New 2018

Civilittee

اللجنة الأكاديمية للهندسة المدنية

دفتر

فيزياء 2

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Physics 2

30/1/2017 — Ch 23 — Tuesday

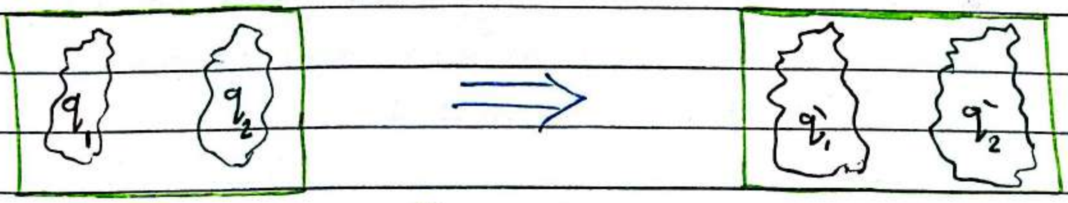
The Coulomb's law

1) The charge properties (خواص الشحنة):

A) The charge is conserved (محفوظة)

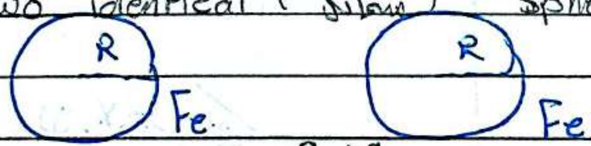
Charge = Q / q

System.



$Q_i = q_1 + q_2$ $\qquad$ $Q_i = Q_f$ $\qquad$ $Q_f = q_1' + q_2'$

E.X: Two identical (متماثل) spheres



$q_1' = q_2' = \frac{q_1 + q_2}{2}$

B) The charge is quantized (مكممة)

$q = N . e$

$N = \pm 1, \pm 2, \pm 3, ---$

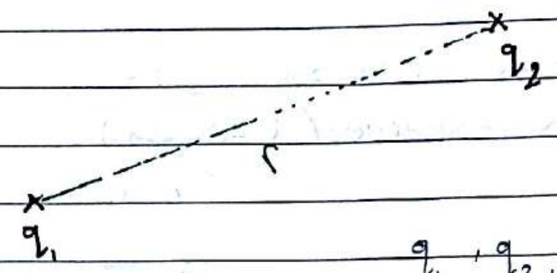
$e = -1.6 * 10^{-19}$ C

E.X: Find the number of electrons on the charged object $Q = 3.2 * 10^{-15}$ C

sol. $Q = N . e$

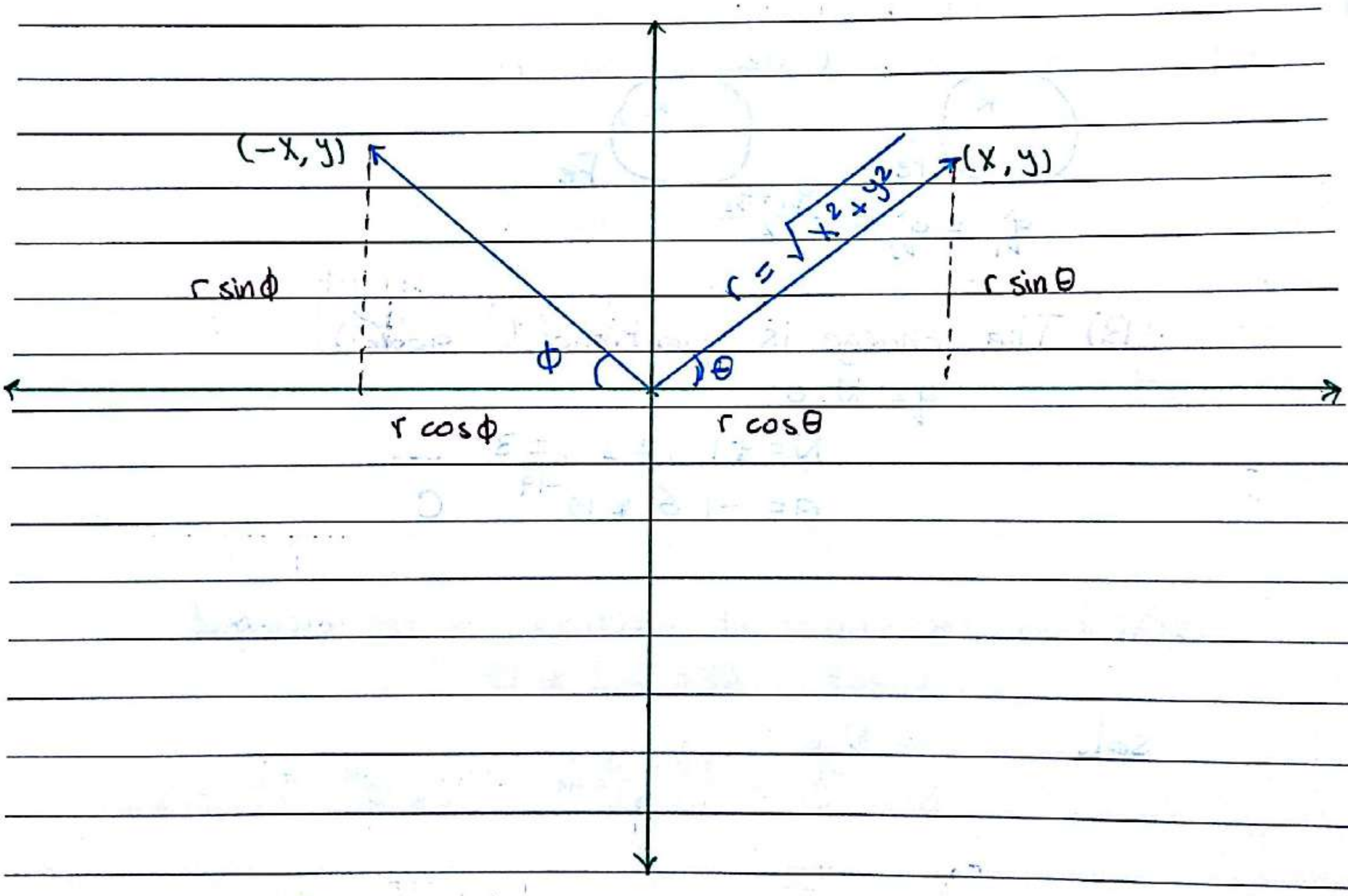
$N = \frac{Q}{e} = \frac{3.2 * 10^{-15}}{1.6 * 10^{-19}} = 2 * 10^{4}$ electrons

2) Coulomb's low



q_1 , q_2 are point charges
r is distance or seperation (البعد)

Attractive force = قوة التجاذب.
Repulsive force = قوة التنافر



1/2/2018 Thursday

$F \sim \frac{q_1 q_2}{r^2}$

↳ إشارة التناسب

q_1, q_2 ~ propotional تناسب طردي

r^2 ~ inversly propotional تناسب عكسي

$$F = \frac{1}{4\pi E_0} \cdot \frac{q_1 q_2}{r^2}$$

$E_0 = 8.85 * 10^{-12} \quad C^2/N.m^2$

$$F = \frac{K_e \, q_1 q_2}{r^2}$$

$K_e = \frac{1}{4\pi E_0} = 9 * 10^9$

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

$r =$ { $\hat{i}$, $-\hat{i}$
$\hat{j}$, $-\hat{j}$
$\hat{j}$ رقم , $\hat{i}$ رقم

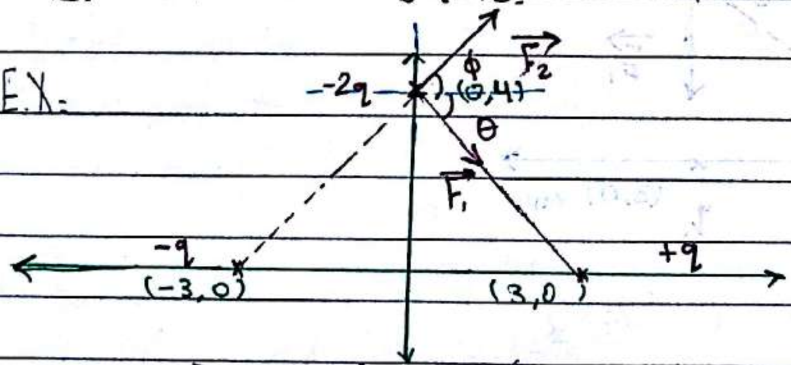
E.X.: q_1 o———— r ————⊖ q_2

Which of the following statement is correct

A) $\vec{F_{12}} = \vec{F_{21}}$ B) $F_{12} = -F_{21}$ C) $\vec{F_{12}} = -3\vec{F_{21}}$ (D) $\vec{F_{12}} = -\vec{F_{21}}$ ✓

ال 3 غلط ✗ ، لا يوجد إشارة vector ✗ ، لأنه لا يوجد سالب ✗

E.X.:



$q = -5 \mu C$
find the force on the charge $-2q$

$$\vec{F_1} = \frac{9*10^9 * 5*10^{-6} * 10*10^{-6}}{25} (\cos\theta \, \hat{i} - \sin\theta \, \hat{j})$$

$$= 18*10^{-3} \left(\frac{3}{5}\hat{i} - \frac{4}{5}\hat{j}\right)$$

$$\vec{F_2} = \frac{9*10^9 * 5*10^{-6} * 10*10^{-6}}{25} (\cos\theta \, \hat{i} + \sin\theta \, \hat{j})$$

$$= 18*10^{-3} \left(\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\right)$$

$$\vec{F_{net}} = \vec{F_1} + \vec{F_2}$$

$$= \frac{2 * 18 * 10^{-3} * 3}{5} \hat{i} \quad N$$

4/2/2018 Sunday

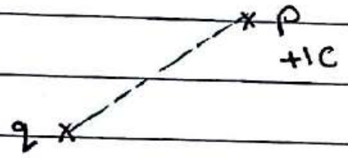
3) The electric field المجال الكهربائي

x q_0 = test charge (+1 C)

q x

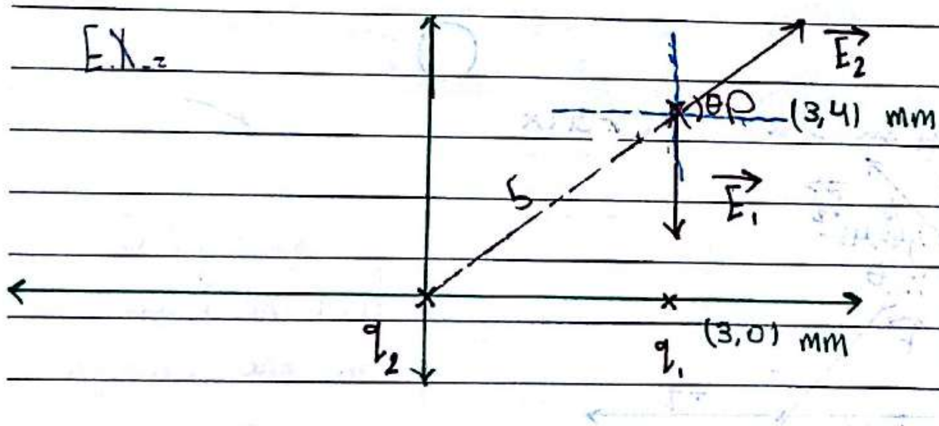
(E) The electric field is the electric force exerted (تؤثر) on a positive unit charge

$$\vec{E} = \frac{\vec{F}}{q_0} = K_e \frac{q}{r^2} \hat{r}$$



Remember: $\vec{F} = \vec{E} \cdot q_0$

EX.:



$q_1 = -5$ nC, $q_2 = 10$ nC

① find the net electric field at the point P

② find the force on the point charge Q = -4 nC located at P

sol ①

$$\vec{E_1} = \frac{9*10^9*5*10^{-9}}{(4*10^{-3})^2} = \frac{45}{16}\,(-\hat{j}) \text{ M N/C}$$

$$\vec{E_2} = \frac{9*10^9*10*10^{-9}}{(5*10^{-3})^2}(\cos\theta\,\hat{i} + \sin\theta\,\hat{j}) = \frac{90}{125}(3\hat{i} + 4\hat{j}) \text{ M N/C}$$

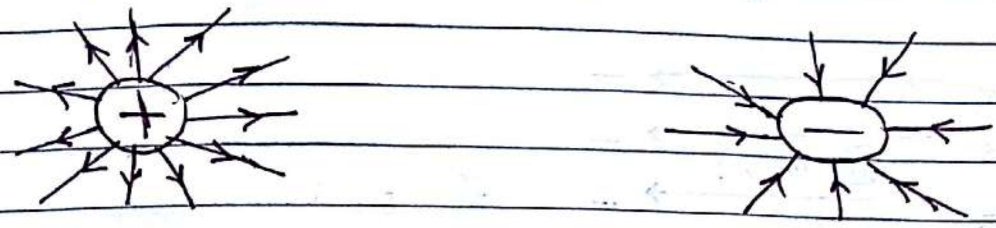
$$\vec{E_p} = \frac{270}{125}\hat{i} + \left(\frac{360}{125} - \frac{45}{16}\right)\hat{j} = \frac{270}{125}\hat{i} + \frac{675}{10000}\hat{j} \text{ M N/C}$$

②

$$\vec{F_e} = q_0 \vec{E_p} = -4*10^{-9}\left(\frac{270}{125}\hat{i} + \frac{675}{10000}\hat{j}\right) \text{ M N}$$

4) The electric field lines properties

A) The electric feild lines emerged (تنبع) from positive charges and end to negative charges

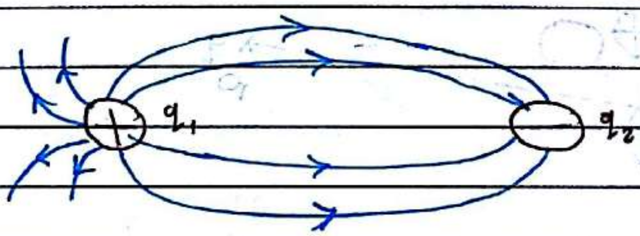


B) The electric field lines intensity (شدة) propotional to the charge magnitude.

# of electric feild lines ~ q

C) The electric fiold lines don't intersect (تتقاطع)

E.X.:



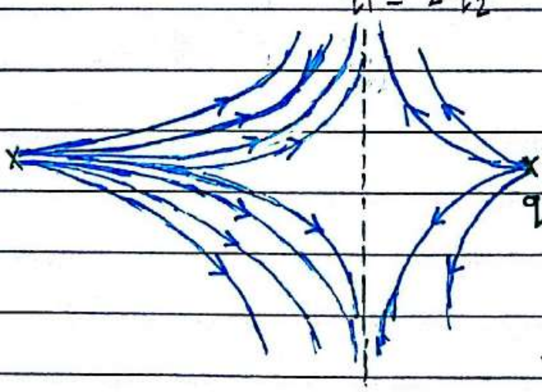
2q q

$$\frac{q_1}{q_2} = \frac{n_1}{n_2}$$

$$\frac{q_1}{q_2} = \frac{8}{4}$$

$$q_1 = 2q_2$$

EX.:



مختلفتين	متشابهتين	الشحنتين
خارجهما وأقرب للأصغر في المقدار	بينهما وأقرب للأصغر في المقدار	منطقة التلاشي

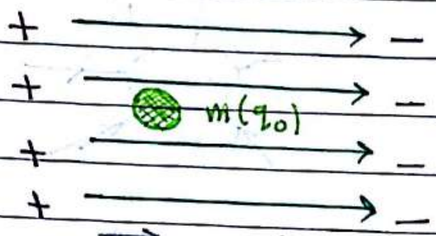
vanshing (تلاشي) electric feild

vanshing electric force

$E = 0$ OR $F = 0$

5) Motion of a charge particle in a uniform E-field

حركة جسيم مشحون في مجال كهربائي منتظم



المسافة بين الخطوط متساوية

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

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

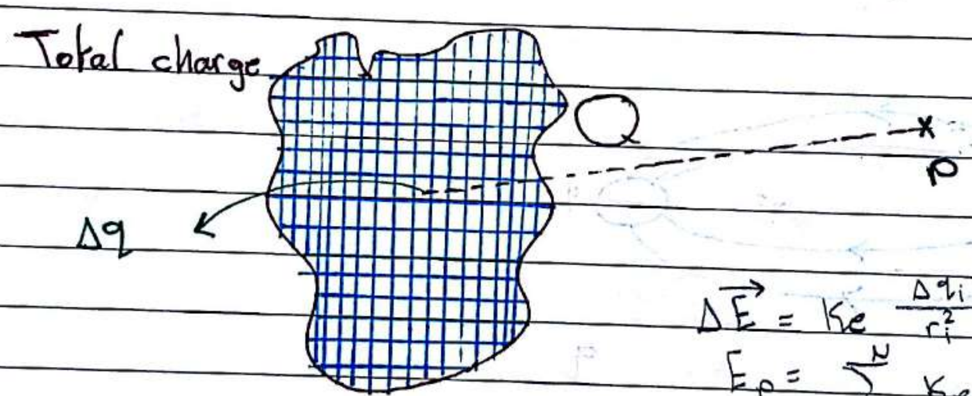
$F = m\vec{a} = q_0 E_0$

$a = \frac{q_0 E_0}{m}$

يعامل هذا التسارع مثل الجاذبية

6) The E-field of a continuous charge distribution (density)

المجال الكهربائي لتوزيع شحني (كثافة)



$\Delta \vec{E} = k_e \frac{\Delta q_i}{r_i^2} \hat{r}_i$

$E_P = \sum_{i=1}^{N} k_e \frac{\Delta q_i}{r_i^2}$

$\xrightarrow[\Delta q \to 0]{N \to \infty} \int k_e \frac{dq}{r^2}$

$E_P = \int_{charge} \frac{k_e \, dq}{r^2}$

Charge density

1) 3D

volume charge density

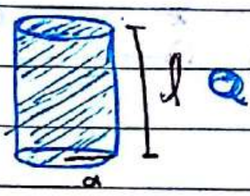
(رو) $\rho = \frac{charge}{volume} = \frac{Q}{V}$

1) sphere (كرة)

R = Radius (نق)

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

2) cylinder (اسطوانة)



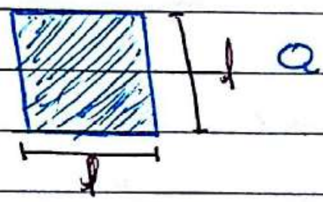
$\rho = \frac{Q}{\pi a^2 l}$

2) 2D

surface charge density

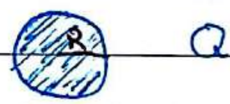
(سيجما) $\sigma = \frac{Q}{Area}$

1) squar



$\sigma = \frac{Q}{2l^2}$

2) desk (قرص)



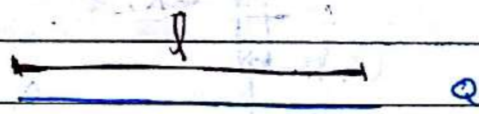
$\sigma = \frac{Q}{\pi R^2}$

3) 1D

linear charge density

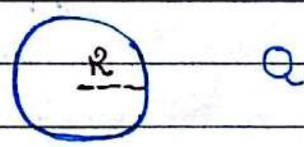
(لمدا) $\lambda = \frac{charge}{Length} = \frac{Q}{l}$

1) wire (سلك)



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

2) Ring (حلقة)



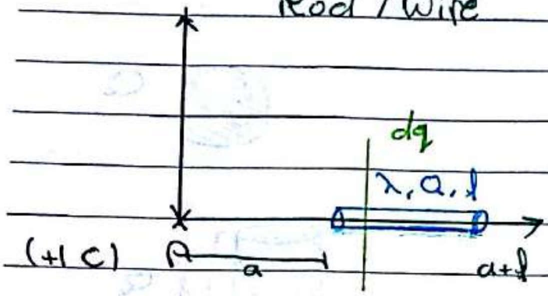
$l = 2\pi R$

$\lambda = \frac{Q}{l} = \frac{Q}{2\pi R}$

8/2/2018 Thursday

Linear charge density (λ) :

Rod / Wire



l = length of wire
Q = charge

$$E_p = \int_{charge} K_e \frac{dq}{r^2}$$

$$= \int_{charge} K_e \frac{dq}{x^2}$$

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

$q = \lambda x$

$dq = \lambda dx$

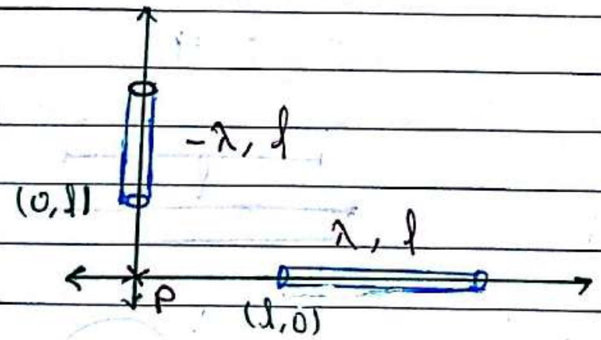
$$= K_e \int_a^{a+l} \frac{\lambda \, dx}{x^2}$$

$$= K_e \lambda \left. \frac{-1}{x} \right|_a^{a+l}$$

$$= K_e \lambda \left[\frac{1}{a} - \frac{1}{(a+l)} \right]$$

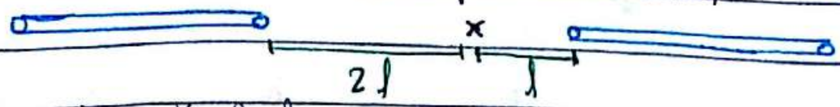
$$= \frac{K_e \lambda l}{a(a+l)} = \frac{K_e Q}{a(a+l)}$$ (مهم)

E.X :



A) $\frac{K_e \lambda}{2l} (\hat{i} + \hat{j})$ (B) $\frac{K_e \lambda}{2l} (-\hat{i} + \hat{j})$ C) $\frac{K_e \lambda}{2l} (-\hat{i} - \hat{j})$ C) $\frac{K_e \lambda}{2l} (\hat{i} - \hat{j})$

E.X. : $+\lambda, l$ P $+\lambda, l$ find $\vec{E_P}$



$$\vec{E_1} = \frac{k_e \lambda l}{2l(2l+l)} = \frac{k_e \lambda}{6l} \quad (\hat{i})$$

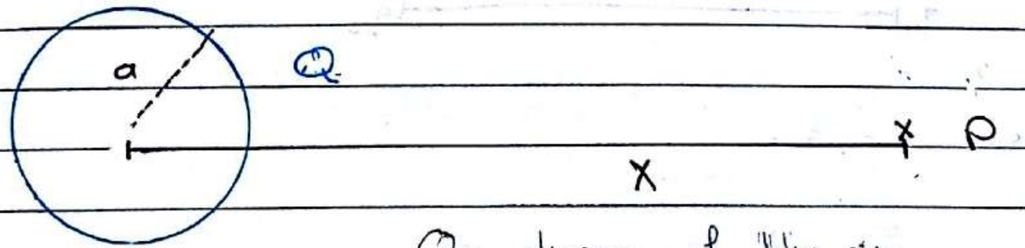
$$\vec{E_2} = \frac{k_e \lambda l}{l(l+l)} = \frac{k_e \lambda}{2l} \quad (-\hat{i})$$

$$\vec{E_P} = \vec{E_1} + \vec{E_2}$$

$$= \left(\frac{k\lambda}{6l} - \frac{k_e \lambda}{2l}\right)\hat{i}$$

$$= \frac{2k_e \lambda}{6l}(-\hat{i}) = \frac{1}{3}\frac{k_e \lambda}{l}(-\hat{i}) \quad N/C$$

Charged Ring

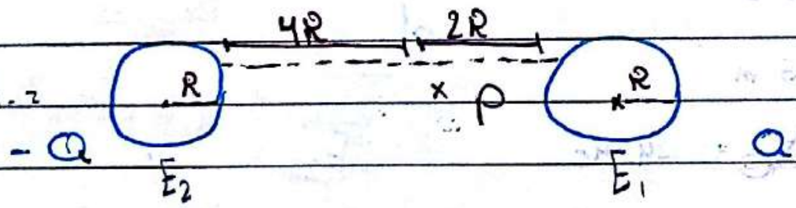


Q : charge of the ring
a : Radius
X : The distance between the ring's center to the point P

$$E_P = \frac{k_e Q X}{(X^2 + a^2)^{3/2}}$$ [حفظ]

Direction : +ve : outwards مبتعد
-ve : inwards مقترب

E.X. :



find E_P

sol
$$\vec{E_1} = \frac{k_e Q \, 2R}{(4R^2 + R^2)^{3/2}} \quad -\hat{i}$$

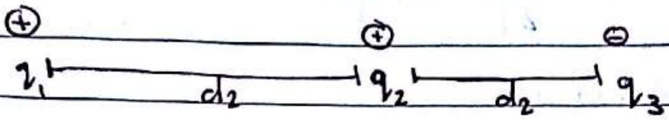
$$\vec{E_2} = \frac{k_e Q \, 4R}{(16R^2 + R^2)^{3/2}} \quad -\hat{i}$$

$$\vec{E_P} = \vec{E_1} + \vec{E_2}$$

Problems of Ch 23

Pages 716 - 724 in 9th edition

12)



$q_1 = 6\ \mu C$, $q_2 = 1.5\ \mu C$

$q_3 = -2\ \mu C$ $d_1 = 3$ cm

$d_2 = 2$ cm

A) Find the net force on q_1

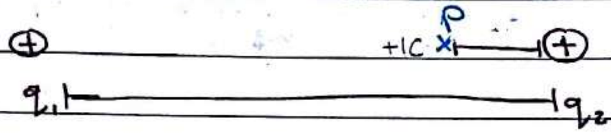
sol. $\vec{F}_{21} = \frac{9*10^9 * 6*10^{-6} * 1.5*10^{-6}}{(2*10^{-2})^2} (-\hat{i})$ N

$\vec{F}_{31} = \frac{9*10^9 * 6*10^{-6} * 2*10^{-6}}{(5*10^{-2})^2} (\hat{i})$ N

$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 \ (\hat{i})$

$= -202.5 + 43.2 = 159.3 (-\hat{i})$ N

13)



$q_1 = 3q$

$q_2 = q$

$d = 1.5$ m

sol $F_1 = F_2$

$\frac{K_e q_1 Q}{(d-x)^2} = \frac{K_e q_2 Q}{x^2}$

$\frac{3q}{(d-x)^2} = \frac{q}{x^2}$

$\frac{3}{(d-x)^2} = \frac{1}{x^2}$

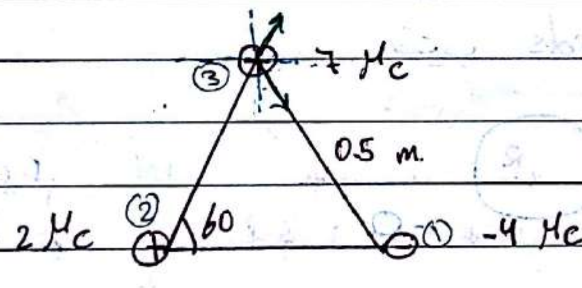
$3x^2 = (d-x)^2$

$\sqrt{3}x = d - x$

$(1+\sqrt{3})x = \frac{3}{2}$

$x = \frac{3}{2(1+\sqrt{3})}$

15)



sol. $\vec{F}_{13} = \frac{K_e q_1 q_3}{r^2}$

$= 1(\cos 60\,\hat{i} - \sin 60\,\hat{j})$ N/C

$\vec{F}_{23} = \frac{K_e q_2 q_3}{r^2}$

$= 0.5(\cos 60\,\hat{i} + \sin 60\,\hat{j})$ N/C

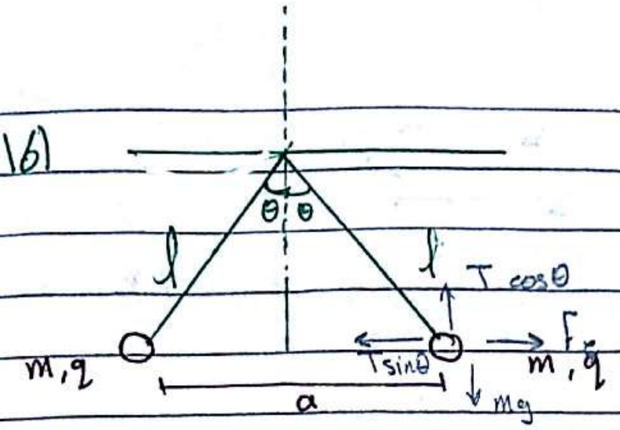
$\vec{F}_{Total} = \vec{F}_{13} + \vec{F}_{23}$

$= (0.5+1)\cos 60\,\hat{i} - (1-0.5)\sin 60\,\hat{j}$

$= 0.75\,\hat{i} - 0.433\,\hat{j}$

$|\vec{F}| = 0.866$, $330°$

16)



الدكتور عدل على المعطيات و المطلوب.

$\theta = 5^\circ$

$l = 15$ cm

$m = 0.2$ g

find q

sol. $m = 0.2 * 10^{-3}$ Kg

$\Sigma F_x = 0$ $\Sigma F_y = 0$

$T\sin\theta = F_e$ بالتقسيم $T\cos\theta = mg$

$F_e = mg\tan\theta$

$a = 2l\sin\theta$

$\frac{K_e q^2}{4l^2\sin^2\theta} = mg\tan\theta$

$q = \pm\sqrt{\frac{4l^2 mg\sin^2\theta\tan\theta}{K_e}} = \pm\sqrt{3.59*10^{-17}}$

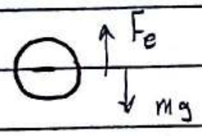
21) A) $|F| = \frac{K_e q_1 q_2}{r^2}$

$= \frac{9*10^9 * 12*10^{-9} * 18*10^{-9}}{(0.3)^2} = 216*10^{-7}$ N

B) $q' = \frac{q_1+q_2}{2}$

$= \frac{12-18}{2} = -3$ nC

24)



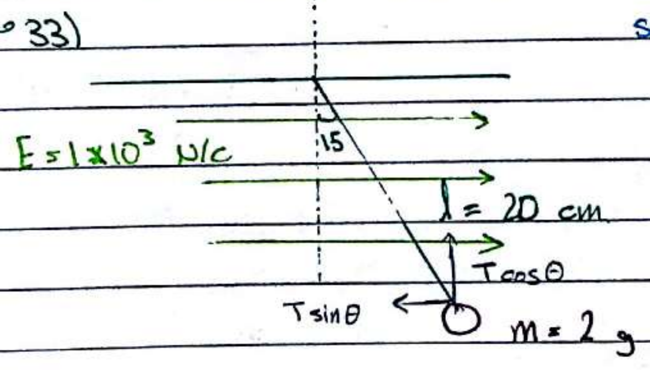
sol. $\Sigma F_y = 0$

$mg = F_E$

$3.8*10^{-3}*10 = E_o * 18*10^{-6}$

$E_o = 3.8*10^4 (-\hat{j})$ N/C

33)



sol. $\Sigma F_y = 0$ $\Sigma F_x = 0$

$mg = T\cos\theta$ $T\sin\theta = F_e$

$2*10^{-3}*10 = T\cos 15$ $T\sin 15 = 1*10^3 * q$

بالتقسيم

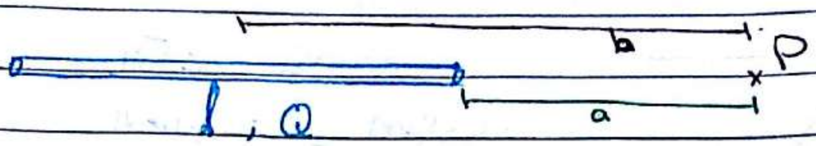
$\tan 15 = \frac{1}{2}*10^6 q$

$q = 2\tan 15 * 10^{-6}$

$= 0.535*10^{-6}$ C

(12)

37)



$Q = -22\ \mu C$
$l = 14\ cm$
$b = 36\ cm$

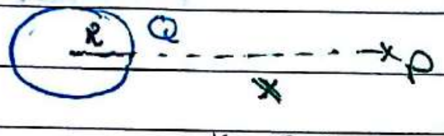
sol. $a = 36 - 7 = 29\ cm$

$E_p = \frac{k_e Q}{a(a+l)}$

$= \frac{9*10^9 * 22 * 10^{-6}}{29*10^{-2}(29*10^{-2} + 14*10^{-2})} = 1.59*10^6\ -\hat{i}\ N/C$

or toward the rod

39)



$Q = 75\ \mu C$
$R = 10\ cm$

c) $E_p\Big|_{x=30\ cm} = \frac{k_e Q x}{(x^2+R^2)^{3/2}}$

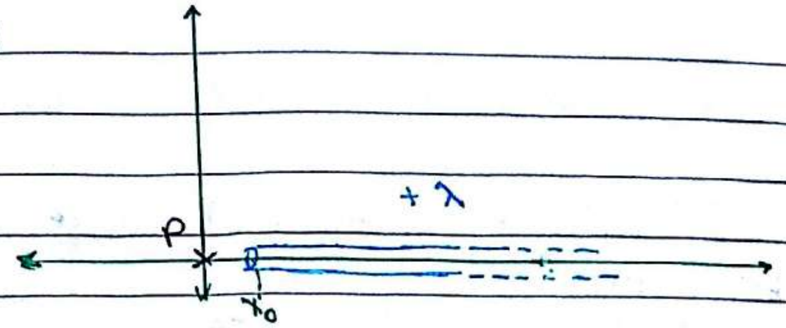
$= \frac{9*10^9 * 75*10^{-6} * 30*10^{-2}}{((30*10^{-2})^2 + (10*10^{-2})^2)^{3/2}} = 6.4*10^6\ \hat{i}\ N/C$ or outward

42) مش مطلوب

Scanned by CamScanner

43)

Infinit wire



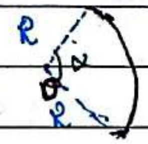
Sol.

$$E_p = \int_{charge} K_e \frac{dq}{r^2}$$
$$= \int_{charge} K_e \frac{dq}{x^2}$$
$$= \int K_e \frac{dq}{x}$$
$$= K_e \lambda \int_{x_0}^{\infty} \frac{dx}{x^2}$$
$$= K_e \lambda \lim_{b \to \infty} \int_{x_0}^{b} \frac{1}{x^2} dx$$
$$= K_e \lambda \lim_{b \to \infty} \left. \frac{-1}{x} \right]_{x_0}^{b}$$
$$= K_e \lambda \lim_{b \to \infty} \frac{-1}{b} + \frac{1}{x_0}$$
$$= K_e \lambda \left(0 + \frac{1}{x_0} \right) = \frac{K_e \lambda}{x_0} \text{, outward.}$$

$\lambda = \frac{Q}{x}$

$dq = \lambda \, dx$

45) Charge Arc (قوس)

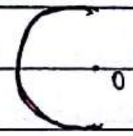


$l = R \alpha$, α = Radian → π = 3.14

$\lambda = \frac{q}{l} = \frac{q}{R\alpha}$

قانون $E_0^{ARC} = \frac{2 K_e \lambda \sin(\alpha/2)}{R}$

sol $l = 14$ cm , $\alpha = \pi$



$R = \frac{l}{\alpha} = \frac{0.14}{3.14} = 0.045$

$\lambda = \frac{-7.5}{0.14} = -53.57 \ \mu C/m$

$E_0 = \frac{2 * 9 * 10^9 * 53.57 * 10^{-6} * \sin(\pi/2)}{0.045} = 2.14 * 10^6$ N/C inward (left)

49) A) $\frac{q_1}{q_2} = \frac{n_1}{n_2}$

$= \frac{18}{6} = 3 \quad (q_1 = 3q_2)$

B) q_1 = +ve , q_2 = −ve.

(14)

51) A) $F = ma$

$E_o * q = m_p * a$

$a = \frac{E_o * q}{m_p} = \frac{640 * 1.6 * 10^{-19}}{1.67 * 10^{-27}} = 613 * 10^8 \ m/s^2$

B) $v_f = v_i + at$

$t = \frac{v_f - v_i}{a} = \frac{1.2 * 10^6 - 0}{613 * 10^8} = 1.9 * 10^{-5} \ s$

C) $\Delta X = v_i t + \frac{1}{2} a t^2$

$= 0 + \frac{1}{2} * 613 * 10^8 * (1.9 * 10^{-5})^2 = 11.06 \ m.$

D) $K = \frac{1}{2} m v^2$

$= \frac{1}{2} * 1.67 * 10^{-27} * (1.2 * 10^6)^2 = 2.4 * 10^{-15} \ J$

52) A) $F = ma$

$a = \frac{E_o * q}{m_p} = 5.74 * 10^{13} (-i) m/s^2$

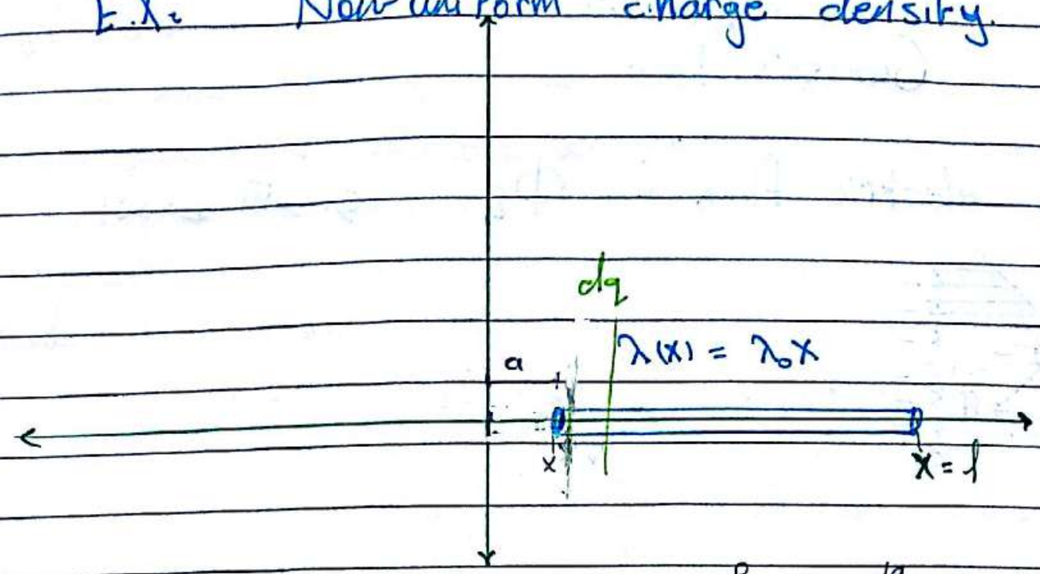
B) $v_f^2 = v_i^2 + 2a\Delta X$

$v_i = \sqrt{-2a\Delta X} = 28.3 * 10^6 \ m/s$

C) $v_f = v_i + at$

$t = \frac{v_i}{a} = 4.93 * 10^{-7} \ s$

E.X. Non-uniform charge density



$$E_p = \int_{charge} K_e \frac{dq}{x^2}$$

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

$dq = \lambda(x)\, dx$

$dq = \lambda_0 x\, dx$

$$= \int_0^l K_e \lambda_0 \frac{x}{(x+a)^2}\, dx$$

$y = x + a$

$x = y - a$

$dy = dx$

$$= K_e \lambda_0 \int \frac{y-a}{y^2}\, dy$$

$$= K_e \lambda_0 \int \frac{1}{y}\, dy - \int \frac{1}{y^2}\, dy$$

$$= K_e \lambda_0 \ln|y| + \frac{1}{y}$$

$$= K_e \lambda_0 \left(\ln|x+a| + \frac{1}{x+a}\right)\Big]_0^l$$

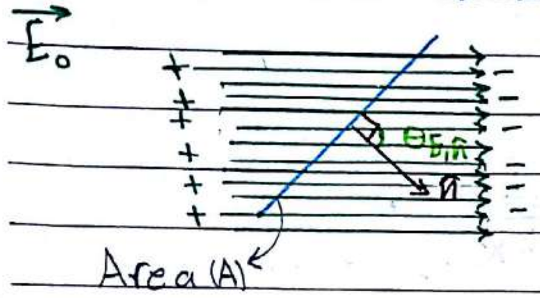
$$= K_e \lambda_0 \left(\left(\ln|l+a| + \frac{1}{l+a}\right) - \left(\ln|a| + \frac{1}{a}\right)\right)$$

$$= K_e \lambda_0 \left(\ln\left|\frac{l+a}{a}\right| + \frac{a}{l+a} - 1\right)$$

15/2/2018 — Thursday

Chapter 24
Gauss's Law

1. The electric flux: Φ_E التدفق الكهربائي



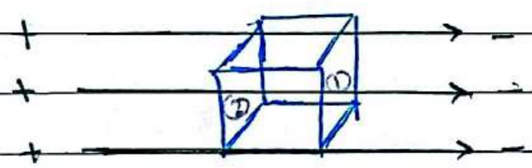
We define the electric flux

$$\Phi_E = E_o A \cos\theta_{E,\hat{n}}$$
$$= \vec{E} \cdot \vec{A} \quad , \quad \vec{A} = A\,\hat{n}$$

For arbitrary (غير منتظم) shape object

$$\Phi_E = \int_{Area} (E \cos\theta_{E,\hat{n}})\, dA$$

E.X: Cube (مكعب) in electric field find the total flux from the cube.

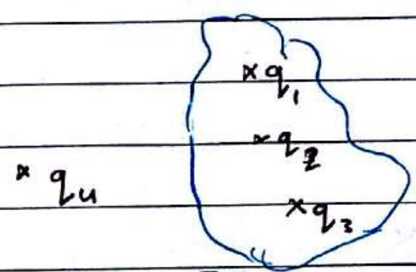


sol.

$$\Phi_1 = E_o A = E_o l$$
$$\Phi_2 = -E_o A = -E\, l$$
$$\Phi_T = \text{Zero}$$

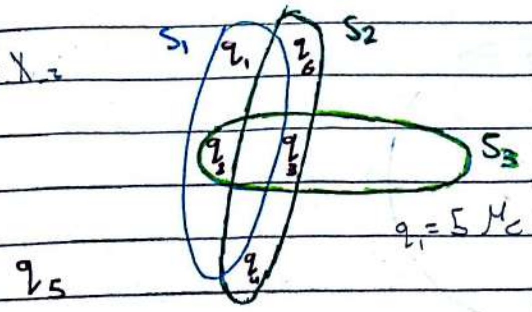
* Conclusion: The total flux for uncharge object immersed in electric field is Zero

Gauss's Law of charged object



$$\Phi_E = \frac{\sum q_{in}}{\epsilon_o} = \frac{q_1 + q_2 + q_3}{\epsilon_o}$$

EX:



Find the flux througout the surfaces:

$q_1 = 5\,\mu C$, $q_2 = 3\,\mu C$, $q_3 = -10\,\mu C$, $q_4 = 5\,\mu C$

$q_5 = 12\,\mu C$, $q_6 = -8\,\mu C$

Sol

$$\Phi_1 = \frac{\Sigma q_{in}}{\epsilon_0} = \frac{q_1 + q_2}{\epsilon_0} = \frac{(5+3) * 10^{-6}}{8.85 * 10^{-12}} = 0.9 * 10^{6}$$

$$\Phi_2 = \frac{q_3 + q_4 + q_5}{\epsilon_0} = \frac{(3+5-8) * 10^{-6}}{8.85 * 10^{-12}} = \text{zero}$$

$$\Phi_3 = \frac{q_2 + q_3}{\epsilon_0} = \frac{(3-10) * 10^{-6}}{8.85 * 10^{-12}} = 0.79 * 10^{6}$$

Gauss's Law

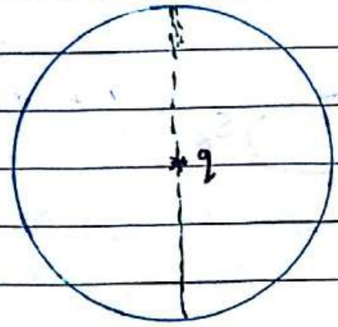
$$\oint E \cos\theta \, dA = \frac{q_{in}}{\epsilon_0}$$

Note: The Gauss's law applicable (يطبق) only to obtain an electric feild for symmetrical charge distribution.

Scanned by CamScanner

18/2/2018 Sunday

E.X 1:



Gaussian surface.

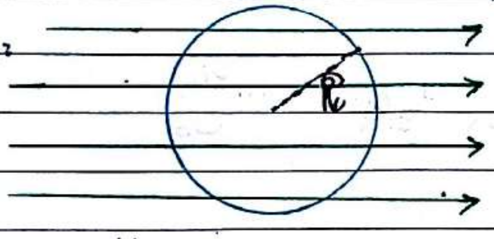
Find the flux through the
1) Sphere
2) Hemi-sphere (نصف كرة)
3) Quarter.

Sol. 1) $\Phi_{sphere} = \frac{q}{\epsilon_0}$

2) $\Phi_{hemi} = \frac{q}{2\epsilon_0}$

3) $\Phi_{quarter} = \frac{q}{4\epsilon_0}$

E.X 2:



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

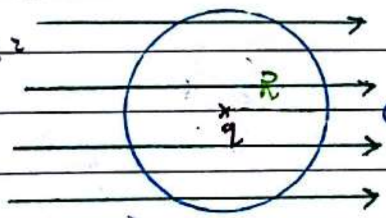
Find the flux through the
1) Sphere
2) hemi-sphere
3) quarter

Sol. 1) $\Phi_T = \text{Zero}$

2) $\Phi_{hemi} = \vec{E} \cdot A_{hemi} = E_0 * \frac{4\pi R^2}{2}$

3) $\Phi_{quarter} = \vec{E} \cdot A_{quarter} = E_0 * \frac{4\pi R^2}{4}$

E.X 3:



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

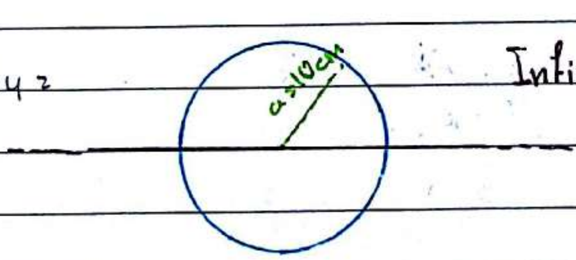
Gaussian surface

Find the flux through the
1) Sphere 2) hemi-sphere

Sol. $\Phi_T = \frac{q}{\epsilon_0}$

$\Phi_{hemi} = E_0 \frac{4\pi R^2}{2} + \frac{q}{2\epsilon_0}$

E.X 4:



Infinite wire

$\lambda = -27 \ nC/m$

Find Φ_T

Sol. $\lambda = \frac{q_{in}}{l}$

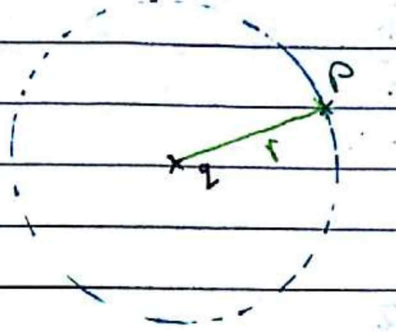
$q_{in} = \lambda * l = -27 * 10^{-9} * 20 * 10^{-1} = -5.4 \ nC$

$\Phi_T = \frac{2 q_{in}}{\epsilon_0} = \frac{-5.4 * 10^{-9}}{8.85 * 10^{-12}} = 0.61 * 10^{3}$

Application on Gauss's law

E.X.1: find the electric field a point charge

sol



$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$$

$$\vec{E} \cdot \oint d\vec{A} = \frac{q_{in}}{\epsilon_0}$$

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

$$E = \frac{q}{4\pi r^2 \epsilon_0} = K_e \frac{q}{r^2} \quad \#$$

E.X.2 Sphere

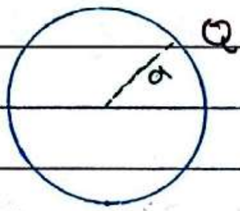
A) Conducting sphere (كرة موصلة) (Copper, Metalic, Al, ...)

1) Conducting solid sphere (كرة مصمتة)

2) Conducting spherical shell (قشرة)

total charge: Q

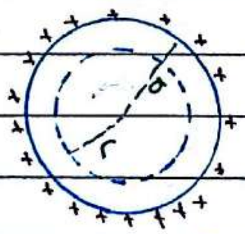
Radius: a



find the electric field inside the spherical shell

a) ($E_{in} = ??$, $r < a$)

sol



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

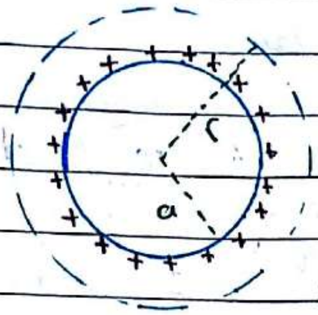
$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$$

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

$$E = zero$$

b) $E_{out} = ??$, $r > a$

sol.

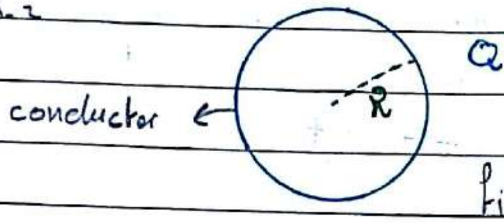


$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$$

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

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

EX.2



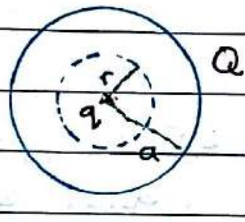
$Q = 7\ \mu C$

$r = 50$ cm

find E at $r = 10$ cm

sol. $E = 0$

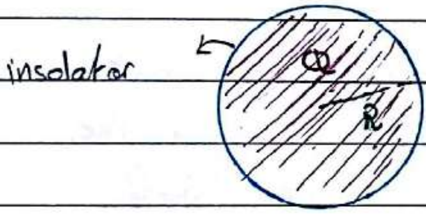
EX.3



sol. $E_{in} = \frac{K_e q}{r^2}$

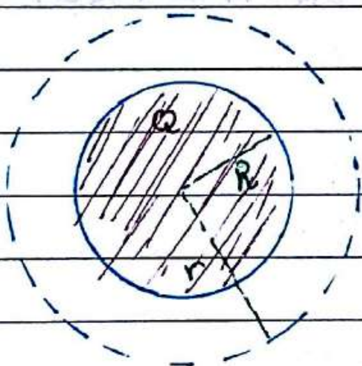
$E_{out} = \frac{K_e (Q+q)}{R^2}$, $R > a$

B) Non-conducting sphere (isolated (عازلة)



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

a) $E_{out} = ??$, $r \geq R$



sol. $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$

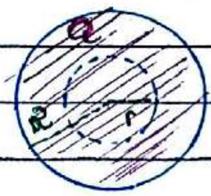
$E(4\pi r^2) = \frac{Q}{\epsilon_0}$

$E = \frac{K_e Q}{r^2}$, $r > R$

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

b) $E_{in} = ??$, $r < R$

ρ , Q



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

$q_{in} = \rho\left(\frac{4}{3}\pi r^3\right)$

$= \dfrac{Q}{\frac{4}{3}\pi R^3}\left(\frac{4}{3}\pi r^3\right)$

$= \dfrac{Q}{R^3} r^3$

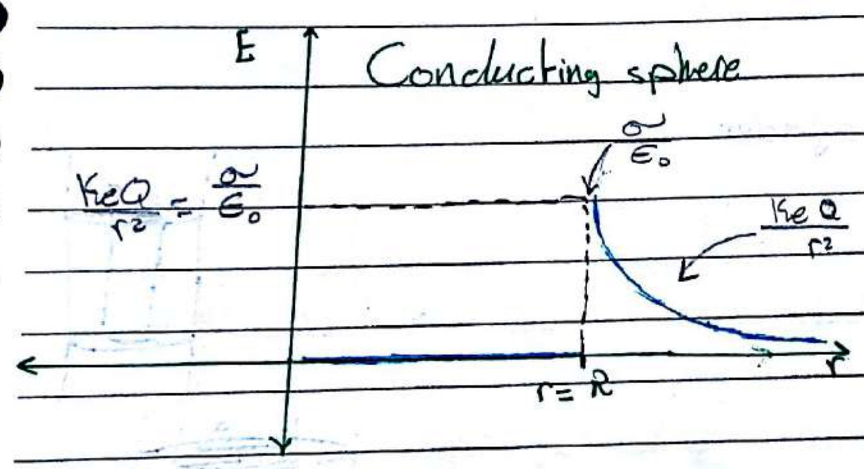
$\oint \vec{E}\cdot d\vec{A} = \dfrac{q_{in}}{\epsilon_0}$

$E(4\pi r^2) = \rho\left(\frac{4}{3}\pi r^3\right) \times \dfrac{1}{\epsilon_0}$

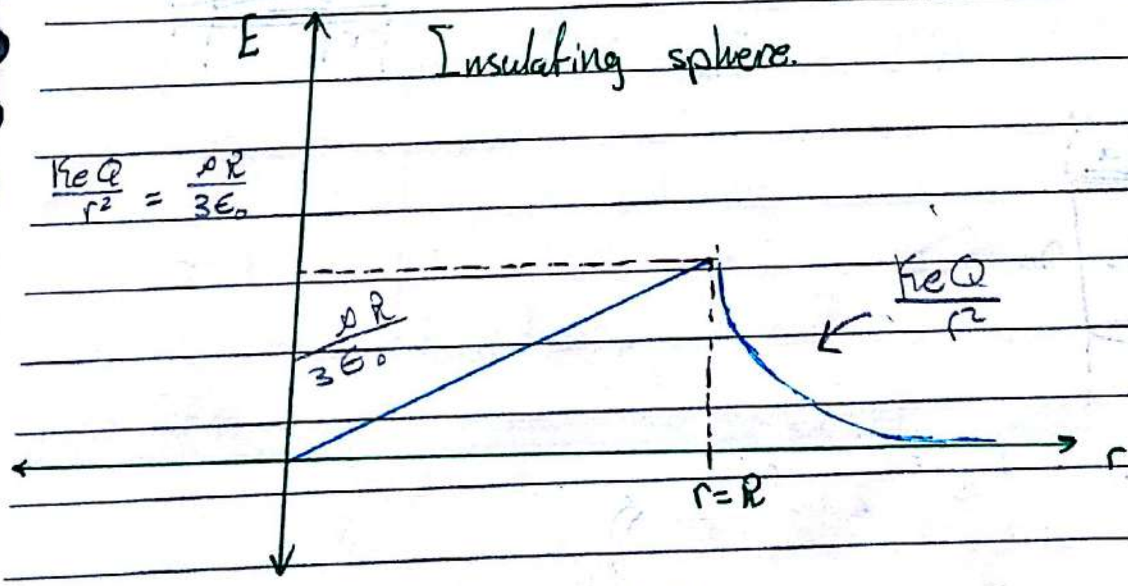
$E_{in} = \dfrac{\rho r}{3\epsilon_0}$, $r < R$

$= \dfrac{K_e Q r}{R^3}$

Conducting sphere

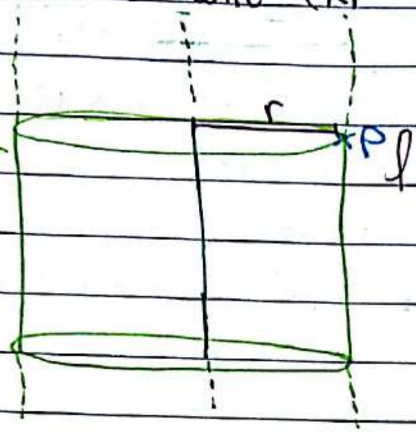


Insulating sphere.



Cylinderical symmetry

① Infinite wire (λ)



Gaussian Surface ←

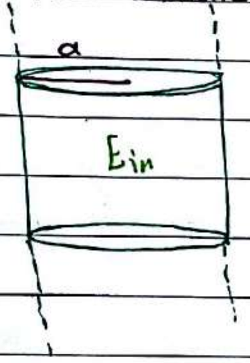
$\oint E \cdot dA = \frac{q_{in}}{\epsilon_0}$

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

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

② Infinite conducting cylinder

λ



E_{out}

① $E_{in} = ??$, $r < a$

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

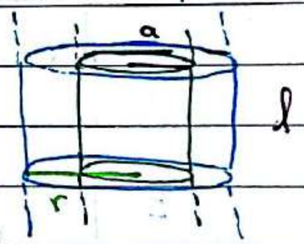
$E_{in} = \text{Zero}$, $r < a$

② $E_{out} = ??$, $r > a$

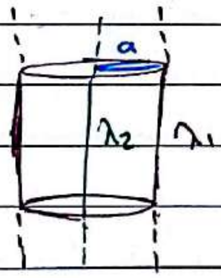
$\oint E \cdot dA = \frac{q_{in}}{\epsilon_0}$

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

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



E.X.₂



$a = 50$ cm

$\lambda_1 = 10\ \mu C/m$ $\lambda_2 = 5\ \mu C/m$

Find the electric feild at 1) 25 cm

2) 75 cm

sol. 1) $E\big|_{25} = \frac{2 k_e \lambda_2}{r} = 3.6 \times 10^5$

2) $E\big|_{75} = \frac{2 k_e (\lambda_1 + \lambda_2)}{r} = 3.6 \times 10^5$

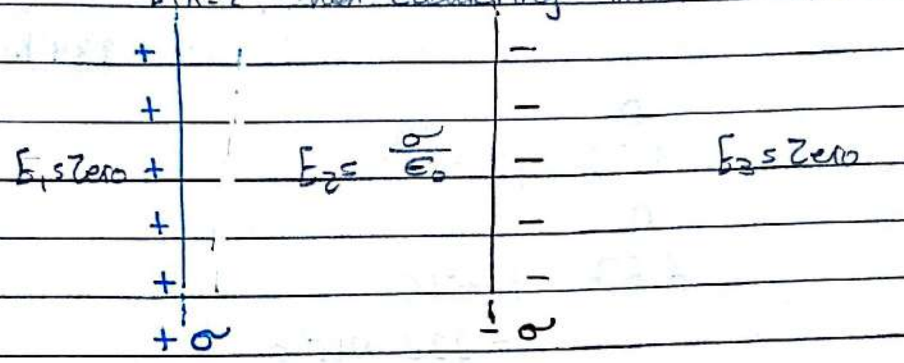
بالاشارات

③ Infinit / Larg sheet, plane, disk. هون ٢ ملاحظات حلوة

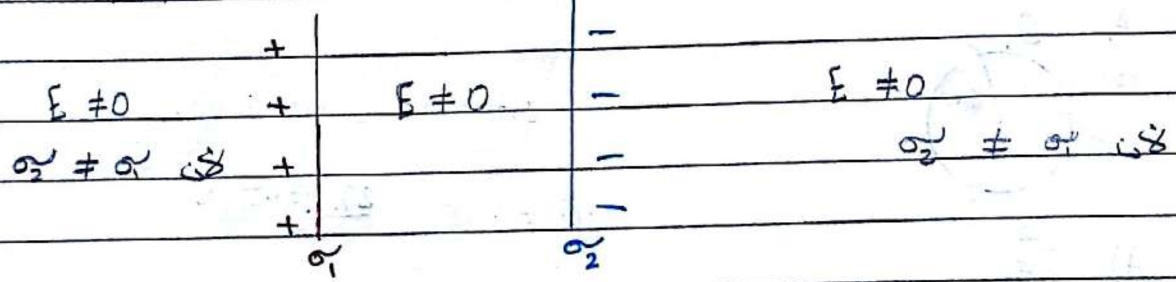
1. non - conductor (Insulator) → $E = \frac{\sigma}{2\epsilon_0}$

2. conducting → $E = \frac{\sigma}{\epsilon_0}$

E.X. → non-conducting infinite sheet



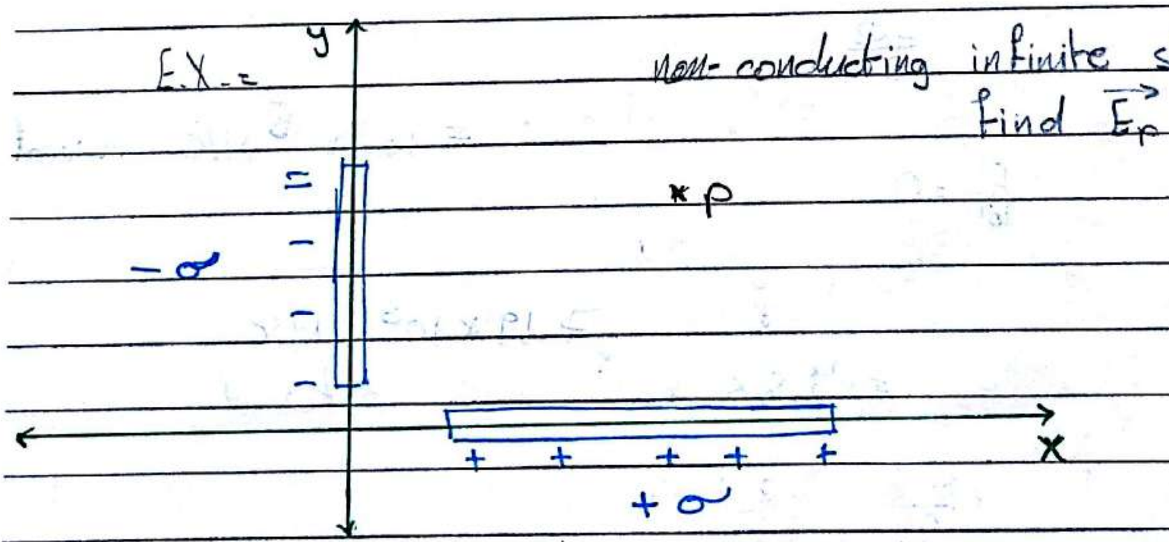
E.X. →



E.X. →

non-conducting infinite sheet

find $\vec{E_p}$



sol. $\vec{E_p} = \frac{\sigma}{2\epsilon_0} (-\hat{i} + \hat{j})$

22/2/2018 — Thursday

Problems of Ch.24

3) $\Phi_{max} = E A \cos\theta$

$5.2 \times 10^5 = E \times (0.2)^2 \pi$

$E = \frac{5.2}{\pi (0.2)^2} \times 10^6$ N/C

حل 4) A) $\Phi = E A \cos 180 = -2.34$ k Nm^2/C

B) $\Phi = E A \cos 60 = 7.8 \times 10^4 \times (0.3 \times \frac{0.1}{\cos 60}) \cos 60 = 2.34$ k Nm^2/C

C) $\Phi = E A \cos 90 = 0$

5) A) $\Phi = E A \cos 0 = 858$ Nm^2/C

B) $\Phi = E A \cos 90 = 0$

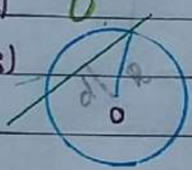
C) $\Phi = E A \cos 40 = 657$ Nm^2/C

8) $\Phi = \frac{q_{in}}{\epsilon_0} = \frac{(1-3) \times 10^{-9}}{8.85 \times 10^{-12}} = -226$ $N.m^2/C$

12) B) $\Phi_T = \frac{q_{in}}{\epsilon_0} = 1.92 \times 10^7$ Nm^2/C

A) $\Phi_{surface} = \frac{\Phi_T}{6} = 3.2 \times 10^6$ Nm^2/C

حل 17) A) 0 — لأنه لا يوجد شحنة

B) 

length of the wire $= 2\sqrt{R^2 - d^2}$

$\lambda = \frac{Q}{l} \Rightarrow Q = \lambda 2 \sqrt{R^2 - d^2}$

$\Phi = \frac{q_{in}}{\epsilon_0} = \frac{2\lambda \sqrt{R^2 - d^2}}{\epsilon_0}$

حل 21) A) $\frac{Q}{2\epsilon_0}$

B) $\Phi_{curved} + \Phi_{flat} = 0$

$\Phi_{flat} = \frac{-Q}{2\epsilon_0}$

24) A) $E)_{10} = \frac{2k\lambda}{r} = \frac{2 \times 9 \times 10^9 \times 90 \times 10^{-6}}{0.1} = 162 \times 10^5$ N/C inward

29) A) $E)_{10} = 0$

B) $E)_{20} = \frac{k_e q}{r^2} = \frac{9 \times 10^9 \times 32 \times 10^{-6}}{(0.2)^4} = 7.19 \times 10^6$ N/C

30) A) $E)_7 = \frac{\sigma}{2\epsilon_0} = 4.86 \times 10^9$ N/C outward

B) No

حل 34) A) $E = \frac{2k_e \lambda}{r} = \frac{2 k_e Q}{l r}$

$E)_{19cm} = \frac{2 \times 9 \times 10^9 \times Q}{2.4 \times 0.19} = 36 \times 10^3$

$Q = +9.12 \times 10^{-9}$ C $= +9.12$ nC

B) 0

35) A) $E_{in} = \frac{\rho}{3\epsilon_0} r$, $\rho = \frac{3Q}{4\pi a^3} = 9.7 * 10^{-5}$ c/m³

$E)_0 = 0$

B) $E)_{10} = \frac{9.7 * 10^{-5}}{3 * 8.85 * 10^{-12}} * 0.1 = 3.65 * 10^5$ N/C

D) $E_{out} = \frac{keQ}{r^2}$

$E)_{60} = \frac{9 * 10^9 * 26 * 10^{-6}}{(0.6)^2} = 1.46 * 10^6$ N/C

ذكي 39) $\frac{keQ}{a^2} = \frac{Q}{4\pi\epsilon_0 a^2} = \frac{\sigma}{\epsilon_0}$

44) A) $E = \frac{\sigma}{\epsilon_0} \Rightarrow \sigma = E\epsilon_0$

$\sigma = 7.08 * 10^{-7}$ c/m² one +ve and one -ve

B) $\sigma = \frac{Q}{2A}$ (حطينا 2A لأنه موصل ، ولو كان عازل مساحة A)

$Q = 2\sigma A = 354 * 10^{-9}$ c

ذكي 47) A) 0

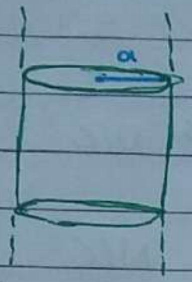
B) $E = \frac{keQ}{r^2} = \frac{9 * 10^9 * 8 * 10^{-6}}{(0.03)^2} = 8 * 10^7$ N/C outward

C) 0

D) $E = \frac{9 * 10^9 * (8-4) * 10^{-6}}{(0.07)} = 73.3 * 10^{-5}$ N/C outward

84) غير مطلوب

Inselating Cylinder



$E_{out} = \frac{\rho A^2}{2\epsilon_0 r}$, $r > a$

$E_{in} = \frac{\rho r}{2\epsilon_0}$, $r < a$

E.X: $Q = 170\ \mu C$, $a = 5$ cm , $l = 2.4$

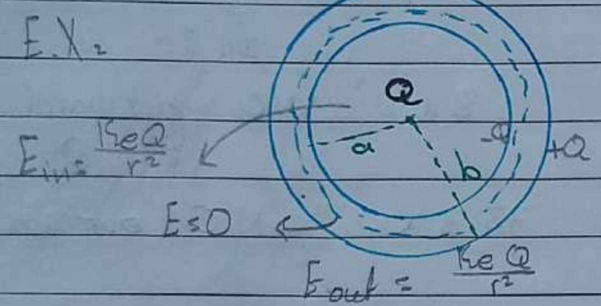
① charge density

$\rho = \frac{Q}{V} = \frac{170}{\pi a^2 l} = 90\ \mu c/m^2$

② $E\big)_{r=1\,cm} = \frac{\rho r}{2\epsilon_0}$

$= \frac{90 * 0.01 * 10^{-6}}{2 * 8.85 * 10^{-12}} = 10.1 * 10^{6}$ N/C

E.X:



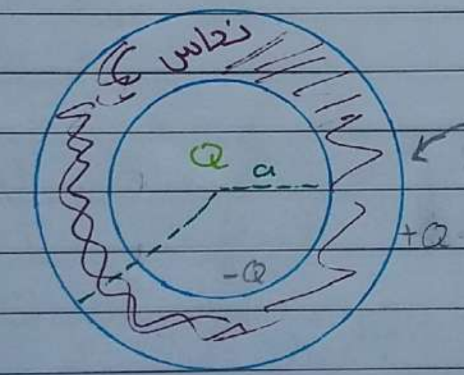
spherical conducting shell

$a = 20$ cm , $b = 50$ cm , $Q = 70\ \mu_C$

Induced charge ⇐ الشحنة المحثة ⇐ إذا Q موجبة ← الداخل - ، الخارج +

إذا Q سالبة ← الداخل + ، الخارج -

E.X:



$Q_{net} = 5\ \mu_c$

$Q = 70\ \mu_c$

Find Q_x

$\times\ Q_x$

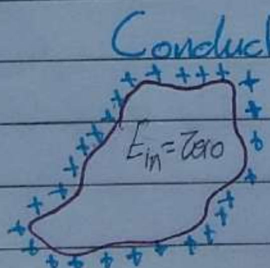
sol

$Q_{net} = Q + Q_x$

$5 = 70 + Q_x$

$Q_x = -65\ \mu_c$

Conductors in electro-static equilibrium



E_{out} (عند السطح مباشرة) $= \frac{\sigma}{\epsilon_0}$

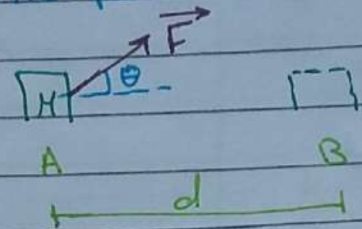
Sunday

25/2/2018

Chapter 25
The electric potential الجهد الكهربائي

1. The electric potential energy

Remember:



The work done

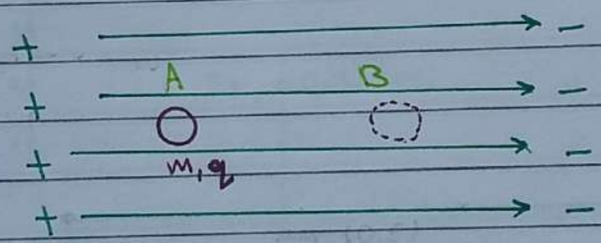
$$W_{A\to B} = \vec{F}\cdot\vec{X}$$

$$= F(\bar{B}-\bar{A})\cdot\cos\theta = F d \cos\theta$$

$$W_{A\to B} = \int_A^B \vec{F}\cdot d\vec{s}$$, $d\vec{s}$: { $dx\,\hat{i}$; $dy\,\hat{j}$; $dx\,\hat{i} + dy\,\hat{j}$ }

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

$$W_{A\to B} = -\Delta U_{A\to B}$$



The electric work done on the particle is

$$W_{A\to B} = \int_A^B \vec{F}_e\cdot d\vec{s}$$

$$= \int_A^B q_0 \vec{E}\cdot d\vec{s} = q_0 \int_A^B E\cos\theta\, ds$$

E.X: $\vec{E} = E_0\,\hat{i}$

$$W = q_0 E_0 \int_A^B \cos\theta\, ds = q_0 E_0 d$$

We define the electric potential energy difference

$$\Delta U_{A\to B} = -W_{A\to B} = -q_0\int_A^B \vec{E}\cdot d\vec{s}$$

$$\Delta U_{A\to B} = -q_0 \int_A^B \vec{E}\, d\vec{s}$$

We define the electric potential difference

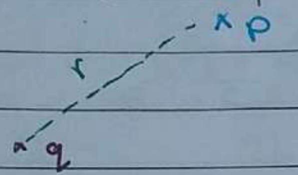
$$\Delta V_{A \to B} = \frac{\Delta U_{A \to B}}{q_0}$$

$$\Delta V_{A \to B} = -\int_A^B \vec{E} \cdot d\vec{s}$$

EX. $\vec{E} = E_0 \hat{i}$

$$\Delta V_{A \to B} = -E_0 d$$

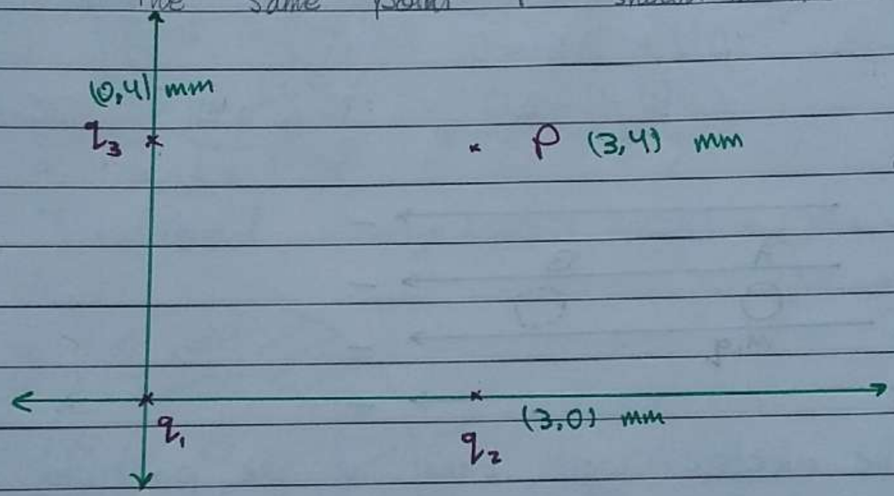
E.X. The electric potential of a point charge



$$E_P = \frac{k_e q}{r^2}$$

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

E.X. Find the electric potential of 3 charges at the same point P shown in the figure



$q_1 = -25\ \mu c$

$q_2 = 16\ \mu c$

$q_3 = -9\ \mu c$

sol. $V_P = V_1 + V_2 + V_3$

$$= \frac{9 \times 10^9 \times 10^{-6}}{10^{-3}} \left(\frac{-25}{5} + \frac{16}{4} + \frac{-9}{3} \right) = -36\ MV$$

② Find the work required to bring a protone (+e) from infinity to the point P

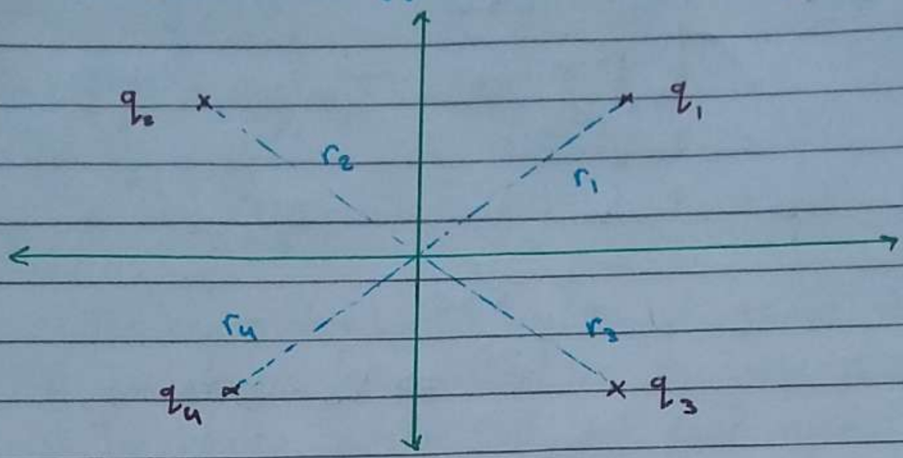
sol. $W_{A \to B} = -U_{A \to B} = -q_0 \Delta V_{A \to B}$

$$W_{\infty \to P} = -e\,(V_P - V_\infty)$$

$$= -1.6 \times 10^{-19} (-36 \times 10^6 - 0) = +57.6 \times 10^{-13}\ J$$

26/2/2018 Monday

The electric energy stored in a system of charges.



صيغة السؤال

1) What is the energy stored in the charges shown in the figure

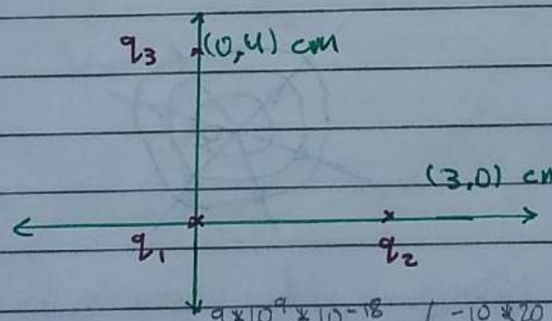
2) What is the work require to assemble (تجميع) charges in the figure

The answer is U

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

(كل شحنة مع الأكبر منها بالرقم (index))

E.X.-



$q_1 = -10$ nc

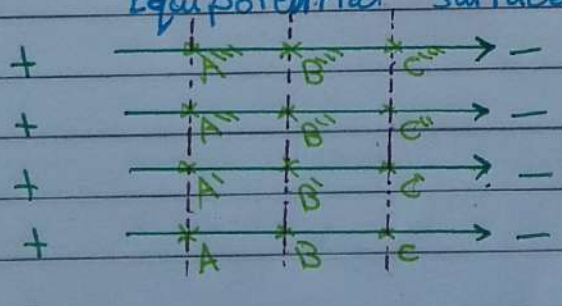
$q_2 = 20$ nc

$q_3 = -15$ nc

sol. $U = \frac{9\times10^{9}\times10^{-18}}{10^{-2}} \left(\frac{-10\times20}{3} + \frac{-10\times-15}{4} + \frac{20\times-15}{5} \right)$ J

Equipotential surface (سطوح تساوي الجهد)

تكون عمودية على خطوط المجال



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

↑V ↓K في حالة الشحنة الموجبة ↓V ↑K

جهد عالي وطاقة حركية قليلة   طاقة حركية عالية وجهد قليل

Find the work required to move the charge q_0 from A' to C'''

sol. $W_{A' \to C'''} = W_{A' \to C} + W_{C \to C'''}$

$= q_0 \int_{A'}^{C} \vec{E} \cdot d\vec{s} + \text{Zero}$

$= q_0 \int_{A'}^{C} E_0 \hat{i} \cdot dx\hat{i}$

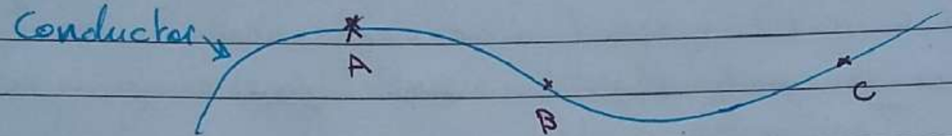
$= q_0 E_0 (\overline{A'C'}) = -\Delta U_{A' \to C'''}$

$= -q_0 \Delta V_{A' \to C}$

$q E_0 d = -q_0 \Delta V_{A' \to C}$

$\Rightarrow V_C - V_{A'} = -E_0 d$

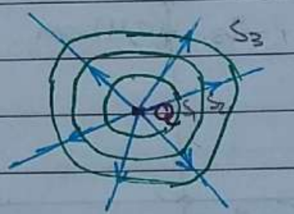
$W_{A \to B} = q_0 \Delta V$



$V_A = V_B = V_C$

Point charge

	S_1	S_2	S_3
+Q ísls	1000	800	600
-Q ísls	-1000	-800	-600

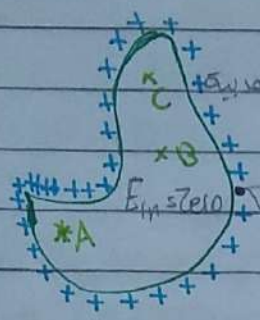


Move a proton from s_1 to s_2

$W_{s_1 \to s_2} = -\Delta U = -q_0 \Delta V_{s_1 \to s_2}$

$= -q_0 (V_{s_2} - V_{s_1})$

Conductor in electrostatic equilibrium (موصلات في اتزان كهروستاتيكي)



الشحنة تتوزع على السطح وأعلى كثافة عند الحواف المدببة

$E_{\text{على السطح}} = \frac{\sigma}{\epsilon_0}$

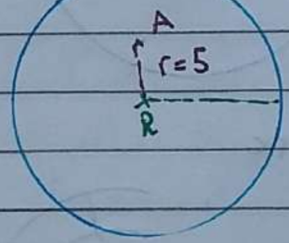
Properteis :

1) The charge density (σ) is maximum at minimum curviture (المدببة)
2) The electric feild inside the conductor is Zero
3) The electric potential of any point inside the conductor is the same as the surface ($V_A = V_B = V_C = V_S$)

Sphere conductor

$Q = 50\ \mu C$

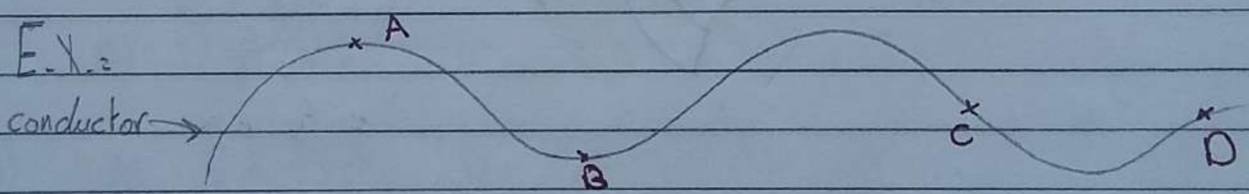
$R = 30\ cm$



$V_A)_{r=5} = V_S = \frac{K_e Q}{r}$

$E)_S = Zero$

E.X. :

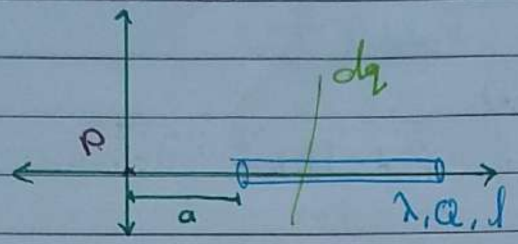


$V_A = V_B = V_C = V_D$

5) The electric potential of a continuous charge distribution

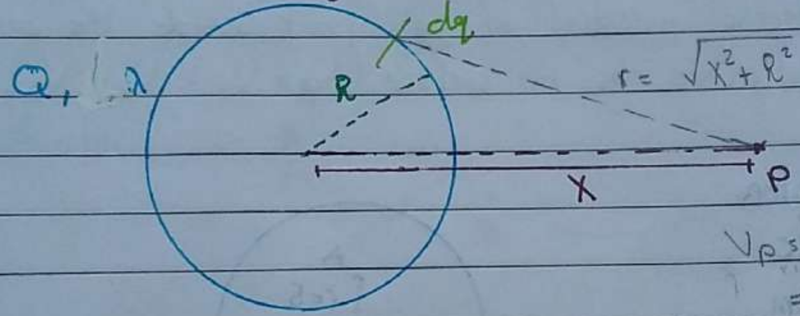
$$V_P = K_e \int_{charge} \frac{dq}{r}$$

1. The rod



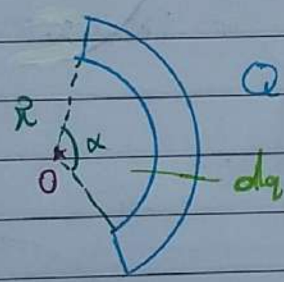
$$V_P = K_e \int \frac{dq}{x+a}$$
$$= K_e \int_0^l \frac{\lambda\, dx}{(x+a)}$$
$$= K_e \lambda \left(\ln|x+a| \Big]_0^l \right)$$
$$= K_e \lambda \ln\left|\frac{a+l}{a}\right|$$

2. The ring



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

3. Arc



$Q, \lambda, l = \alpha R$

$$V_O = K_e \int \frac{dq}{R}$$
$$= K_e \frac{Q}{R}$$
$$= K_e \lambda \alpha$$

27/2/2018

Problems of Ch.25

Tuesday

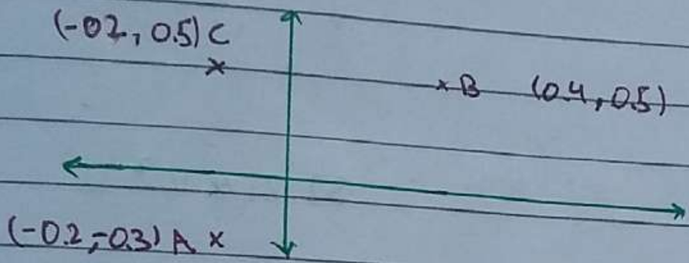
3) $\Delta K + \Delta U = 0$

$\Delta K = -q_o \Delta V$

$\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 = -q_o \Delta V$ (v_i = zero)

$v_f = \sqrt{\frac{-2 q_o \Delta V}{m_p}} = \sqrt{\frac{-2 * 1.6 * 10^{-19} * (-120)}{1.67 * 10^{-27}}} = 15.16 * 10^4$ m/s

5)



$\vec{E} = 325 \; -\hat{j}$

Sol $V_B - V_A$

$\Delta V_{A \to B} = -\int_A^B \vec{E} \cdot d\vec{s}$

$= -\int_A^C \vec{E} \cdot d\vec{s} - \int_C^B \vec{E} \cdot d\vec{s}$ (zero)

$= -\int_{-0.3}^{0.5} E_o (-\hat{j}) \cdot dy (\hat{j}) - \int_{-0.2}^{0.4} E_o (-\hat{j}) \cdot dx (\hat{i})$ (zero)

$= 325 * 0.8 = 260$ V

16) A) $V = \frac{K_e q_1}{d/2} + \frac{K_e q_2}{d/2}$

$= \frac{K_e (q_1 + q_2)}{d/2} = \frac{9 * 10^9 * 2 * 10^{-9}}{0.175} = 103$ V

B) $U = \frac{K_e q_1 q_2}{r_{12}} = -3.85 * 10^{-7}$ J

20) A) $E = \frac{K_e q}{r^2}$, $V = \frac{K_e q}{r}$

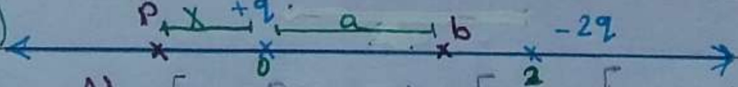
$V = E * r$

$r = \frac{V}{E} = \frac{3000}{500} = 6$ m

B) $V = \frac{K_e q}{r}$

$q = \frac{V r}{K_e} = 2 * 10^{-6}$ C

23)



A) $E_p = 0 \Rightarrow E_q = -E_{-2q} \Rightarrow \frac{K_e q}{x^2} = \frac{-K_e (-2q)}{(x+2)^2}$

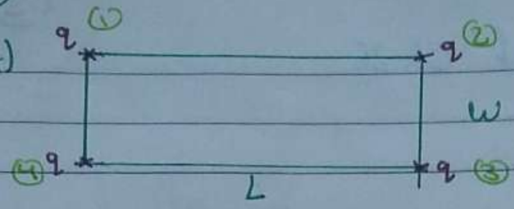
$\frac{1}{x^2} = \frac{2}{(x+2)^2} \Rightarrow 2x^2 = (x+2)^2 \Rightarrow x = \frac{-2}{\sqrt{2}-1} = -4.83$ m

B) $V_B = 0 \Rightarrow V_q = -V_{-2q} \Rightarrow \frac{K_e q}{a} = \frac{-K_e (-2q)}{2-a}$

$2a = 2 - a \Rightarrow 3a = 2 \Rightarrow a = 0.67$

(34)

27)



$q = +10\ \mu C$

$L = 60\ cm$

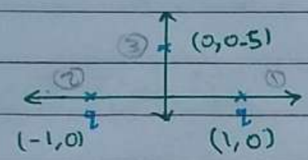
$W = 15\ cm$

$$\Delta U = U_f - U_i$$

$$= \frac{K_e q^2}{10^{-2}}\left(\frac{1}{L} + \frac{1}{\sqrt{L^2+W^2}} + \frac{1}{W} + \frac{1}{W} + \frac{1}{\sqrt{L^2+W^2}} + \frac{1}{L}\right) - \frac{K_e q}{10^{-2}}\left(\frac{1}{L} + \frac{1}{\sqrt{L^2+W^2}} + \frac{1}{W} + \frac{1}{W}\right)$$

$$= \frac{K_e q^2}{10^{-2}}\left(\frac{1}{\sqrt{L^2+W^2}} + \frac{1}{L}\right) = 274 * 10^{8}\ J$$

حل 25)



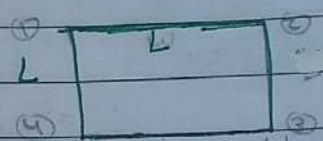
$q = 2\ \mu C$

A) $V = \frac{K_e\, 2q}{d} = \frac{9*10^{9} * 2 * 2 * 10^{-6}}{1.12} = 32.2 * 10^{3}\ V$

B) $\Delta U = U_f - U_i$

$$= K_e q_1\left(\frac{q_1}{2} + \frac{q_2}{1.12} + \frac{q_2}{1.12}\right) - \frac{K_e q_1^2}{2} = 96.4 * 10^{-3}\ J$$

حل 34)



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

$$K_f + U_f = K_i + U_i$$

$$4\left(\frac{1}{2} m v^2\right) + K_e q^2\left(\frac{1}{2L} + \frac{1}{2\sqrt{2}L} + \frac{1}{2L} + \frac{1}{2L} + \frac{1}{2\sqrt{2}L} + \frac{1}{2L}\right) = 0 + K_e q^2\left(\frac{1}{L} + \frac{1}{\sqrt{2}L} + \frac{1}{L} + \frac{1}{L} + \frac{1}{\sqrt{2}L} + \frac{1}{L}\right)$$

$$2 m v^2 = \left(\frac{1}{\sqrt{2}} + 2\right)\frac{K_e q^2}{L}$$

$$V = \sqrt{\frac{\left(\frac{1}{\sqrt{2}} + 2\right)\frac{K_e q^2}{L}}{2m}} = \sqrt{\frac{\left(\frac{1}{\sqrt{8}} + 1\right)\frac{K_e q^2}{L}}{m}}$$

حل 39) A) $\Delta V = -\int \vec{E} \cdot d\vec{s}$

$$E = -\frac{dV}{dx}$$

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

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

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

B) At $(1, 0, -2)$

$E_x = -5\ \hat{i}$, $E_y = -5\ \hat{j}$, $E_z = 0$

$$|E| = \sqrt{-5^2 + 0^2 + -5^2} = 7.07$$

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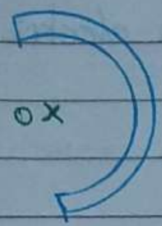
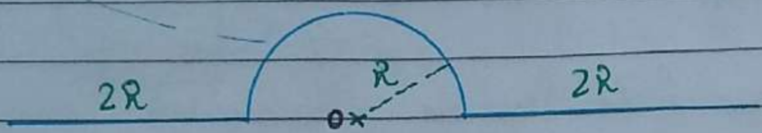
44)



sol. $V_o = K_e \lambda \alpha = K_e \frac{Q}{l} \alpha$

$= \frac{9 \times 10^9 \times (-7.5) \times 10^{-6} \times 3.14}{0.14} = -29.7 \times 10^3$

47)



$V_o = V_{1\,(\text{السلك اليمين})} + V_{2\,(\text{السلك الشمال})} + V_{3\,(\text{نصف الدائرة})}$

$= K_e \lambda \ln\left|\frac{a+l}{a}\right| + K_e \lambda \ln\left|\frac{a+l}{a}\right| + K_e \lambda \alpha$

$= K_e \lambda \left(\ln\left|\left(\frac{a+l}{a}\right)^2\right| + 3.14 \right) = K_e \lambda \left(\ln\left|\frac{R+2R}{R}\right|^2 + 3.14 \right)$

49)

$V_s = \frac{K_e Q}{R}$

$7500 = \frac{9 \times 10^9 \times Q}{0.3}$

$Q = 2.5 \times 10^{-7}$ c

$Q = N q_e$

$N = \frac{Q}{q_e} = \frac{2.5 \times 10^{-7}}{1.6 \times 10^{-19}} = 1.56 \times 10^{12}$ e^-

50) A) $r = 10$

$E)_{10} = \text{Zero}$

$V)_{10} = V_s = \frac{K_e Q}{R} = 16.7 \times 10^{11}$

B) $r = 20$

$E)_{20} = \frac{K_e Q}{R^2} = 54 \times 10^{11}$

$V)_{20} = \frac{K_e Q}{R} = 10.8 \times 10^{11}$

C) $r = 14$

$E)_{14} = \frac{K_e Q}{r^2} = 11.02 \times 10$

$V)_{14} = \frac{K_e Q}{r} = 16.7 \times 10^{11}$

6/3/2018 Tuesday

Obtaining the electric field from electric potential

Rem: $\Delta V = -\int E \cdot dx$

$E_x = \frac{-\partial V}{\partial x}$

The electric field $\vec{E}$

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

E.X.: Find the electric field from the potential

$V_{(x,y,z)} = 5xyz$

$\frac{\partial V}{\partial x} = 5yz$, $\frac{\partial V}{\partial y} = 5xz$, $\frac{\partial V}{\partial z} = 5xy$

$\vec{E} = -5yz\,\hat{i} - 5xz\,\hat{j} - 5xy\,\hat{k}$

$\vec{E}_{(1,-1,0)} = 0 - 0 - 5 \times 1 \times -1 = 5\,\hat{k}$

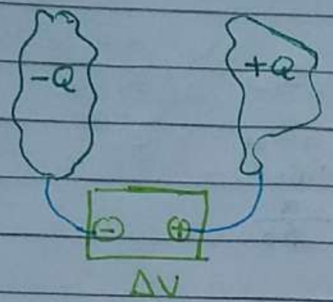
$|E| = 5$ V/m

E.X: $V_{(x)} = \frac{1}{x}$

$E_x\Big)_{x=5} = \frac{-\partial V}{\partial x}\Big)_{x=5} = \frac{+1}{x^2}\Big)_{x=5} = \frac{1}{25}$

Chapter 26
The capacitors المواسعات

1. Capacitance definision.



We define the capacitance "C" as

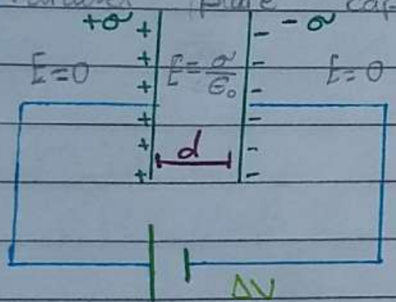
$$C = \frac{Q}{\Delta V}$$

* Note: C doesn't depend on the charge

$$[C] = \frac{C}{V} = \text{Farad}$$

Examples on capacitors

1. Parallel plate capacitor (المواسعة ذو الصفيحتين المتوازيتين)



d: seperation between the plates

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

but $\Delta V = E \cdot (\text{distance})$

$$= \frac{\sigma}{\epsilon_0} \cdot d = \frac{Qd}{\epsilon_0 A}$$

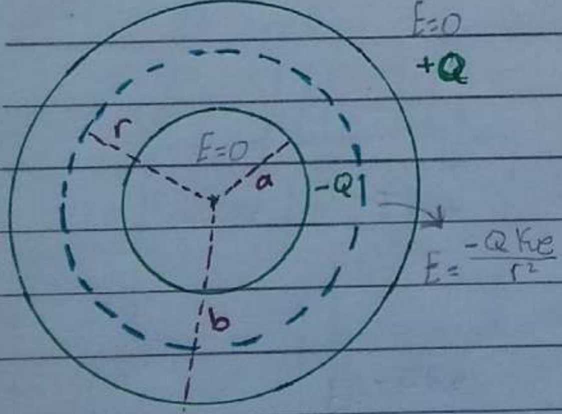
$$C = \frac{Q}{\frac{Qd}{\epsilon_0 A}} = \frac{\epsilon_0 A}{d}$$

$$C_{parallel} = \frac{\epsilon_0 A}{d}$$ مهم

$$A = X \text{ cm}^2 = X * 10^{-4} \text{ m}$$

$$X \text{ mm}^2 = X * 10^{-6} \text{ m}$$

2. Spherical capacitor



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

$$= +\int_a^b \frac{Q K_e}{r^2} dr$$

$$= Q K_e \int_a^b \frac{1}{r^2} dr$$

$$= Q K_e \left(\frac{-1}{r}\right)\Big]_a^b = K_e Q \left(\frac{1}{a} - \frac{1}{b}\right)$$

$$= K_e Q \frac{b-a}{ab}$$

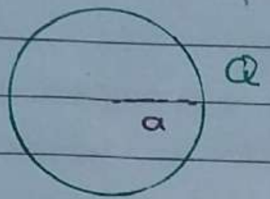
$$C = \frac{Q}{\Delta V} = \frac{4\pi\epsilon_0 \, ab}{b-a}$$ مهم

$$= \frac{ab}{K_e(b-a)}$$

Special case

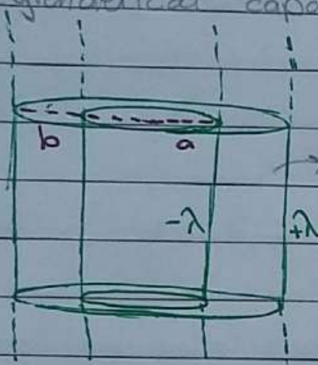
Isolated sphere

1. isolated spherical capacitor　　　　يعطيك السؤال بس
2. isolated drop of water　　　　نص قطر كرة واحدة



$$C_{\text{isolated sphere}} = \lim_{b \to \infty} (C_{sph}) = \lim_{b \to \infty} \frac{4\pi \epsilon_0 a b}{b - a} = 4\pi \epsilon_0 a = \frac{a}{k_e}$$

3. Cylenderical capacitor



$$E = \frac{2k_e \lambda}{r}$$

$$\Delta V = -\int E \cdot dr = -2k_e\lambda \int_a^b \frac{dr}{r} = -2k_e\lambda \ln\left|\frac{b}{a}\right|$$

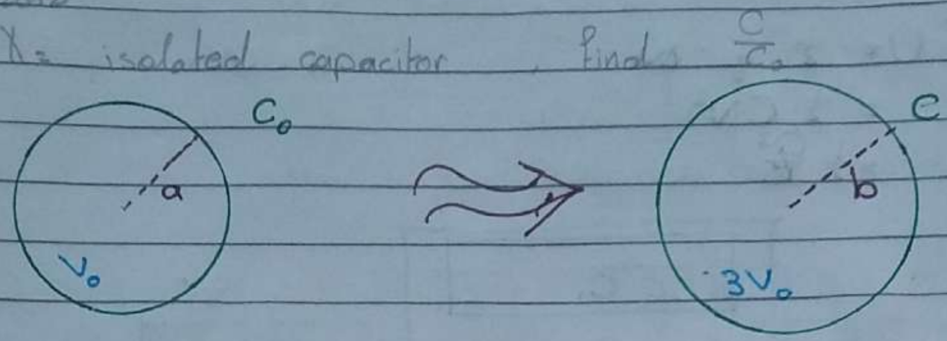
$$C = \frac{Q}{\Delta V} = \frac{\lambda l}{-2k_e\lambda \ln\left|\frac{b}{a}\right|} = \frac{l}{2k_e\lambda \ln\left|\frac{b}{a}\right|}$$　حفظ

Capacitance per unit length (لو ما أعطاك الطول بالامتحان)

$$\frac{C}{l} = \frac{1}{2k_e\lambda \ln\left|\frac{b}{a}\right|}$$

8/3/2018 Thursday

E.X: isolated capacitor, find $\frac{C}{C_o}$



$C_o = 4\pi \epsilon_o a$, $V(C_o) = \frac{4}{3}\pi a^3$

$C = 4\pi \epsilon_o b$, $V(C) = \frac{4}{3}\pi b^3$

$V(C_o) = 3V(C)$

$3(\frac{4}{3}\pi a^3) = \frac{4}{3}\pi b^3$

$3a^3 = b^3$

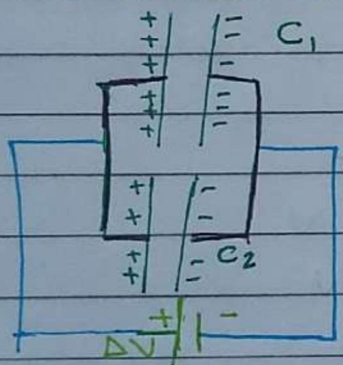
$b = \sqrt[3]{3}\, a$

$C = 4\pi \epsilon_o \sqrt[3]{3}\, a$

$\frac{C}{C_o} = \frac{4\pi \epsilon_o \sqrt[3]{3}\, a}{4\pi \epsilon_o a} = \sqrt[3]{3}$

2- Combination of capacitors (توصيل المواسعات)

1) Parallel combination (توصيل على التوازي)



الموجب و السالب في المواسعتين على نفس الجهد

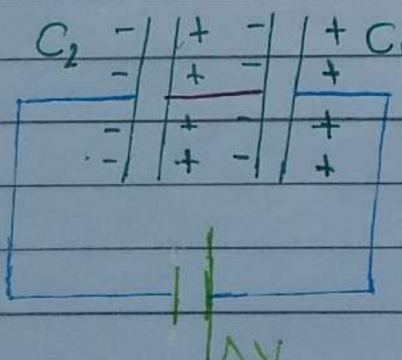
A) The charge on each capacitor: $Q_1 \neq Q_2$

B) The potential difference across each capacitor: $V_1 = V_2$

C) Equivillant capacitance (المواسعة المكافئة)

$C_{eq} = C_1 + C_2$

2) Series combination (توصيل على التوالي)



A) $Q_1 = Q_2 = Q_{eq}$

B) $\Delta V = \Delta V_1 + \Delta V_2$

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

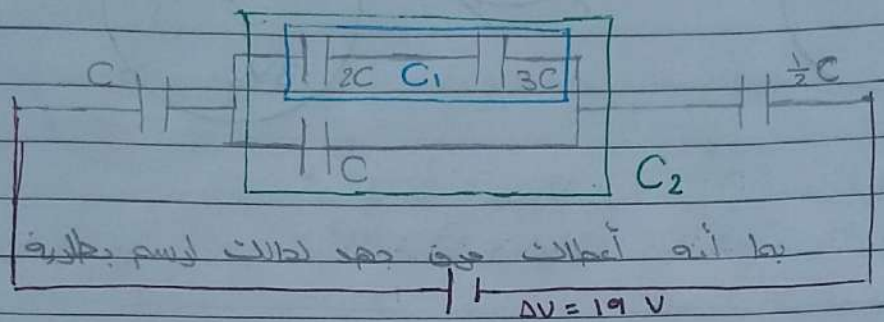
Energy stored in a capacitor (U)

$$U = \frac{1}{2} q \Delta V \qquad Q = CV$$
$$= \frac{1}{2} C V^2$$
$$= \frac{1}{2} \frac{Q^2}{C}$$

EX.:

$C = 2\mu C$

$\Delta V = 19\ V$

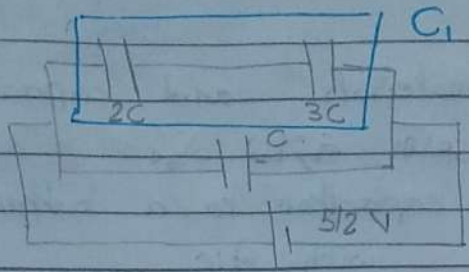


1) The equivillent capcitance

$$\frac{1}{C_1} = \frac{1}{2c} + \frac{1}{3c} = \frac{1}{4} + \frac{1}{6} = \frac{10}{24} = \frac{5}{12}$$
$$C_1 = \frac{12}{5}\ \mu c$$
$$C_2 = C_1 + C = \frac{12}{5} + 2 = \frac{22}{5}\ \mu c$$
$$\frac{1}{C_{eq}} = \frac{1}{c} + \frac{1}{C_2} + \frac{1}{\frac{1}{2}C} = \frac{1}{2} + \frac{5}{22} + \frac{1}{1} = \frac{38}{22} = \frac{19}{11}$$
$$C_{eq} = \frac{11}{19}\ \mu c$$

2) find the potential difference across each capacitor.

$$Q_{eq} = C_{eq} \Delta V$$
$$= \frac{11}{19} * 19 = 11\ \mu c$$
$$Q_{\frac{1}{2}c} = Q_{c_2} = Q_c = Q_{eq} = 11\ \mu c$$
$$\Delta V_{\frac{1}{2}c} = \frac{Q_{\frac{1}{2}c}}{C_{\frac{1}{2}c}} = \frac{11}{1} = 11\ V$$
$$\Delta V_{c_2} = \frac{Q_{c_2}}{C_{c_2}} = \frac{11}{22} * 5 = \frac{5}{2}\ V$$
$$\Delta V_c = \frac{Q_c}{C_c} = \frac{11}{2}\ V$$
$$U_{\frac{1}{2}c} = \frac{1}{2} Q_{\frac{1}{2}c} \Delta V_{\frac{1}{2}c} = \frac{1}{2} * 11 * 11 = 60.5\ \mu J$$



$\Delta V_C = \Delta V_{C_1} = \frac{5}{2}\ V$

$Q_C = C_C\,\Delta V_C = 2 \times \frac{5}{2} = 5\ \mu C$

$Q_{C_1} = C_{C_1}\,\Delta V_{C_1} = \frac{12}{5} \times \frac{5}{12} = 6\ \mu C$

$Q_{2C} = Q_{3C} = Q_{C_1} = 6\ \mu C$

$\Delta V_{2C} = \frac{Q_{2C}}{C_{2C}} = \frac{6}{4} = 1.5\ V$

$\Delta V_{3C} = \frac{Q_{3C}}{C_{3C}} = \frac{6}{6} = 1\ V$

Look to EX 26.4 in the book.

Rewiring — فتح و إغلاق المفاتيح

Q بعد $= Q$ قبل — طريقة الحل

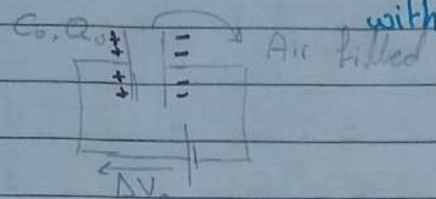
* إذا كان هناك مواسعة مشحونة و أخرى لا و تم توصيلهم يكون التوصيل على التوازي

11/3/2018 Sunday

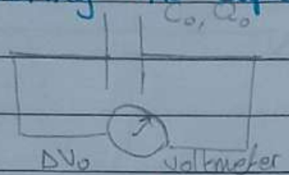
3. Dielectric materials and capacitance

مواد نشائية التكهرب.

1- Connecting the capacitor to a battary while is filled with Air

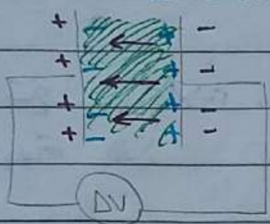


2. Disconnecting the capacitor from the battary



3. Inserting the dielectric material inside the capacitor.

مادة عازلة.



1) The potential differance across the capacitor =

$\Delta V < \Delta V_0$, $\Delta V = \frac{\Delta V_0}{K}$, K = dielectric constant, $K \geq 1$

2) The charge on the capacitor = $Q = Q_0$

3) The capacitance $C = C_0 K$

4) The energy stored in the capacitor =

$U_0 = \frac{1}{2} Q \Delta V_0$, $U_f = \frac{1}{2} Q \Delta V = \frac{1}{2} Q \frac{\Delta V_0}{K} = \frac{U_0}{K}$

The work required to insert the dielectric material inside the capacitor

$$W = \Delta U$$
$$= U_f - U_0 = \left(\frac{1}{K} - 1\right) U_0$$

K تقرأ كابا

Problems

حلي 2) A) $C = \frac{Q}{\Delta V} = \frac{10 \times 10^{-6}}{10} = 1\ \mu F$

B) بما أن الأبعاد لم تتغير ⇐ المواسعة ثابتة

$1 \times 10^{-6} = \frac{100 \times 10^{-6}}{\Delta V} = 100\ V$

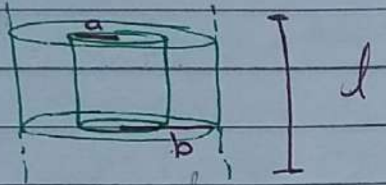
3) A) $Q = CV = 4 \times 12 = 48\ \mu C$

B) $Q = CV = 4 \times 1.5 = 6\ \mu C$

حلي 4) A) $C = \frac{ab}{K_e (b-a)} = \frac{7 \times 10^{-2} \times 14 \times 10^{-2}}{9 \times 10^{9}\ (14-7) \times 10^{-2}} = 15\ pF$

B) $\Delta V = \frac{Q}{C} = \frac{4 \times 10^{-6}}{15 \times 10^{-12}} = 26 \times 10^{4}\ V$

5)



$d = 50\ m$, $Q = 8.1\ \mu C$

$2a = 2.58\ mm$

$2b = 7.27\ mm$

A) $C = \frac{d}{2 K_e \ln\left|\frac{b}{a}\right|} = \frac{50}{2 \times 9 \times 10^{9} \times \ln\left|\frac{7.27}{2.58}\right|} = 2.69\ nF$

B) $\Delta V = \frac{Q}{C} = \frac{8.1 \times 10^{-6}}{2.69 \times 10^{-12}} = 3.02\ kV$

حلي 7)
سؤال فكري

$Q = CV$ —① , $C = \frac{\epsilon_0 A}{d}$ —②

نعوض ② في ①

$Q = \frac{\epsilon_0 A \Delta V}{d}$

charge density $(\sigma) = \frac{Q}{A}$

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

$d = \frac{\epsilon_0 \Delta V}{\sigma} = \frac{8.85 \times 10^{-12} \times 150}{30 \times 10^{-9} \times 10^{4}} = 44.3\ \mu m$

$\sigma = 30 \times 10^{-9}\ C/cm^2$
$= 30 \times 10^{-9} \times 10^{4}\ C/m^2$

9) A) $\Delta V = E \cdot d \Rightarrow E = \frac{\Delta V}{d} = \frac{20}{1.8 \times 10^{-3}} = 11 \times 10^{3}\ N/C$

B) $E = \frac{\sigma}{\epsilon_0} \Rightarrow \sigma = E\,\epsilon_0 = 11 \times 10^{3} \times 8.85 \times 10^{-12} = 98.3 \times 10^{-9}\ nC/m$

C) $C = \frac{Q}{V} = \frac{\epsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \times 7.6 \times 10^{-4}}{1.8 \times 10^{-3}} = 37.4 \times 10^{-13}\ F$

D) $Q = CV = 74.7\ pC$

OR $Q = \sigma A = 74.7\ pC$

(44)

11) A) $E = \frac{k_e Q}{r^2} \Rightarrow Q = \frac{E r^2}{k_e} = \frac{0.21^2 * 4.9 * 10^4}{9 * 10^9} = 2.4 * 10^{-7}$ C

$\sigma = \frac{Q}{4\pi R^2} = \frac{2.4 * 10^{-7}}{4\pi * 0.16^2} = 7.46 * 10^{-7}$ C/m²

B) $C = 4\pi \epsilon_0 R = 17.8$ pF

21) $C_p = 100\, C_s$

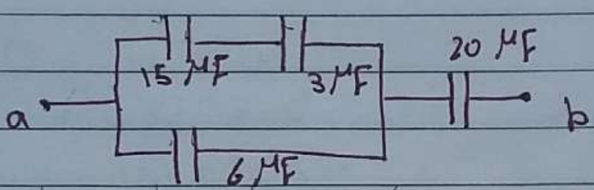
$C_p = C + C + C + \dots + C = nC$

$\frac{1}{C_s} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} + \dots + \frac{1}{C} = \frac{n}{C} \Rightarrow C_s = \frac{C}{n}$

$nC = 100 \frac{C}{n}$

$n^2 = 100 \Rightarrow n = 10$

23)



A) $\frac{1}{C_1} = \frac{1}{15} + \frac{1}{3} = \frac{6}{15} \Rightarrow C_1 = \frac{15}{6} = 2.5$ μF

$C_2 = \frac{15}{6} + 6 = \frac{51}{6} = 8.5$ μF

$\frac{1}{C_{eq}} = \frac{6}{51} + \frac{1}{20} = \frac{171}{1020} \Rightarrow C_{eq} = \frac{1020}{171} = 5.96$ μF

B) $Q = CV = 89.5$ μC

$Q_{C_{eq}} = Q_{20} = Q_{C_2} = 89.5$ μC

$V_{C_2} = \frac{Q_{C_2}}{C_{C_2}} = 10.5$ V

$V_{C_2} = V_6 = V_{C_1}$

$Q_6 = C_6 V_6 = 63.16$ μC

$Q_{C_1} = C_{C_1} V_{C_1} = 26.32$ μC

OR $Q_{C_1} = Q_{C_{eq}} - Q_6 = 26.32$

$Q_{C_1} = Q_{15} = Q_3 = 26.32$ μC

27) $C_p = C_1 + C_2 = 9$ pF

$C_s = 2$ pF $\Rightarrow \frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{2}$

$\frac{C_1 + C_2}{C_1 C_2} = \frac{1}{2} \Rightarrow \frac{9}{C_1 C_2} = \frac{1}{2}$

$C_1 C_2 = 18 \Rightarrow C_1 (9 - C_1) = 18$

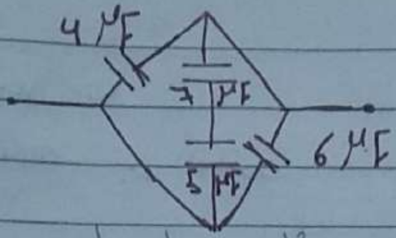
$C_1^2 - 9C_1 + 18 = 0$

$(C_1 - 3)(C_1 - 6) = 0$

$C_1 = 3 \qquad C_1 = 6$

$C_2 = 6 \qquad C_2 = 3$

25) حلي



$\frac{1}{C_1} = \frac{1}{7} + \frac{1}{5} = \frac{12}{35} \Rightarrow C_1 = \frac{35}{12}$

$C_{eq} = \frac{35}{12} + 4 + 5 = \frac{143}{12} = 11.9\ \mu F$

32) حلي

A) $U = \frac{1}{2} CV^2 = \frac{1}{2} * 3 * 12^2 = 212\ J$

B) $U = \frac{1}{2} CV^2 = \frac{1}{2} * 3 * 6^2 = 54$

47) حلي

A) $C = \frac{\epsilon_0 A}{d} = \frac{8.85 * 10^{-12} * 25 * 10^{-4}}{1.5 * 10^{-2}} = 1475 * 10^{-14}\ F$

$Q = CV = 147.5 * 10^{-14} * 250 = 369\ pC$

$Q_{befor} = Q_{after} = 369\ pC$

B) $C_f = C_0 * K = 147.5 * 10^{-14} * 80 = 118\ pF$

$= 1.2 * 10^{-10}\ F$

$V_f = \frac{V_0}{K} = \frac{250}{80} = 3.1\ V$

C) $\Delta U = (\frac{1}{K} - 1) U_0$

$= (\frac{1}{80} - 1) * \frac{1}{2} * 369 * 10^{-12} * 250 = -45.5\ nJ$

63) حلي سؤال حلو

initially: $Q = CV$

$= 10 * 15 = 150\ \mu C$

then: $V = \frac{q_1}{C_1} + \frac{q_2}{C_2}$

$50 = \frac{q}{5} + \frac{150+q}{10}$

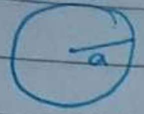
$50 = \frac{2q}{10} + \frac{150+q}{10}$

$3q = 350$

$q = 117\ \mu C$

in $5\ \mu F$: $\Delta V = \frac{q}{C} = \frac{117}{5} = 23.3\ V$

in $10\ \mu F$: $\Delta V = \frac{q}{C} = \frac{117+150}{10} = 26.7\ V$

Q.  $C = 1\ pF$

هذا سؤال ٤
بال edition تبع الدكتور

1) Its radius ?

$C = \frac{a}{k_e}$

$a = 9 \times 10^{-3}$ m

2) If r = 2 cm, what is the capacitance?

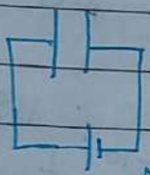
$C = \frac{2 * 10^{-2}}{9 * 10^{9}}$

$= 2.2\ pF$

3) $\Delta V = 100$, find charge.

$Q = CV$

$= 10\ nC$

Q.  $Q = 48\ \mu C$

$\Delta V = 12$ V

هذا سؤال ٤٥
بال edition تبع الدكتور

1) find C

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

$= \frac{48}{12} = 4\ \mu F$

b)  Teflon ($k = 2.1$)

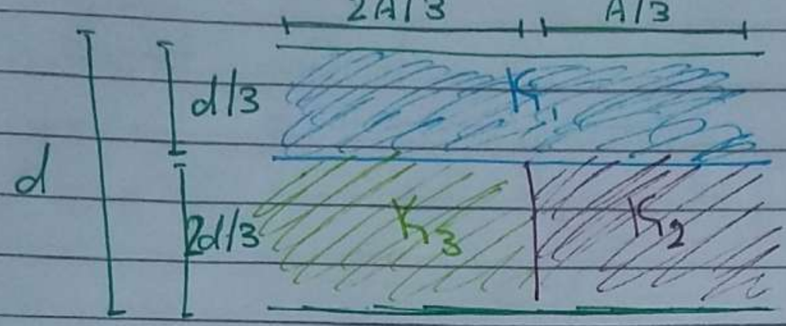
1) $Q = Q_0 = 48\ \mu F$

2) $C = k C_0 = 8.4\ \mu F$

3) $\Delta V = \frac{\Delta V_0}{k} = 5.7$ V

4) $U_f = \frac{U_0}{k} = \frac{1}{2} \frac{Q \Delta V_0}{k} = 137.1$ J

Ex. موجود في نسخة الكتاب القديمة.



هذه رسمة لمواسعة تحتوي ٣ مواد dielectric

المواد اللي فوق بعض بتكون على التوالي.

و اللي جنب بعض على التوازي

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

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

$$C_3 = K_3 \frac{\epsilon_0 \, 2A/3}{2d/3} = \frac{K_3 \epsilon_0 A}{d}$$

$$C_{23} = C_2 + C_3 = \frac{\epsilon_0 A}{d}\left(\frac{K_2}{2} + K_3\right)$$

$$\frac{1}{C_{eq}} = \frac{1}{C_{23}} + \frac{1}{C_1}$$

إذا كان عندك مواسعات مشحونة و وصلتها ببعضها.

1) على التوالي $Q_f = V(C_2 - C_1)$

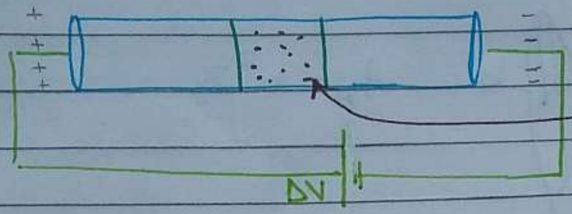
2) على التوازي $Q_f = V(C_2 + C_1)$

دائماً $Q_i = Q_f$.

15/3/2018 Thursday

Chapter 27
Current and Resistance التيار و المقاومة

1) Current deffination تعريف التيار



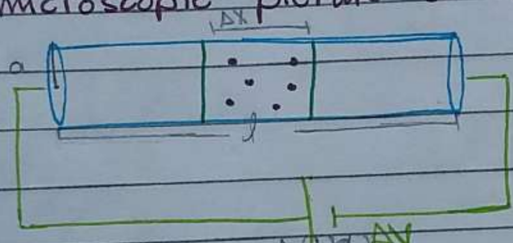
1) The average current التيار المتوسط

$I_{avg} = \frac{\Delta Q}{\Delta t} = \frac{Q_f - Q_i}{t_f - t_i} = \frac{C}{S}$, $[I] = $ Amper

2) Inastanuous current (I) التيار اللحظي

$I = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t} = \frac{dQ(t)}{dt}$

2) The microscopic picture of the current



Rem: $I = \frac{\Delta Q}{\Delta t} = \frac{\Delta(N q_o)}{\Delta t}$, N: number of charge carriers
q_o: charge of charge carriers

We define the number density "n" as

$n = \frac{\#\text{ of charge carriers}}{\text{volume}} = \frac{N}{A \Delta x} = \frac{\text{electrons}}{m^3}$

$I = \frac{\Delta(n A \Delta x q_o)}{\Delta t} = n A q_o v_d$

v_d: drift velocity السرعة الانسياقية

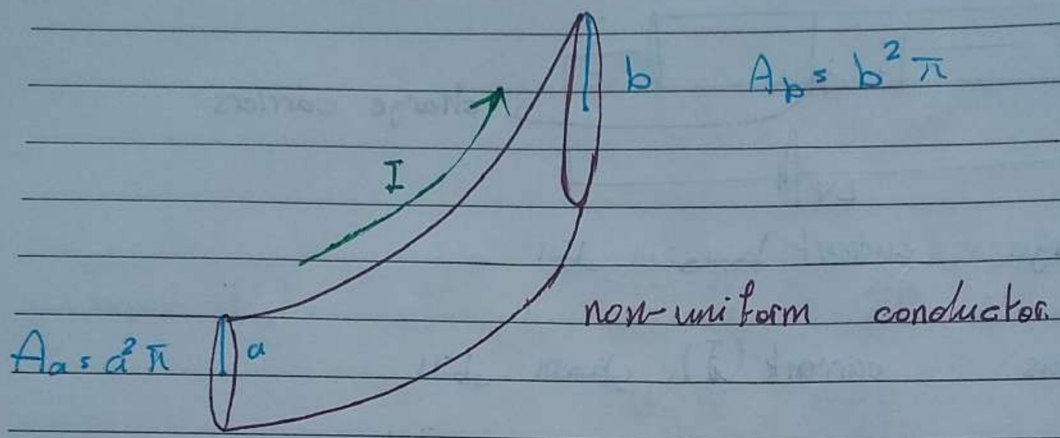
حل مثال 27.1 في الكتاب , copper

$I = n A q_o v_d$ حفظ

3) The current density ($\vec{J}$)

The current (I) = scalar

current density (J) = vector



$$J = \frac{I}{A}$$

$$J_a = \frac{I}{a^2\pi} \quad , \quad J_b = \frac{I}{b^2\pi}$$

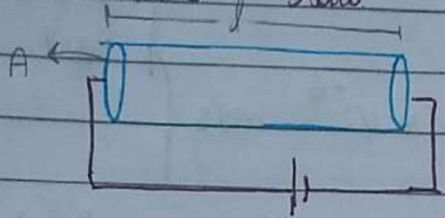
$$J = \frac{I}{A} = n\, q_0\, v_d$$

18/3/2018

Sunday

$\vec{J} = n q_o \vec{v}_d$

4) Ohm's law



ΔV

$E = \frac{\Delta V}{l}$

$\vec{J} \sim \vec{E}$ Ohm's law

$J = \sigma E$

σ = conductivity = الموصلية

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

$J = \frac{E}{\rho} = \frac{\Delta V}{\rho l}$

$\frac{I}{A} = \frac{\Delta V}{\rho l}$

$\Delta V = \left(\frac{\rho l}{A}\right) I$

$\Delta V = R \; I$

R is called the resistance (المقاومة) $(\Omega) = \frac{\rho l}{A}$

What is the power delivered in the resistance

OR What is the heat dissipated(السخونة المبددة) in the resistance

Answer: $P = I^2 R$ [Watt]

$= I \Delta V$

5) Resistance temperature dependent

اعتماد المقاومة على درجة الحرارة

$R(T) = R_o (1 + \alpha (T - T_o))$ where

$R(T)$ = resistance of temperature T

R_o = resistance of temperature T_o $(T_o = 20\,°C)$

ألفا α = thermal resistance coeffecient معامل المقاومة الحراري $[°C^{-1}]$

$\rho(T) = \rho_o (1 + \alpha (T - T_o))$

Problems

3) تعديل على السؤال = Cu بدل Al

$n_{Cu} = 8.49 * 10^{28}$ e/m^3

a) $v_d = ??$

$I = n A q_0 v_d$

$v_d = \frac{I}{n A q_0} = 9.2 * 10^{-5}$ m/s

b) Current density

$J = \frac{I}{A} = \frac{5}{4 * 10^{-6}} = 1.25 * 10^{6}$ A/m^2

c) electric field in the wire. , resistivity = $1.7 * 10^{-8}$

$J = \sigma E = \frac{E}{\rho}$

$E = \rho J = 2.125 * 10^{-2}$ Ω.m

d) $\Delta V = ??$

$\Delta V = E l$

7) $I(t) = I_0 e^{-t/\beta}$, $\beta > 0$.

a) $I(t) = \frac{dq}{dt}$

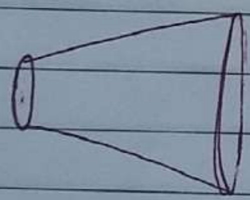
$\int dq = \int I(t)\, dt$

$Q = \int_0^{\beta} I_0 e^{-t/\beta} = I_0 (-\beta) e^{-t/\beta} \Big]_0^{\beta} = I_0 \beta (1 - e^{-1})$

b) $Q = I(-\beta) e^{-t/\beta} \Big]_0^{10\beta} = I_0 \beta (1 - e^{-10})$

c) $Q = \lim_{x \to \infty} I_0 \beta (1 - e^{-x})$

$= I_0 \beta$

8) 

a) $J_1 = \frac{I}{A_1} = \frac{5}{\pi * 16 * 10^{-6}} = 9.8 * 10^{4}$ A/m^2

b) the same

c) smaller

d) $J_2 = \frac{J_1}{4}$

$= \frac{I}{4\pi * 16 * 10^{-6}} = 24.5 * 10^{4}$ A/m^2

9) $q(t) = 4t^3 + 5t + 6$

a) $I = \dot{q}(t) = 12t^2 + 5$

$I(1) = 17$ A

b) $\vec{J} = \frac{I}{A} = \frac{17}{2 * 10^{-3}} = 8.5 * 10^{3}$ A/m^2

معلومة tungsten رمزه W وهو السلك الذي داخل اللمبة

15) حلي $\Delta V = I R$

$\Delta V = I \frac{\rho l}{A} \Rightarrow \rho = \frac{\Delta V A}{I l} = 1.589 * 10^{-8}$

the wire is made from silver

16) $I = \frac{A \Delta V}{\rho l} = \frac{0.6 * 10^{-6} * 0.9}{5.6 * 10^{-8} * 1.5} = 6.4 A$

19) حلي سؤال زنخ بدو الكتلة المولية و خصص حصة انشالله سنى ☺

23) $J = \sigma E$

$\sigma = \frac{J}{E} = 6 * 10^{-15} \frac{1}{\Omega . m}$

26) $R(t) = R_0 (1 + \alpha (T - T_0))$

$T = \frac{\frac{R(t)}{R} - 1}{\alpha} + T_0 = 1435 °C$

حلي 31) a) $I = \frac{A \Delta V}{\rho l} = 30 A$

b) ρ at $20 °C = 1.7 * 10^{-8} \Omega . m$

$\rho(30) = 1.7 * 10^{-8} (1 + \alpha (10))$

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

حلي 39) a) $P = I \Delta V$

$I = \frac{P}{\Delta V} = \frac{1000}{120} = 8.3 A$

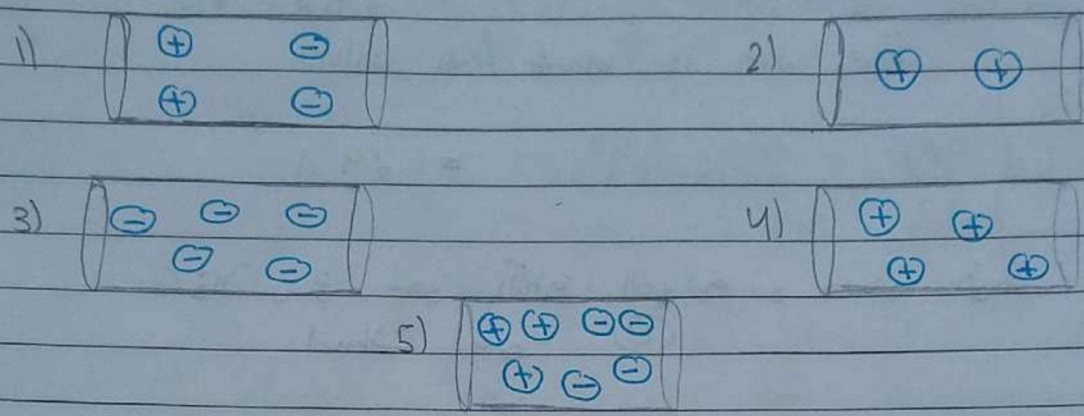
b) $P = I^2 R$

$R = \frac{P}{I^2} = \frac{1000}{(8.3)^2} = 14.5 \Omega$

Q: $P = 600 W$, $\Delta V = 120 V$, find I

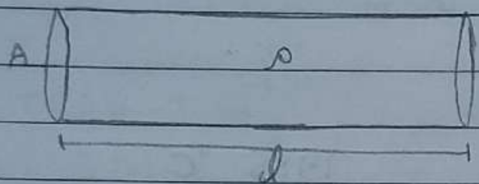
sol $I = \frac{P}{\Delta V} = 5 A$

E.X. Rank (رتب) the current from the largest to least



$$I_5 > I_3 > I_1 = I_4 > I_2$$

E.X.



تم قص هذا السلك إلى n أسلاك بنفس الطول و جمعهم بجانب بعضهم ،

Find $\frac{R_n}{R_o}$

$$R_o = \frac{\rho l}{A}$$

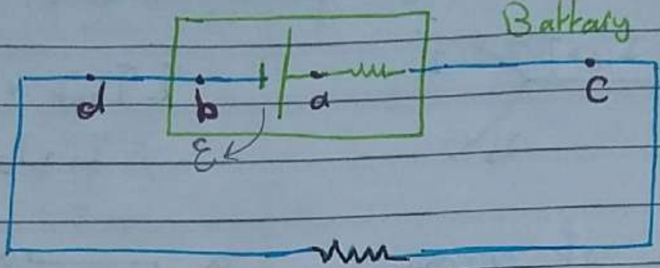
$$R_n = \frac{\rho\, l/n}{nA}$$

$$\frac{R_o}{R_n} = \frac{1}{n^2}$$

بتقدر تحل السؤال على أنه توصيل توازي

22/3/2018 — Chapter 28 — Thursday

[1] electromotive force ($\mathcal{E}_{mf}$) القوة الدافعة الكهربائية



R = load risestance مقاومة الحمل

$\mathcal{E} = \mathcal{E}_{mf}$

$\Delta V_{cd} = \mathcal{E} - I r = IR$

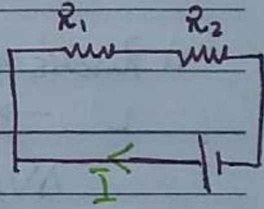
ΔV_{cd} = terminal voltage

r = internal resistance of the battary

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

[2] Combination of resistance

1. the series combination

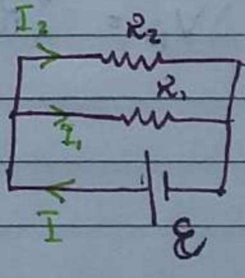


a) the current across each resistance $I = I_1 = I_2$

b) potential difference across each resistance $\mathcal{E} = \Delta V_1 + \Delta V_2$

c) equivillent resistance $R_{eq} = R_1 + R_2$

2. the parallel combination



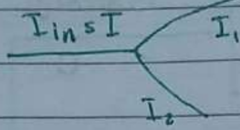
a) $I = I_1 + I_2$

b) $\Delta V_1 = \Delta V_2 = \mathcal{E}$

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

[3] Kirchoff's Rules

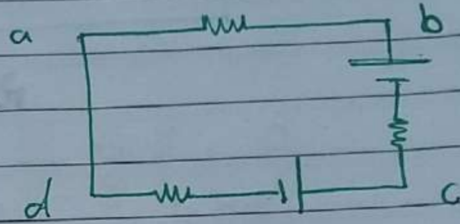
1) Conservation of charge (حفظ الشحنة)



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

$$I_1 + I_2 = I$$

2) Conservation of energy



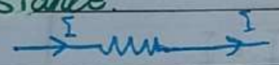
$$\sum_{\text{closed loop}} \Delta V_{abcda} = 0$$

Kirchoff convention كيرتشوف في حل الدوائر الكهربائية.

→ +ve direction

1) Risestance.

1\.



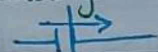
$\Delta V_R = - IR$

2\.

$\Delta V_R = IR$

2) Battary ($\mathcal{E}$mf)

1\.



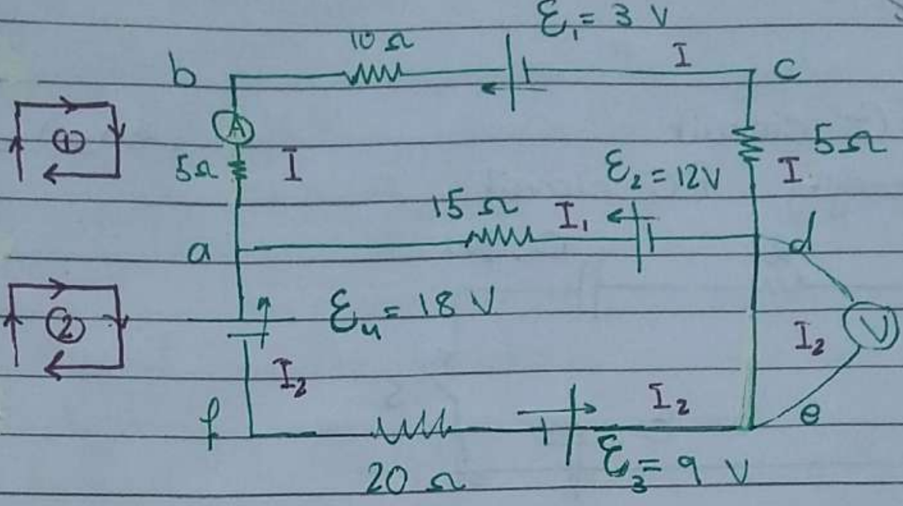
$\Delta V = + \mathcal{E}$

2\.

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

25/3/2018 Sunday

E.X



أنت اختار اتجاه الحركة الموجب

$I = I_1 + I_2$ — (1)

بلش من الدبل

$\Sigma \Delta V_{abcda} = 0$

$-5I + (-10I) + (-3) + (-5I) + 12 + (-15I_1) = 0$

$-20I - 15I_1 + 9 = 0$ — (2)

$\Sigma \Delta V_{fadef} = 0$

$18 + 15I_1 + (-12) + (-9) + (-20I_2) = 0$

$15I_1 - 20I_2 - 3 = 0$ — (3)

(1) into (2)

$-35I_1 - 20I_2 + 9 = 0$ — (4)

(3) into (4)

$-35\left(\frac{1}{5} + \frac{4}{3}I_2\right) - 20I_2 + 9 = 0 \Rightarrow I_2 = \frac{3}{100}$ A

(4) $\Rightarrow I_1 = \frac{9}{35} - \frac{20}{35} * \frac{3}{100} = \frac{24}{100} = \frac{6}{25}$ A

(1) $\Rightarrow I = I_1 + I_2 = \frac{27}{100}$ A

find $V_d - V_e$

sol. $V_e + \text{-----} = V_d$

$V_e + (-9) + (-20 * \frac{3}{100}) + 18 + (15 * \frac{24}{100}) - 12 = V_d$

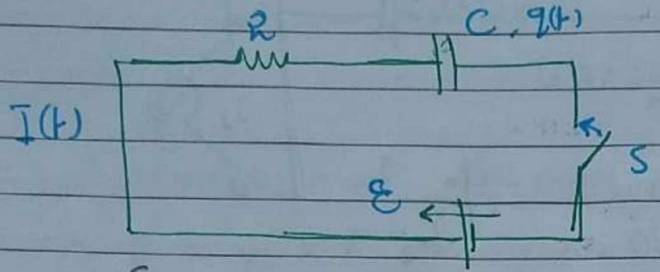
$V_e + 3 - 3 = V_d \Rightarrow V_e - V_d = \text{Zero}$

H.W find $V_d - V_b$

27/3/2018 Tuesday

RC - circuit زي خزان الماء و العوامة.

a) charging RC- circuit



$$\mathcal{E} = \Delta V_R + \Delta V_c$$
$$= R\, I(t) + \frac{q(t)}{C}$$

but $I(t) = \frac{d\, q(t)}{dt}$

$$\mathcal{E} = R \frac{dq}{dt} + \frac{q(t)}{C}$$
$$\frac{dq}{dt} + \frac{q(t)}{RC} = \frac{\mathcal{E}}{R}$$

we define a time constant or charchtaristic time $= \tau$, $\tau = RC$, [sec]

$$\frac{dq}{dt} + \frac{q(t)}{\tau} = \frac{\mathcal{E}}{R}$$
$$\Longrightarrow q(t) = Q_{max} \left(1 - e^{-t/\tau}\right)$$

$Q_{max} = \mathcal{E} C$, at time $= \infty$

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

the current in the circuite

$$I(t) = \frac{dq}{dt}$$
$$= \frac{\mathcal{E}}{R} e^{-t/\tau} = I_{max}\, e^{-t/\tau}$$

$I_{max} = \frac{\mathcal{E}}{R}$, when $t = 0$.

1) the potential difference across the capacitor

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

2) the potential difference across the resistance.

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

3) the energy stored in a capacitor

$$U(t) = \frac{1}{2} q_c(t) V_c(t)$$
$$= \frac{1}{2} C \mathcal{E}^2 (1-e^{-t/\tau})^2$$
$$= \frac{1}{2} U_{max} (1-e^{-t/\tau})^2$$

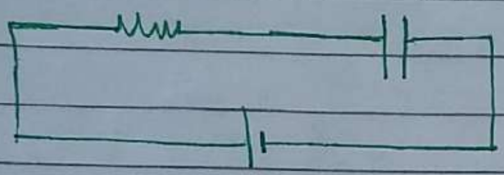
U_{max} when $t = \infty$

4) the power dilivered in the resistance.

$$P(t) = R I^2(t)$$
$$= \frac{\mathcal{E}^2}{R} e^{-2t/\tau} = P_{max} e^{-2t/\tau}$$

P_{max} when $t = 0$.

E.X the figure shows an RC - circuit the $R = 2 M\Omega$ $C = 4 nF$ and $\mathcal{E} = 12 V$, initially the capacitor is uncharge



1) what is the time constant?
2) what is the maximum charge in capacitor?
3) what is the maximum current?
4) what is the charge on capacitor when $T = 2\tau = 16$ ms.

sol. 1) $\tau = RC = 2 \times 10^6 \times 4 \times 10^{-9} = 8$ ms

2) $Q_{max} = \mathcal{E}C = 12 \times 4 = 48$ nC

3) $I_{max} = \frac{\mathcal{E}}{R} = \frac{12}{2 \times 10^6} = 6 \mu A$

4) $q(t) = Q_{max}(1 - e^{-t/\tau})$

$= 48(1 - e^{-2})$ nC

29/3/2018 Thursday

charging RC- circuit.

⟹ 1. initially uncharged capacitor.

2. R, C, ε are constant.

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

5) find the time at which the energy stored in the capacitor is 25% of its maximum value

sol.

$$U(t) = U_{max}\left(1-e^{-t/2}\right)^2$$

$$\frac{U(t)}{U_{max}} = \left(1-e^{-t/\tau}\right)^2 = 0.25$$

$$1-e^{-t/\tau} = \pm 0.5$$

$$e^{-t/\tau} = 1 \mp 0.5$$

$$e^{-t/\tau} = 0.5,\ 1.5$$

$$\frac{-t}{\tau} = \ln 0.5,\ \ln 1.5$$

$$t = -\tau \ln 0.5 = 0.69\,\tau$$

6) find the time at which the charge on the capacitor is 0.3 of its maximum value

sol

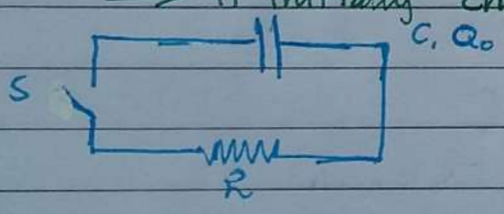
$$\frac{q(t)}{Q_{max}} = 1-e^{-t/\tau} = 0.3$$

$$e^{-t/\tau} = 0.7$$

$$t = -\tau \ln 0.7$$

b) Discharging the RC- circuit

⟹ 1) initially charged capacitor. 2) C, R are constant.



$$\Delta V_C + \Delta V_R = 0$$

$$\frac{q(t)}{C} + R\,I(t) = 0$$

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

$$q(t) = Q_0\,e^{-t/\tau}$$

$$I(t) = \frac{-Q_0}{RC}\,e^{-t/\tau} = I_{max}\,e^{-t/\tau}$$

$$I_{max} = \frac{-Q_0}{RC}, \text{ when } t = 0$$

$$U(t) = \frac{q(t)^2}{2C} = \frac{Q_0^2}{2C}\,e^{-2t/\tau}$$

$$= U_{max}\,e^{-2t/\tau}$$

Problems

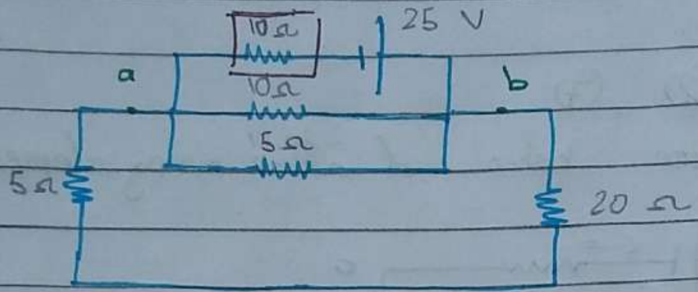
1) a) $P_R = \frac{\Delta V^2}{R} \Rightarrow R = \frac{\Delta V^2}{P} = \frac{11.6^2}{20} = 6.728\ \Omega$

b) $\mathcal{E} = I_r + I_r$

$P = I^2 R \Rightarrow I = \sqrt{\frac{P}{R}} = 1.72\ A$

$r = \frac{\mathcal{E} - IR}{I} = \frac{15 - 11.6}{1.72} = 1.982\ \Omega$

9)



a) $R_1 = 20 + 5 = 25\ \Omega$

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

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

$I = \frac{\Delta V}{R} = 25 * \frac{17}{220} = \frac{85}{44} = 1.9318\ A$

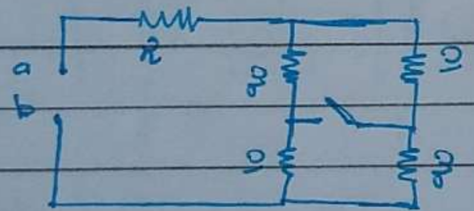
$\Delta V_{\boxed{10}} = I_{\boxed{10}} * R_{\boxed{10}} = 19.318\ V$

$\Delta V_{R_2} = 25 - 19.318 = 5.682\ V$

$I_{25} = I_{20} = I_5 = \frac{\Delta V_{R_2}}{25} = \frac{5.682}{25} = 0.22\ A = 220\ mA$

b) $\Delta V_{ab} = \Delta V_{25} = \Delta V_{R_2} = 5.682\ V$

14)



a) before closing the key

$R_1 = 10 + 90 = 100\ \Omega$, $R_2 = 10 + 90 = 100\ \Omega$

$\frac{1}{R_3} = \frac{1}{100} + \frac{1}{100} = \frac{2}{100} \Rightarrow R_3 = \frac{100}{2} = 50\ \Omega$

$R_{eq} = 50 + R$

after closing key

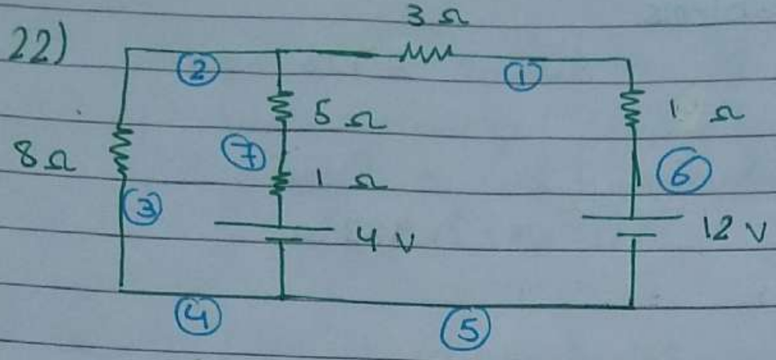
$\frac{1}{R_1} = \frac{1}{10} + \frac{1}{90} = \frac{9}{90} \Rightarrow R_1 = R_2 = 10\ A$

$R_{eq} = R + R_1 + R_2 = 20 + R$

∴ decrease

b) $20 + R = \frac{1}{2}(50 + R) \Rightarrow \frac{1}{2} R = 5 \Rightarrow R = 10\ \Omega$

22) حلي

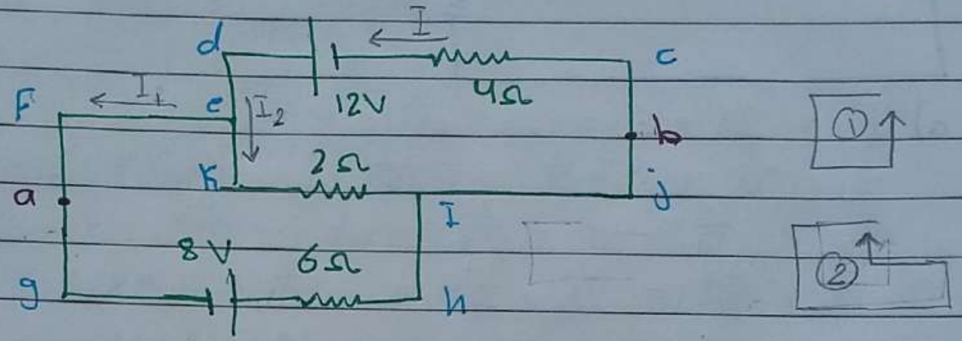


الأرقام هي أرقام الأضلاع (الأسلاك)

Ammeter in ⑤ , ② , ⑦

Voltmeter in all number befor and after every element

24) حلي



a) $I = I_1 + I_2$ — ①

$\Sigma \Delta V_{cdkjc} = 0$

$= -4I + 12 - 2I_2 = 0$ — ②

$\Sigma \Delta V_{efghIke} = 0$

$8 - 6I_1 + 2I_2 = 0$ — ③

① into ②

$-4I_1 - 6I_2 + 12 = 0$ — ④

$-2 * ③ + 3 * ④$

$-16 + 12I_1 - 4I_2 - 12I_1 - 18I_2 + 36 = 0$

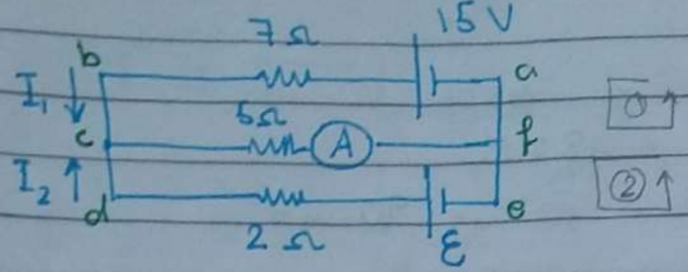
$22I_2 = 20 \Rightarrow I_2 = 0.909$

b) $V_b + \text{-----} = V_a$

$V_b + 2I_2 = V_a$

$V_b - V_a = 2I_2 = -1.82$

29)



$I = I_1 + I_2 = 2 \Rightarrow I_2 = 2 - I_1$ —①

$\Sigma \Delta V_{abcfa} = 0$

$15 - 7I_1 - 5I = 0$

$15 - 7I_1 - 10 = 0 \Rightarrow I_1 = \frac{5}{7}$ A

$\frac{5}{7} + I_2 = 2 \Rightarrow I_2 = \frac{9}{7}$ A

$\Sigma \Delta V_{fcdef} = 0$

$5I + 2I_2 - \varepsilon = 0$

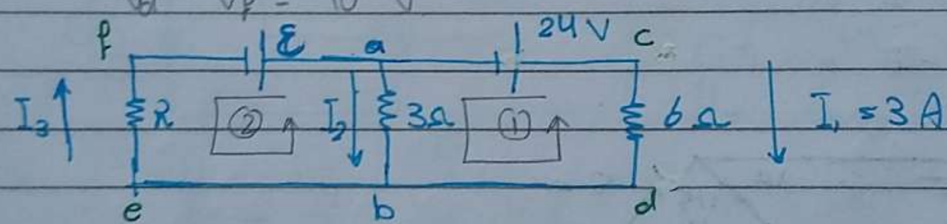
$10 + \frac{18}{7} = \varepsilon \Rightarrow \varepsilon = \frac{88}{7}$ V

$V_d - V_f = ??$ فرع زيادة من الدكتور

$V_d + 2 \times \frac{9}{7} - \frac{88}{7} = V_f$

$V_d - V_f = 10$ V

دو 32)



a) $\Sigma \Delta V_{cabdc} = 0$

$-24 - 3I_2 + 3 \times 6 = 0 \Rightarrow I_2 = -2$ A

b) $I_3 = I_2 + I_1$

$= -2 + 3 = 1$ A

c) No, we can't

37) a) $\tau = RC = 2 \text{ ms}$

b) $Q_{max} = \mathcal{E}C = 180 \ \mu C$

c) $I_{max} = \frac{\mathcal{E}}{R} = \frac{9}{100} = 90 \text{ mA}$

من عند الدكتور d) $q(t)\Big|_{t=\tau} = Q_{max}\left(1 - e^{-\tau/\tau}\right)$

$= 180\left(1 - e^{-1}\right) \mu C$

من عند الدكتور e) find the charge on capacitor after long time.

$Q_{max} = 180 \ \mu C$.

39) a) $I(t) = \frac{Q_0}{RC} e^{-t/RC}$

$= \frac{5.1}{2.6} e^{-9/2.6}$

b) $Q(t) = Q_0 e^{-t/\tau}$

$= 5.1 \ e^{-8/2.6}$

c) $I_{max} = \frac{Q_0}{RC} = \frac{5.1}{2.6}$

من الدكتور d) find the time at which the energy stored on the capacitor is 10% of its maximum value.

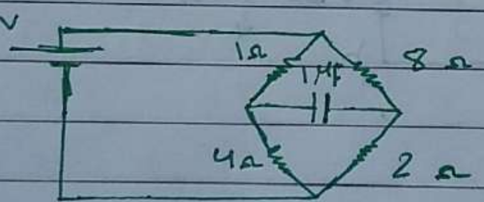
$U(t) = U_{max} e^{-2t/\tau}$

$\frac{1}{10} = e^{-t/\tau}$

$-2t/\tau = \ln 0.1$

$t = -\frac{\tau}{2} \ln 0.1$

حلو 43)



a) $R_1 = 1 + 4 = 5 \ \Omega \Rightarrow I_1 = \frac{\Delta V}{R_1} = \frac{10}{5} = 2A \Rightarrow V_1 = 10 - 1 \times 2 = 8 \ V$

$R_2 = 8 + 2 = 10 \ \Omega \Rightarrow I_2 = \frac{\Delta V}{R_2} = \frac{10}{10} = 1 \ A \Rightarrow V_2 = 10 - 8 \times 1 = 2 \ V$

$\Delta V = V_1 - V_2 = 6 \ V$

b) $R_1 = 4 + 2 = 6 \ \Omega$

$R_2 = 1 + 8 = 9 \ \Omega$

$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{9} = \frac{15}{54} \Rightarrow R_{eq} = \frac{54}{15} = 3.6 \ \Omega$

$q(t) = Q_0 e^{-t/RC} \Longrightarrow \frac{q(t)}{Q_0} = e^{-t/RC}$

$0.1 = e^{-t/3.6}$

$t = -3.6 \ln 0.1 = 8.29 \ \mu s$

(68)

3/4 — Tuesday

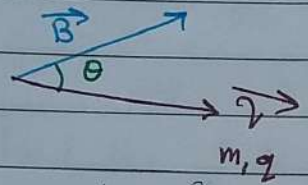
Chapter 29
The Magnetic field. ($\vec{B}$)

Note:

1. The electric affects both stationary (ثابت) ($v=0$) or moving charge particle.
2. The magnetic field ($\vec{B}$) [Tesla] affect only moving particles.

صفات ال particle ١. نقطية ٢. مشحونة ٣. لها كتلة

[1] The magnetic force on a moving charged particle.



The magnetic force on the charge particle is

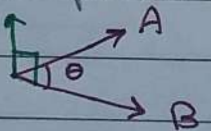
$$\vec{F}_{\vec{B}} = q\,\vec{v} \times \vec{B}$$

$\times$ → cross product

$$|\vec{F}_B| = q\,v\,B\sin\theta$$

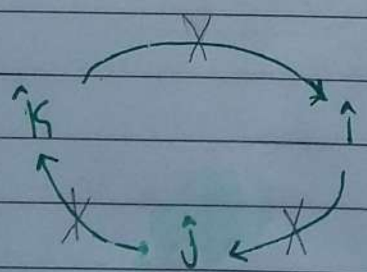
cross product

تكون عمودية على المستوى



1) $\vec{C} = \vec{A} \times \vec{B}$

2) $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$



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

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

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

3/4 — Tuesday

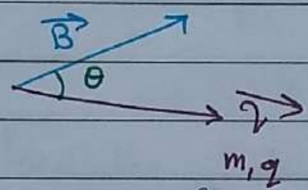
Chapter 29
The Magnetic field ($\vec{B}$)

Note:

1. The electric affects both stationary (ثابت) ($v=0$) or moving charge particle.
2. The magnetic field ($\vec{B}$) [Tesla] affect only moving particles.

صفات الـ particle الـ نقطية : مشحونة ، لها كتلة

[1] The magnetic force on a moving charged particle.



The magnetic force on the charge particle is

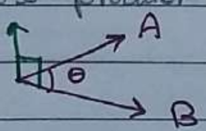
$$\vec{F}_{\vec{B}} = q\,\vec{v} \times \vec{B}$$

(× → cross product)

$$|\vec{F}_B| = q\,v\,B\sin\theta$$

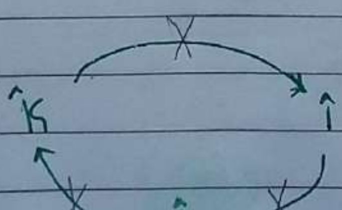
cross product

تكون عمودية على المستوى



1) $\vec{C} = \vec{A} \times \vec{B}$

2) $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$



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

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

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

Ex: Find the magnetic force on a proton with $\vec{v} = 3\hat{i} - \hat{k}$ in a magnetic field $\vec{B} = 2\hat{k} + 5\hat{j}$ (T)

sol. $\vec{v} = 3\hat{i} + 0\hat{j} - \hat{k}$

$\vec{B} = 0\hat{i} + 5\hat{j} + 2\hat{k}$

$\vec{F} = q\,\vec{v} \times \vec{B}$

$= q \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & -1 \\ 0 & 5 & 2 \end{vmatrix}$ } مصفوفة

$= q\left((0\times2 - (-1)\times5)\hat{i} - (3\times2 - 0\times0)\hat{j} + (3\times5 - 0\times(-1))\hat{k}\right)$

$= q\,(5\hat{i} - 6\hat{j} + 15\hat{k})$ N

طريقة الضرب بالمصفوفات

1) رتب مداخل المصفوفة بالي $\hat{i}$ ، $\hat{j}$ ، $\hat{k}$

2) تحسب كل من $\hat{i}$ ، $\hat{j}$ ، $\hat{k}$ كل وحدة (لحالها) و بالطريقة:

١. اشطب العمود تبعها.

٢. بطل عند ذي هيك

① ②

③ ④

اضرب 1×4 و اطرح منها 2×3

٣ عوض كل وحدة مكانها $((\ \ )\hat{i} - (\ \ )\hat{j} + (\ \ )\hat{k})$

و بس

جرب غيرو

5/4/2018 Thursday

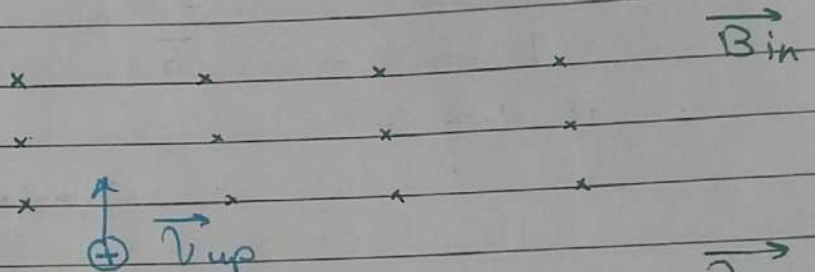
Right hand rule for positive charge.

conwension : 1) ⊙ : out of the page
2) ⊗ : into the page.

١- يقوس الأصابع باتجاه السرعة
٢- باطن اليد باتجاه المجال المغناطيسي
٣- تكون القوة باتجاه الابهام

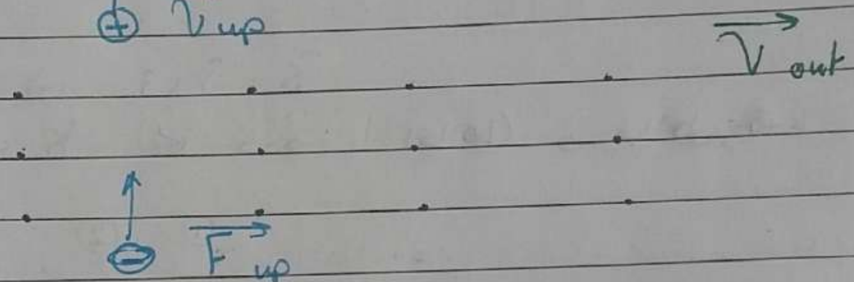
E.X1 : +ve

⇒ $\vec{F}$: left



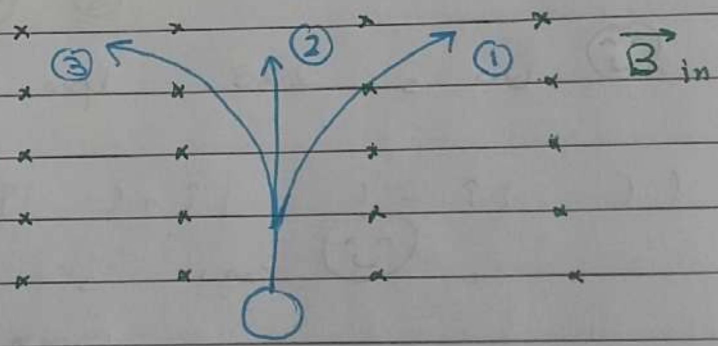
E.X2 : -ve

⇒ $\vec{B}$: left



انتبه أن الشحنة سالبة

E.X3 : حدد شحنة كل واحد



1 : electron (-ve)
2 : n, α (نيوترون ، ألفا)
3 : proton (+ve)

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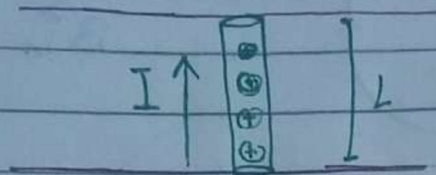
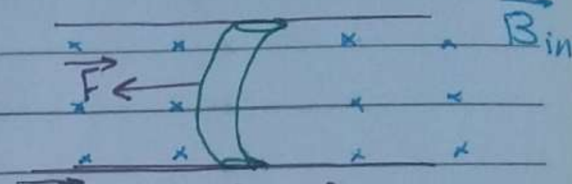
[2] The magnetic force on a current-carrying conductor

القوة المغناطيسية على سلك يحمل تيار



$\Longrightarrow$



$I = n q A v_d$

$\vec{F} = q\,\vec{v} \times \vec{B}$

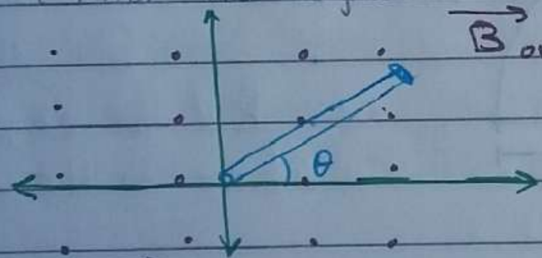
The magnetic force on a charge

$$\vec{F}_q = q\,\vec{v} \times \vec{B}$$

The magnetic force on a wire

$$\vec{F}_L = q(\vec{v} \times \vec{B})\,n A L$$
$$= (n q v A)\,\vec{L} \times \vec{B}$$
$$= I\,\vec{L} \times \vec{B}$$
$$|\vec{F}_L| = I L B \sin\theta_{L,B}$$

E.X: find the magnetic force on the following wire



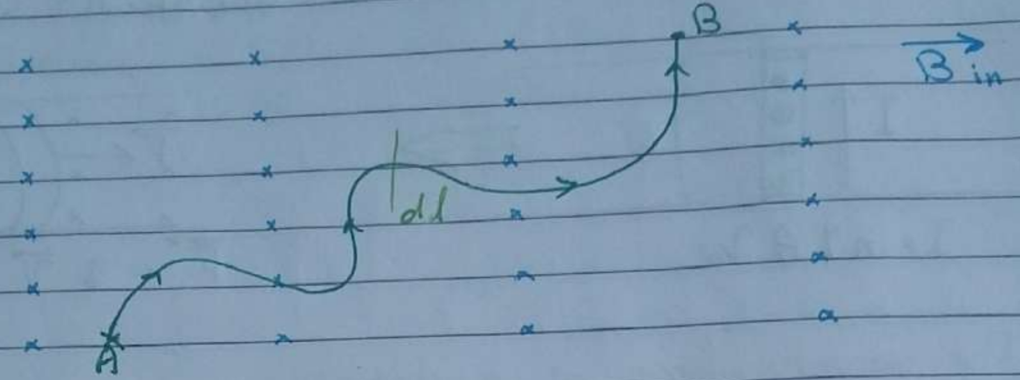
$\vec{B}_{out} = 6\,\mu T$

$I = 5\,A,\ L = 20\ cm,\ \theta = 30^\circ$

sol. $\vec{L} = 20\cos\theta\,\hat{i} + 20\sin\theta\,\hat{j}$ cm

$$\vec{F} = I\,\vec{L} \times \vec{B}$$
$$= 5\left(\frac{20}{100} * \frac{\sqrt{3}}{2}\,\hat{i} + \frac{20}{100} * \frac{1}{2}\,\hat{j}\right) \times 6\,\hat{k}$$
$$= 5 * \frac{20}{100} * \frac{1}{2}(\sqrt{3}\,\hat{i} + 1\,\hat{j}) \times 6\,\hat{k}$$
$$= 5 * \frac{20}{100} * \frac{1}{2} * 6(-\sqrt{3}\,\hat{j} + 1\,\hat{i})\ \mu N$$
$$\vec{F}_L = 3(\hat{i} - \sqrt{3}\,\hat{j})\ \mu N$$

A magnetic force on a non-uniform wire.

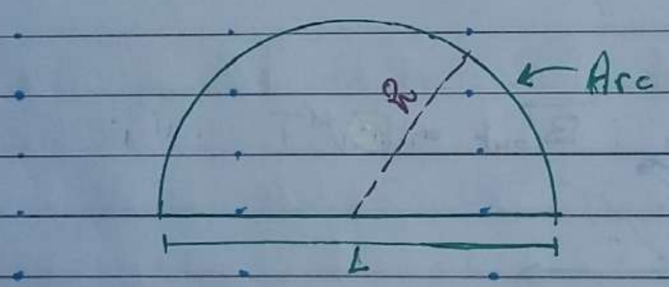


$$\vec{F_L} = I \int_A^B d\vec{l} \times \vec{B}$$

$$F_L = I \int_A^B B \sin\theta \, dl$$ صعب --- انساك

F_L closed loop $= Zero$

E.X :



$I = 2\,mA$

$B = 50\,\mu T$

$L = 50\,cm$

$R = 2L$

Find the magnetic force on the Arc

sol $\vec{F}_{closed\ loop} = 0$

$$\vec{F_L} + \vec{F}_{Arc} = 0$$

$$\vec{F}_{Arc} = -\vec{F_L}$$

$$|\vec{F_L}| = I\, \vec{L} \times \vec{B}$$

$$\vec{F_L} = I\, L B \sin\theta$$

$$= 2 * 10^{-3} * 50 * 10^{-2} * 50 * 10^{-6} * \sin 90 = 5 * 10^{-8}\ N\ (down)$$

$$\vec{F}_{Arc} = 5 * 10^{-8}\ N\ (up)$$

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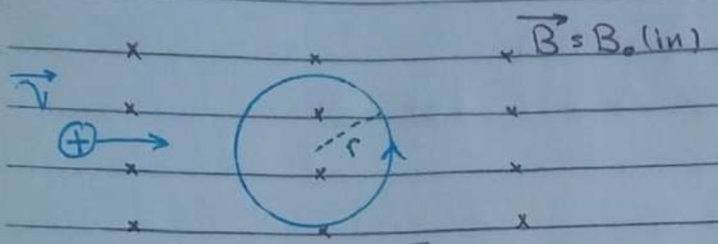
12/4/2018 Thursday

[4] Motion of a charge particle in magnetic field.

circular path ($\vec{B} \perp \vec{v}$)

إذا الزاوية 90 ⇐ حركة دائرية ، إذا أكبر أو أقل من 90 ⇐ حركة لولبية (helical)



1) $F_{mag} = F_{central}$

$$q v B = m a_c$$

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

$$r = \frac{m v}{q B}$$ = radius of the circular path (revilution دوران)

2) periodic time الزمن الدوري

$$v = \frac{2 \pi r}{T}$$

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

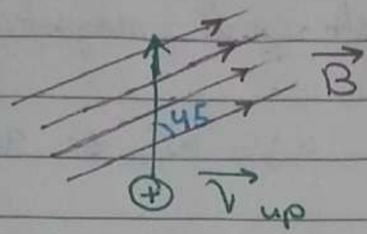
3) Angular speed (velocity) (السرعة الزاوية)(ω)

Angular Frequency (التردد الزاوي)

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

Problems

2) d)



deflection ، انحراف

sol. $B = B_0 \cos 45\, \hat{i} + B_0 \sin 45\, \hat{j}$

اللي اتجاه الـ $\hat{j}$ لن يكون لها تأثير

$\Rightarrow \vec{F} = in$

3) b) $\vec{v} = out$, $\vec{F} = up$

$\Rightarrow \vec{B} = right$

6) $F = qvB \sin\theta$

$\theta = \sin^{-1} \frac{F}{qvB} = \sin^{-1}\left(\frac{8.2 \times 10^{-13}}{1.6 \times 10^{-19} \times 4 \times 10^{6} \times 1.7}\right) = 49$

b) من عند الدكتور find the central acceleration.

$F = m a_c$

$a_c = \frac{F}{m} = \frac{8.2 \times 10^{-13}}{1.67 \times 10^{-23}} = 4.9 \times 10^{10}$

7) a) $F_{min} = 0$; when $\theta = 0, 180$

b) $F_{max} = qvB$; when $\theta = \pi , \frac{3\pi}{2}$

$\Delta U + \Delta K = 0$

$v = \sqrt{\frac{2q\,\Delta V}{m_e}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 2400}{9.11 \times 10^{-31}}} = 2.9 \times 10^{4}$

$F_{max} = qvB$

$= 1.6 \times 10^{-19} \times 2.9 \times 10^{4} \times 1.7 = 7.9 \times 10^{-15}$ N

8) $\vec{F} = q\, \vec{v} \times \vec{B}$

$= q \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -4 & 1 \\ 1 & 2 & -1 \end{vmatrix}$

$\vec{F} = e(2\hat{i} + 3\hat{j} + 8\hat{k})$

$|F| = e\sqrt{4 + 9 + 64}$

ē أو البروتون نفس الرقم
بس لل ē اضرب الاتجاهات
($\hat{i}, \hat{j}, \hat{k}$) بسالب.

9) a) $F = q v B \sin\theta$

$= 1.6 * 10^{-19} * 5.02 * 10^{6} * 0.18 * \sin 60 = 1.252 * 10^{-13}$ N

b) $F = ma$

$a = \frac{F}{m} = \frac{1.252 * 10^{-13}}{1.67 * 10^{-27}} = 7.4 * 10^{13}$ m/s^2.

11) $F = q v B = m_p a$

$B = \frac{m_p a}{q v} = \frac{1.67 * 10^{-27} * 2 * 10^{13}}{1.6 * 10^{-19} * 1 * 10^{7}} = 2.1 * 10^{26} - \hat{j}$

13) a) $q v B = m \frac{v^2}{r}$ perpendicular عمودي

$r = \frac{m v}{q B} = \frac{9.11 * 10^{-31} * 1.5 * 10^{7}}{1.6 * 10^{-19} * 2 * 10^{-3}} = 4.3 * 10^{8}$ m.

b) $T = \frac{2 \pi r m}{q v} = \frac{2 \pi * 4.3 * 10^{8} * 9.11 * 10^{-31}}{1.6 * 10^{-19} * 1.5 * 10^{7}} = 102.6 * 10^{-11}$

32) a) $F = I L B \sin\theta$

$= 3 * 14 * 10^{-2} * 0.28 * \sin 90 = 0.1176$

33) a) $\vec{F} = I \vec{L} \times \vec{B}$

$\frac{F}{L} = I \vec{B}$

$0.12 = 15 \vec{B} \Rightarrow \vec{B} = 8 * 10^{-3}$ T

b) up $(\hat{k})$.

34) a) $F = I L B \sin\theta$

$= 5 * 2.8 * 0.39 * \sin 60 = 4.728$ N

35) $\vec{F} = I \vec{L} \times \vec{B}$

$= 24 * 0.75 * 1.6 = 2.88 \; -\hat{j}$

Q. هذا سؤال رقم 1 بالنسخة اللي مع الدكتور

+ve, $\vec{B} = B_0 \hat{i}$, find the direction when

a) $\vec{v} = v_0 (\hat{j})$

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

b) $\vec{v} = v_0 (-\hat{j})$

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

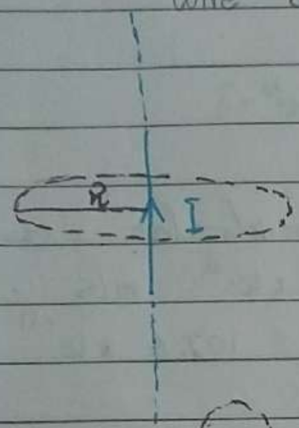
c) $\vec{v} = v_0 \hat{i}$

no effect

17/4/2018 — Tuesday

Chapter 30
Magnetic field

[1] Amper's law :
To calculate the magnetic field of an infinit wire carrying a current I



Amperian loop

$\oint B \cdot ds = \mu_0 \sum I_{in}$

B = magnetic field

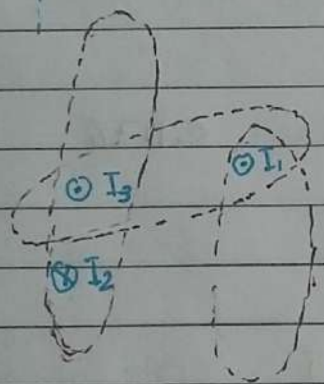
S = circumference ($2\pi r$) (المحيط)

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

is free space permeability

سماحية الوسط المغناطيسية

EX.



$I_1 = 5\ A$, $I_2 = 10\ A$, $I_3 = 20\ A$

Rank $\oint B \cdot ds$ for the above loop from least to greast

sol. $B_2 > B_3 > B_1$

انتبه على اتجاه التيار للداخل أو للخارج

عشان الجمع و الطرح

EX. a) find the magnetic field of an infinit wire carrying current I at distance r from it.

$\oint B \cdot ds = \mu_0 \sum I_{in}$

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

b) find the magnetic force exerted by the conductor ($I = 10A$) at distance $r = 100$ mm on an electron moving perpendicular at the magnetic field with speed 4 M m/s $\hat{i}$

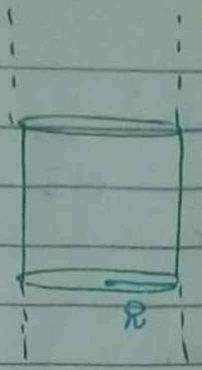
$F = q \vec{v} \times \vec{B}$

$= q \vec{v} \left(\frac{\mu_0 I}{2\pi r} \right)$

$= 1.6 \times 10^{-19} \times 4 \times 10^{6} \times \frac{4\pi \times 10^{-7} \times 10}{2\pi \times 100 \times 10^{-3}} = 1.28$ nN down

19/4/2018 Thursday

EX.



find the magnetic field

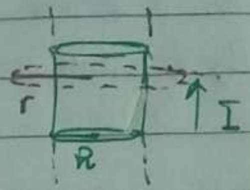
a) outside the wire $r \geq R$

b) inside the wire $r \leq R$

sol a) $\oint B \cdot ds = \mu_0 I_{in}$

$B \times 2\pi r = \mu_0 I$

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



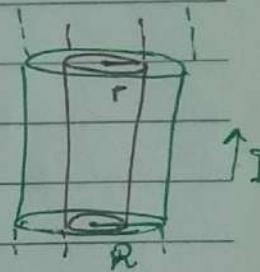
b) $\oint B \cdot ds = \mu_0 I_{in}$

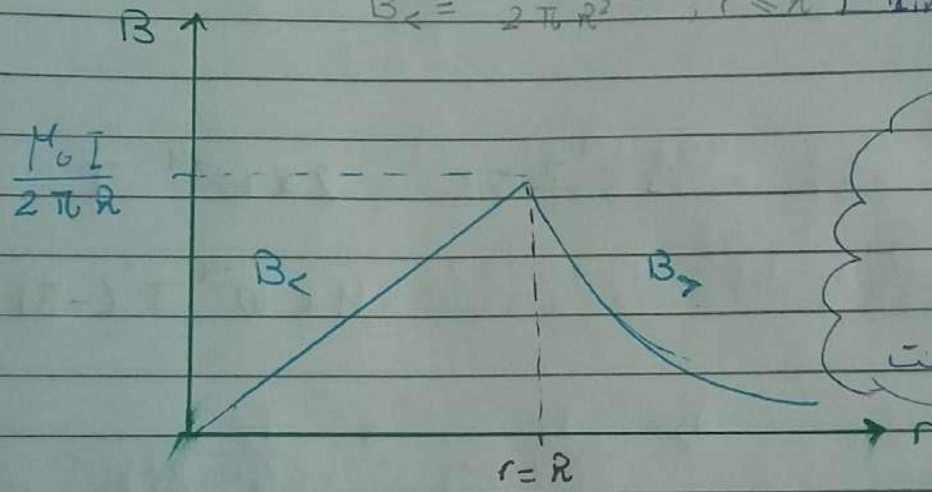
$B \times 2\pi r = \mu_0 I_{in}$

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

$B_< = \frac{\mu_0 I r}{2\pi R^2}$, $r \leq R$

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





$Slope = S = \frac{\mu_0 I}{2\pi R}$

$\frac{I}{R} = \frac{2\pi S}{\mu_0}$

إذا ما عطاك الميل احسبه أنت

قاعدة اليد اليمنى للسلك

1) الابهام باتجاه التيار

2) اتجاه المجال يكون مع اتجاه دوران الأصابع

Q 31 in problems.

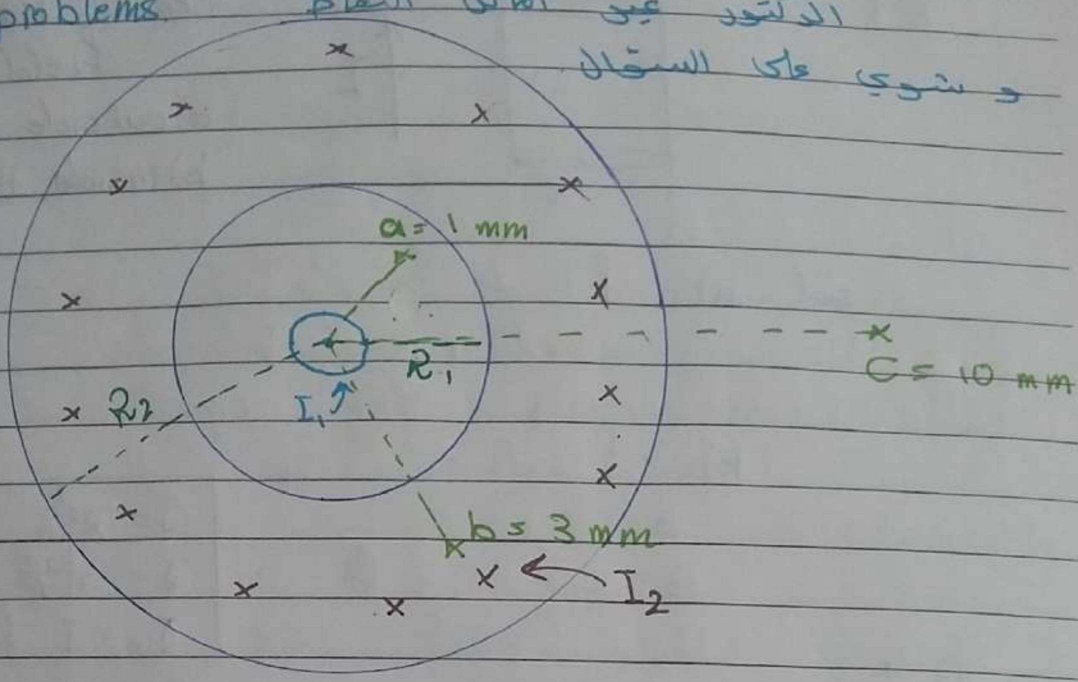
الدكتور غير أماكن النقاط
و شوي على السؤال

$I_1 = 1\,A$

$I_2 = 3\,A$

$R_1 = 2\,mm$

$R_2 = 5\,mm$



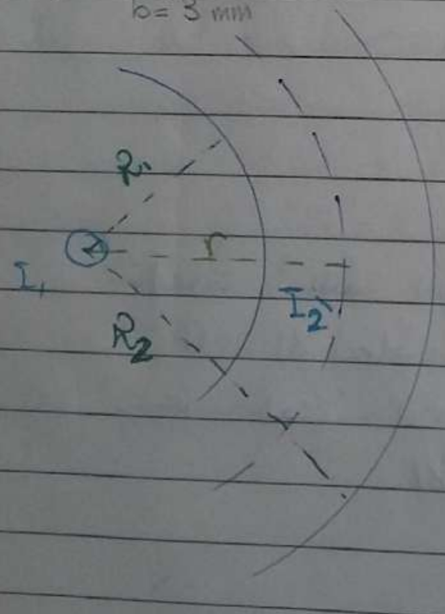
a) $B)_{a=1\,mm}$

$$B_a = \frac{\mu_0 I}{2\pi r} = \frac{4\pi * 10^{-7} * 1}{2 * \pi * 1 * 10^{-3}} = 2 * 10^{-4}\ T$$

b) $B)_{c=10\,mm}$

$$B_c = \frac{\mu_0 (I_2 - I_1)}{2\pi\ r} = \frac{4\pi * 10^{-7} * 2}{2\pi * 10 * 10^{-3}} = 4 * 10^{-4}\ T\ (-\hat{J})$$

c) $B)_{b=3\,mm}$



$$J_2 = \frac{I_2}{\pi(R_2^2 - R_1^2)} = \frac{I_2'}{\pi(r^2 - R_1^2)}$$

$$I_2' = \frac{I_2 (r^2 - R_1^2)}{(R_2^2 - R_1^2)}$$

$$= \frac{3\ (9-4)}{(25-4)} = \frac{15}{21} < 1$$

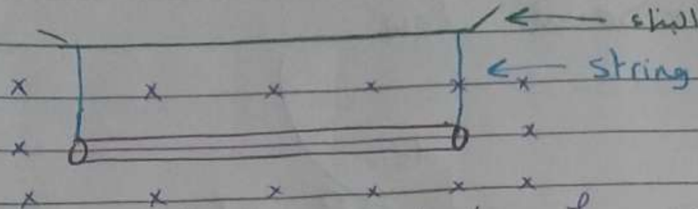
$$B_b = \frac{\mu_0 (I_1 - I_2')}{2\pi\ r}$$

$$= \frac{4\pi * 10^{-7}\left(1 - \frac{15}{21}\right)}{2\pi * 3 * 10^{-3}}$$

$$= 0.38 * 10^{-4}\ T$$

22/4/2018 Sunday

Ex:



$B_{in} = 20\ mT$

Find the direction and the magnitude of current passing the wire such that the tension in the string is zero if the mass per length of the wire = 0.5 g/mm

sol. $\sum F = 0$

$2T + ILB\sin\theta = mg$ (T → 0)

$ILB = mg$

$I = \frac{mg}{LB} = \frac{\lambda g}{B} = \frac{0.5 \times 10}{20 \times 10^{-3}} = 2.5 \times 10^{3}\ (+\hat{i})$

Ex: $q = 1\ mC$, $\vec{v} = 2\hat{i} + \hat{k}$, $\vec{F} = \hat{j}$, find B

assume $B_x = 0$

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

$\hat{j} = q \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 0 & 1 \\ B_x & B_y & B_z \end{vmatrix}$

$\hat{j} = q\left((-B_y)\hat{i} - (2B_z - B_x)\hat{j} + (2B_y)\hat{k}\right)$

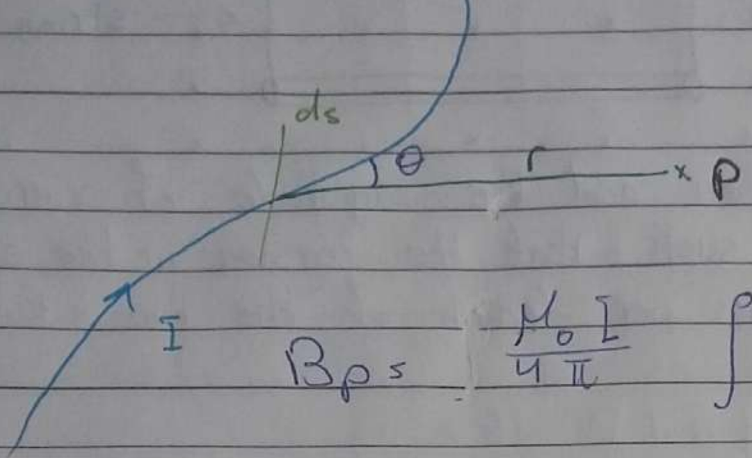
بما أن $\vec{F}$ فقط باتجاه $\hat{j}$ ⇐ $\hat{i}$, $\hat{k} = 0$ ⇐ $B_y = 0$

$\hat{j} = -2qB_z\ \hat{j}$

$1 = -2qB_z$

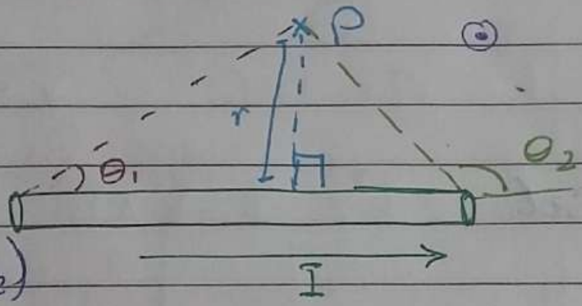
$B = B_z = \frac{1}{2q}\ \hat{k}$

[2] Biot - Savart law.



$$B_p = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{s} \times \hat{r}}{r^3}$$

1) The magnetic field of a finit wire



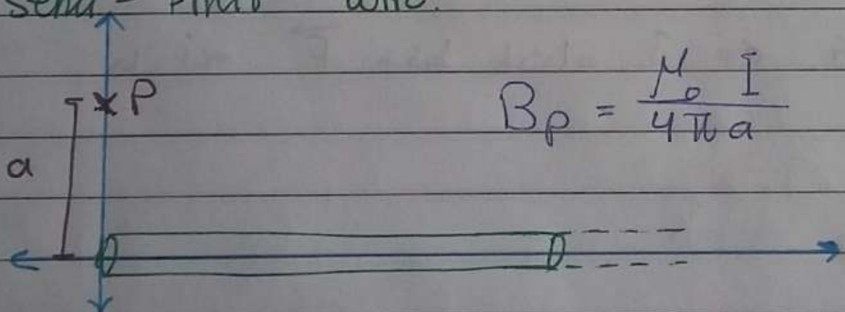
θ_1 = دائما حادة.

θ_2 = دائما منفرجة

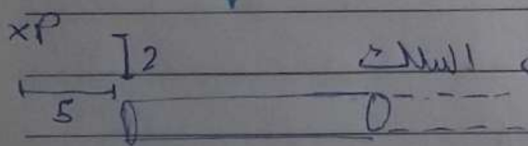
$$B_p = \frac{\mu_0 I}{4\pi r}(\cos\theta_1 - \cos\theta_2)$$

حفظ

* semi - finit wire.



$$B_p = \frac{\mu_0 I}{4\pi a}$$

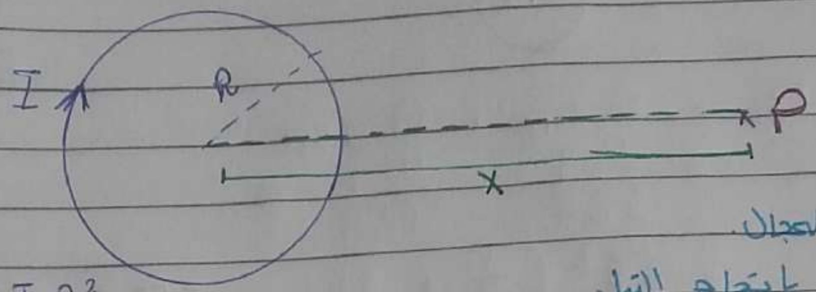


* حتى لو كانت النقطة بعيدة عن السلك نعمل نفس القانون

$$B_p = \frac{\mu_0 I}{4\pi \times 2}$$

24/4/2018 Tuesday

2) Circular loop carrying a current



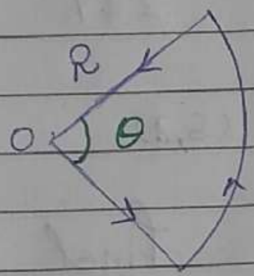
لمعرفة اتجاه المجال.
1) أصابع اليد باتجاه التيار
⇐ يكون المجال باتجاه الابهام.

$$B_P = \frac{\mu_0 I R^2}{2(X^2+R^2)^{3/2}}$$ حفظ

لو كانت أكثر من لفة أضرب B_P بعدد اللفات

3) Circular Arc

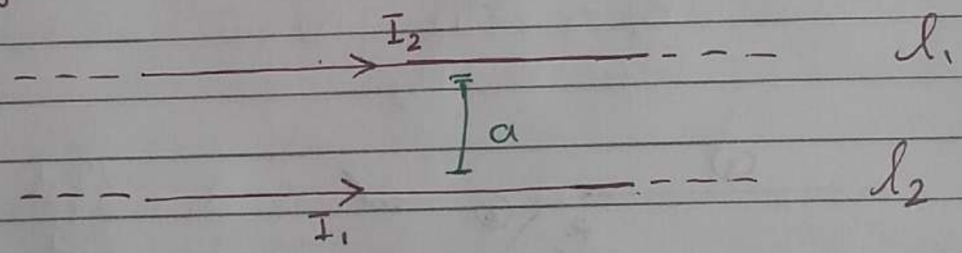
الزاوية بالراديان (π)



$$B_o = \frac{\mu_0}{4\pi R}\,\theta$$ حفظ

بنعوض الـ π 3.14 مش 180
دير بالك

The magnetic force between two conductors.

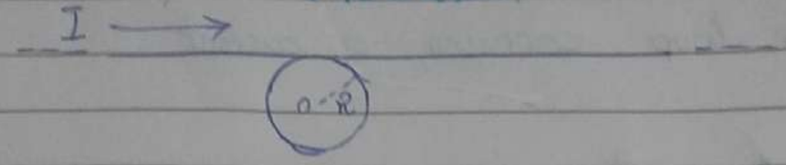


$$\vec{F}_{1\to 2} = I_2\, l_2 \times \vec{B}$$
$$= I_2\, l_2\, \frac{\mu_0 I_1}{2\pi a}$$
$$= \frac{\mu_0 I_1 I_2}{2\pi a}\, l_2$$

إذا التيارين نفس الاتجاه ⇐ تجاذب
إذا عكس الاتجاه ⇐ تنافر

Problems

7)



$I = 1A$

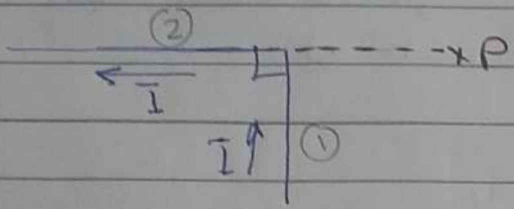
$R = 0.15$ cm

sol. $B_O = B_{wire} + B_{loop}$

$= \frac{\mu_0 I}{2\pi R} + \frac{\mu_0 I}{4\pi R} \theta$

$= \frac{\mu_0 I}{2R}\left(\frac{1}{\pi} + 1\right) = 552\ \mu T$

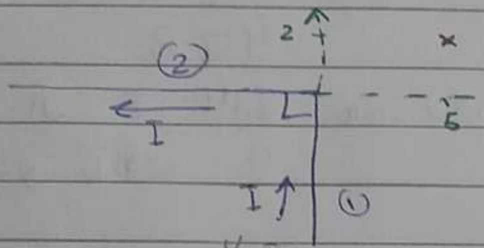
10)



sol. السلك (2) لن يؤثر

$B_P = \frac{\mu_0 I}{2\pi x}$ ⊗

مهم E.X



× P (5, 1)

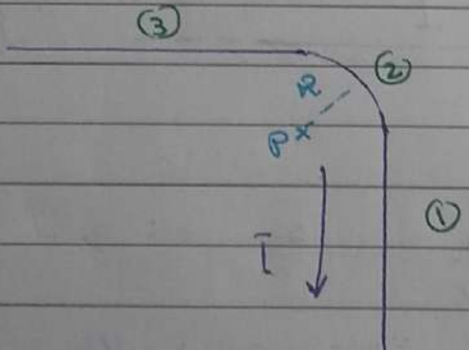
find B_P

sol. $B_1 = \frac{\mu_0 I}{2\pi (5)}$ ⊗

$B_2 = \frac{\mu_0 I}{2\pi (1)}$ ⊗

$B_P = B_1 + B_2$

11)



sol.

$B_1 = \frac{\mu_0 I}{2\pi R}$ ⊗

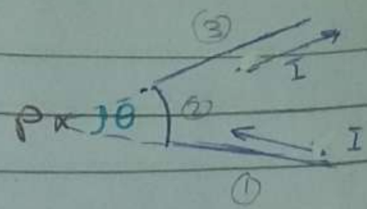
$B_3 = \frac{\mu_0 I}{2\pi R}$ ⊗

$B_2 = \frac{\mu_0 I}{4\pi R} \theta = \frac{\mu_0 I}{8R}$ ⊗

$B_P = B_1 + B_2 + B_3$

$= \frac{\mu_0 I}{2R}\left(\frac{1}{\pi} + \frac{1}{4}\right)$

13)



$\theta = 30 = \frac{\pi}{6}$

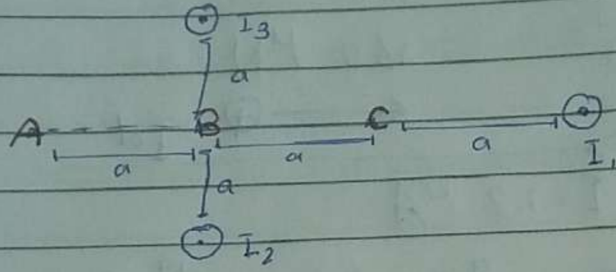
$R = 0.3\ m$, $I = 3A$

الدكتور عدل على السؤال

sol. السلك ① و السلك ② بعطو أثر

$B_P = \frac{\mu_0 I}{4\pi R}\theta = \frac{4\pi \times 10^{-7} \times 3 \times \frac{\pi}{6}}{4\pi \times 0.3} = \frac{\pi}{6}\ \mu T$ ⊙

ملغي 15)

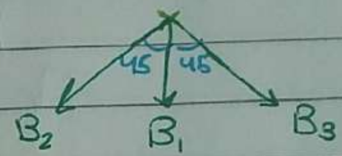


$I_1 = I_2 = I_3 = 2A$

$a = 1cm$

a) $B_2 = B_3 = \frac{\mu_0 I}{2\pi R} = \frac{\mu_0 I}{2\pi\ a\sqrt{2}}$

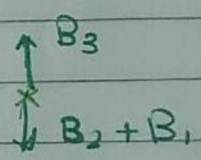
$B_1 = \frac{\mu_0 I}{2\pi(3a)}$



$B_3\ \hat{i} = -B_2\ \hat{i} \Rightarrow$ بلغوا بعض

$B_A = B_1 + B_2 \cos 45 + B_3 \cos 45$ $\quad -\hat{j}$

$= \frac{\mu_0 I}{2\pi a}\left(\frac{1}{3} + \frac{1}{\sqrt{2}}\cos 45 + \frac{1}{\sqrt{2}}\cos 45\right) = 53.3\ \mu T \quad -\hat{j}$



b) $B_2 = B_3 = \frac{\mu_0 I}{2\pi a}$

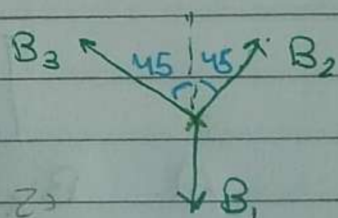
$B_1 = \frac{\mu_0 I}{2\pi(2a)}$

B_2 و B_1 بلغوا بعض

$B_B = B_1 = 20\ \mu T \quad -\hat{j}$

C) $B_2 = B_3 = \frac{\mu_0 I}{2\pi(a\sqrt{2})}$

$B_1 = \frac{\mu_0 I}{2\pi a}$

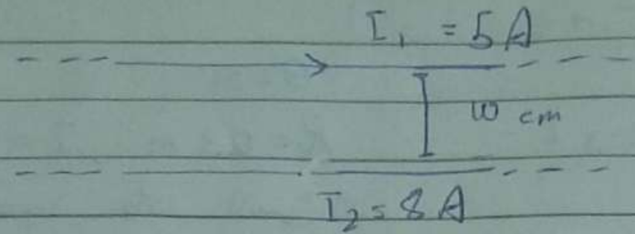


$B_2\ \hat{i} = -B_3\ \hat{i} \Rightarrow$ بلغوا بعض

$B_C = B_1 - (B_2 + B_3)$

$= \frac{\mu_0 I}{2\pi a}\left(1 - \left(\frac{1}{\sqrt{2}}\cos 45 + \frac{1}{\sqrt{2}}\cos 45\right)\right) = \text{Zero}$

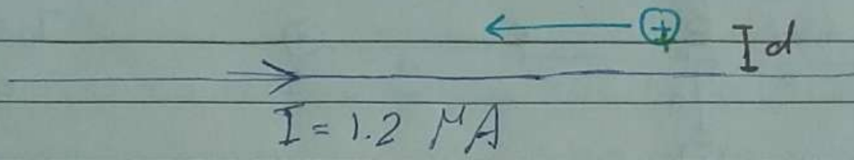
21)



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

$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2 \pi a} = 160 \ \mu N$

33)



$m_p = 1.67 \times 10^{-27}$ Kg , $q_e = 1.6 \times 10^{-19}$ C

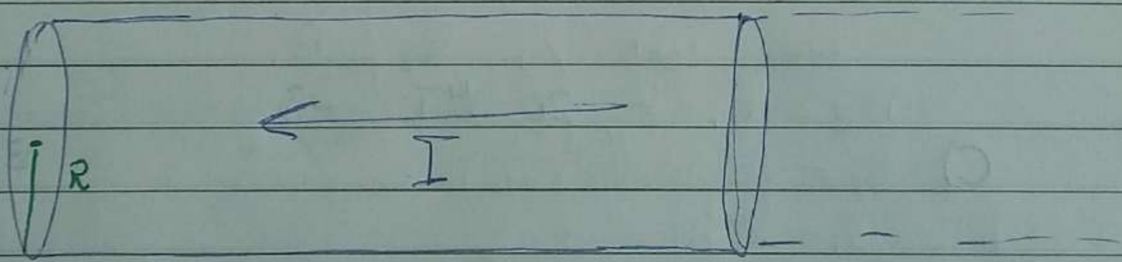
$F_B = m_p g$

$\frac{q v \mu_0 I}{2 \pi d} = m_p g$

$d = \frac{q v \mu_0 I}{2 \pi m_p g} = 5.3$ cm.

* لما يكون proton بكون بتحرك عكس اتجاه التيار
ولما يكون electron بكون بتحرك مع اتجاه التيار

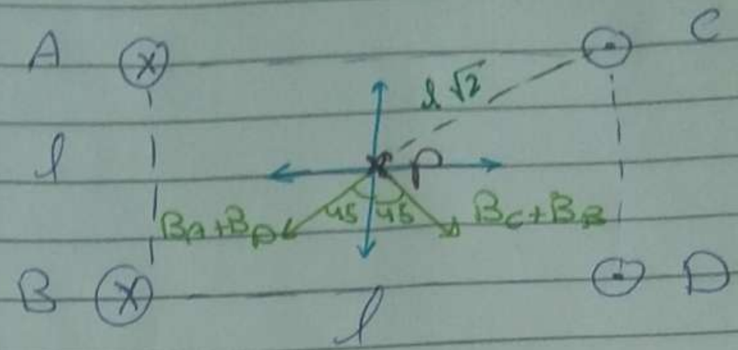
38)



A) $B_< = \frac{\mu_0 I r}{2 \pi R^2} \Big)_{r = R/2}$

$B_> = \frac{\mu_0 I}{2 \pi r} \Big)_{r = 2R}$

39)

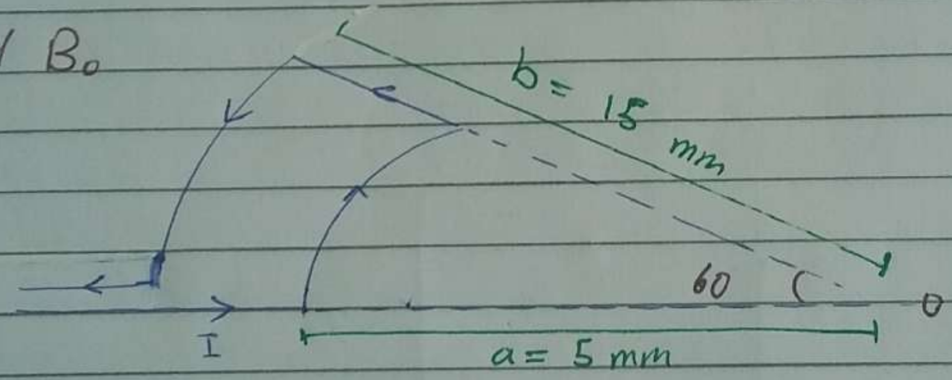


$$B_A = B_B = B_C = B_D = \frac{\mu_0 I}{2\pi a}$$

$$B_P = \frac{4\,\mu_0 I}{2\pi a} * \cos 45 = 20\ \mu T\ \ -\hat{j}$$

EX : موجود سؤال 11 بطبعة الدكتور

find B_0



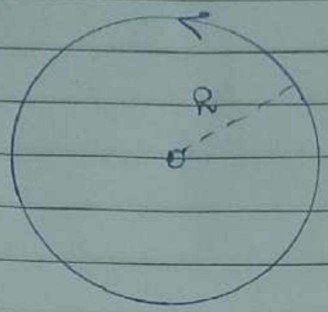
$I = 5A$

sol. $B_0 = B_a - B_b$

$$= \frac{\mu_0 I}{4\pi a} * \frac{\pi}{3} - \frac{\mu_0 I}{4\pi b} * \frac{\pi}{3}$$

$$= \frac{\mu_0 I}{12}\left(\frac{1}{a} - \frac{1}{b}\right) = 13.96\ \mu T$$

E.X موجود سؤال ٦ بطبعة الدكتور



$I = 5\ A$

$B_O = 10\ \mu T$

Find R

sol $B_o = \frac{\mu_0 I}{2R}$

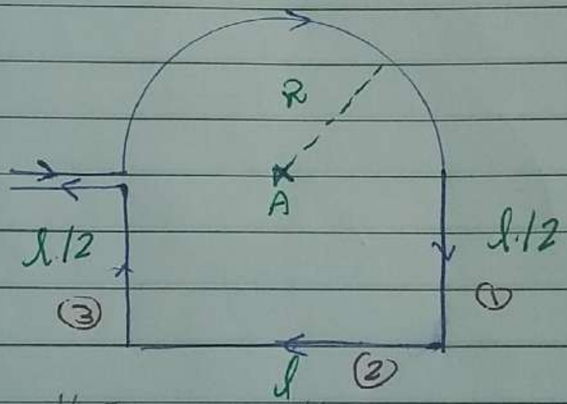
$10 \times 10^{-6} = \frac{4\pi \times 10^{-7} \times 5}{2R}$

$R = \frac{\pi}{10} = 0.314$ m

مهم E.X سؤال 13 بطبعة الدكتور

Find B_A

$R = l/2$



sol $B_{Arc} = \frac{\mu_0 I}{4\pi R}\theta = \frac{\mu_0 I}{4R}$

$B_1 = B_3 = \frac{\mu_0 I}{4\pi R}\left(\cos\frac{\pi}{4} - \cos 90\right)$

$B_2 = \frac{\mu_0 I}{4\pi R}\left(\cos\frac{\pi}{4} - \cos 135\right) = \frac{2\mu_0 I}{4\pi R}\cos\frac{\pi}{4}$