,d\theta = dq.$

$= \frac{-k\sigma}{r}\int_0^{\frac{\pi}{2}}\sin\theta\,d\theta = \frac{-k\sigma}{r}\left[-\cos\theta\right]_0^{\frac{\pi}{2}}$

$= \frac{k\sigma}{r}\left[\cos\frac{\pi}{2} - \cos 0\right] \Rightarrow E_1 = -\frac{k\sigma}{r}$

$E_2 = E_1$

$E_{net} = E_1 + E_2$

$= \frac{k\sigma}{r} + \frac{k\sigma}{r} = \frac{2k\sigma}{r}.$

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23 A 10.0 g block with a charge of $+8.00 \times 10^{-5}$ C is placed in an electric field $\vec{E} = (3000\hat{i} - 6000\hat{j})$ N/C. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the electrostatic force on the block? If the block is released from rest at the origin at time $t = 0$, then at $t = 3.00$ s what are its (c) x and (d) y coordinates and (e) its speed?

$m = 10 \times 10^{-3}$ kg , $q = 8 \times 10^{-15}$ C , $E = (3000\hat{i} - 6000\hat{j})$.

$v_i = 0$, $t = 3$.

$F = ??$

$\boxed{1}$ $F = qE = 2.4 \times 10^{-11}\hat{i} - 4.8 \times 10^{-11}\hat{j} = 5.37 \times 10^{-11}$.

$F_x = m a_x$.

$2.4 \times 10^{-11} = 10 \times 10^{-3} a_x$.

$a_x = 2.4 \times 10^{-9}$.

$F_y = m a_y$.

$-4.8 \times 10^{-11} = 10 \times 10^{-3} a_y$.

$a_y = -4.8 \times 10^{-9}$.

$\boxed{2}$ $\Delta x = v_{ix} t + \frac{1}{2} a_x t^2$.

$= 0 + \frac{1}{2}(2.4 \times 10^{-9})(9) = 1.08 \times 10^{-8}$.

$\Delta y = v_{iy} t + \frac{1}{2} a_y t^2$.

$= 0 + \frac{1}{2}(9)(4.8 \times 10^{-9}) = 2.16 \times 10^{-8}$.

$\boxed{3}$ $v_{fx} = v_{ix} + at$.

$= 0 + 3 \times 2.4 \times 10^{-9} = 7.2 \times 10^{-9}$

$v_{fy} = v_{iy} + at$.

$= 0 + (4.8 \times 10^{-9}) \times 3 = 1.44 \times 10^{-8}$

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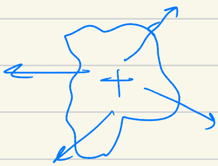
Chapter 23:

* Electric flux $\Rightarrow \phi = \vec{E} \cdot \vec{A} = EA\cos\theta$. (إذا المجال ثابت).

$\phi = \int E \cdot dA \Rightarrow$ (إذا المجال مش ثابت).

* $\phi = \dfrac{q_{enc}}{\varepsilon_0}$. * $\int E \cdot dA = \dfrac{q_{enc}}{\varepsilon_0}$.



$= \dfrac{+q}{\varepsilon_0}$.

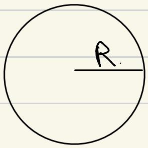
$= \dfrac{-q}{\varepsilon_0}$.

Applications on Guass's law :

1- spherical symmetry:

E due to a uniformly charged conducting sphere: $\longrightarrow$ $\sigma = \dfrac{q}{A} = \dfrac{q}{4\pi R^2}$

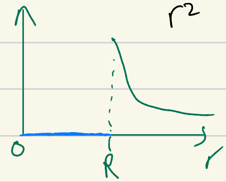
$\rho = \dfrac{q}{V} = \dfrac{q}{\frac{4}{3}\pi R^3}$.



E at $r > R = \dfrac{kq}{r^2}$

E at $r < R = 0$.

E at $r = R = \dfrac{kq}{r^2}$



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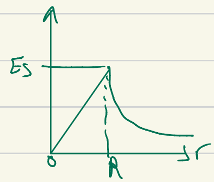
E due to a uniformly charged nonconducting solid sphere: $\rightarrow \rho = \frac{q}{V} = \frac{q}{\frac{4}{3}\pi R^3}$

E at $r \geqslant R \Rightarrow \int E \cdot dA = \frac{q}{\varepsilon_0} = \frac{kq}{r^2}$.

E at $r \leqslant R \Rightarrow E = \frac{\rho r}{3\varepsilon_0}$

$\int E \cdot dA = \frac{q}{\varepsilon_0}$ → ρ volume



$E_s = \frac{kq}{R^2}$

2- cylindrical symmetry :

E due to a uniformly charged infinite rod .

$\hookrightarrow \int E\,dA = \frac{q_{enc}}{\varepsilon_0} \rightarrow \lambda h$

مساحة الاسطوانة

$E = \frac{\lambda}{2\pi r \varepsilon_0}$; $r <<<< L$.

3- planer symmetry :

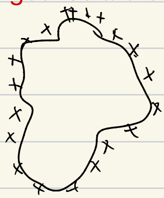
E due to a uniformly charged thin infinite nonconducting surface:

$\hookrightarrow \int E \cdot dA = \frac{q_{enc}}{\varepsilon_0} \rightarrow \sigma A$

$EA + EA$

$\Rightarrow E = \frac{\sigma}{2\varepsilon_0}$.

4- a charged isolatd conductor :



$\Rightarrow E$ inside $= 0$.

q inside $= 0$.

$E_{outside} = \frac{\sigma}{\varepsilon_0}$.

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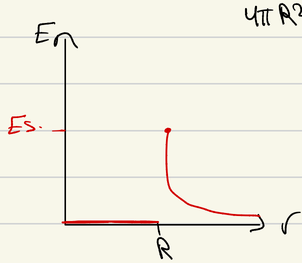
5- E due to a uniformly charged conducting sphere: $\rightarrow \sigma = \frac{q}{4\pi R^2}$.

$\rightarrow$ E at $r < R = 0$.

$\rightarrow$ E at $r \geq R = \frac{kq}{r^2}$.



$E_s = \frac{kq}{R^2}$.

E due to a uniformly charged conducting sphere :

E at $r < R = 0$.

E at $r \geq R = \frac{kq}{r^2}$.

E due to a uniformly charged nonconducting solid sphere:

$E = \frac{kq}{r^2}$, $r \geq R$.

$E = \frac{\rho r}{3\varepsilon_0}$. $r \leq R$.

E due to a uniformly charged infinite rod :

$E = \frac{\lambda}{2\pi r \varepsilon_0}$.

E due to a uniformly charged thin infinite nonconducting surface:

$E = \frac{\sigma}{2\varepsilon_0}$.

A charged isolated conductor: $E = \frac{\sigma}{\varepsilon_0}$.

17 In Fig. 23-30, a proton is a distance $d/2$ directly above the center of a square of side d. What is the magnitude of the electric flux through the square? (*Hint:* Think of the square as one face of a cube with edge d.)

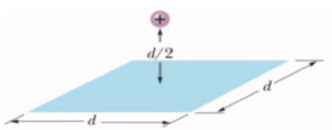


Figure 23-30 Problem 17.

$\Phi_{\text{total cube}} = \frac{q_{enc}}{\varepsilon_0} = \frac{1.6\times10^{-19}}{8.85\times10^{-12}} = 1.8\times10^{-8}$.

$\Phi_{\text{for one face}} = \frac{1.8\times10^{-8}}{6} = 3.01\times10^{-9}$.

3 An unknown charge sits on a conducting solid sphere of radius 10 cm. If the electric field 30 cm from the center of the sphere has the magnitude 3.0×10^3 N/C and is directed radially inward, (a) what is the net charge on the sphere? and (b) what is the charge density?

$\boxed{a}$ $E = \frac{kq}{r^2}$

$-3 \times 10^{3} = \frac{9 \times 10^{9} \; q}{(0.3)^2} \Rightarrow q = -3 \times 10^{-8}.$

$\boxed{b}$ $\sigma = \frac{q}{A} = \frac{-3 \times 10^{-9}}{4\pi (0.1)^2} = -2.38 \times 10^{-8}.$

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Chapter 24:

$F = qE$. $\Rightarrow U = qV$.

$W = \int_i^f q\vec{E}\cdot\vec{ds}$. $= -(u_f - u_i)$.

$U_f = -q\int_{\infty}^{f}\vec{E}\cdot\vec{ds}$.

$V_f = -\int_{\infty}^{f} E\cdot ds = \frac{kq}{r_f}$

$V = \frac{U}{q}$ J/C (volt).

$V_f - V_i = -\int \vec{E}\cdot\vec{ds}$.

$E = \frac{kq}{r^2}$.

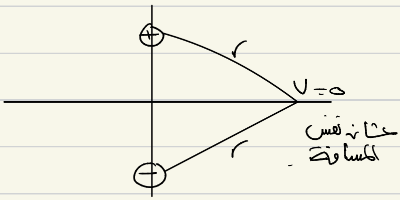
$V = \frac{kq}{r}$.

V due to an electric dipole :

$V = \frac{kP}{z^2 - a^2}$, $P = qd$, $d = 2a$.

المسافة من الشحنة السالبة للموجبة.

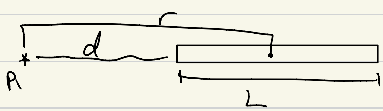
for $z \ggg a \Rightarrow V = \frac{kP}{z^2}$.



Potential due to a continues distribution:

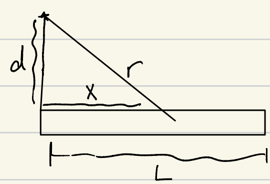
1- v due to a uniformly charged rod (line of charge):

$V = k\lambda \ln\left(\frac{d+L}{d}\right)$.



$V = k\underset{\Downarrow}{C}\left[\sqrt{d^2 + x^2} - d\right]$

$\lambda = Cx$



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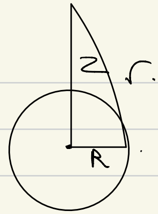
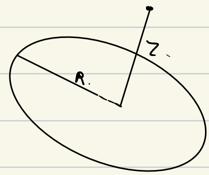
2- v due to a uniformly charged ring :

$\hookrightarrow \lambda = \frac{q}{2\pi r} \Rightarrow \quad V = \frac{kq}{\sqrt{z^2 + R^2}}$



3- v due to a uniformly charged disk :

$\hookrightarrow V = \frac{\sigma}{2\varepsilon_0}\left[\sqrt{R^2 + z^2} - z\right]$



$* \; E_x = \frac{-dV}{dx}, \quad E_y = \frac{-dV}{dy}, \quad E_z = \frac{-dV}{dz}$

$U_{12} = \frac{kq_1 q_2}{r_{12}} \longrightarrow$ نعوض الإشارات

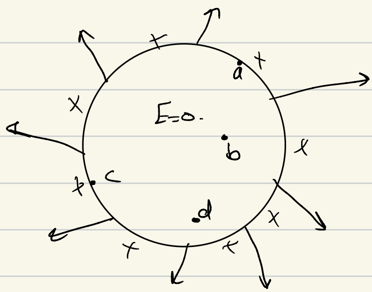
Potential of charged isolated conductor:

1- the charge inside the conductor =0.

2- E inside the conductor =0.

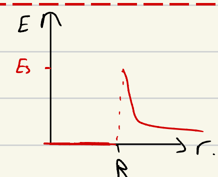
3- E near the outer surface = $\frac{\sigma}{\varepsilon_0}$

4-all points have the same potential. $V_a = V_c = V_b = V_d$



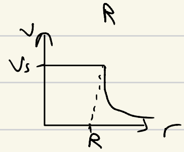
charged isolated conducting sphere :

$\sigma = \frac{q}{4\pi R^2}, \quad \rho = 0$



$E_s = \frac{kq}{R^2}, \quad E_s = \frac{\sigma}{\varepsilon_0}, \quad V_s = \frac{kq}{R} \rightarrow r < R$

$\hookrightarrow V_{inside}$



$E_{inside} = 0$

$E_{outside} = \frac{kq}{r^2}, \quad r \geq R$

$V_{outside} = \frac{kq}{r}, \quad r \geq R$

qV

$U_i + k_i = U_f + k_f$

$\frac{kq}{r_i} \quad \frac{1}{2}mv^2$

*momentum magnitud $\Rightarrow p = mv$

المقدار

Chapter 25:

$\Rightarrow C = \frac{q}{V}$ c/volt = farad.

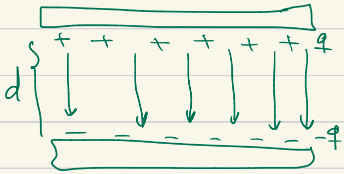
conducting sphere $\Rightarrow V = \frac{kq}{r}$, $C = kR$.

Parallel plate capacitor:

$E = \frac{q}{\varepsilon_0 A}$

$V = \frac{qd}{\varepsilon_0 A}$.

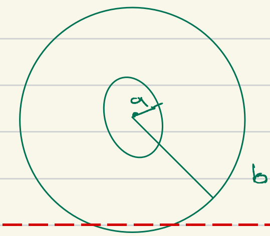
$C = \frac{\varepsilon_0 A}{d}$.



Spherical capacitor:

$E = \frac{kq}{r^2}$. $V = kq\left[\frac{b-a}{ab}\right]$.

$C = \frac{kab}{b-a}$.



Clindrical capacitor: $\Rightarrow E = \frac{\lambda}{2\pi r \varepsilon_0}$, $V = \frac{\lambda}{2\pi r \varepsilon_0} \ln\left(\frac{b}{a}\right)$. , $C = \frac{q}{V}$.

Energy density $\Rightarrow u = \frac{U}{\text{volume}} =$ 1- $\frac{1}{2}\varepsilon_0 \frac{V^2}{d^2}$.

2- $\frac{1}{2}\varepsilon_0 \left(\frac{V}{d}\right)^2$

3- $\frac{1}{2}\varepsilon_0 E^2$.

U = Area .u. / q vs V curve.

1- $\frac{1}{2} qV$.

2- $\frac{1}{2} CV^2$.

3- $\frac{1}{2}\frac{q^2}{C}$.

Capacitor with dielectric $\Rightarrow K = \frac{\varepsilon}{\varepsilon_0} > 1 \Rightarrow C = KC_0$

$= K\left(\frac{\varepsilon_0 A}{d}\right)$.

Capacitor in parallel $\Rightarrow q_{total} = q_1 + q_2 + q_3$. $= C_1V_1 + C_2V_2 + C_3V_3$.

$V_{total} = V_1 = V_2 = V_3$.

$C_{eq} = C_1 + C_2 + C_3$. $\Rightarrow C = \frac{\varepsilon_0 A}{d}$.

Capacitor in series $\Rightarrow q_1 = q_2 = q_3 = q_{total}$.

$V = V_1 + V_2 + V_3. \Rightarrow V = \frac{q_1}{C_1} + \frac{q_2}{C_2} + \frac{q_3}{C_3}$.

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

---

2 In Fig. 25-18, a potential difference $V = 75.0$ V is applied across a capacitor arrangement with capacitances $C_1 = 10.0\ \mu F$, $C_2 = 5.00\ \mu F$, and $C_3 = 15.0\ \mu F$. What are (a) charge q_3, (b) potential difference V_3, and (c) stored energy U_3 for capacitor 3, (d) q_1, (e) V_1, and (f) U_1 for capacitor 1, and (g) q_2, (h) V_2, and (i) U_2 for capacitor 2?

Figure 25-18 Problems 1, 2, and 3.

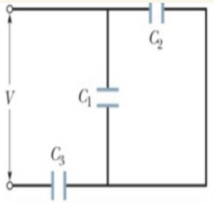


Figure 25-18 Problems 1, 2,

$V = 75$.

$C_1 = 10\ \mu F$.

$C_2 = 5\ \mu F$.

$C_3 = 15\ \mu F$.

$C_{12} = C_1 + C_2 = 15\ \mu F \Rightarrow \frac{1}{C_{eq}} = \frac{1}{15\ \mu F} + \frac{1}{15\ \mu F} = \frac{2}{15\ \mu F}$

$C_{eq} = 7.5\ \mu F$.

$* \ C_{eq} = \frac{q_{eq}}{V} \Rightarrow q_{eq} = 75 \times 7.5 = 562.5\ \mu C$.

$\boxed{a}$ $q_3 = 562.5\ \mu C$.

$\boxed{b}$ $V_3 = \frac{q_3}{C_3} = \frac{562.5\ \cancel{\mu}}{15\ \cancel{\mu}} = 37.5$.

$\boxed{e}$ $\boxed{h}$ $V_1 = V_2 = 75 - 37.5 = 37.5$.

$\boxed{d}$ $q_1 = C_1 V_1 = 37.5 \times 10\ \mu = 375\ \mu$.

$\boxed{g}$ $q_2 = V_2 C_2 = 37.5 \times 5\ \mu = 187.5\ \mu$.

$\boxed{c}$ $U_3 = \frac{1}{2} C_3 V_3^2 = \frac{1}{2} (15\ \mu) (37.5)^2 = 10546.875\ \mu J$.

$\boxed{f}$ $U_1 = \frac{1}{2} C_1 V_1^2 = \frac{1}{2} (10\ \mu) (37.5)^2 = 7031.25\ \mu J$

$\boxed{i}$ $U_2 = \frac{1}{2} C_2 V_2^2 = \frac{1}{2} (5\ \mu) (37.5)^2 = 3515.625\ \mu J$.

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$\Leftarrow$ the negative (work) in pushing them together إذا طلب *

$W = \Delta U = U_f - U_i$

مجمعها . لوحدها .

- بعدين بجمعهم

P53: A 100 pF capacitor is charged to a potential difference of 80.0 V and the charging bettery is disconnected. The capacitor is then connected in parallel with a second (initially uncharged) capacitor. If the potential difference across the first capacitor drops to 35.0 V, what is the capacitance of this second capacitor?

Sol: $Q = CV$

q_i: before the charging bettery is disconnected

$q_i = C_1 V = 100\,pF \times 80\,V = 8000\,pC$

q_f: aftere the charging bettery is disconnected and connected in parallel with C_2

$q_f = C_2 V = 100\,pF \times 35 = 3500\,pC$

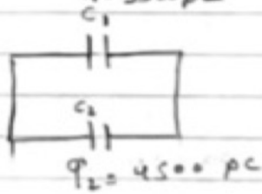
q_2: the charge on capacitor 2

$q_2 = q_i - q_f$

لانهم على التوازي الشحنه
هي مجموعهم

$= 8000\,pC - 3500\,pC$

$q_2 = 4500\,pC$



$q_2 = C_2 V$

$C_2 = \frac{q_2}{V}$

$= \frac{4500 \times 10^{-9}}{35}$

$= 128.57 \times 10^{-9}$

$\simeq 129\,pF$

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31 Figure 25-30 shows a parallel-plate capacitor with a plate area $A = 7.89\ \text{cm}^2$ and plate separation $d = 4.62$ mm. The top half of the gap is filled with material of dielectric constant $\kappa_1 = 11.0$; the bottom half is filled with material of dielectric constant $\kappa_2 = 4.0$. What is the capacitance?

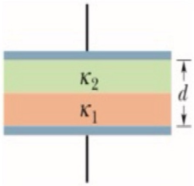

Figure 25-30

$A = 7.89 \times 10^{-4}$.

$d = 4.62 \times 10^{-3}$.

$$C_1 = \frac{k \varepsilon_0 A}{d}$$

$$= \frac{11 \times 8.85 \times 10^{-12} \left(\frac{7.89 \times 10^{-4}}{2}\right)}{\left(\frac{4.62 \times 10^{-3}}{2}\right)}$$

$$= 1.66 \times 10^{-11}.$$

$$C_2 = \frac{k \varepsilon_0 A}{d} = 6.05 \times 10^{-12}.$$

$$C_{eq} = \frac{1}{1.66 \times 10^{-11}} + \frac{1}{6.05 \times 10^{-12}} \Rightarrow C_{eq} = 2.26 \times 10^{-11}\ C.$$

$$* \ F = \frac{q^2}{2\varepsilon_0 A} = \frac{qE}{2},\ U = \frac{q^2}{2C} = \frac{q^2 d}{2\varepsilon_0 A}.$$

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Chapter 26:

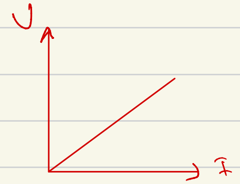
$* I = \frac{dq}{dt} = \int \vec{J} \cdot d\vec{A} = JA = \frac{\Delta q}{\Delta t} = \frac{enAL}{\Delta t} = enA v_d$

السرعة الانسياقية = drift speed

$*$ number of electrons in the wire $= nAL$

$q = enAL$

$* J = \frac{I}{A} = enA\vec{v_d}$



$* V = EL$

$* E = \rho J$

$* R = \frac{\rho L}{A}$

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

$* V = IR$

$* \rho - \rho_0 = \rho_0 \alpha (T - T_0)$

$* R - R_0 = R_0 \alpha (T - T_0)$

Resistors in series $\Rightarrow$ $V = V_1 + V_2 + V_3$

$V = IR_1 + IR_2 + IR_3$

$R_{eq} = R_1 + R_2 + R_3$

$I_{eq} = I_1 = I_2 = I_3$

Resistors in parallel $\Rightarrow$ $V_{eq} = V_1 = V_2 = V_3$

$I = I_1 + I_2 + I_3$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$* P = \frac{\Delta U}{\Delta t} = VI = \frac{E}{\Delta t}$

$= I^2 R$

$= \frac{V^2}{R}$

$= \varepsilon I$

$= IV$

$* \varepsilon = \frac{\Delta W}{\Delta q}$

$* I = \frac{\varepsilon}{R} = \frac{\varepsilon}{R + r}$

$* t = \frac{L}{v_d}$ المسافة . السرعة

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3 An electrical cable consists of 63 strands of fine wire, each having 2.65 $\mu\Omega$ resistance. The same potential difference is applied between the ends of all the strands and results in a total current of 0.750 A. (a) What is the current in each strand? (b) What is the applied potential difference? (c) What is the resistance of the cable?

$R = 2.65 \times 10^{-6}$. $V \Rightarrow$ ثابت كله توازي

$I = 0.75$

$\boxed{a}$ $I = \dfrac{I_{\text{كلي}}}{\text{عدد standard}} = \dfrac{0.75}{63} = 0.0119\ A$.

$\boxed{b}$ $V = IR = 0.0119 \times 2.65 \times 10^{-6} = 3.15 \times 10^{-8}$.

$\boxed{c}$ $R_{\text{كلي}} = \dfrac{V}{I_{\text{كلي}}} = \dfrac{3.15 \times 10^{-8}}{0.75} = 4.2 \times 10^{-8}$.

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Chapter 27:

$\mathcal{E} \Rightarrow$ electromotive force of the power source.

$\mathcal{E} = \frac{dw}{dq}$ J/C = volt.

$P_{\mathcal{E}} = \mathcal{E} I$, $P_R = I^2 R$ $\Rightarrow$ * consumed :- استهلاك   * supplied $\Rightarrow$ توفير.

* kirchoff's $\Rightarrow$ $\Sigma I_{entering} = \Sigma I_{leaving}$.

$\Sigma V = 0$.

---

* Circuits :-

RC-circuit $\Rightarrow$ $\mathcal{E} = RI + \frac{q}{C}$.

$\cancel{q(t)} = C\mathcal{E}\left(1 - e^{-t/RC}\right)$.

$q(t) = C\mathcal{E}\left(1 - e^{-t/\tau}\right)$

time constant $\leftarrow \tau = RC$.

$I = \frac{\mathcal{E}}{R} e^{-t/RC}$

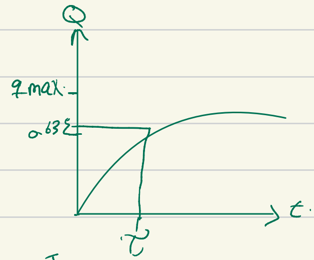
$V_C(t) = \frac{q(t)}{C} = \mathcal{E}\left(1 - e^{-t/\tau}\right)$.

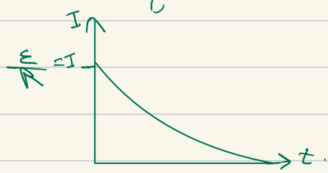
$V_R = RI = \mathcal{E} e^{(-t/\tau)}$

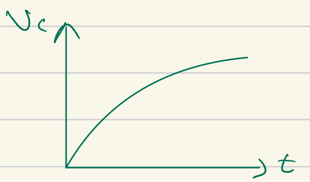
$\Rightarrow Q_{max} = C\mathcal{E}$.

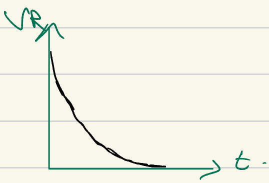
$\mathcal{E} = \mathcal{E}_0 \left(e^{-t/\tau}\right)$.

* $\mathcal{E} = \frac{W}{q}$









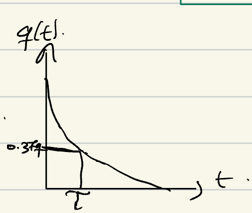
* Discharging a capacitor $\Rightarrow$

$q(t) = q_{max}\, e^{-t/\tau}$.

$I(t) = I_{max}\, e^{-t/\tau} = \frac{-q_0}{\tau} e^{-t/\tau}$.

$E = \frac{q^2}{2C}$

stored energy.



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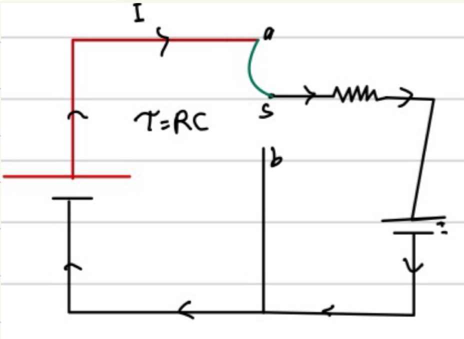
15 What multiple of the time constant τ gives the time taken by an initially uncharged capacitor in an RC series circuit to be charged to 89.0% of its final charge?



$Q(t) = Q_m(1 - e^{-t/\tau})$

$0.89\,\cancel{Q}_m = \cancel{Q}_m\,(1 - e^{-t/\tau})$

$0.89 = 1 - e^{-t/\tau}$

$e^{-t/\tau} = 1 - 0.89$

$e^{-t/\tau} = 0.11$

$\frac{-t}{\tau} = \ln 0.11$

$t = -\tau(-2.21) \Rightarrow t = 2.21\tau$

$\boxed{b}$ $Q(t) = Q_m(1 - e^{-t/\tau})$

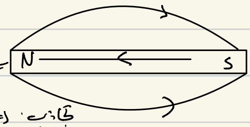
$0.99\,\cancel{Q}_m = \cancel{Q}_m\,(1 - e^{-t/\tau})$

$e^{-t/\tau} = 0.01$

$\frac{-t}{\tau} = \ln 0.01 \Rightarrow t = -\tau(-5)$

$t = 5\tau$

Chapter 28:



ما في قطب مفرد. ⇐

N - S ⇒ attractive force. ⇒ تجاذب.

N-N, S-S ⇒ replusive force ⇒ تنافر

* $F_B = q\vec{v} \times \vec{B} = qvB\sin\theta$.
  ⟶ only changes the direction of v only.
  it could not change K. energy.
  it could not change the magnitude of v.
* $W_B = 0$ ⇒ always.
* F_B change the $\underbrace{\text{linear momentum}}_{\text{الزخم}}$. $(m\vec{v})$.

* $K = \frac{1}{2}mv^2$.

Application on qv x B :

q moves in a uniform circular motion :

* $r = \frac{mv}{qB}$.
* $v = \frac{qBr}{m}$.
* $T = \frac{2\pi m}{qB} = \frac{2\pi r}{v}$.
* $f = \frac{1}{T} = \frac{qB}{2\pi m}$.

Cyclotron:to accelerate charged particles:

$K_{max} = \frac{1}{2}mv_{max}^2 = N2qV. = \frac{1}{2}\frac{q^2B^2R^2}{m}$.

$V_{max} = \frac{qBR}{m}$.

$V = V_{max}\sin\omega t = V_{max}\sin(2\pi f t)$.

Mass spectrometer ⇒ to measure mass of ions:-

$qV = \frac{1}{2}mv^2$, $r = \frac{mv}{qB}$.

$r^2 = \frac{2mV}{qB^2}$

$m = \frac{qB^2r^2}{2V} = \frac{qB^2x^2}{8V}$. $r = \frac{x}{2}$

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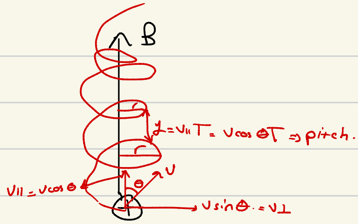
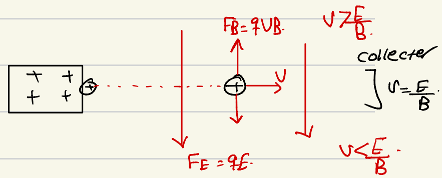
Helical motion :



$$\frac{m v_{\perp}^2}{r} = q\, v_{\perp} B.$$

$$r = \frac{m v \sin\theta}{q B} \quad , \quad T = \frac{2\pi r}{v_{\perp}} = \frac{2\pi m}{q B}.$$

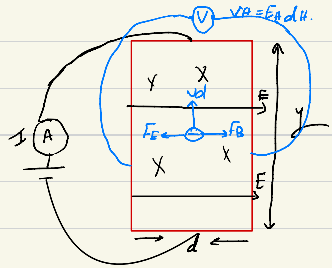
Crossed field velocity selector :



$F_B - F_E = 0.$

$qvB - qE = 0 \Rightarrow v = \frac{E}{B}$. collected selected.

Hall effect (crossed fields):



$I = en A v_d.$

$\vec{F} = e\, \vec{v_d} \times \vec{B}$

at equilibrium $\Rightarrow e v_d B - e E_H = 0$

السرعة الانسياقية $v_d = \frac{E_H}{B} = \frac{V_H}{Bd}$ فرق الجهد

$n = \frac{I B}{e L V_H}$

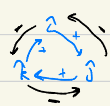
Lorentz force:

$F = q\vec{E} + q\vec{v} \times \vec{B}.$

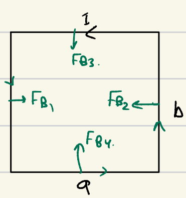
موجودة في أي مكان.

Magnetic force on a wire carrying current :

$\vec{F} = I \vec{L} \times \vec{B} = I L B \sin\theta.$



case 1 :-



$\Rightarrow F_{net} = 0. \quad , \tau_{net} = 0. \quad \Rightarrow F = I L \times B.$

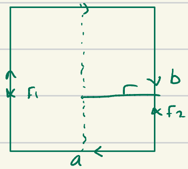
$F_1 = I b B \ (\hat{i})$

$F_2 = I b B \ (-\hat{i}).$

$F_3 = I b B \ (-\hat{j}).$

$F_4 = I b B \ (\hat{j}).$

case 2:-



$\Rightarrow F_{net} = 0 \quad , \tau \neq 0$

$\tau = r \times \vec{F} = \frac{a}{2} \times (IbB)$ clockwise.

$\tau_{net} = I(ab)B$ clockwise.

$\tau_{net} = IAB.$

for N Loops $\Rightarrow \tau_{Net} = NIAB.$ clockwise.

case 3 $\Rightarrow$ general case $\Rightarrow$ There is an angle between $\vec{B}$ and the normal of the plane.

يعني إله زاوية بين B والعمودي على السطح.

$\tau = IabB \sin\theta.$

$\tau = NIabB \sin\theta = (NIA)B \sin\theta.$

---

* Magnatic dipole moment $\Rightarrow \tau = \mu B; \mu = NIA$

In general $\Rightarrow \tau = \mu \times \vec{B} = \mu B \sin\theta.$

* Magnatic potential energy $\Rightarrow -\mu \cdot B.$

Remember $\Rightarrow$ Electric Dipole moment $= qd.$

$\tau = P \times E, \quad U = -P \cdot E.$

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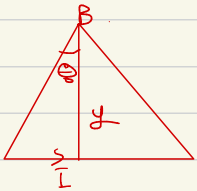
Chapter 29:

$$|dB| = \left(\frac{\mu_0}{4\pi}\right) \frac{I\,ds\,\sin\theta}{r^2}.$$. اليد اليمين الاصابع باتجاه ds وبتطلع r

$\mu_0 = 4\pi \times 10^{-7}\ T.m/A.$

B due to I in a long straight wire(not infinite):

$$B = \frac{\mu_0 I \sin\theta}{2\pi y}.$$



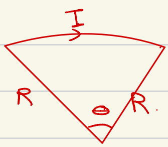
consider The following two cases:-

$\boxed{1}$ for infinite wire $L \ggg R. \Rightarrow \theta_0 = \frac{\pi}{2}.$

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

$\boxed{2}$ for semi infinite wire $\Rightarrow B = \frac{\mu_0 I}{4\pi r}.$

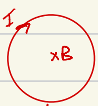
B due to I in Arc:



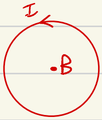
$$\vec{B} = \frac{\mu_0 I \theta}{4\pi R},\ \theta \text{ in rad}.$$

consider the following cases:-

$\boxed{1}$

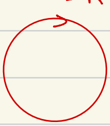


$\theta = 2\pi.$



$$B = \frac{\mu_0 I}{2R}.$$

$\boxed{2}$

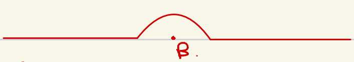


N من الحلقات

$$B = \frac{\mu_0 I N}{2R}. \Rightarrow$$ عكس إذا الزاوية 60 .

$$N = \frac{60}{360}$$

$\boxed{3}$



$\theta = \pi.$

$$B = \frac{\mu_0 I}{4R}.$$

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* Ampere's Law:-

$$\int \vec{B} \cdot \vec{ds} = \mu_0 \, I_{enc}$$

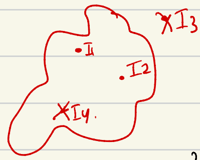
$\downarrow$

$B \cos\theta \, ds$

$\boxed{\cdot}$ +

$\boxed{\times}$ −

Exp ⇒



$$\Rightarrow \int B \cdot ds = \mu_0 (I_1 + I_2 - I_3)$$

* B due to wire ⇒ (not infinite). ⇒ $B = \dfrac{\mu I \sin\theta}{2\pi r}$

* B due to infinite wire $= \dfrac{\mu I}{2\pi r}$.

* B due to semi infinite wire ⇒ $B = \dfrac{\mu I}{4\pi r}$

* B due to arc ⇒ $B = \dfrac{\mu I \theta}{4\pi R}$

بيو سافار:

$$B = \frac{\mu}{4\pi} \frac{I \, ds \sin\theta}{R^2}$$

قانون أمبير

$$\int B \cdot ds = \mu I_{enc}$$

* $B = \dfrac{\mu I}{2R}$ لفة واحدة.

* $B = \dfrac{\mu I N}{2R}$ لعدة لفات.

* B due to infinite wire ⇒

$r > R$.

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

$r < R$.

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

* B due to solenoid ⇒ $B = \mu n I$; $n = \dfrac{N}{l}$

* B due to Toroid ⇒ $B = \dfrac{\mu I N}{2\pi r}$

* force between 2 wires ⇒ $F_a = \dfrac{\mu I_a I_b L_1}{2\pi d}$.

* Ampere's Law is useful in calculating B due to I in a system having high symmetry.

* B due I outside an infinite wire:- $= \int J \cdot dA$

Infinite wire => very long   current = I, $J = \frac{I}{A} = \frac{I}{\pi R^2}$.

B outside $(r > R)$ => $B = \frac{\mu_0 I}{2\pi r}$.

B inside $(r < R)$ => $B = \frac{\mu_0 I r}{2\pi R^2}$, $r \leq R$.

* B due to I in an ideal solonoid => ملف الحلزوني

↳ B near the solonoid is zero.

* B inside the solonoid => $B = \mu_0 I n$; $n = \frac{N}{L}$.

L ← طول الملف وليس طول السلك.

طول السلك = طول الملف X عدد اللفات.

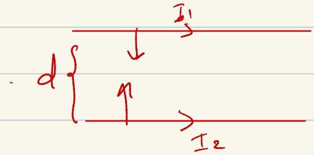
* B due to I in Toroid:- $B = \frac{\mu N I}{2\pi r}$.

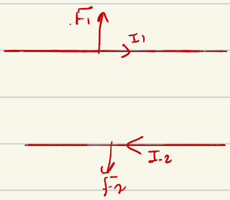
$\mu = I A$ => Magnatic dipole moment.

* Magnatic force between 2 parallel wires:

$B_2 = \frac{\mu_0 I_2}{2\pi d}$.

$F_2 = \frac{\mu_0 I_1 I_2 l_2}{2\pi d}$.





تنافر

replusive force

تلخيص سريع :- (أ-سهل).

قانون أمبير في المغناطيسية ⇐

$\Sigma B\cdot dL = \Sigma I \mu_0$.

لو إذا طلب أوجد الدوران المغناطيسي ⇐ بدي بعوض $\Sigma B\cdot dL$.

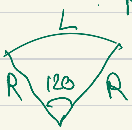
ولـ $\Sigma I =$ $\boxed{\cdot}$ + بعوض

$\boxed{X}$ − بعوض

+ الملف الحلزوني ⇐

$n=\frac{N}{L}$, $B_c=\mu I n$ = $B_c=\frac{\mu I N}{L}$ (طول الملف)

⇐ سلك طوله 20.47 cm كما في الشكل احسب نصف القطر للملف R.



$L_{(\text{سلك})} = 2R + L_{(\text{القوس})}$

$20.47 = 2R + N(2\pi R)$.

$20.47 = 2R + \frac{1}{3}(2\pi R)$.

$\boxed{R = 5\,cm}$

⇐ للملفات المتحدة بالمركز ⇐ الزاوية بين المستويين تكون الزاوية بين المجالين $\theta = 60°$

B_1، B_2 تساوي $60°$ إذا كانت مجالات الحلقة أعلى الحلقة لنفس الاتجاه.

⇐ إذا كانت المجالات أعلى الحلقة متعاكسة $\theta = 180-120°$

⇐ مستويات متعامدة ⇐ $\theta=90°$ ⇐ $B=90°$ الزاوية بين المجالين B_1، B_2.

$\Rightarrow F_B = qVB\sin\theta = \frac{\mu_0 I_1 I_2 L_2}{2\pi R} = ILB\sin\theta$.

$\Rightarrow F_B = \frac{mv^2}{R} \Rightarrow R = \frac{mv}{qB}$.

⇐ الشحنات الساكنة تولد فقط مجال كهربائي E، لكن الشحنات الكهربائية المتحركة مجالين E، B.

شحنة متحركة $= I\,dL$

تيار ، سلك.

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قانون بيوسافارت ⇐ $U = \frac{\Delta L}{\Delta t}$, $I = \frac{\Delta q}{\Delta t}$ ⇐ الشحنة المتحركة $= \Delta q \, V$

$= I \, \Delta L$

$$\Delta B = \frac{\mu_0}{4\pi} \frac{I \Delta L}{R^2} \sin\theta$$

الإبهام مع I والباقي مع R.

$\Rightarrow B_{\text{سلك طويل}} = \frac{\mu I}{2\pi R_\perp}$, $R_\perp = R \sin\theta$.

نقطة التعادل:

١- إذا كان التياران بنفس الاتجاه تقع نقطة التعادل بينهما قرب الصغرى.

٢- إذا كان التياران متعاكسين بالاتجاه تقع نقطة التعادل في الخارج قرب الصغرى.

٣- إذا كان التياران بنفس الاتجاه ومتساويان مقداراً تقع نقطة التعادل في المنتصف.

تيار ⊕ قاعدة يد اليمنى ، تيار ⊖ قاعدة يد اليمنى مع عكس الاتجاه الناتج.

⇐ الملف الدائري ⇐

$B_c = \frac{\mu I N}{2R}$, $N = \frac{L}{2\pi R}$ ← طول السلك / طول اللفة } عدد اللفات.

$N = \frac{\theta}{360}$

$B_{out\text{ حلزوني + دائري}} = 0$.

$$\Rightarrow \frac{B_f}{B_i} = \left(\frac{N_f}{N_i}\right)^2$$

Chapter 30:

Magnetic flux $\Rightarrow$ $\phi_B = \vec{B}\cdot\vec{A} = BA\cos\theta$.

* التدفق المغناطيسي خلال أي سطح مغلق = 0.

$\mathcal{E}_{ind} = (-)\,\dfrac{N\,d\phi_B}{dt}$. $\Rightarrow$ الاتجاه مع المجال تلف مع التيار $=$ $\mathcal{E}_{ind} = BLV$.

$I_{ind} = \dfrac{\mathcal{E}_{ind}}{R}$. , $\mathcal{E}_{net} = \mathcal{E}_{bat} + \mathcal{E}_{ind}$.

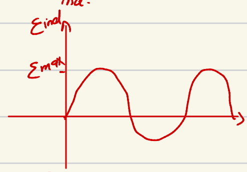
$I_{net} = \dfrac{\mathcal{E}_{net}}{R}$.

* Therminal power $\Rightarrow$ $P_R = I^2R = \dfrac{B^2L^2V^2}{R}$. , $P_{\mathcal{E}} = I\mathcal{E}$.

$F_B = \dfrac{L^2B^2V}{R}$.

$P = \vec{F}\cdot\vec{v} = \dfrac{B^2L^2v^2}{R}$. , $F_{ext} = F_{wire} = \underset{ind.}{I}LB\sin\theta$.

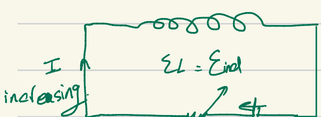
* $\mathcal{E}_{ind} = 2\pi f\,NB\,\underset{\text{الطول X العرض.}}{ab}\,\sin\omega t$.



$\boxed{\mathcal{E}_{max} = 2\pi f\,NBab \quad \text{volt.}}$

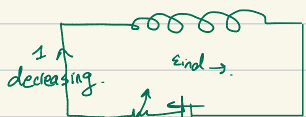
* Inductor and Inductance.

ملف.



Eind تعيق نحو التيار الأصلي.

قلت المقاومة.



Eind تعيق نحو التيار الأصلي.

زادت المقاومة.

$\mathcal{E}_L = -L\dfrac{dI}{dt}$. , $L_{inductance} = \dfrac{V.s}{A} = H$.

$\mathcal{E}_L = \dfrac{N\,d\,\phi B}{dt}$. $= -L\dfrac{dI}{dt}$.

$\hookrightarrow L = \dfrac{N\,\phi B}{I} = \dfrac{T.m^2}{Ampere} = H$.

$\hookrightarrow L = \mu_0 n^2 A L$.

$\mathcal{E}_L = \mathcal{E}\,e^{-t/\tau_L}$.

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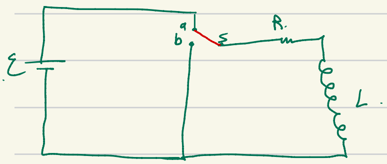
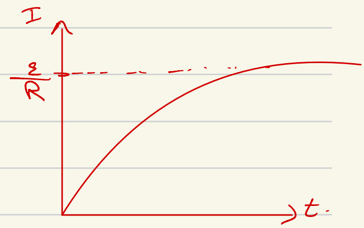
* RL - circuit:-



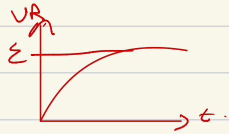


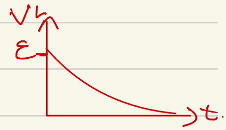
$I(t) = \frac{\varepsilon}{R}(1 - e^{-Rt/L}) = \frac{\varepsilon}{R}(1 - e^{-t/\tau_L})$, $\tau_L = \frac{L}{R}$.

$I_\infty = \frac{\varepsilon}{R}$.

* $V_R(t) = IR = \varepsilon(1 - e^{-t/\tau_L})$.

* $V_L = -L\frac{dI}{dt} = \varepsilon e^{-t/\tau_L}$.





$\boxed{2}$ connect s with b $\Rightarrow$ تفريغ المخزون بالملف

$I(t) = I_m e^{-t/\tau_L}$; $I_m = I$ at $t=0$.

$I = \frac{-t}{\tau_L}$, $\tau_L = \frac{L}{R}$.

* Magnatic energy:-

↳ (RL-circuit) $\Rightarrow \varepsilon = RI + L\frac{dI}{dt}$.

$\varepsilon I = RI^2 + LI\frac{dI}{dt}$.

P_ε $\quad P_R \quad \frac{dU_B}{dt}$

$U_B = \frac{1}{2}LI^2$

* magnatic energy density $= \frac{U_B}{\text{volume}}$

$u_B = \frac{1}{2}\frac{B^2}{\mu_0}$ J/m^3

$U_E = \frac{1}{2}\frac{Q^2}{C}$.

$u_E = \frac{1}{2}\varepsilon_0 E$. J/m^3.

$\Rightarrow \varepsilon_{ind} = L\frac{\Delta I}{\Delta t}$

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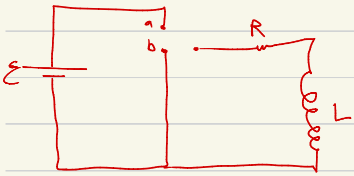

connect s with b :.

$\mathcal{E} = RI + L\frac{dI}{dt} = 0.$

$I(t) = I_m \, e^{-t/\tau_L}$. $I_m = I$ at $t=0$.

$\tau_L = \frac{L}{R}$

connect s with a :-

$I(t) = \frac{\mathcal{E}}{R}(1 - e^{-t/\tau_L})$

$I(t) = I_m \,(1 - e^{-t/\tau_L}).$

$\mathcal{E}_L = \mathcal{E} e^{-t/\tau_L}$

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