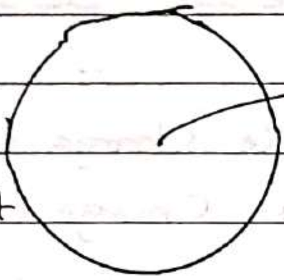
الاثنين

Subject Ch.23 : Electric Fields. Date 2021 / 7 / 5 No. 1

23.1 Properties of electric charge



object

Charge : q , Q $\xrightarrow[\text{بوحدة}]{\text{تقاس}}$ C (كولوم)
شحنة

في الاجسام المتعادلة يكون عدد البروتونات يساوي عدد الالكترونات اي انه لا يحمل اي شحنة (نيترون) اما في حالة ان الجسم يفقد او يكتسب الكترونات يسمى بـ charged object.

charged object
- → Positive (يفقد)
- → negative (يكتسب)

وهذه الاجسام المشحونة ممكن ان ينتج بين بعضها البعض قوى (قوة تجاذب ، قوة تنافر)

(+) ⟷ (+)

(−) ⟷ (−)

القوة المتبادلة بين هذه الاجسام قوة تنافر Repul

(−) ⟷ (+)

القوة المتبادلة بين هذه الاجسام قوة جذب attract

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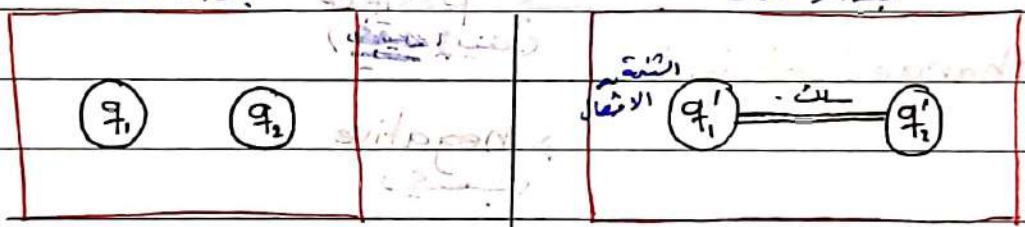
electric force → attractive → قوة تجاذب
electric force → repulsive → قوة تنافر

1. attractive force: between unlike Charge (+ − , − +).
2. repulsive force: between like Charge (+ + , − −)

$\boxed{2}$ The Charge is conseired "الشحنة محفوظة"

قبل الاتصال | بعد الاتصال

نظام مغلق يوجد فيه جسمين مشحونين



شحنة كل منهما.

$q_1 + q_2$ | $q_1' + q_2'$

$$\Rightarrow \Rightarrow \quad \boxed{q_1 + q_2 = q_1' + q_2'}$$

توضيح للتجربة مثال

$q_1 = 6$, $q_2 = -8$, $q_2' = -4$

$q_1 + q_2 = -2$

$\therefore \quad q_1 + q_2 = q_1' + q_2'$

$-2 = q_1' + -4$

$+4 \qquad\qquad +4$

$\therefore \quad q_1' = 2$

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3 The Charge is quantized "مكمم"

الشحنة الموجودة على الجسم عبارة عن كميات محددة من شحنة الالكترون.

الشحنة على اي جسم عبارة عن عدد صحيح. من شحنة الالكترون.

The Charge on any object is a multiple of electron's Charge

$$Q = Ne \qquad N: 0, \pm 1, \pm 2, \dots$$

$-e: -1{,}6 * 10^{-19}$

$+e = 1{,}6 * 10^{-19}$

Ex: $Q = 3{,}2 * 10^{-14}$ C

what is the number of lost electrons?

$$Q = Ne$$

$$N = \frac{Q}{e} = \frac{3{,}2 * 10^{-14}}{1{,}6 * 10^{-19}}$$

عرفت ع موجبة لانه طلب عدد الالكترونات

$$N = 2 * 10^{5} \text{ electrons}$$

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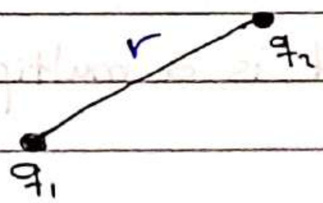
شحنة نقطية

Coulomb's Law : Point Charges

يصف القوة المتبادلة بين جسمين كهربائيين.

في الأجسام المشحونة غير النقطية اعتبر ان كتلة الجسم مركزة في مركز هذا الجسم والشحنة كذلك.



★ $$F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r^2}$$

q: Charge [C]

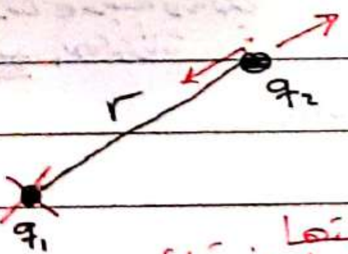
r: distance [m]

ϵ_0 = Free space Permittivity

سماحية الوسط الكهربائية.

$$\epsilon_0 = 8.85 * 10^{-12} \ \frac{C^2}{N \cdot m^2}$$

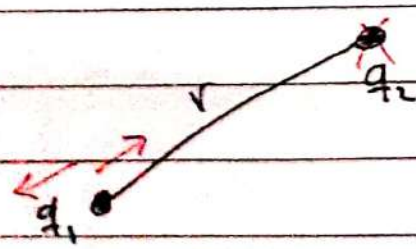
★ $$F = K_e \frac{q_1 q_2}{r^2} \quad , \quad K_e = 9 * 10^9$$



$$F_{1\to 2} = K_e \frac{q_1 q_2}{r^2}$$

تأثير الشحنة 1 على 2

الشحنة المؤثرة إشارتها والجسم المتأثر هي التي يترك على الخط الواصل بينهم هل يقرب او يبتعد؟



$$F_{2\to 1} = K_e \frac{q_2 q_1}{r^2}$$

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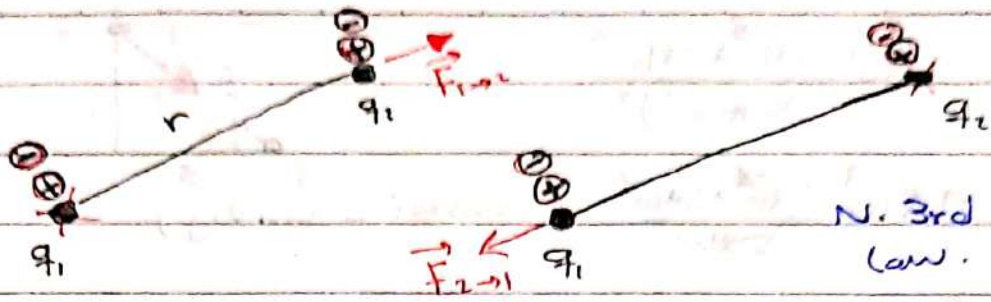


N. 3rd Law.

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

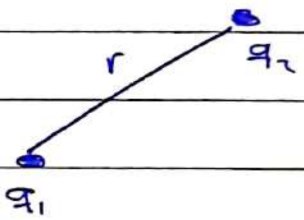
Ex: Which of the following statments is Correct?

A) $F_{1\to2} = -F_{2\to1}$ (X) $\rightsquigarrow F_{1\to2} = F_{21}$

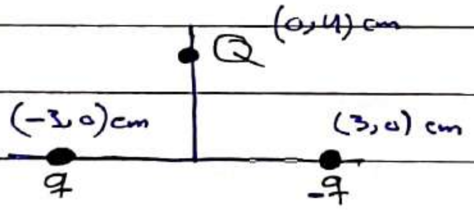
B) $\vec{F}_{1\to2} = \vec{F}_{2\to1}$ (X)

C) $\vec{F}_{1\to2} = -\vec{F}_{2\to1}$ (✓)

D) $\vec{F}_{1\to2} = -2\vec{F}_{2\to1}$ (X)



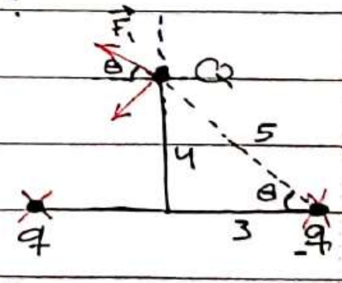
Ex.1



$q = 1\mu C = 1*10^{-6}$ C

$Q = -3\mu C = -3*10^{-6}$ C

What is the force exerted on Q?
اعوذ بالله



$F_1 = K_e \dfrac{q_1 q_2}{r^2} = 9*10^9 \dfrac{1*10^{-6} * 3*10^{-6}}{(5*10^{-2})^2}$

اذا حددنا اتجاه القوة على الرسمة اعوض بالقانون القيمة موجبة للشحنة |q|

$\vec{F_1} = \dfrac{9*10^9 * 1*10^{-6} * 3*10^{-6}}{(5*10^{-2})^2} * (-\overset{3/5}{\cos\theta}\,\hat{i} + \overset{4/5}{\sin\theta}\,\hat{j})$

$\vec{F_1} = \dfrac{9*30}{25}(-\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j})$ N

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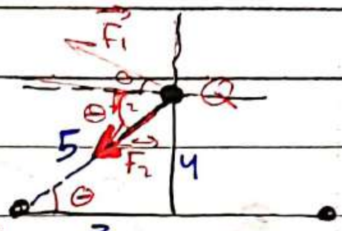

$$F_2 = 9*10^9 \frac{1*10^{-6}*3*10^{-6}}{(5*10^{-2})^2}$$

$$\vec{F_2} = 9*10^9 \frac{1*10^{-6}*3*10^{-6}}{5*10^{-2}} (-\cos\theta \hat{i} - \sin\theta \hat{j})$$

$$\vec{F_2} = \frac{9*30}{25} (-\frac{3}{5}\hat{i} - \frac{4}{5}\hat{j})$$

$$\vec{F_T} = \vec{F_1} + \vec{F_2} = \frac{9*30}{25} * \frac{2*3}{5} (-\hat{i})$$

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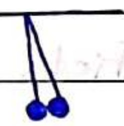
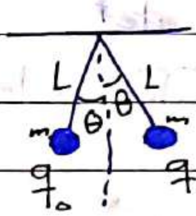
Ex.1 → Ex (23.4) في الكتاب





$L = 20\ cm \approx 20 * 10^{-2}\ m$

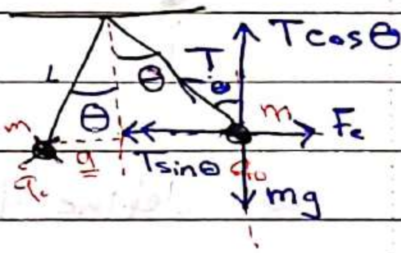
$\theta = 15^{\circ}$

$m = 25\ mg \Rightarrow 25 * 10^{-3} * 10^{-3}\ kg = 25 * 10^{-6}\ kg$

Sol:

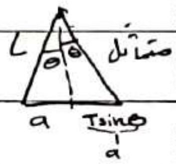
$q_o = ?!$

$g = 10\ m/s^2$



$\Sigma F_x = 0$

$\Sigma F_y = 0$



$\Sigma F_x = 0 \approx Fe - T\sin\theta = 0$

$Fe = T\sin\theta \quad \text{---(1)}$

$\Sigma F_y = 0 \approx T\cos\theta - mg = 0$

$T\cos\theta = mg \quad \text{----(2)}$

$$\frac{Fe}{mg} = \frac{\sin\theta}{\cos\theta} \Rightarrow \frac{Fe}{mg} = \tan\theta$$

$Fe = mg\tan\theta$

$\sin\theta = \frac{a}{L} \approx a = l\sin\theta$

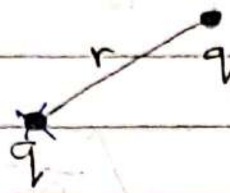
$$\frac{Ke\, q_o^2}{(2L\sin\theta)^2} = mg\tan\theta$$

$$q_o = \pm\sqrt{\frac{(2L\sin\theta)^2 mg\tan\theta}{Ke}} = \pm\sqrt{\frac{(2*20*10^{-2})^2 * 25*10^{-6} * \tan 15}{9*10^9}}$$

$= \pm\sqrt{1.19*10^{-16}}$

$= \pm 1.09 * 10^{-8}\ C$

The electric Field (المجال الكهربائي)



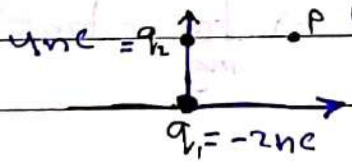
$F = k_e \dfrac{q q_0}{r^2}$

we define the electric field as: $\vec{E} = \dfrac{\vec{F}}{q_0} = k_e \dfrac{q}{r^2}\hat{r}$

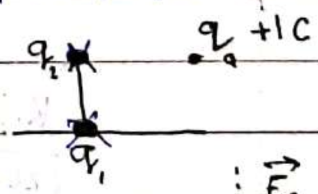
$\hat{r} \rightarrow \hat{i} , -\hat{i}$; $\hat{j} , -\hat{j}$

$\boxed{E = k_e \dfrac{q}{r^2}}$ $\quad F = q_0 E$

Ex.1:

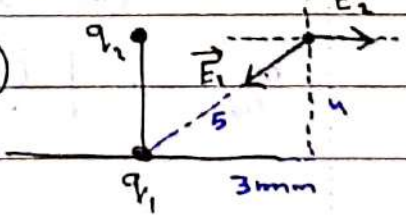


1. Find the electric field at the Point P.



$E_1 = k_e \dfrac{q}{r^2} = \dfrac{9*10^9 * 2*10^{-9}}{(5*10^{-3})^2}$

$\vec{E}_1 = k_e \dfrac{q}{r^2}\hat{r}$



$\vec{E}_1 = \dfrac{9*10^9 * 2*10^{-9}}{(5*10^{-3})^2} \left(-\hat{i}\cos\theta - \sin\theta\,\hat{j}\right)$ with $\cos\theta = \frac{3}{5}$, $\sin\theta = \frac{4}{5}$

$\vec{E}_1 = \dfrac{18}{25}\left(-\dfrac{3}{5}\hat{i} - \dfrac{4}{5}\hat{j}\right) * 10^6$

$= \dfrac{18}{125}\left(-3\hat{i} - 4\hat{j}\right)$ M N/C

"غرق" :
m : 10^{-3}
M = 10^6
$\mu = 10^{-6}$

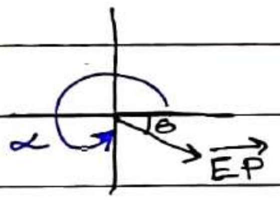
$$E_2 = k_e \frac{q}{r^2} = 9*10^9 * \frac{4*10^{-9}}{(3*10^{-3})^2}$$

$$\vec{E_2} = k_e \frac{q}{r^2} \cdot \hat{r} = 9*10^9 * \frac{4*10^{-9}}{(3*10^{-3})^2} \cdot (+\hat{i}) = 4*10^6 \hat{i}$$

$$\vec{E_2} = 4 \hat{i} \ M \ N/c$$

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

$$\vec{E_P} = \frac{446}{125}\hat{i} - \frac{72}{125}\hat{j} \ M \ N/c$$



$$\tan\theta = \frac{E_y}{E_x}$$

بالإشارة موجبة لأن الزاوية حادة

$$\tan\theta = \frac{72}{446}$$

$$\theta = \tan^{-1}\left(\frac{72}{446}\right) = 9,17^\circ$$

ممكن تطلب حسب السؤال ← $\alpha = 360 - 9,17 = 350,83^\circ$

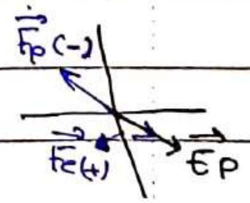
2. Find the electric force on a Charged Particle located at the Point. P.

$(Q = -5 \mu c)$

$$\vec{F_P} = Q \vec{E_P}$$

انتبه هون 1. $\vec{E_P}$ الذي اوجدناه هو لوحدة الشحنات موجبة، إما الشحنة المطلوبة هنا هي شحنة سالبة فإن المجال يعكس اتجاهه

2. اذا الشحنة موجبة يكون اتجاه القوة مع اتجاه المجال الكهربائي
المتنافرة
اذا الشحنة سالبة يكون اتجاه القوة عكس اتجاه المجال الكهربائي
المتجاذبة



$$\vec{F_P} = 5 * \left(\frac{-446}{125}\hat{i} + \frac{72}{125}\hat{j}\right) N$$

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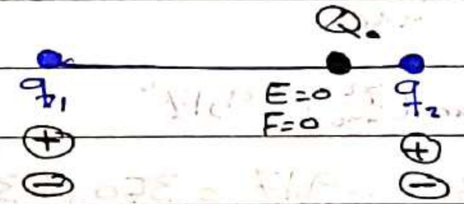
الشحنة الموجبة تبث خطوط المجال الكهربائي بينما الشحنة السالبة تستقبل خطوط المجال الكهربائي.

كلما زادت الشحنة كلما كانت خطوط المجال الكهربائي اكثر وتكون شدة المجال الكهربائي اكثر.

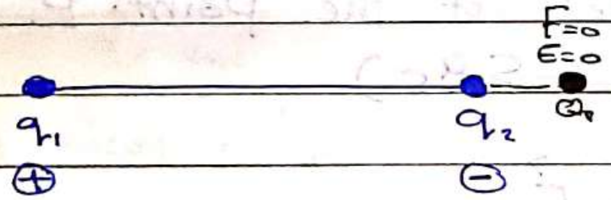
where the resulant Force (electric Field) Zero (vanishes) ~> تتلاشى.

(1)



اذا كانت الشحنتين موجبتين او سالبتين تكون نقطة انعدام المجال بينهما وأقرب الى الاصغر بدون الاشارة.

(2)



اذا كانت الشحنتين مختلفتين تكون نقطة انعدام المجال خارجهما واقرب الى الاصغر بدون اشارة.

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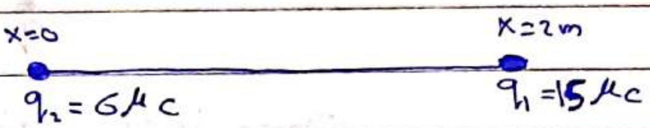
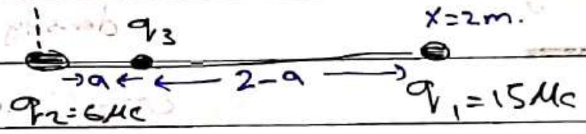
[redacted]. where the resultant force is zero?

Ex.



where to put a third charge q_3 such that the net force on q_3 is zero?



$$\Sigma F = \text{zero}$$

$$F_{1\to3} = F_{2\to3}$$

$$\cancel{K_e} \frac{q_1 \cancel{q_3}}{(2-a)^2} = \cancel{K_e} \frac{q_2 \cancel{q_3}}{a^2}$$

$$E_1 = E_2$$

$$K_e \frac{q_1}{(2-a)^2} = K_e \frac{q_2}{a^2}$$

#, شحنة تعوض بدون اشارة.

$$\frac{q_1}{(2-a)^2} = \frac{q_2}{a^2}$$

$$\frac{15}{(2-a)^2} = \frac{6}{a^2}$$

$$15a^2 = 6(2-a)^2$$

$$\sqrt{15}\, a = \pm\sqrt{6}\,(2-a)$$

$$\sqrt{15}\, a = \pm 2\sqrt{6} \pm \sqrt{6}\, a$$

$$\sqrt{15}\, a \mp \sqrt{6}\, a = \pm 2\sqrt{6} \Rightarrow a(\sqrt{15} \pm \sqrt{6}) = 2\sqrt{6}$$

$$a = \frac{\pm 2\sqrt{6}}{\sqrt{15} \mp \sqrt{6}} = 0.775\,m.$$

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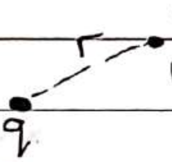
The electric field of a cts Charge distribution



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

Charge density (كثافة شحنة)

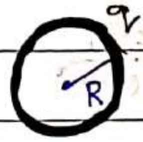
1D · 2D · 3D

* linear Charge : λ

1. Rod : q, L

$\lambda = \frac{q}{L} = \frac{\text{charge}}{\text{length}}$

2. Ring :



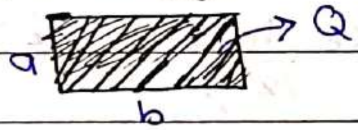
R: radius

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

2D: Surface Charge density

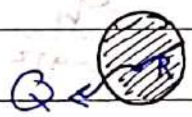
$\sigma = \frac{\text{Charge}}{\text{Area}}$

Exam: 1. Rectangle مستطيل



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

2. Disk قرص

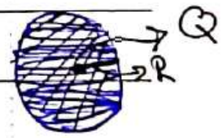


$\sigma = \frac{Q}{\pi r^2}$

3D: Volume Charge density

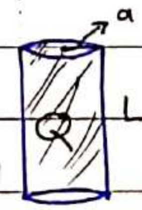
$\rho = \frac{\text{charge}}{\text{Volume}}$

1. sphere كرة

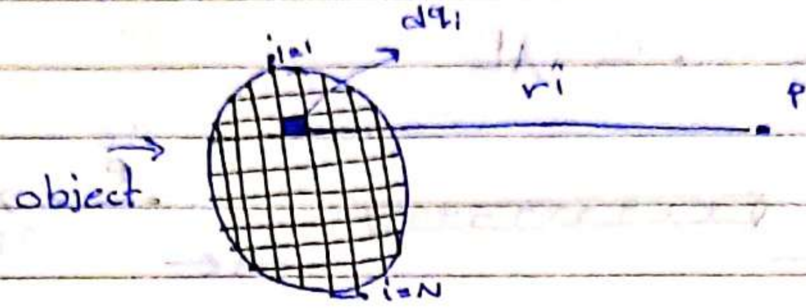


$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$

2. Cylinder



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



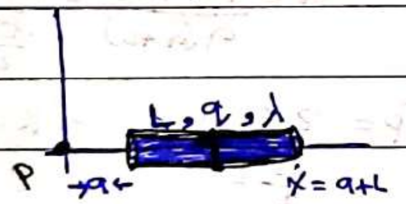
$$dE_i = K_e \frac{dq_i}{r_i^2}$$

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

العام $\Rightarrow$ $\boxed{E_p = \int K_e \frac{dq}{r^2}}$ الأشكال المهمة :

١. السلك ، Ring

- The electric field due to a Charged Rod.

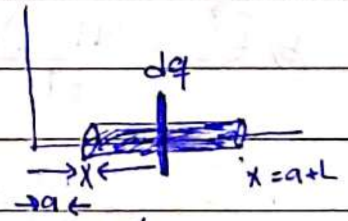


Sol:

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

$$dq = \lambda\, dx$$

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



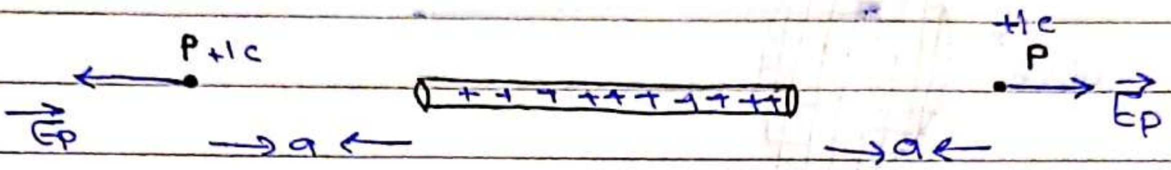
$$E_p = K_e \int \frac{dq}{x^2} \Rightarrow K_e \int_a^{a+L} \frac{\lambda\, dx}{x^2} \Rightarrow K_e \cdot \lambda \int_a^{a+L} \frac{dx}{x^2} = K_e \cdot \lambda \left[\frac{-1}{x}\right]_a^{a+L}$$

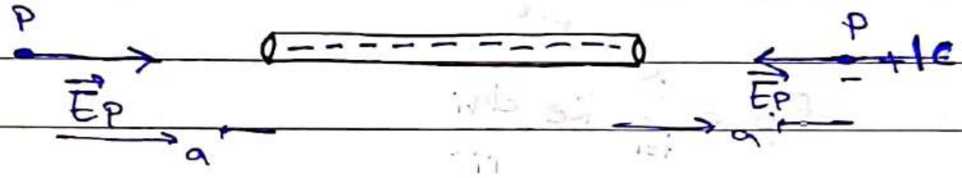
$$E_p = -K_e \lambda \left[\frac{1}{a+L} - \frac{1}{a}\right] = K_e \frac{\lambda L}{a(a+L)}$$

$$= K_e \frac{q}{a(a+L)}$$

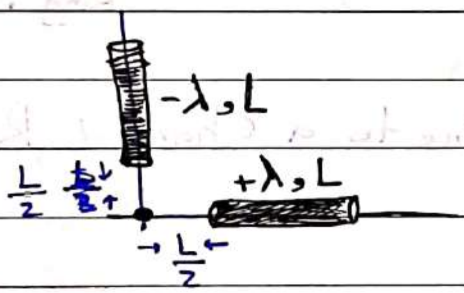
حفظ

$$E_p = \frac{k_e \lambda L}{a(a+L)} \quad , \quad Q = \lambda L$$





Ex:

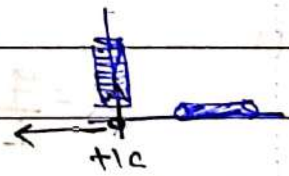


$E_o = ?!$

$$E_p = \frac{k_e \lambda L}{a(a+L)} = \frac{k_e \lambda L}{\frac{L}{2}\left(\frac{L}{2}+L\right)}$$

$$E_p = \frac{2 k_e \lambda}{\frac{3}{2} L} = \frac{4 k_e \lambda}{3L}$$

a) $\vec{E}_o = \frac{4 k_e \lambda}{3L} (\hat{i} + \hat{j})$

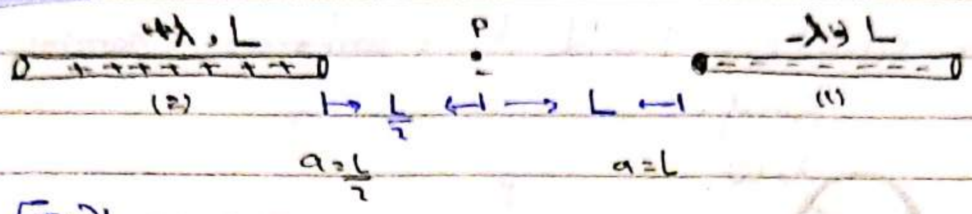


b) $\vec{E}_o = \frac{4 k_e \lambda}{3L} (-\hat{i} - \hat{j})$

c) $\vec{E}_o = \frac{4 k_e \lambda}{3L} (\hat{i} - \hat{j})$

d) $\vec{E}_o = \frac{4 k_e \lambda}{3L} (-\hat{i} + \hat{j})$ (✓)

H.w



Ep ?!

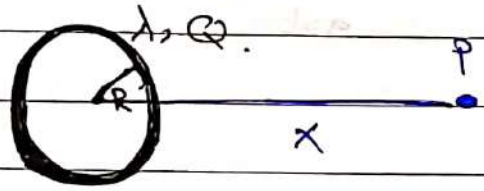
$$\vec{E}_1 = ke \cdot \frac{\lambda L}{a(a+L)} = ke \cdot \frac{-\lambda \cancel{L}}{\cancel{L}(L+L)} = \frac{-ke\lambda}{2L} \, (\hat{i})$$

$$\vec{E}_2 = ke \cdot \frac{\lambda L}{a(a+L)} = \frac{ke \cdot \lambda \cancel{L}}{\frac{\cancel{L}}{2}(\frac{L}{2}+L)} = \frac{2ke\lambda}{\frac{3}{2}L} = \frac{4ke\lambda}{3L} (\hat{i})$$

$$\vec{E}_P = \vec{E}_1 + \vec{E}$$

$$\vec{E}_p = \frac{-ke\lambda}{2L} + \frac{4ke\lambda}{3L} = \frac{5 \, ke\lambda}{6L} \hat{i}$$

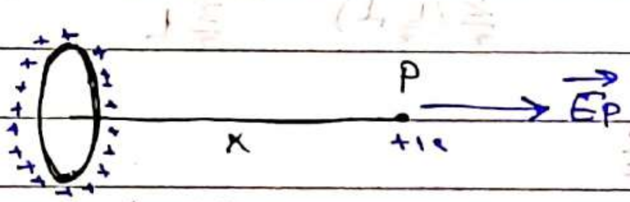
The electric field of a uniform charged Ring:



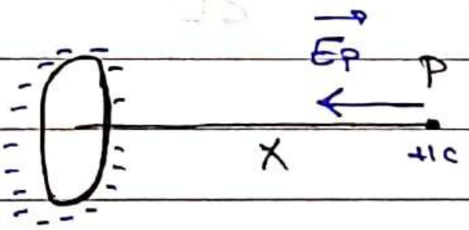
في النقطة عمودية لمركز الدائرة

$\lambda = \frac{Q}{2\pi r}$

$$E_p = \frac{k_e \, X \, Q}{(X^2+R^2)^{3/2}}$$ احفظ

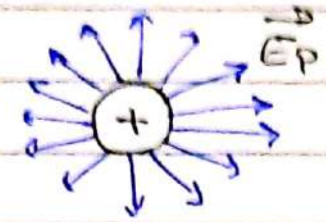
1. 

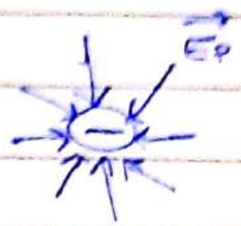
"out wards" مبتعد

2. 

"in Wards" مقترب

electric field lines.



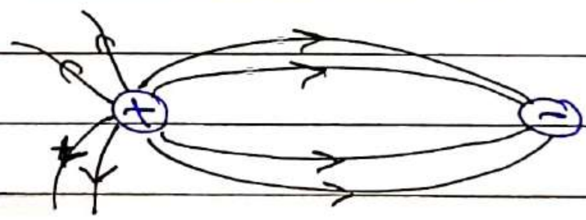


* كلما تزداد الشحنة
عدد خطوط المجال الكهربائي
تزداد ويزداد المجال الكهربائي

* كلما تزداد الشحنة
تزداد خطوط المجال الكهربائي.

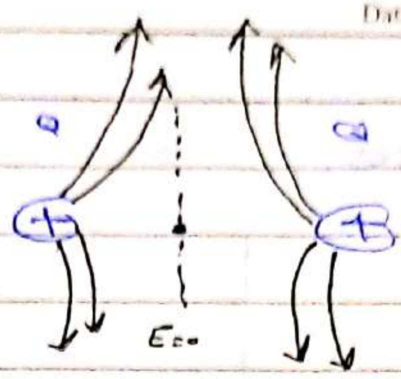
$$\frac{q_1}{q_2} = \frac{N_1}{N_2} = \frac{5}{5} = 1$$

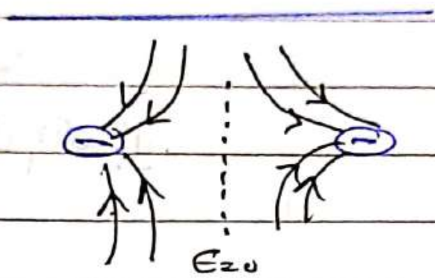
N: No. of electric field lines.

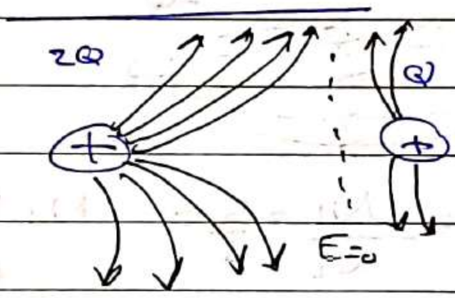


$$\frac{q_1}{q_2} = \frac{N_1}{N_2} \Rightarrow \frac{q_1}{q_2} = \frac{8}{4} = 2$$

$$q_1 = 2q_2$$

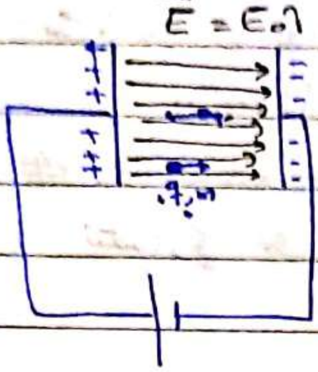

Q
Q
E=0


E=0


2Q
Q
E=0

Subject   Date   No.

- motion of Charge Particle in a uniform electric field.



المجال الكهربائي المنتظم

اذا قذفت جسم موجب بالطاقة الصفيحة الموجبة سوف يترك الجسم ليصل الى اقصى مسافة ثم يعود الى مكانها.

$\Rightarrow F_e = q_0 E_0 = ma$

$\Rightarrow a = \dfrac{q_0 E_0}{m}$

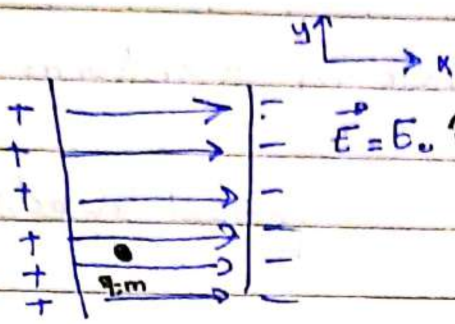
1. $v = v_0 + at$
2. $\Delta X = v_0 t + \frac{1}{2} a t^2$
3. $v^2 = v_0^2 + 2a \Delta X.$

تعوض (a) سالبة او موجبة حسب الجسم اذا كان يتسارع أم يتباطئ.

الاسم

Subject

Date ٢٠٢١/٧/١١ No. 4



$\vec{E} = E_0$?

إذا الشحنة موجبة سوف تتسارع مع اتجاه المجال الكهربائي.

إذا الشحنة سالبة سوف تتسارع عكس خطوط المجال الكهربائي.

$$F_e = q_0 E_0 = ma$$

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

$$v = v_0 + at$$

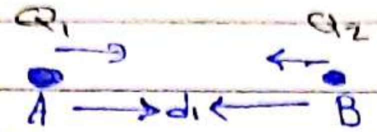
$$\Delta X = v_0 t + \frac{1}{2} a t^2$$

$$v^2 = v_0^2 + 2a\Delta X.$$

عند اقصى ارتفاع السرعة = صفر.

Ch.23.

716. 4



$F = 2,62\ \mu N$

$F = 2,62 * 10^{-6}\ N$

when $d1 = 13,7mm$

$F_2 = ?!$ when $d_2 = 17,7.$

Sol:-

$$F_1 = Ke\ \frac{Q_1 Q_2}{d_1^2}$$

$$F_2 = ke\ \frac{Q_1 Q_2}{d_2^2}$$

$$\frac{F_2}{F_1} = \frac{1}{d_2^2} \div \frac{1}{d_1^2} \Rightarrow \frac{F_2}{F_1} = \left(\frac{d_1}{d_2}\right)^2$$

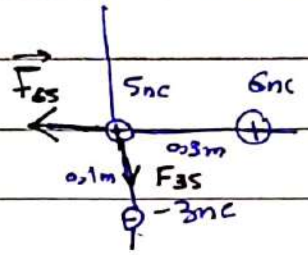
$$F_2 = F_1 \left(\frac{d_1}{d_2}\right)^2$$

$$F_2 = 2,62 \left(\frac{13,7}{17,7}\right)^2$$

$$F_2 = 1,57\ \mu N$$

Subject Date No.

717.11



A. Sol:

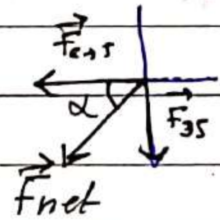
$$F_{6\to5} = 9*10^{9}\ \frac{6*10^{-9}*5*10^{-9}}{(0,3)^2} = 3000*10^{-9} = 3\mu N$$

$$\vec{F}_{6\to5} = 3\ \mu N\ (-\hat{i})$$

$$F_{3\to5} = 9*10^{9}\ \frac{3*10^{-9}*5*10^{-9}}{(0,1)^2} = 13500*10^{-9}\ N$$

$$= 13,5\ \mu N$$

$$\vec{F}_{3\to5} = 13,5\ \mu N\ (-\hat{j})$$



$$F_{net} = \sqrt{(3)^2 + (13,5)^2}\ \mu N$$

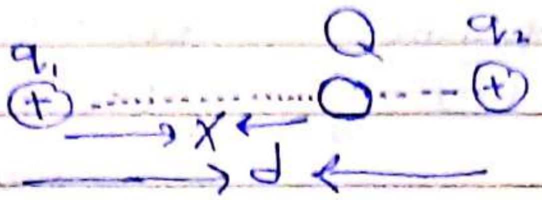
$$F_{net} = 185,25\ \mu N$$

$$\tan\alpha = \frac{13,5}{3}$$

$$\alpha = \tan^{-1}\left(\frac{13,5}{3}\right)$$

$$\alpha = 77,5^{\circ}$$

717. 14



بفرض $q_1 = 2q$

$q_2 = q$

$d = 1m.$

Sol: In Equilibrium.

$\Rightarrow F_T = zero = QE$

$\Rightarrow E_T = zero$

نعوض الشحنات بدون الاشارة
$$\left[\begin{array}{l} F_1 = F_2 \\ E_1 = E_2 \end{array}\right.$$

$$E_1 = E_2$$

$$\frac{\cancel{k_e} q_1}{x^2} = \frac{\cancel{k_e} q_2}{(d-x)^2}$$

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

$$\frac{2\cancel{q}}{x^2} = \frac{\cancel{q}}{(1-x)^2}$$

$2(1-x)^2 = x^2$

$x = \pm\sqrt{2}\,(1-x)$

$x = \pm\sqrt{2} \pm \sqrt{2}\,x$

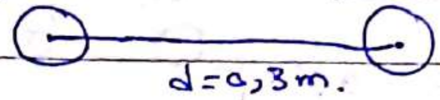
$x(1 \pm \sqrt{2}) = \pm\sqrt{2}$ $\qquad \Rightarrow \; x = \dfrac{\pm\sqrt{2}}{1 \pm \sqrt{2}}$

$x = \dfrac{\sqrt{2}}{1+\sqrt{2}} = 0,585 \text{ m.}$

Subject Date No.

7.18, 21

$q_1 = 12nc$ $q_2 = -18nc$



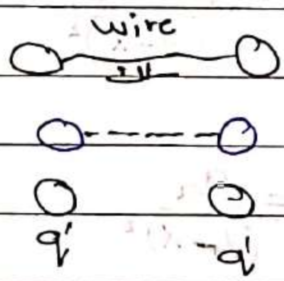
كرتان متماثلتين
يعني نفس المادة
ونفس الكتلة ونفس (نق)
لكل منهما

A. $F_{1\to2} = 9*10^{9} \dfrac{12*10^{-9} * 18*10^{-9}}{(0,3)^2} = 2,16*10^{-5}$ attractive
تجاذب

$\vec{F}_{1\to2} = 2,16*10^{-5}$ (-î)

$\vec{F}_{2\to1} = 2,16*10^{-5}$ (î)

B.



$q_1 + q_2 = q' + q'$

$q_1 + q_2 = 2q'$

$q' = \dfrac{q_1+q_2}{2} \Rightarrow \dfrac{-6}{2}$

$q' = -3\,nC.$

$F = 9*10^{9} * \dfrac{3*10^{-9} * 3*10^{-9}}{(0,3)^2} = 9*10^{-7}.$ Replusive
تنافر

N O T E B O O K

Subject Date No.

718 . 24

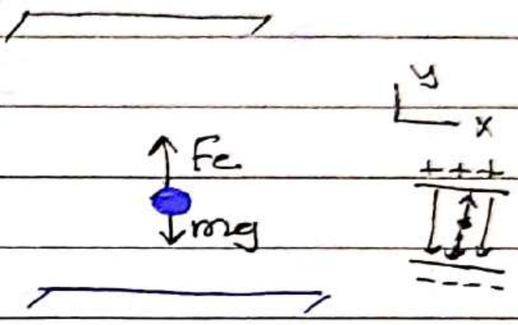
$m = 3.8g$

$q_0 = -18\ \mu c$

suspended: معلقة

motion less: بدون حركة

immersed: مغمور



$$\vec{E} = E_0\,(-\hat{j})$$

$$F_e = mg$$

$$q_0 E_0 = mg \Rightarrow E_0 = \frac{mg}{q_0}$$

$$E_0 = \frac{3.8 * 10^{-3} * 10}{18 * 10^{-6}} = 0,2111 * 10^{4} = 2111\ N/c$$

718.29

$q_1 = -2,5\ \mu c$ $q_2 = 6\ \mu c$

⊖ - - - - - - - - ⊕

← 1m →

S-1

$E = zero$ $q_1 = -2,5\ \mu c$ $q_2 = 6\ \mu c$

● - - - ⊖ - - - - - ⊕

← x → ← 1m →

$$E_1 = E_2 \Rightarrow \frac{\cancel{k_e}\, q_1}{x^2} = \frac{\cancel{k_e}\, q_2}{(1+x)^2}$$

$$\frac{2,5 * \cancel{10^{-6}}}{x^2} = \frac{6 * \cancel{10^{-6}}}{(1+x)^2}$$

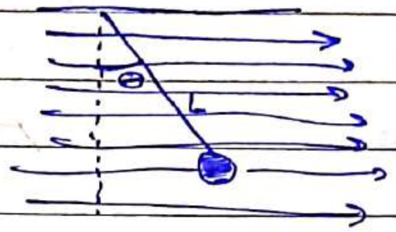
$$\sqrt{2,5}\,(1+x)^{\cancel{2}} = 6x \Rightarrow \sqrt{2,5} + \sqrt{2,5}\,x = 6x$$

$$x = \frac{\sqrt{2,5}}{\sqrt{6} - \sqrt{2,5}} = 0,35m$$

N O T E B O O K

Subject Date No.

719.33



$E = 1*10^3\ N/c$

$E_o = 1000 N/c$

$m = 2g$ / $\vec{E} = E_o \hat{i}$.

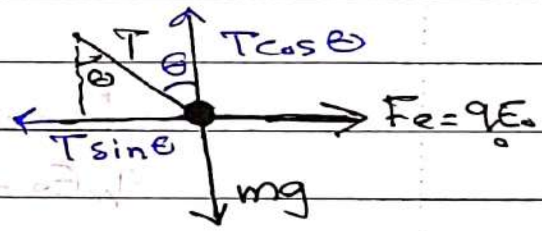
$L = 20\ cm$

$\theta = 15°$

$q_o = ??!$

Sol:

$E.$



$\Sigma F = 0$

$\Sigma F_x = 0 \Rightarrow Fe = T\sin\theta \Rightarrow q_o E_o = T\sin\theta$

$\Sigma F_y = 0 \Rightarrow T\cos\theta = mg$

$$\frac{q_o E_o}{mg} = \tan\theta$$

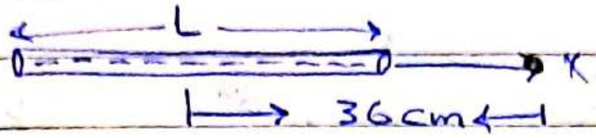
$$q_o = \frac{mg\tan\theta}{E_o} = \frac{2*10^{-3}*10\tan(15)}{1000}$$

$$q_o = 5,36\ \mu C$$

N O T E B O O K

Subject Date No.

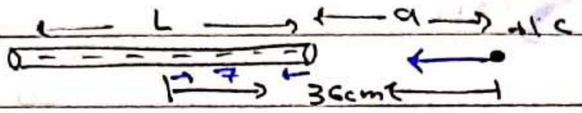
19.37



$L = 14\,cm$

$q = -22\,\mu C$

Sol:



A.

Rod:

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

Ring:

$$E = \frac{k_e Q x}{(x^2+R^2)^{3/2}}$$

$$E_{Rod} = \frac{k_e \lambda L}{a(a+L)} , \quad q = \lambda L , \quad \vec{E} = E_0 (-\hat{i})$$

$$a = 36 - 7 = 29\,cm$$

$$E_{Rod} = \frac{k_e q}{a(a+L)} \Rightarrow E = \frac{9*10^{9} * 22*10^{-6}}{0.29\,(0.29-0.14)}\ N/C$$

B. $q_0 = -5\,\mu C$

what is the force exerted by the Rod on the Charge?!

$$F = q E_0 \Rightarrow \vec{F} = q_0 E_0 \,(\hat{i})$$

N O T E B O O K

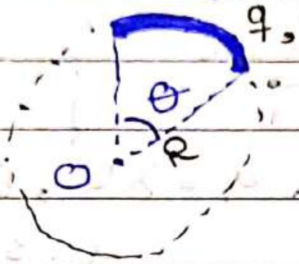
الاثنين

Subject Date 12/7/2021 No. 5

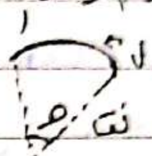
The $\vec{E}$ - field of a charged arc:

Arc : قوس ⌒ ,

bent : منحني منثني



طول القوس الدائري



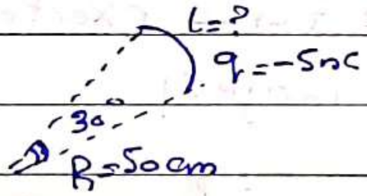
① ل = $\frac{هـ}{٣٦٠}$ ٢ط نق

② ل = هـ نق

$L = R\theta$, θ : radian.

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

Ex :



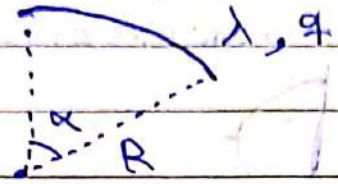
$30° \longrightarrow \frac{\pi}{6}$

$L = R\theta$

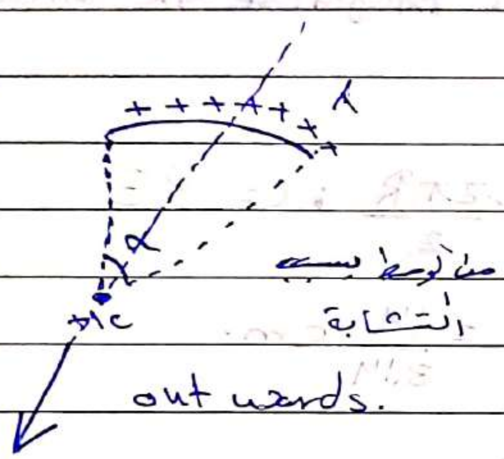
$L = \frac{50}{100} * \frac{\pi}{6} = \frac{5\pi}{60} = 0,262$ m.

$\lambda = \frac{-5}{0,262}$ $\frac{nC}{m}$

$$E_o = \frac{2K_e \lambda}{R} \sin\left(\frac{\alpha}{2}\right)$$

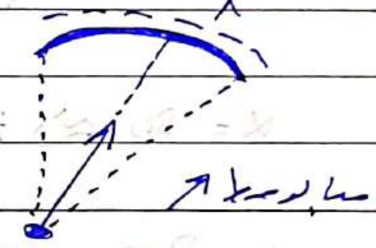


(1)



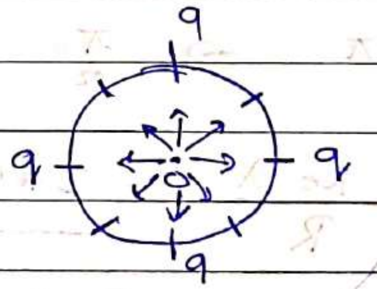
out wards.

(2)



in wards.

(3)



$\alpha = 360^\circ$
$= 2\pi$

$$E_o = \frac{2K_e \lambda}{R} \sin(\pi)$$

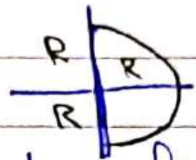
$E_o =$ Zero

720.45

$L = 14\ cm$

$q = -7{,}5\ \mu C$

bent ↓ semi circle: ثنت



what is the electric field magnitude and direction in origin.

$\alpha = 180 \approx \pi \quad , \quad l = \frac{2\pi R}{2} \quad ; \quad l = R\theta$

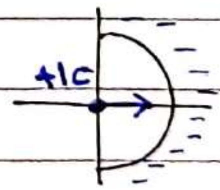
$l = R\theta \Rightarrow R = \frac{l}{\pi} = \frac{14}{3.14}\ cm.$

$\lambda = \frac{q}{L} = \frac{-7{,}5}{14 * 10^{-2}}\ \frac{\mu c}{m.}$

$\alpha = \pi \rightarrow \frac{\pi}{2}$

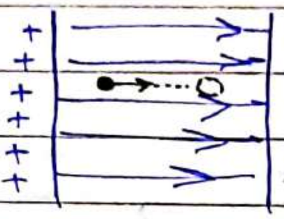
$E_0 = \frac{2\ Ke\ \lambda}{R} = \frac{2 * 9 * 10^9 * \frac{7{,}5 * 10^{-6}}{14 * 10^{-2}}}{\frac{14 * 10^{-2}}{3{,}14}} * \sin\left(\frac{\pi}{2}\right)$

$E_0 = 22{,}43\ N/C$



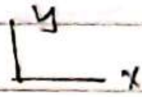
720.51 Proton $\to e^{+} = +1,6 * 10^{-19}$ C

$m_p = 1,67 * 10^{-27}$ Kg.



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

$v_0 = zero$



$E_0 = 640$ N/c

$v_f = 1,20$ M m/s.

(a) accelaration ?

$F = ma = qE_0$

$a = \frac{qE_0}{m} \Rightarrow a = \frac{1,6*10^{-19} * 640}{1,67*10^{-27}}$

$a = 613,2 * 10^{8}$ m/s^2

(b) $v_f^2 = v_0^2 + 2a\Delta X$.

$v_f = v_0 + at \longrightarrow v$

$t = \frac{v_f}{a} = \frac{1,2 * 10^{6}}{613,2*10^{8}}$

(c) $(1,2 * 10^{6})^2 = (0)^2 + 2 * 613,2 * 10^{8} * \Delta X$

$\Delta X = \frac{(1,2 * 10^{6})^2}{2 * 613,2 * 10^{8}}$ m.

(D) $K.E = \frac{1}{2} m_p v^2 = \frac{1}{2} * 1,67 * 10^{-27} * (1,2 * 10^{6})^2$

$K.E = \frac{1}{2}$ J

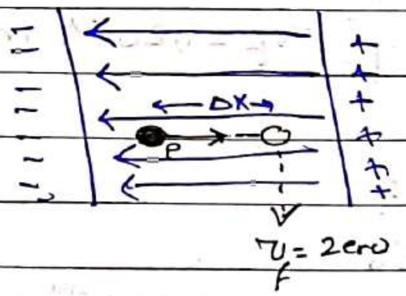
Subject   Date   No.

P1

الالكترون اذا قذف مع المجال يتوقف عند مسافة معينة ثم يعود.

البروتون اذا قذف عكس المجال يتوقف عند مسافة معينة ثم يعود.

$\boxed{52}$



$\vec{E} = [-6*10^{5}]\,\hat{i}$ N/C

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

$\Delta x = 7$ cm.

$v_i = ?!$

(a)

$$a = \frac{q_0 E_0}{m} = \frac{1.6*10^{-19} * -6*10^{5}}{1.67*10^{-27}}$$

$$a = -5.75*10^{13}\ m/s^2$$

(b)

$$v_f^2 = v_0^2 + 2a\,\Delta x$$

$$(0)^2 = (v_0)^2 + 2*-5.75*10^{13}*7*10^{-2}$$

$$v_0 = \sqrt{2*5.75*10^{11}}$$

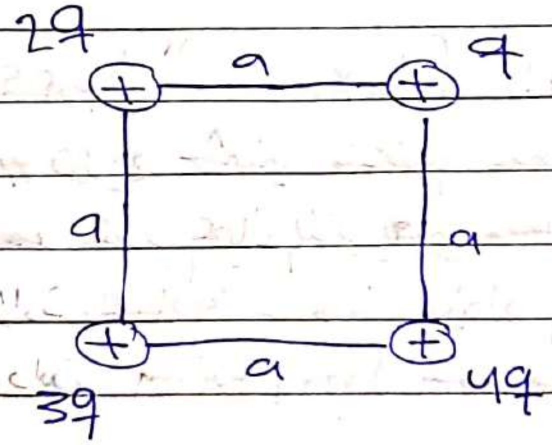
$$v_0 = 2.8*10^{6}\ m/s.$$

(c)

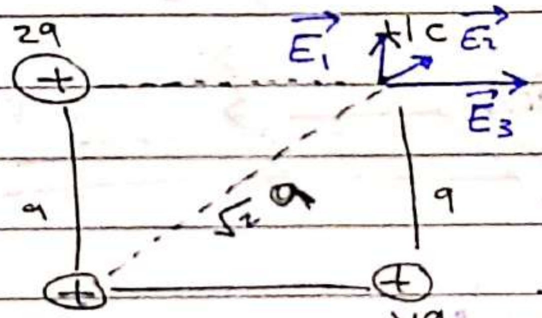
$$v_f = v_i + at \Rightarrow 0 = 2.8*10^{6} + -5.75*10^{13}t$$

$$t = \frac{2.8*10^{6}}{5.75*10^{13}}\ (s)$$

$\boxed{25}$



Sol:



$$\vec{E}_3 = ke\frac{2q}{a^2}\hat{i}$$

$$\vec{E}_2 = \frac{ke\,3q}{2a^2} \leftarrow 3q$$

$$4q \rightarrow \vec{E}_1 = ke\frac{4q}{a^2}\hat{j}$$

$$\vec{E}_2 = \frac{ke\,3q}{2a^2}\left(\cos 45\,\hat{i} + \sin 45\,\hat{j}\right)$$

$E_T =$

⟹ Ch.24 Gauss's law.

(1) The electric flux. "التدفق الكهربائي"

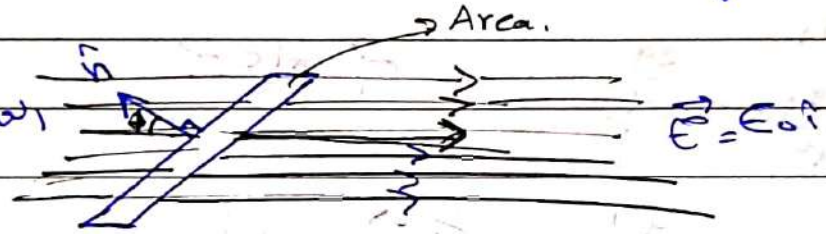
توزيع شحني منتظم متماثل.

مقدار المجال الذي يعبر مساحة معينة.

كلما زادت المساحة سوف يزداد التدفق.

كلما زادت شدة المجال سوف يزداد التدفق.

الزاوية ↙

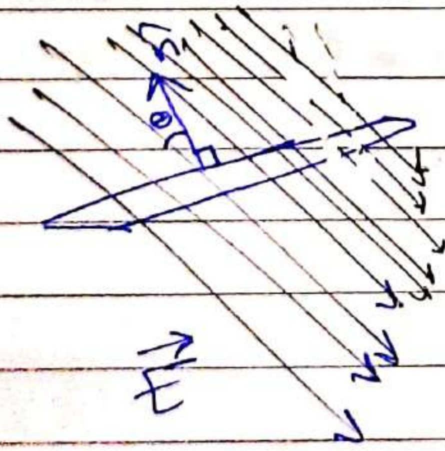


العامودي على السطح

Electric flux

$$\Phi = E_0 A \cos\theta_{\hat{n}\vec{E}_0}$$

θ الزاوية تكون بين العامودي على السطح و خطوط المجال الكهربائي.

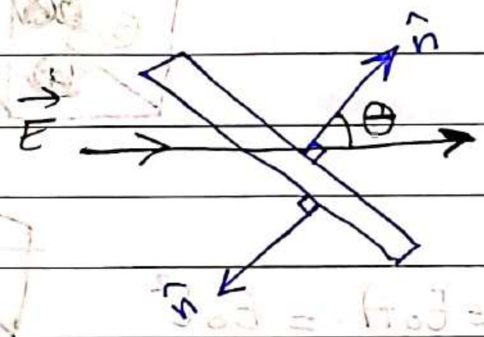


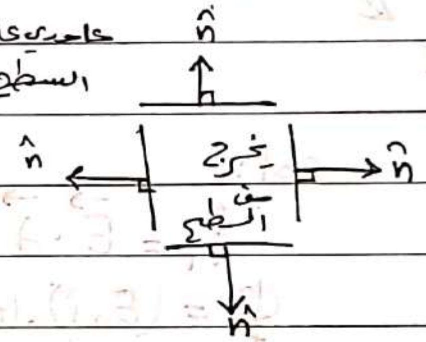
$$\hat{n} = \begin{cases} \hat{i}, -\hat{i} \\ \hat{j}, -\hat{j} \\ \hat{k}, -\hat{k}. \end{cases}$$

Electric Flux.

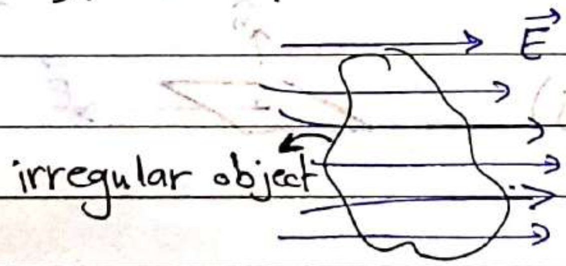
$$\Phi = EA\cos\theta_{\hat{n},E}$$

$$\Phi = \vec{E}\cdot\vec{A}$$ $\hat{n}$: Normal unit vector.





بالاجسام غير المنتظمة (irregular) يخترقها مجال كهربائي.

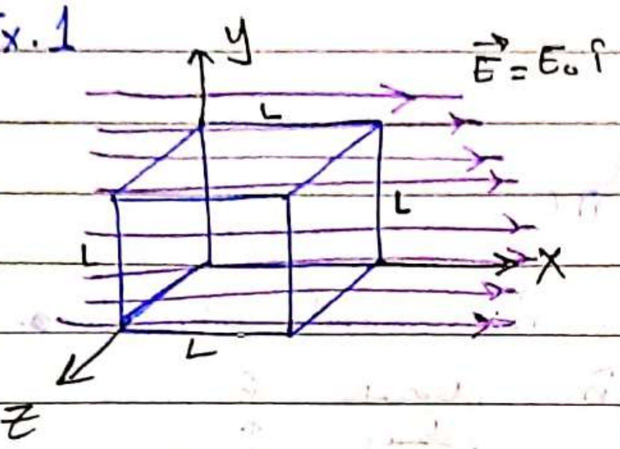


$$\Phi = \int_{Area} \vec{E}\cdot d\vec{a}$$

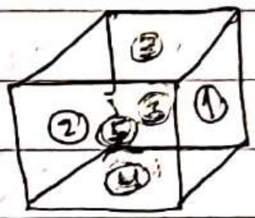
$\rightarrow +1$ $\vec{E}$, $\hat{n}$

$\rightarrow -1$ $\vec{E}$, $\hat{n}$

Ex. 1



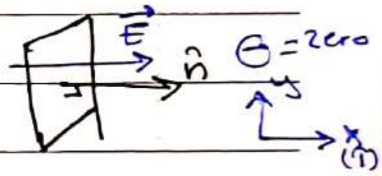
Find the flux throughout the cubes



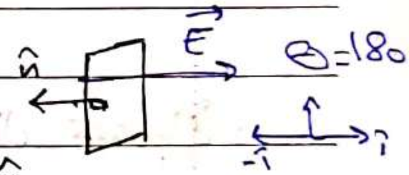
sol:

$$\Phi_1 = \vec{E} \cdot \vec{A}$$

$$\Phi_1 = (E_0 \hat{i}) \cdot (A \hat{i}) = E_0 A = E_0 L^2$$

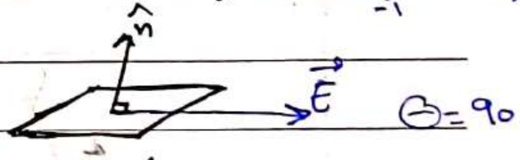


$$\Phi_2 = \vec{E} \cdot \vec{A} = (E_0 \hat{i}) \cdot (-A \hat{i}) = -E_0 A$$
$$= -E_0 L^2$$



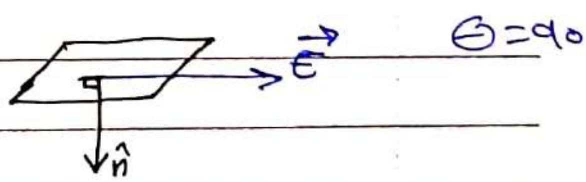
$$\Phi_3 = \vec{E} \cdot \vec{A} = (E_0 \hat{i}) \cdot (A \hat{j})$$

$$\Phi_3 = zero$$



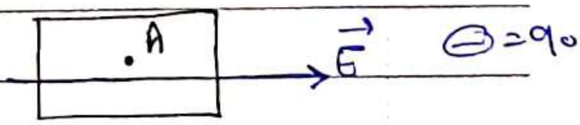
$$\Phi_4 = \vec{E} \cdot \vec{A} = (E_0 \hat{i}) \cdot (-A \hat{j})$$

$$\Phi_4 = zero$$



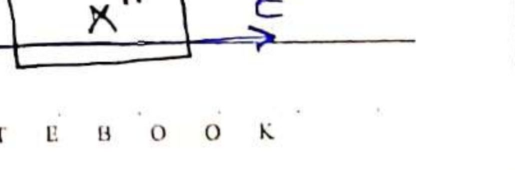
$$\Phi_5 = \vec{E} \cdot \vec{A} = (E_0 \hat{i})(A \hat{k})$$

$$\Phi_5 = zero$$



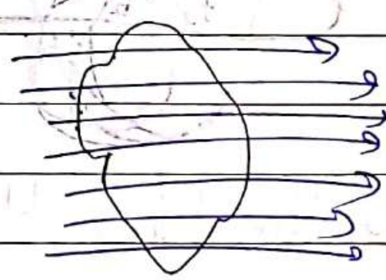
$$\Phi_6 = \vec{E} \cdot \vec{A} = (E_0 \hat{i})(-A \hat{k})$$

$$\Phi_6 = zero$$



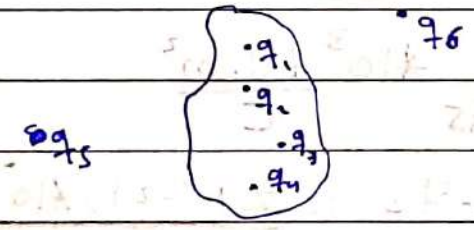
$$\Phi_{Total} = \Phi_1 + \Phi_2 + \Phi_3 + \Phi_4 + \Phi_5 + \Phi_6$$
$$= E_0 L^2 + -(E_0 L^2)$$
$$\Phi_{total} = zero$$

Conculsion: The total flux of un charged object immersed in an electric field is always Zero.



$\Phi_T = zero$

$$\Phi = \int \vec{E} \cdot d\vec{A} = \vec{E} \cdot \vec{A}$$



او الجسم

سطح يحتوي على شحنة يصبح هذا السطح لديه تدفق كهربائي.

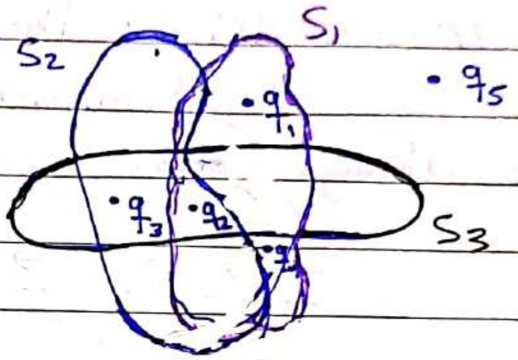
اذا كان مجموع الشحنة في السطح موجبة يكون التدفق يخرج من السطح او الجسم.

اذا كان مجموع الشحنة في السطح او الجسم سالبة يكون التدفق يدخل في السطح او الجسم

$$\Phi = \frac{\Sigma q_{in}}{\epsilon_0} \longrightarrow$$ تعرضه لإحاطة الشحنة

للجسم العلوي $\Phi = \dfrac{q_1 + q_2 + q_3 + q_4}{\epsilon_0}$

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



tz خارج
عشان q_5
الأسطح أو كجسم
ليس لها اي
تأثير بالتدفق.

$q_1 = 1nc$

$q_2 = -2nc$

$q_3 = 2nc$

$q_4 = 5nc$

$q_5 = -3nc$

Find the flux through each surface?

$$\Phi_1 = \frac{q_{in}}{\epsilon_0} = \frac{q_1 + q_2 + q_4}{\epsilon_0} = \frac{(1 + (-2) + 5)\, 10^{-9}}{8.85 \times 10^{-12}}$$

$$\Phi_1 = \frac{4}{8.85} \times 10^{3} \ \frac{N.m^2}{C}$$

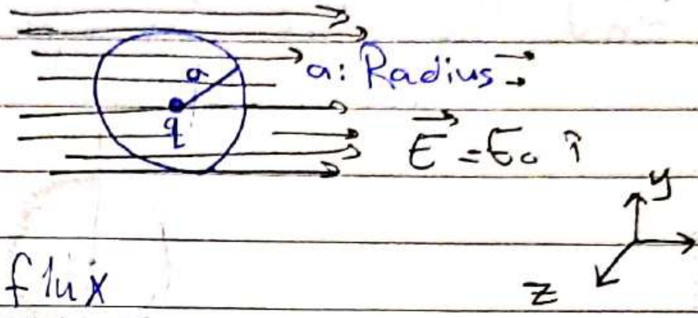
$$\Phi_2 = \frac{q_{in}}{\epsilon_0} = \frac{q_3 + q_2}{\epsilon_0} = \frac{(2 + (-2)) \times 10^{-9}}{8.85 \times 10^{-12}} = \text{zero} \ \frac{N.m^2}{C}$$

$$\Phi_3 = \frac{q_{in}}{\epsilon_0} = \frac{q_3 + q_2}{\epsilon_0} = \text{zero} \ \frac{N.m^2}{C}$$

Subject Date No.

الجسـم قشرة كروية

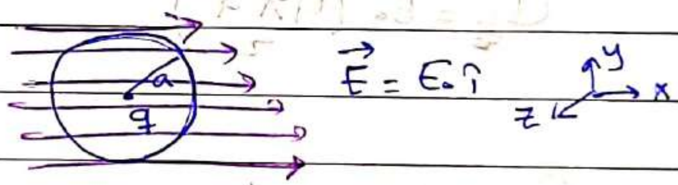
Gaussion Surface : spherical shell



flux (التدفق)

ناتج عن الشحنة النقطية (q) ناتج من المجال الكهربائي الخارجي

Find the flux thraghout the Gaussian surface



$$\Phi_T = \Phi_E + \Phi_q$$

نوجد التدفق الناتج من المجال ونعتبر الشحنة ليست موجودة عند ايجاد Φ_E .

$$\Phi_E = \text{zero}$$

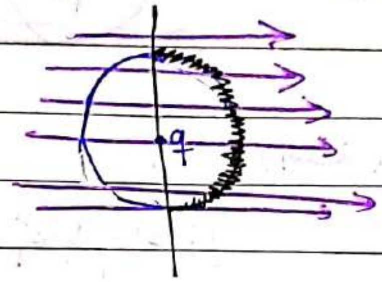
نوجد التدفق الناتج عن (Gaussian surface) ونوجد عدد الشحنات الداخلية وهو قانون $\frac{q_{in}}{\epsilon_0}$

$$\Phi = \frac{q_{in}}{\epsilon_0}$$

$$\Phi_T = \text{zero} + \frac{q}{\epsilon_0} = \frac{q}{\epsilon_0}$$

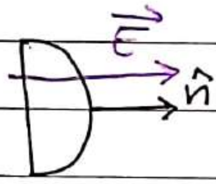
NOTEBOOK

Find the flux throughout the right hemi-sphere (نصف الكرة) ?

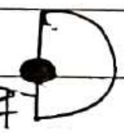


$$\Phi_{\underset{H.s}{Righ}} = \Phi_E + \Phi_q$$

$$\Phi_E = E_0 \left(\frac{4\pi a^2}{2}\right)$$



$$\Phi_q = \frac{q}{\epsilon_0} = \frac{q}{2\epsilon_0}$$

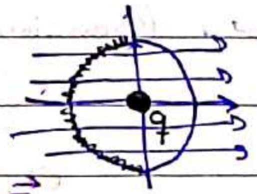


الشحنة موجودة في مركز الشكل والشكل متماثل

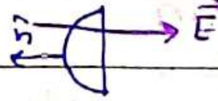
$$\Phi_{\underset{H.S}{Righ}} = E_0 \left(\frac{4\pi a^2}{2}\right) + \frac{q}{2\epsilon_0}$$

اذا طلب السؤال left hemi-sphere.

$$\Phi_{\underset{H.s}{Left}} = \Phi_E + \Phi_q$$



$$\Phi_E = -E_0 \left(\frac{4\pi a^2}{2}\right)$$



$$\Phi_q = \frac{q}{\epsilon_0} = \frac{q}{2\epsilon_0}$$

$$\Phi_{\underset{H.s}{left}} = -E_0 \left(\frac{4\pi a^2}{2}\right) + \frac{q}{2\epsilon_0}$$

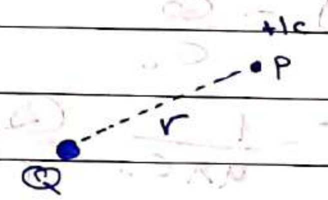
Gauss's Law.

$$\Phi = \int \vec{E} \cdot d\vec{a}$$

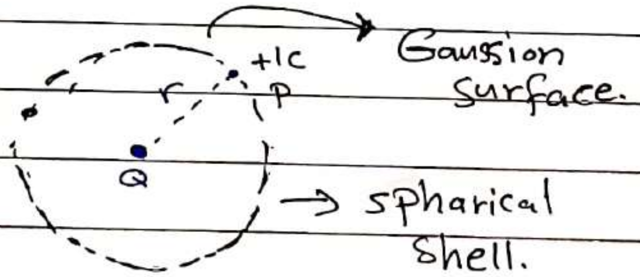
$$= \frac{q_{in}}{\epsilon_0}$$

$$\therefore \int \vec{E} \cdot d\vec{a} = \frac{q_{in}}{\epsilon_0}$$ ← # نوجد مجال الكهربائي لتوزيع شحني منتظم ومتماثل.

Ex: The electric field of a Point Charge.



نرسم سطح Gauss يمر بالنقطة (P) ويكون مركزه الشحنة Q.



سطح جاوس هو ثلاثي الابعاد (كرة) لذلك الشحنة الموجودة في المركز تبث المجال الكهربائي من جميع الاتجاهات.

$$\Phi = \frac{q_{in}}{\epsilon_0} = \frac{Q}{\epsilon_0}$$

Subject Date No.

بالإشارة

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

شحنة موجبة

Dot product → +1 / −1

شحنة سالبة

↓ $\cos\theta$

الزاوية بين كل مجال والعامودي على كل المساحة

$\vec{E}$ → $d\vec{A}$ $\cos 0 = 1$

$\vec{E}$ ← $d\vec{A}$ $\cos 180 = -1$

نستطيع نشيل Dot Product ونعتبره مجرد ⟵ لكن بشرط توزيع الشحنة $\frac{Q_{in}}{\epsilon_0}$ بالإشارة.

$$\# \int da = A$$

إذا كان التوزيع الشحني كروي ⟸

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

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{r^2}$$

spherical Charge distribution.

موصل

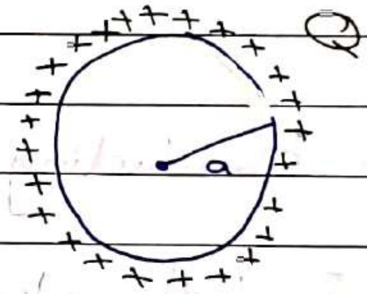
Conductor (metalic, copper, AL, ...) sphere.

عازل

non-Conducting, Insulator (Rubber, Plastic, ...)

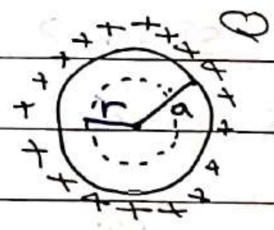
Ex: (a) Conducting sphere :-

① Find the electric Field inside the sphere?
(E_{in} ; $r < a$)



a: radius

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



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

$$E_{in} = zero \;;\; r < a.$$

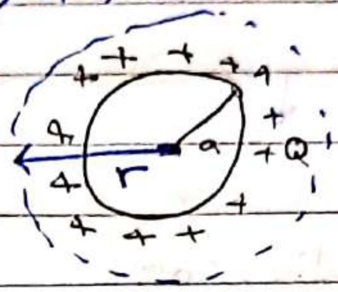
اي سطح معدني و مطلوب ايجاد المجال الكهربائي داخلة يكون المجال الكهربائي صفر لان الشحنة تتوزع على السطح الخارجي

NOTEBOOK

Subject　　　　Date　　　　No.

ⓒ Find the electric field outside the sphere?

$E_{out} = ?!$ $(r \geq a)$



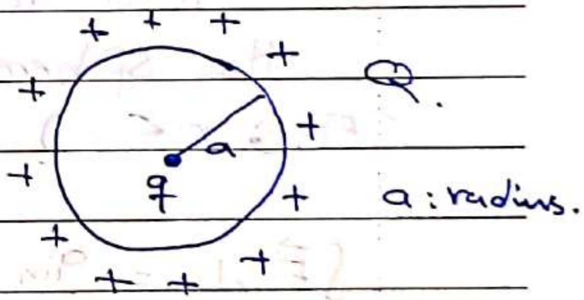
$$\oint E\,da = \frac{q_{in}}{\epsilon_o}$$

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

$$E_{out} = \frac{Q}{4\pi\epsilon_o r^2} = \frac{K_e Q}{r^2} \quad ; \quad r \geq a.$$

المجال الكهربائي خارج الكرة هو نفسه المجال الكهربائي للشحنة النقطية.

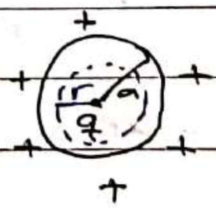
Ex2: Conducting sphere



1) Find the electric field inside the sphere?

E_{in} ; $r < a$

$$\oint E\,da = \frac{Q_{in}}{\epsilon_o}$$



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

$$E_{in} = K_e \frac{q}{r^2} \quad ; \quad r < a.$$

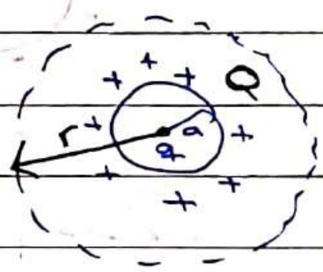
N O T E B O O K

2) Find the electric field out side the sphere?

$E_{out} = ?!$ $(r \geq a)$

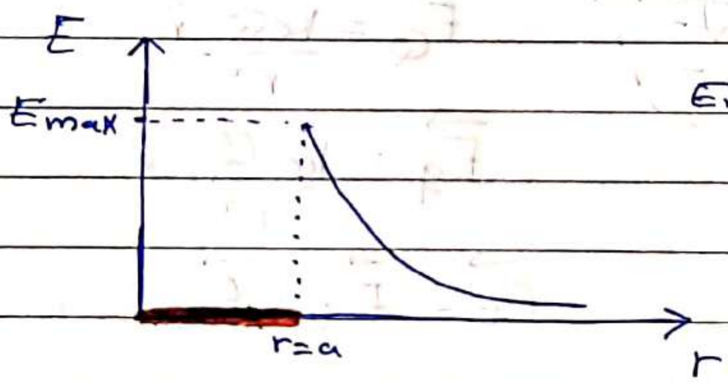
$$\oint E\,da = \frac{Q_{in}}{\epsilon_0}$$

بالإشارة



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

$$E_{out} = K_e \frac{Q+q}{r^2} \quad r \geq a.$$



$$E_{max} = \frac{K_e Q}{a^2}$$

$$E = \begin{cases} \text{zero} & ; r < a \\ \dfrac{K_e Q}{r^2} & ; r \geq a. \end{cases}$$

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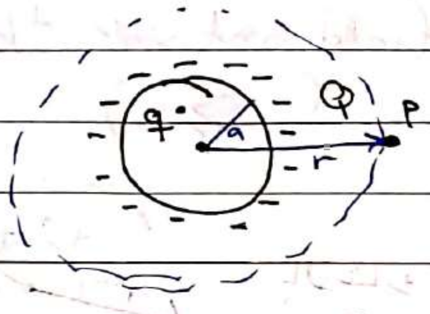
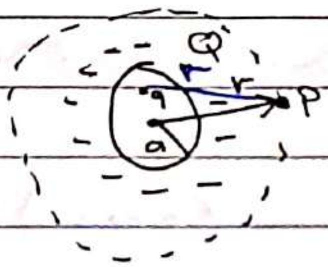


في هذا المثال لا نستطيع تطبيق قانون جاوس لان Q و q ليس لهم نفس المركز ، يمكن نستطيع ايجاد التدفق .

$$\Phi = \frac{Q+q}{\epsilon}$$



نوجد المجال ⇐

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

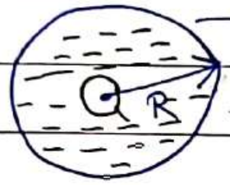
$$\vec{E}_q = \frac{k_e Q}{r^2}\hat{r}$$

$$\vec{E}_P = \vec{E}_Q + \vec{E}_q$$

b) Non-conducting sphere
[Insulating]

4 الفرق ان هذه الكرة يكون الشحنات داخلها.

Insulator



Ex: (1) $E_{out} = ?!$; $r \geq R$

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

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

$$E_{out} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$E_{out} = \frac{k_e Q}{r^2} \quad ; \quad r \geq R.$$

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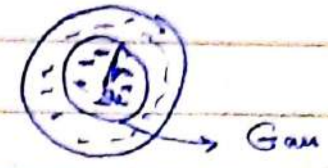
(2) $E_{in} = ?!$ $\quad r < a$ مسطح جاوس هنا اخذ جزء من الشحنة.

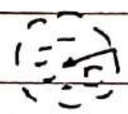


$$\int E\,da = \frac{Q_{in}}{\epsilon_0}$$

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

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

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



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

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

$$E(4\pi \cancel{r^2}) = \frac{4\pi}{3}\rho\frac{\cancel{r^3}^{\,r}}{\epsilon_0} \qquad\qquad E(4\pi \cancel{r^2}) = \frac{\cancel{r^3}^{\,r} Q}{R^3 \epsilon_0}$$

$$E_{in} = \frac{\rho r}{3\epsilon_0} \quad r \leq R \qquad\qquad E_{in} = \frac{K_e Q r}{R^3}$$

نستخدم القانونين حسب معطيات السؤال.

N O T E B O O K

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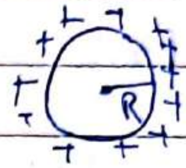
Conducting sphere :- The Charge is distributed on surface.

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



Non-Conducting sphere [Insulator] :- The Charge is distributed throughout The Volume of the surface

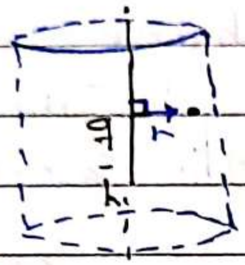
$$\rho = \frac{\text{Charge}}{\text{Volume}} = \frac{Q}{\frac{4}{3}\pi R^3}.$$

تماثل . اسطوانة .

Charged Cylinderical symmtry

Ex.1 : Infinite Charge rod : very thin wire

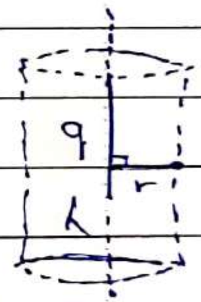
الفرق بين السلكين - [ch.23 / ch24] ان هذا السلك لا نهائي نوجد المجال عند نقطة بسيطة على استقامة



لكن السلك . في ch.23 نوجد المجال على استقامة

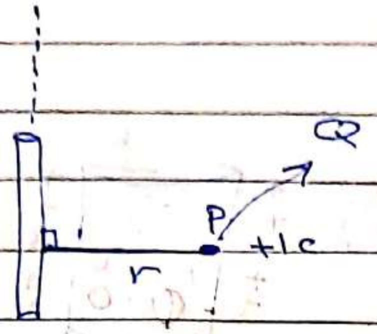
$$\int E da = \frac{q_{in}}{\epsilon_0} \qquad \lambda = \frac{q}{L}$$

$$q = \lambda L$$



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

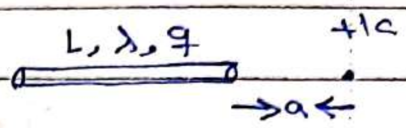
$$E = \frac{\lambda}{2\pi\epsilon_0 r} * \frac{2}{2} = \frac{2 k_e \lambda}{r}$$



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

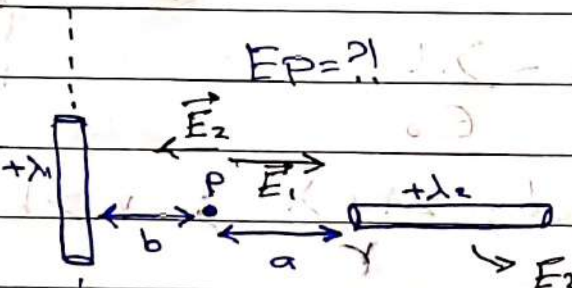
$$F = QE = \frac{2k_e\lambda}{r}Q$$

↓
القوة المؤثرة



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

$E_P = ?!$



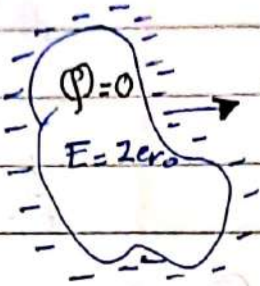
$$E_1 = \frac{2k_e\lambda}{r}$$

$$E_2 = \frac{k_e \lambda L}{a(a+L)}$$

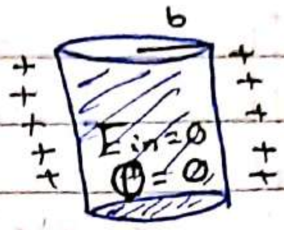
$$E_P = \vec{E_1} - \vec{E_2}$$

Subject Date No.

Conducting Cylinder



→ Conductor



الشحنة على السطح في الخارج

$E_{in}=0 \; ; \; r<b$

$$\oint E\,da = \frac{Q_{in}}{\epsilon_0} = \frac{\lambda L}{\epsilon_0}$$

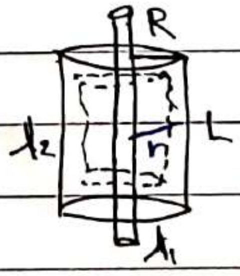
مساحة محيط الاسطوانة

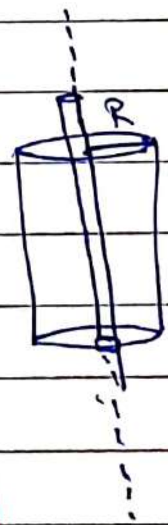
$$E(2\pi r\cancel{L}) = \frac{\lambda \cancel{L}}{\epsilon_0}$$

$$E_{out} = \frac{2k_e\lambda}{r} \; ; \; r>b$$

Ex: Conducting cylinder

(1) $E_{in} = ?! \quad r<R$





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

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

$$E_{in} = \frac{\lambda_1}{2\pi\epsilon_0 r} = \frac{2k_e\lambda_1}{r} \; ; \; r<R.$$

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2) $E_{out} = ?$; $r > R$.

$E_{out} = E_{\lambda_1} + E_{\lambda_2}$

بالإضافة

$= \frac{2k_e \lambda_1}{r} + \frac{2k_e \lambda_2}{r}$

Ex.3 Infinite sheet (Plane, surface, Disk, ...)

Conducting

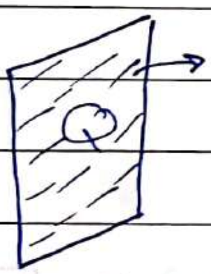
Non-Conducting

مطلوب إيجاد المجال على بعد قريب جداً.

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

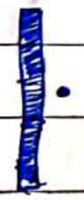
$E = \frac{\sigma}{\epsilon_0}$

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



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

$A = \pi r^2$
Disk



$\sigma = \frac{Q}{2A}$

لأن الجسم معدن
تنتقل الشحنة على الطرفين

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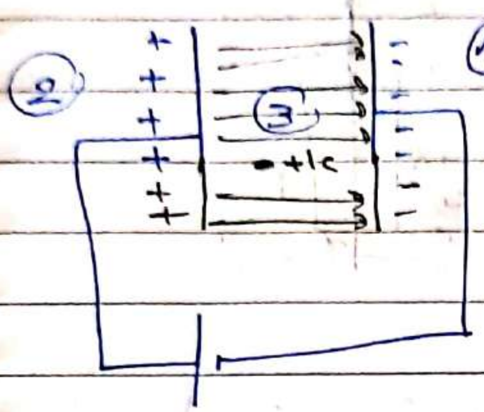
Non-Conducting Plane. $\left(E = \frac{\sigma}{2\epsilon_0}\right)$



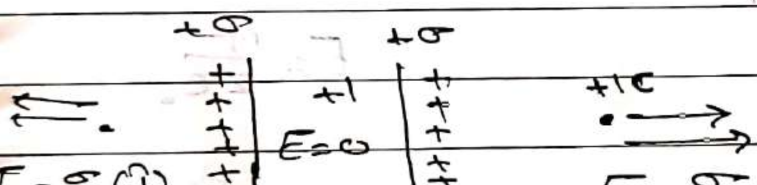
+1c

$$E_1 = \frac{\sigma}{2\epsilon_0}(-\hat{i}) + \frac{\sigma}{2\epsilon_0}(\hat{i}) = \text{zero}$$

المجال خارج الالواح يساوي صفر.

$$E_3 = \frac{\sigma}{2\epsilon_0}\hat{i} + \frac{\sigma}{2\epsilon_0}\hat{i}$$

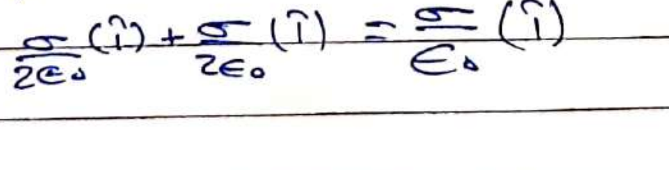
المجال داخل الالواح ⟸ $E_3 = \frac{\sigma}{\epsilon_0}$



$E = \frac{\sigma}{\epsilon_0}(-\hat{i})$

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

H.w.

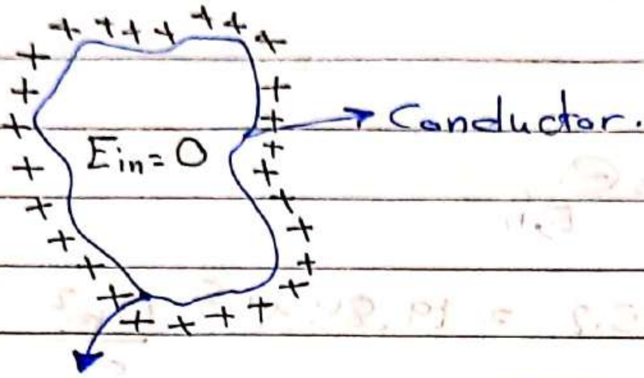


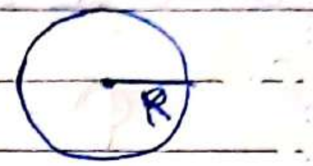
$$E = \frac{\sigma}{2\epsilon_0}(-\hat{i}) + \frac{\sigma}{2\epsilon_0}(-\hat{i}) = \frac{\sigma}{\epsilon_0}(-\hat{i})$$

$$E = \frac{\sigma}{2\epsilon_0}(\hat{i}) + \frac{\sigma}{2\epsilon_0}(\hat{i}) = \frac{\sigma}{\epsilon_0}(\hat{i})$$

Conductors in electrostatic equilibrium

موصلات في اتزان كهربائي.



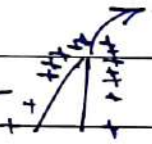


$$E_s = \frac{\sigma}{\epsilon_0} = \frac{k_e Q}{R^2}$$

$; \ r = R.$

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

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



سطح مدبب/حاد.

σ greatest.

Subject (740). اسئلة,الكتاب Date No.

$\frac{1}{740}$ Area $= 3.2\ m^2$

$E = 6.2 * 10^6\ N/c$

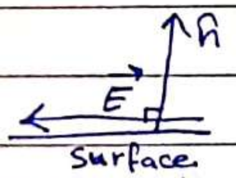
$\Phi = ?!$

a) $\vec{E} \perp$ Surface

$$\Phi = EA\cos\theta_{E,\hat{n}}$$

$$\Phi = 6.2 * 10^6 * 3.2 = 19.84 * 10^5\ \frac{Nm^2}{c}$$

b) $\vec{E}$ // Surface.



$\theta = 90°$

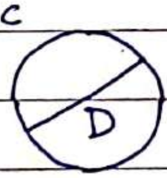
$$\Phi = EA\cos\theta_{E,\hat{n}}$$

$$\Phi = \text{Zero}.$$

$\frac{3}{740}$ Diameter: القطر ~> $D = 40$ cm

Radius: نصف القطر ~> $R = 20$ cm.

$\Phi^{max} = 5,2 * 10^5\ Nm^2/c$



اكبر تدفق لجسم يكون عندما الزاوية

تساوي ← θ (Zero) , π

Sol:-

$$\Phi = EA\cos\theta$$

$$E = \frac{\Phi^{max}}{\text{Area}} = \frac{5.2 * 10^5}{\pi * (0.2)^2} = 41,4 * 10^5\ N/c.$$

$\pi \rightarrow 3.14$

NOTEBOOK

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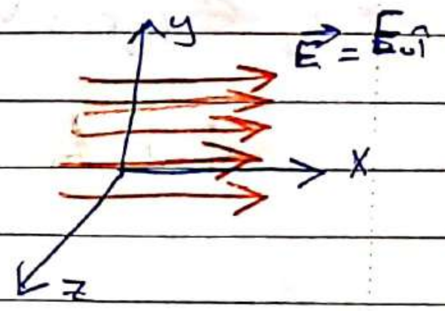
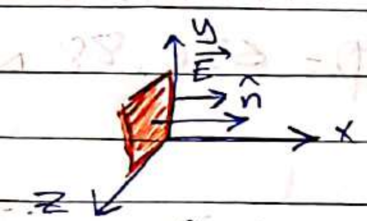
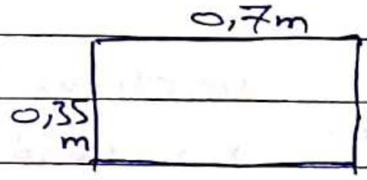
$E = 3.5\ KN/C$



a) Plane // yz





ح1 $\hat{n} = \hat{i}$

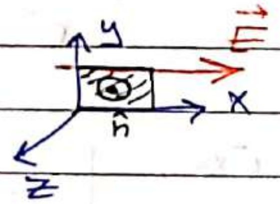
$\Phi = \vec{E}\cdot\vec{A}$

$\Phi = (E_0\hat{i})\cdot(A\hat{i}) = E_0 A$

ح2 $\Phi = EA\cos\theta_{\vec{E},\hat{n}}$

$\Phi = E_0 A = 3500 * 0,7 * 0,35 = 857,5\ \frac{Nm^2}{c}$

b) Plane // xy



$\hat{n} = \hat{k}$

ح1 $\Phi = \vec{E}\cdot\vec{A}$

$\Phi = (E_0\hat{i})\cdot(A\hat{k}) = \text{zero}$

ح2 $\Phi = EA\cos\theta_{\vec{E},\hat{n}}$

$\Phi = EA\cos 90 = \text{zero}.$

c) $\Theta_{\hat{n},E} = 40^\circ$

$$\Phi = EA\cos\Theta_{\hat{n},\vec{E}}$$

$$\Phi = 3500 * 0{,}7 * 0{,}35 * \cos(40)$$

$$\Phi = 656{,}88 \ N.m^2/C.$$

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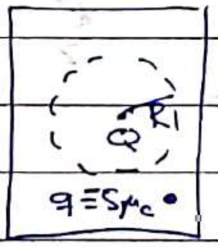
740.

un charge : غير مشحونة
non-conducting : عازلة
hollow-sphere : كرة مفرغة
$R = 10\,cm$, $Q = 10\,\mu C$

$$\Phi = \frac{q_{in}}{\epsilon_0} = \frac{Q}{\epsilon_0} = \frac{10*10^{-6}}{8{,}85*10^{-12}}$$

$$E = \frac{k_e Q}{r^2} = \frac{9*10^9*10*10^{-6}}{(0{,}1)^2} = 9*10^6$$

Ex.



$$\Phi_{\square} = \frac{Q+q}{\epsilon_0} \rightarrow \text{بالداخل}$$

$$\Phi_{\square} = \frac{5*10^{-6}}{8{,}85*10^{-12}} = 0{,}56*10^6$$
$$= 5{,}6*10^5$$

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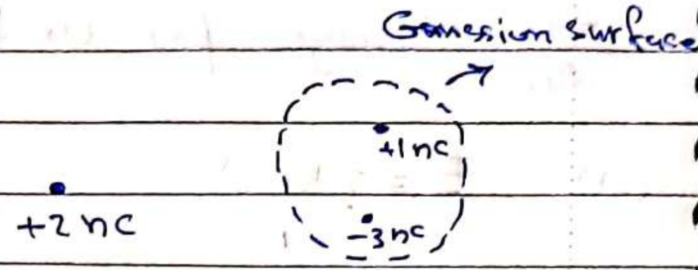
$$\Phi = \frac{Q+q}{\epsilon_0}$$



$$\Phi = \frac{(1-3)*10^{-9}}{8.85*10^{-12}}$$

$$\Phi = \frac{-2*10^{3}}{8.85} \frac{N m^2}{C} = -2.25*10^{2} \ Nm^2/C$$

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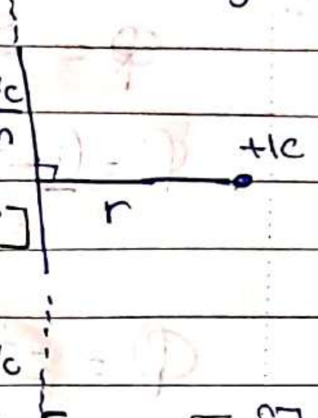
742 Charge per unit length : Rod : Long infinite



(a) $E = \frac{2k_e \lambda}{r}$ $\lambda = -90 \frac{\mu c}{m}$

$$E\Big|_{r=10cm} = \frac{2 * 9 * 10^{9} * 90 * 10^{-6}}{0.1} \; N/c \; [-\hat{i}]$$

$$E\Big|_{r=10cm} = [-\hat{i}] \; 162 * 10^{5} \; N/c$$

$$F = Q\,\vec{E} \Rightarrow 10 * 10^{-6} * 162 * 10^{5} \quad [-\hat{i}]$$

$$F = 162 \; [-\hat{i}] \; N$$

(b)
$$E\Big|_{r=20cm} = \frac{2 * 9 * 10^{9} * 90 * 10^{-6}}{0.2} \; N/c \; [-\hat{i}]$$

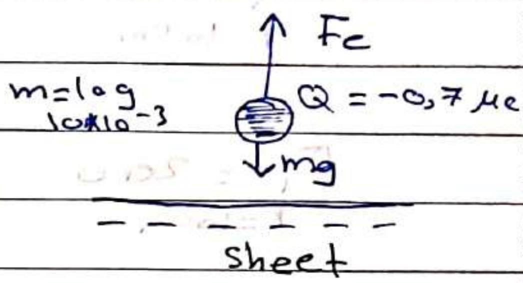
$$E\Big|_{r=20cm} = 81 * 10^{5}$$

(c)
$$E\Big|_{r=1m} = \frac{2 * 9 * 10^{9} * 90 * 10^{-6}}{1} \; [-\hat{i}]$$

$$E\Big|_{r=1m} = 162 * 10^{4} \; N/c$$

$\frac{25}{742}$ Large , Sheet , Plastic

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



$$F_e = mg$$

$$QE = mg$$

$$Q * \frac{\sigma}{2\epsilon_0} = mg$$

$$\sigma = \frac{2\epsilon_0 \, mg}{Q} = \frac{2 * 8,85 * 10^{-12} * 10 * 10^{-3} * 10}{0,7 * 10^{-6}}$$

$$\sigma = 2,52 * 10^{-6}$$

$\frac{27}{742}$ large , Sheet , non-Conducting

$$\sigma = 9 \frac{\mu c}{m}$$

$$E = \frac{\sigma}{2\epsilon_0} = \frac{9 * 10^{-6}}{2 * 8.85 * 10^{-12}} \; N/c$$

conducting $\Rightarrow E = \frac{\sigma}{\epsilon_0}$ *

Subject Date

Solid metelic sphere

مثال شائع

مفرغة

shell

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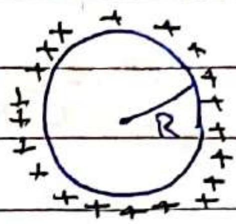
742

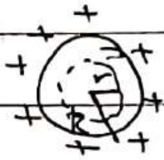
$E|_{r=10\,cm}$?!



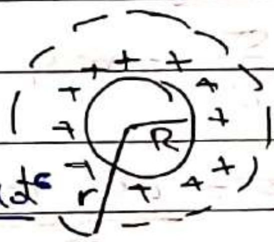
$R : 14\,cm$

$Q = 32\,\mu C$

$E|_{r=10cm} = zero$



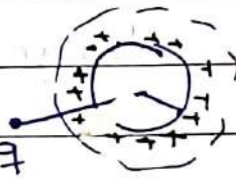
$E|_{r=20\,cm}$?!



$$E = K_e \frac{Q}{r^2} = \frac{9*10^9 * 32*10^{-6}}{(0,2)^2}$$

$E = 72*10^5\ N/C$

$F_e \rightarrow q$



$F_q = q\, E|_{r=20}$

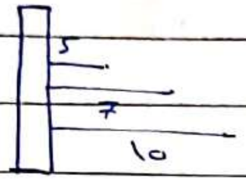
Surface Charge density.

$$\sigma = \frac{Q}{\text{مساحة } A} = \frac{Q}{4\pi R^2} = \frac{32*10^{-6}}{4(3.14)*(0.14)^2} = 1,29*10^{-4}$$

$\frac{34}{742}$ non-Conducting wall : larg sheet

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

$$\sigma = 8.6 \frac{\mu c}{m^2}$$



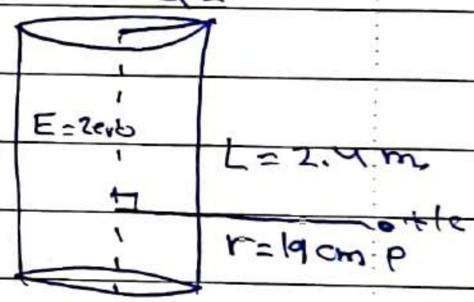
$$E = \frac{\sigma}{2\epsilon_0} = \frac{8.6 * 10^{-6}}{2 * 8.85 * 10^{-12}}$$

$r = 7$
10
5

$\frac{34}{742}$

$E_{in} = \text{zero}$

$E_{out} = ?!$ $r \geq 7cm.$

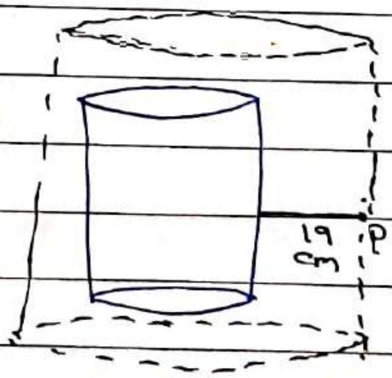


$Ep = 36 \, KN/C$

$$\oint E\,da = \frac{q_{in}}{\epsilon_0} = \frac{\sigma A}{\epsilon_0}$$

$$E(2\pi r L) = \frac{\sigma}{\epsilon}[2\pi a L]$$

$$E_{out} = \frac{\sigma \cancel{2}\pi a}{\cancel{2}\pi \epsilon_0 r} = \frac{\sigma a}{\epsilon_0 r}$$



$$\sigma = \frac{\epsilon_0 \, r \, E_{out}}{a}$$

$$\sigma = \frac{8.85 * 10^{-12} * 0.19 * 36000}{(0.07)} = 0.865 \, \mu C/m^2$$

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$$Q = \sigma A = \sigma \, [2\pi a L]$$

$$Q = 0{,}865\,(2 * 3{,}14 * 0{,}07 * 2{,}4)$$

$$Q = 0{,}9126\ \mu C$$

N O T E B O O K

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Charge is distriubed throughout its volume: كلة [ρ]

$E = ?$

a) $r = 0$

$$E = \begin{cases} \dfrac{\rho r}{3\epsilon} & r < R \\ \dfrac{k_e Q}{r^2} & r \geq R \end{cases}$$

$$E\Big|_{r=0} = \text{zero}$$

b) $E\Big|_{r=10cm} = ?$

$$\rho = \frac{Q}{\text{volume}} = \frac{26 * 10^{-6}}{\frac{4}{3}\pi (0,4)^3}$$

$$\rho = 97 * 10^{-6} \ \mu c/m^2$$

$$E_{in} = \frac{\rho}{3\epsilon_0} r = \frac{97 * 10^{-6} * 0,1}{3 * 8,85 * 10^{-12}}$$

c) $E\Big|_{r=40cm.} = \dfrac{k_e Q}{r^2} = \dfrac{9 * 10^{9} * 26 * 10^{-6}}{0,4}$ N/c.

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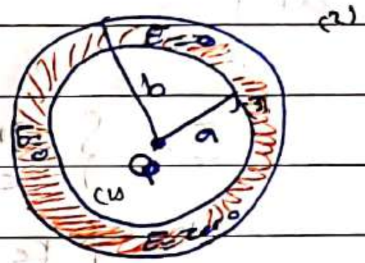
Conducting spherical shell.

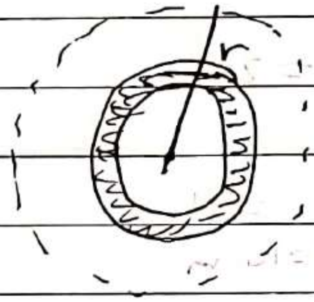
inner, outer } radii — نصف قطر داخلي وخارجي



(1) $0 < r < a$

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

(2) $r > b$

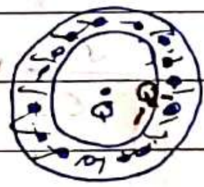


$$E = \frac{k_e Q}{r^2}$$

(3) $E_3 = zero$.

Induced Charge الشحنة بالحث!

السطح الداخلي للكرة يحمل شحنة معاكسة للشحنة.



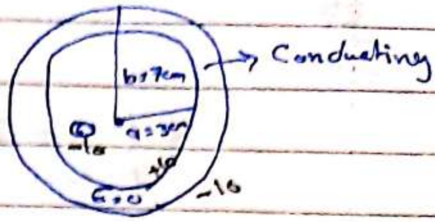
$$\oint E_3 \, dA = \frac{q_{in}}{\epsilon_0} = zero$$

$$E_3 = zero.$$

NOTEBOOK

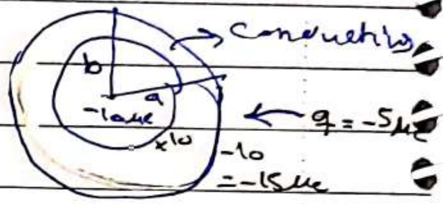
$Q = -10\ \mu c$

(1) what is the Charges on the inner and outer radii of the conducting spherical shell?



inner $\rightarrow +10\ \mu c$, outer $\rightarrow -10\ \mu c$

(2) what is the Charge on the inner and outer radii?

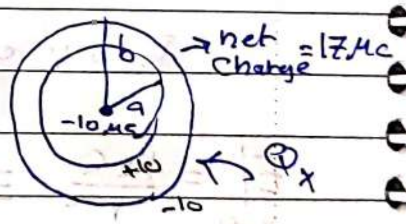


inner $\rightarrow +10\ \mu c$

outer $\rightarrow -15\ \mu c$

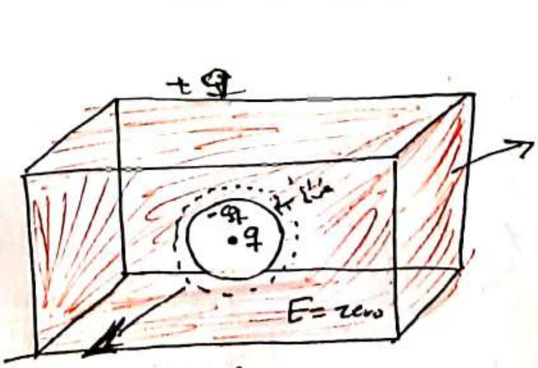
$$E_{net} = \frac{k_e\,(Q+q)}{r^2} \quad ; \quad r > b$$

(3) what is the unknow Charge Q_x?



$-10 + Q_x = 17$

$Q_x = 27\ \mu c$



metalic blok.

Gaussian surface.

Φ = zero

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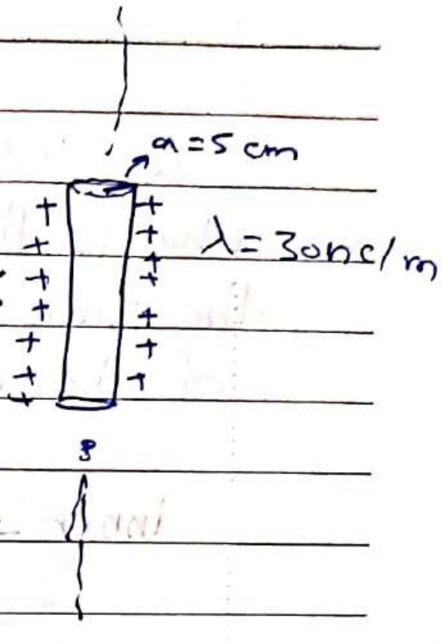


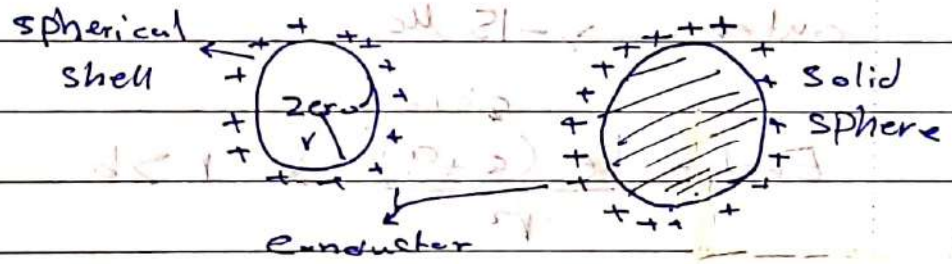
$E\big|_{r=3cm} = zero$

$E\big|_{r=10} = \dfrac{2ke\lambda}{r}$

$E\big|_{r=10} = \dfrac{2*9*10^9 * 30*10^{-9}}{0.1}$

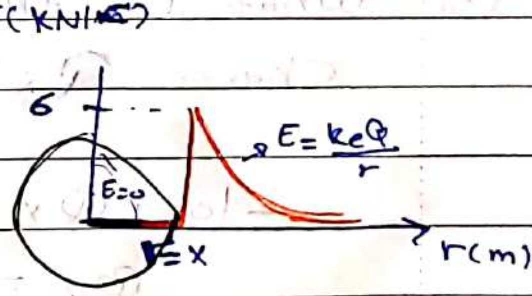
$E = 54*10^2 \; N/c$

الاربعاء ٢٨/٧/٢٠٢١ 10



38
743

$R = 0.15 \; cm$



$E\big|_{r=R} = \dfrac{keQ}{r^2} = \dfrac{\sigma}{\epsilon_0}$

$6000 = \dfrac{9*10^9 * Q}{0.15^2} \Rightarrow Q = \dfrac{6000 * 0.15^2}{9*10^9} = 15*10^{-9} C$

$Q = 15 \; nC$

$\frac{38}{743}$

$$E_s = 6000 = \frac{\sigma}{\epsilon_0}$$

b

$$\sigma = 6000\,\epsilon_0$$

$$\sigma = 6000 * 8.85 * 10^{-12}$$

$$\sigma = 58.1\ nc/m^2$$

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

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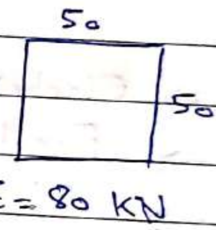
$\frac{44}{743}$



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

$$\sigma = E\,\epsilon_0$$

$$\sigma = 80 * 10^3 * 8.85 * 10^{-12}$$

$$\sigma = 708\ nc/m^2$$

$$\sigma = \frac{Q}{2A} \Rightarrow Q = \sigma(2A)$$

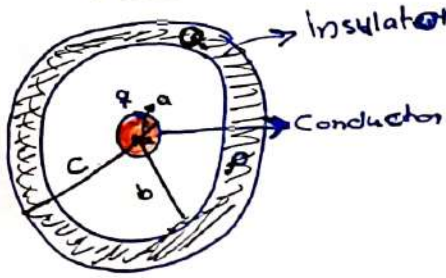
$$Q = 708\,(2 * 0,5^2)$$

$$Q = 354\ nc$$

$\frac{54}{7434}$

$a = 1\ cm$
$b = 5\ cm$
$c = 7\ cm$
$\rho = 9\ nC/m^3$
$q = -2\ nC$

sphere



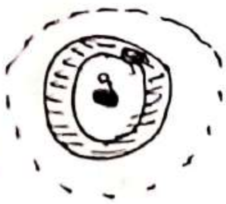
a) $E\Big|_{r=0.5\ cm} = \text{Zero}$

b) $E\Big|_{r=3cm} = \frac{K_e Q}{r^2}$

$E = \frac{9*10^9 * 2*10^{-9}}{(3*10^{-2})^2}\ N/C$

(Inwords)

(c) $E\Big|_{r=10cm} = \frac{K_e\ (Q+q)}{r^2}$



$\rho = \frac{Q}{Volume}$

$Q = \rho\ Volume$

$Q = \rho\ [V_c - V_b]$

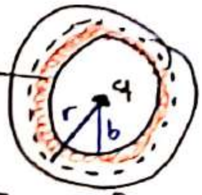
$Q = \rho * \frac{4\pi}{3} [c^3 - b^3]$

$Q = \frac{4\pi}{3} * 9 * (7^3 - 5^3)\ (10^{-2})^3\ nC$

$Q = 0.00821\ nC$

$E\Big|_{r=10cm} = \frac{9*10^9\ (0.821 - 2)*10^{-9}}{0.1^2} =$ inwords.

$\rho = \frac{Q}{Volume}$



$q_{in} = \rho * Volume$

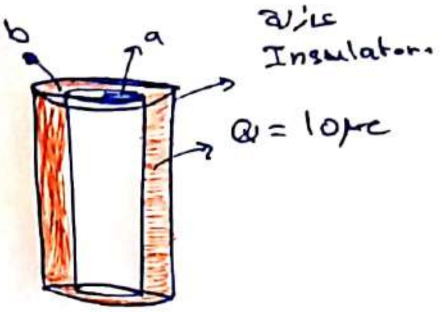
$q_{in} = \rho * \frac{4\pi}{3} (r^3 - b^3) = 9 * \frac{4\pi}{3} [6^3 - 5^3] (10^{-2})^3 = 0.0034\ nC$

$E\Big|_{r=6cm} = \frac{9*10^9\ (-2*10^{-9} + q_{in})}{0.06^2} = \frac{9*10^9 (-2 + 0.0034)*10^{-9}}{0.06^2}\ N/C$

(Inwords)

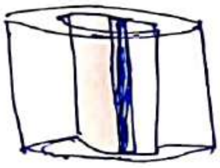
Ex. $a = 5\ mm$

$b = 20\ mm.$ $L = 2.4\ m$



1) Find $E|_{r=2mm} = \text{zero}$

اذا كان موجود سلك داخل الاسطوانة -



يكون عبارة $\frac{2ke\lambda}{r}$

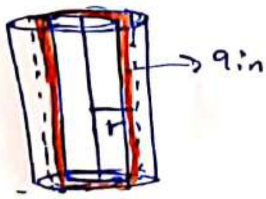
2) $E|_{r=30\ mm}$

$$\int E\,dA = \frac{q_{in}}{\epsilon_0} = \frac{Q}{\epsilon_0}$$

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

$$E = \frac{10 * 10^{-6}}{2\pi * 2.4 * 8.85 * 10^{-12} * 30 * 10^{-3}}$$

3) $q_{in} = \rho V$



$$q_{in} = \rho(V_r - V_a)$$

$$q_{in} = \rho \pi L (r^2 - a^2)$$

$$\rho = \frac{Q}{V} = \frac{Q}{\pi L (b^2 - a^2)}$$

$$\rho = \frac{10}{\pi * (2.4) * (20^2 - 5^2)(10^{-3})^2} = 3.5\ mc/m^3$$

$$q_{in}|_{r=10\ mm} = 3.5 * \pi (2.4) * (10^2 - 5^2)(10^{-3})^2$$

$$q_{in} = 1.97\ \mu c$$

$$q_{in} \approx 2\ \mu c$$

$$\int E\,dA = \frac{q_{in}}{\epsilon_0} = \frac{2 * 10^{-6}}{8.85 * 10^{-12}}$$

$$E(2\pi r L) = \frac{2 * 10^{-6}}{8.85 * 10^{-12}} \Rightarrow E = \frac{2 * 10^{+6}}{8.85 * 2\pi * 2.4 * 10 * 10^{-3}}\ N/C$$

CH. 25 Electric Potential

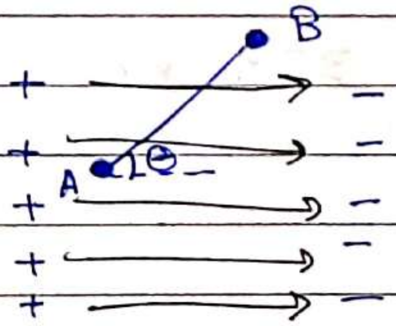
الجهد الكهربائي.

$\left.\begin{array}{l}\rightarrow \text{Electric Force} \\ \rightarrow \text{Electric field}\end{array}\right\}$ vector

$\left.\begin{array}{l}\rightarrow \text{Flux} \\ \rightarrow \text{electric Potential}\end{array}\right\}$ scaler.

* which of the following is a vector quantity

• Difference in electric Potential Energy



$\vec{F_e} = q_o \vec{E}$

$w = \vec{F} . d$

$w = Fd \cos\theta$

$w = F(AB) \cos\theta$

$w = q_o \vec{E} . \vec{d}$

$w = -\Delta u$

$\Delta u = -w$

$u_f - u_i = -q_o \vec{E} . \vec{d}$

The difference in e.p.E is the negative of the work done on the charged

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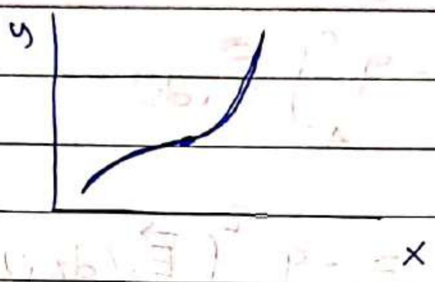
Particle moving it from the point (A) to Point (B)

$$\Delta u = -q_0 \int \vec{E} \cdot d\vec{s}$$



$d\vec{s} = \pm dx\,\hat{i} \mp dy\,\hat{j}$

we define the difference in electric Potential: V

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

$$V_f - V_i = -\int_A^B \vec{E} \cdot d\vec{s}$$

uniform electric field

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

$$\Delta V = -E_0 d \cos\theta$$

$$V_f - V_i = E \cdot d$$

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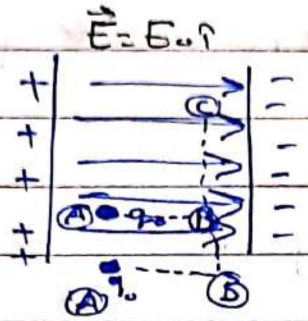

$$\omega_{A\to C} = -q_0 \int_A^C \vec{E} \cdot d\vec{s}$$

$$\omega_{A\to C} = -q_0 \int_A^B \vec{E} \cdot (dx\hat{i}) - q_0 \int_B^C \vec{E} \cdot (dy\hat{j})$$

$$\omega_{A\to C} = -q_0 \int_A^B (E_0\hat{i}) \cdot (dx\hat{i}) - q_0 \int_B^C (E_0\hat{i}) (dy\hat{j})$$

$$\omega_{A\to C} = -q_0 E_0 \int_A^B dx - q_0 E_0 \underbrace{\cancel{\int_B^C dy\, \hat{i}\hat{j}}}_{\text{zero}}$$

$$\omega_{A\to C} = -q_0 E$$

$$\omega_{A\to C} = -\Delta U_{A\to C}$$

$$\omega_{A\to B} + \omega_{BC} = -\Delta U_{A\to B} - \Delta U_{B\to C}$$

$$\Delta U_{BC} = \text{zero} = q_0 \Delta V_{B\to C}$$

$$U_B = U_C \iff V_B = V_C$$

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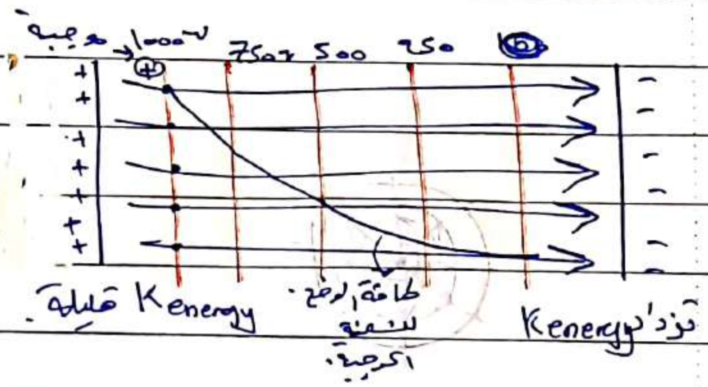
$$W_{A\to B} = -\Delta U_{A\to B}$$

$$-\cancel{q_0}\,\Delta V_{A\to B} = -\cancel{q_0}\,E_0\,d$$

$$V_B - V_A = E_0\,d$$



$\Delta U + \Delta K = zero$

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

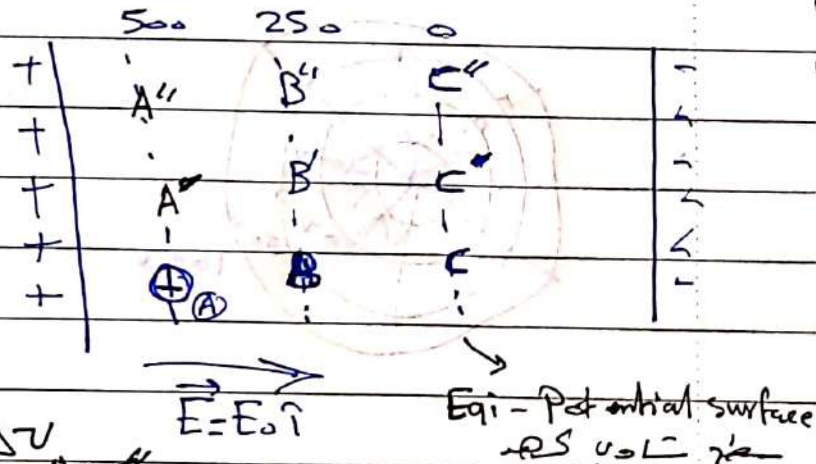
$K = \frac{1}{2} m v^2$

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

$= -q\,\Delta V_{A\to A''}$

$= -q_0\,[V_{A''} - V_A]$

$W_{A\to A''} = zero$



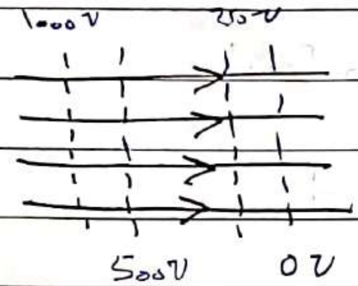
$W_{A\to C''} = -\Delta U_{A\to C''} = -q\,\Delta V_{A\to C''}$

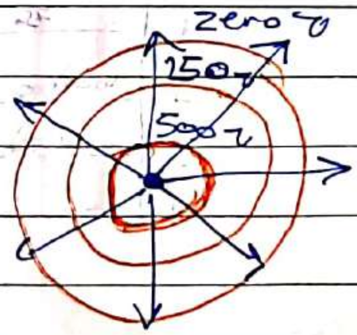
$= -q\,(V_{C''} - V_A) = q\,(0 - 500) = 500q$

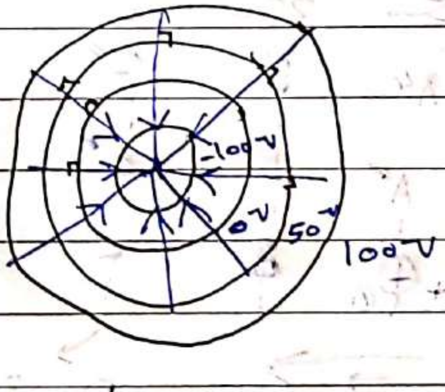
الشغل الموجب يمكن الاستفادة منه اما الشغل السالب لا يمكن الاستفادة منه بل يخسر.

NOTEBOOK

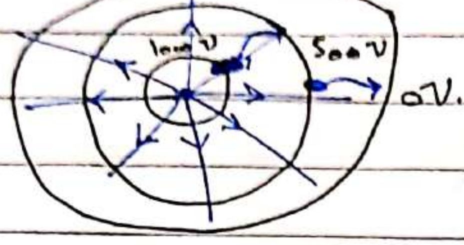
Equi - Potential surfaces: سطوح تساوي كهد







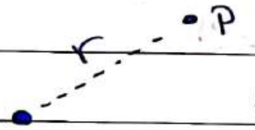
سطوح تساوي كهد
ومخطوط مجال دائماً
الزاوية بينهما
90°



% الشغل اللازم لنقل شحنة
من سطح الى سطح اخر يساوي
نفس المقدار بالتالي اذا كان
نفس سطح تساوي الجهد
الشغل اللازم لنقل شحنة على نفس السطح يساوي صفر.

$$\Delta V = -\int E\,ds$$

obtaing the electri Potetional of a Point charge



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

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

$$\Delta V = -\int \frac{k_e Q}{r^2}\,ds$$

$$\Delta V = \frac{k_e Q}{r} \quad , \quad V_p = \frac{k_e Q}{r}$$

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obtaining the electric field from the electric Potential

$$V = -\int E\,dx$$

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

$$\vec{E} = -\frac{\partial v}{\partial x}\hat{i} - \frac{dv}{\partial y}\hat{j} - \frac{\partial v}{dz}\hat{k}$$

Example: $v(x,y,z) = 5xyz$

Find $\vec{E}(x,y,z) = ?!$

$$\frac{\partial v}{dx} = 5yz \;;\; \frac{dv}{\partial y} = 5xz \;,\; \frac{dv}{\partial z} = 5xy$$

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

$$\vec{E}(0,1,1) = 5\hat{i} \;,\; |E| = 5\,N/C$$

Ex: $V(x) = \frac{-1}{x}$, $E(x)\Big|_{x=10} = ?$

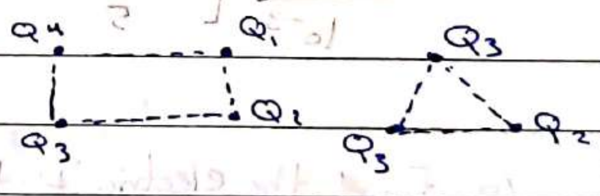
Sol: $E(x) = -\frac{\partial V}{\partial x}$

$$\frac{\partial V}{\partial x} = \frac{\partial}{\partial x}(-x^{-1}) = x^{-2} = \frac{1}{x^2}$$

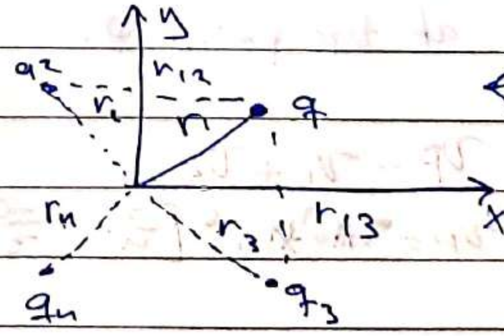
$$E(x) = \frac{-1}{x^2} \qquad E(10) = \frac{-1}{100} \ N/C$$

Find The energy stored in a system of Charge Particle?

Find the work required to assemble the charged particle on their Position?



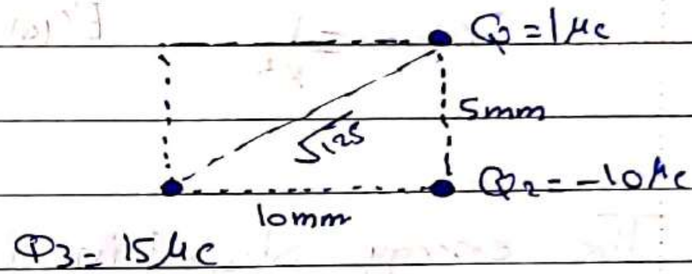
$\frac{Ke\, q_1 q_2}{r_{12}}$



q_2, q_3, q_4

$$w = U = \frac{Ke\, q_1 q_2}{r_{12}} + \frac{Ke\, q_1 q_3}{r_{13}} + \frac{Ke\, q_2 q_3}{r_{23}} + \frac{Ke\, q_1 q_4}{r_{14}} + \frac{Ke\, q_2 q_4}{r_{24}} + \frac{Ke\, q_3 q_4}{r_{34}}.$$

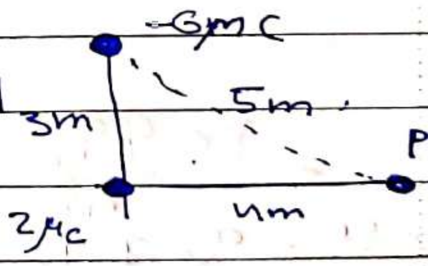
Ex :



$$U = K_e \frac{q_1 q_2}{r}$$ بالإشارة

$$U = \frac{K_e * 10^{-6}}{10^{-3}} \left[\frac{(1)(-10)}{5} + \frac{(1)(15)}{\sqrt{125}} + \frac{(-10)(15)}{10} \right] J$$

Ex: (a) Find the electric Potential at the Point P.



$$V_P = V_1 + V_2$$

$$V_P = 9*10^{9}*10^{-6} \left[\frac{2}{4} + \frac{-6}{3} \right] = -6{,}29 * 10^{3}\ V$$

(b) Find the charge in Potential energy of a $3\,\mu c$ charge as it moves from infinity to the Point P.

$$\Delta U = U_f - U_i$$

$$U_P - \cancel{U_\infty} \text{ Zero.}$$

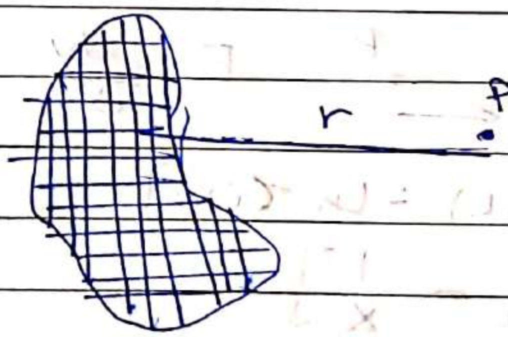
$$\Delta U = q_0 V_P = 3 \times 10^{-6} (-6.29) \times 10^{3}$$

→ الاشارة

$$= -18.9 \text{ mJ}$$

$$W = -\Delta U = 18.9 \text{ mJ}$$

Electric Potential due to cts Charge distribution.

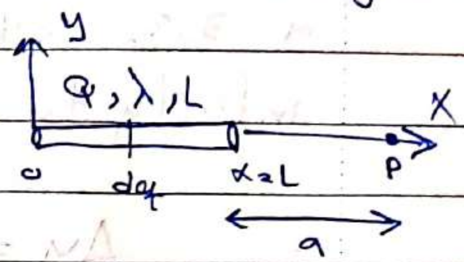


$$V_P = K_e \int \frac{dq}{r}$$

Charge.

Subject Date No.

Ex: The electric Potential due to a charge Rod:



$$v_p = \int \frac{K_e\, dq}{(a+L-x)} = K_e \int_0^L \frac{\lambda\, dx}{(a+L-x)}$$

$$v_p = -K_e \lambda \int \frac{dx}{(x-a-L)} \quad , \quad u = x-a-L$$

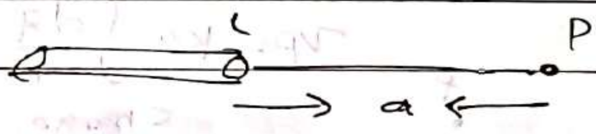
$$du = dx$$

$$\int \frac{du}{u} = \quad = -K_e \lambda \, Ln|x-a-L| \Big|_0^L$$

$$= -K_e \lambda \, Ln|a| - Ln|a+L|$$

$$= -K_e \lambda \, Ln \frac{a}{a+L}$$

$$v_p = K_e \lambda \, Ln \left| \frac{a+L}{a} \right|$$



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

$$V(x) = K_e L [Ln(x+L) - Ln(x)]$$

$$\frac{dV}{dx} = K_e L \left[\frac{1}{x+L} - \frac{1}{x}\right]$$

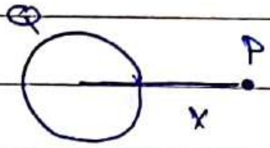
$$K_e \lambda \left[\frac{\cancel{x} - \cancel{x} - L}{x(x+L)}\right] = \frac{-K_e L \lambda}{x(x+L)}$$

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

N O T E B O O K

Ex: electric Potential due to acharged Ring

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



$$V(x) = -\int E(x)\, dx$$

$$V(x) = -k_e Q \int \frac{x\, dx}{(x^2+R^2)^{3/2}} \qquad u = x^2+R^2$$

$$du = 2x\, dx,$$

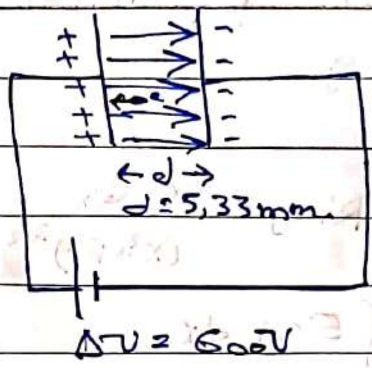
$$dx = \frac{du}{2x}$$

$$V(x) = -k_e Q \int \frac{\cancel{x} \cdot \frac{du}{2\cancel{x}}}{u^{3/2}} = -\frac{k_e Q}{2} \int u^{-3/2} = \frac{-k_e Q}{\cancel{2}} \left[\frac{-\cancel{2}}{u^{1/2}} \right]$$

$$V = \frac{k_e Q}{\sqrt{x^2+R^2}}$$

Subject حل اسئلة الكتاب Date No.

$\frac{1}{769}$



(a) E?

$$\Delta V = Ed$$

$$E = \frac{\Delta V}{d} = \frac{600}{5,33 * 10^{-3}} \; N/C$$

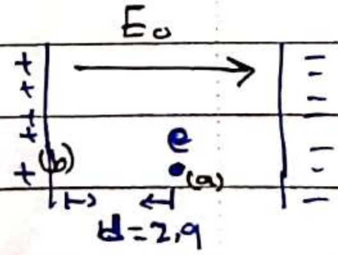
$$E = 112.57 * 10^{3} \; N/C$$

(b) $F = q_0 E.$

$$F = 1,6 * 10^{-19} * \frac{600}{5,33 * 10^{-3}} \; N$$

$$F = 180 * 10^{-16} \; N$$

(c)



$$\underset{A\to B}{W} = -\underset{A\to B}{\Delta U}$$

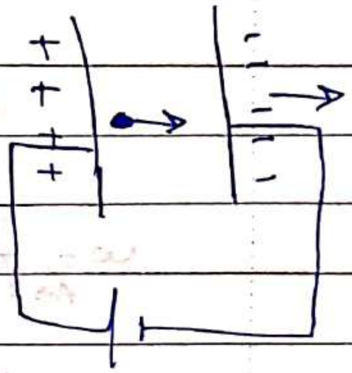
$$W = -q_0 \underset{A\to B}{\Delta V} = -q_0 [V_B - V_A]$$

$$\Delta V = -\int_A^B \vec{E} \cdot ds = -\int_{2,9}^{0} (E_0 \hat{i}) \cdot (-dx\,\hat{i}) = E_0 \int_{2.9}^{0} dx$$

N O T E B O O K

$\frac{3}{769}$ Proton $\rightarrow m_p = 1{,}67 \times 10^{-27}$ K

$+e = +1{,}6 \times 10^{-19}$



$\Delta U + \Delta K = 0$

$\Delta K = -\Delta U$

$K_f - K_i = -q_0 \Delta V$

$\Delta V = 120$

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

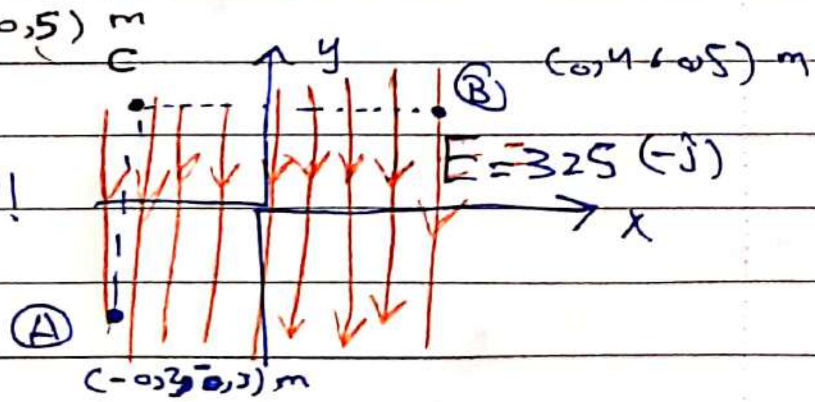
$\frac{1}{2} m v_f^2 - 0 = -q_0 \Delta V$

$v_f^2 = \frac{-2 q_0 \Delta V}{m} \Rightarrow v_f = \sqrt{\left|\frac{2 e \Delta V}{m}\right|}$

$v_f = \sqrt{\frac{2 \times 1{,}6 \times 10^{-19} \times 120}{1{,}67 \times 10^{-27}}}$ m/s.

$\frac{5}{769}$

$V_B - V_A = ?!$



$$v_B - v_A = -\int_A^B E \cdot ds$$

$$= -\left[\int_A^C 325(-\hat{j})\cdot(dy\,\hat{j}) + \cancel{\int_C^B 325(-\hat{j})\cdot(dx\,\hat{i})}\right]$$

Zero

$$325\int_{-0,3}^{0,5} dy = 325 * 0,8 = 278\ v$$

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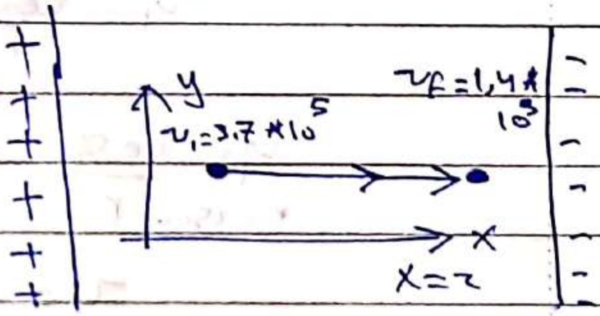
$$m_e = 9.11 * 10^{-31}$$

$$-e = -1,6 * 10^{-19}\ c$$



$$v^2 = v_i^2 + 2a\,\Delta x$$

$$(1,4 * 10^5)^2 = (3.7 * 10^5)^2 + 2a(2 * 10^{-2})$$

$$4 * 10^{-2} a = (1.4 * 10^5)^2 - (3.7 * 10^5)^2$$

$$4 * 10^{-2} a = -1,367 * 10^{13}$$

$$a = -0,34 * 10^{15}$$

$$\frac{q_o E}{m_e} = -34 * 10^{13}\ m/s^2$$

$$E_o = \frac{m_e * -34 * 10^{13}}{-1,6 * 10^{-19}} = \frac{9.11 * 34 * 10^{-18}}{1.6 * 10^{-19}} = 1936\ v/m$$

$\Delta V = -Ed$

$\Delta V = -1936 * 2 * 10^{-2}\ V/m$

$V_f - V_i = -1936 * 2 * 10^{-2}\ V/m$

$V_i > V_f$

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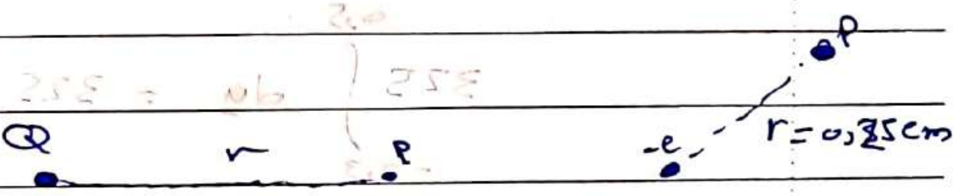

$V_p = \frac{k_e Q}{r}$, $E_p = \frac{k_e Q}{r^2}$

$V\Big|_{r=25cm} = \frac{k_e q}{r} = \frac{9*10^9(-1,6*10^{-19})}{0,25*10^{-2}}\ V$

$V\Big|_{r=75cm} = \frac{9*10^9(-1,6*10^{-19})}{0,75*10^{-2}}\ V$

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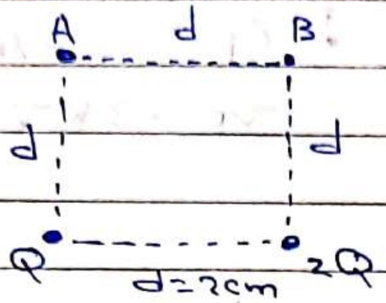


$Q = 5nC$

$v = K_e \frac{q}{r}$

$\Rightarrow V_A = V_Q + V_{2Q}$

$$V_A = \frac{9*10^9 * 10^{-9}}{10^{-2}} \left[\frac{5}{2} + \frac{10}{2\sqrt{2}} \right]$$

$\Rightarrow V_A = 900 * \frac{5}{2} (1 + \sqrt{2}) = 5400\ V$

$$\Rightarrow V_B = \frac{9*10^9 * 10^{-9}}{10^{-2}} \left[\frac{5}{2\sqrt{2}} + \frac{10}{2} \right]$$

$\Rightarrow V_B = 900 * 5 \left(1 + \frac{1}{2\sqrt{2}}\right) = 6090\ V$

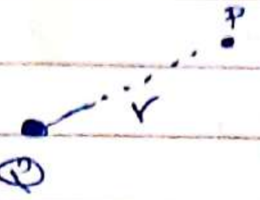
$V_B - V_A = 6090 - 5432 = 658\ V$

$w_{B\to A} = -\Delta U_{B\to A} = -q_0 \Delta V_{B\to A}$ $A \xleftarrow{w_{B\to A}} B$ $q_0 = -3nC$

$= -q_0 [V_A - V_B]$

$= 3*10^{-9}(-658) = -1974*10^{-9}\ J$

$\frac{20}{771}$



$E_p = 500\ V/m$

$V_p = -3\ kV$

$$E_p = \frac{k_e Q}{r^2} \quad ; \quad V = \frac{k_e Q}{r}$$

$$\frac{E_p}{V_p} = \frac{\cancel{k_e Q}}{r^2} * \frac{\cancel{r}}{\cancel{k_e Q}}$$

$$\frac{1}{r} = \frac{E_p}{V_p}$$

$$r = \frac{V_p}{E_p} = \frac{3000}{500}$$

$$r = 6m$$

$$Q = \frac{V_p\ r}{k_e} \Rightarrow \frac{-3000 * 6}{9 * 10^9}\ C$$

$$Q = -2000 * 10^{-9}$$

$$Q = -2 * 10^{-6}\ C$$

$$\vec{E} = (6xy-5)\hat{i} + (3x^2-2z^2)\hat{j} - 4yz\hat{k}$$

$$\vec{E}(1,0,-2) = -5\hat{i} - 5\hat{j}$$

$$|E| = \sqrt{(5)^2+5^2} = 5\sqrt{2}\ \text{V/m.}$$

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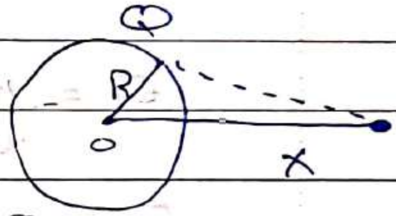
$\frac{43}{772}$



$$V(x) = \frac{k_e Q}{\sqrt{x^2+R^2}}$$

$$V(x=0) = \frac{k_e Q}{R}$$

$$V(2R) = \frac{k_e Q}{\sqrt{5}R}$$

$$\Rightarrow \Delta V = V_0 - V_{2R} \Rightarrow \Delta V = \frac{k_e Q}{R}\left(1 - \frac{1}{\sqrt{5}}\right)$$

$$W_{0\to 2R} = -\Delta U_{0\to 2R} \Rightarrow W_{0\to 2R} = -q_0 \Delta V_{0\to 2R}$$

$$W = -q[V_{2R} - V_0]$$

$$W = -\frac{q_0 k_e Q}{R}\left(\frac{1}{\sqrt{5}} - 1\right)$$

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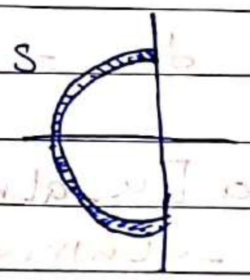
772

$L = 14cm \; ; \; Q = -7.5 \mu c$

bent into
كحنى



$E =$

$S = R\theta \Rightarrow S = R\pi$

$R = \frac{S}{\pi} \Rightarrow R = \frac{14}{\pi} cm.$

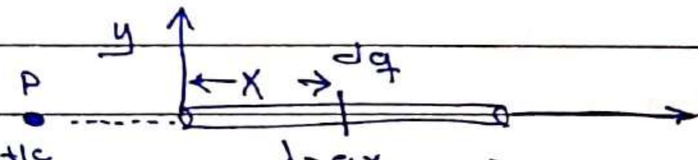
$V = \int \frac{K_e \, dq}{r} = \frac{K_e}{r} \int dq$

$$\boxed{V = \frac{K_e Q}{R}}$$

$V = \frac{9 * 10^9 * -7.5 * 10^{-6}}{(14 * 10^{-2} / \pi)} \; V$

$V =$

45
772



(a) $a = \frac{\lambda}{x} \Rightarrow [a] = \frac{[\lambda]}{[x]} = \frac{c/m}{m} = c/m^2$

$V = K_e \int \frac{dq}{\cancel{x} + a} = K_e \int \frac{\lambda \, dx}{x + a}$

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$$= Kea\int \frac{x\,dx}{x+a} \qquad u = x+a \qquad du = dx$$

$$= Ke\,a\int \frac{u-a}{u}\,du = Ke\,a\int 1-\frac{a}{u}\,du$$

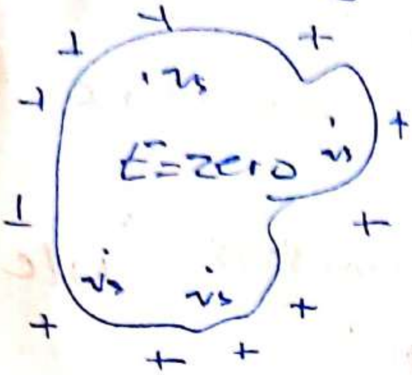
$$= Ke\,a\,[u - a\,Ln\,u]$$

$$= Ke\,a\,[x+a - a\,Ln|x+a|]$$

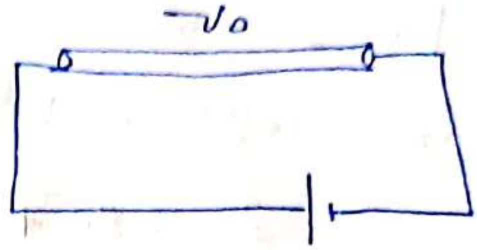
$$= Ke\,a\,[L+a - a\,Ln|L+a|]$$

$$= -Ke\,a\,[a - a\,Ln\,a]$$

=) Charged Conductor



$$E_s = \frac{\sigma}{\varepsilon_0}$$

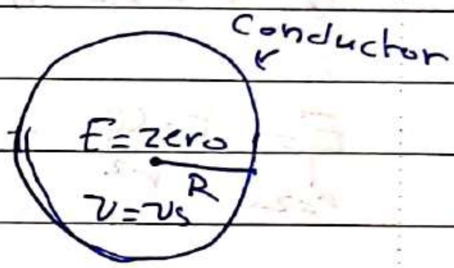


$\frac{49}{773}$

$R = 0,3\ m$

$|V_s| = 7.5\ kV$

$r=R = 7500\ V$



$$V_s = \frac{k_e Q}{r}\Big|_{r=R}$$

$$7500 = \frac{9*10^9*Q}{0,3} \Rightarrow Q = \frac{0,3*7500}{9*10^9}$$

$$Q = 250\,nC$$

$$Q = Ne \Rightarrow 250*10^{-9} = N * 1.6*10^{-19}$$

$$N = \frac{250*10^{-9}}{1.6*10^{-19}} = 156.25*10^{10}\ \text{electron}$$

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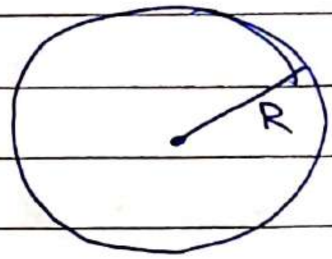
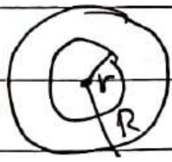
773

$R = 14 cm.$

$Q = 26 \mu c$



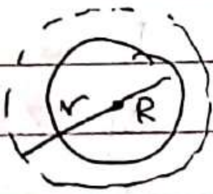
(1) $r = 10 cm$



$E\Big|_{r=10cm} = zero$

$V\Big|_{r=10cm} = \frac{ke\,Q}{r} = \frac{9*10^{9} * 26*10^{-6}}{0{,}14}$

(2)- $r = 20 cm$



$E\Big|_{r=20} = \frac{ke\,Q}{r^2} = \frac{9*10^{9} * 26*10^{-6}}{(0{,}2)^2}$

$V\Big|_{r=20} = \frac{ke\,Q}{r} = \frac{9*10^{9} * 26*10^{-6}}{0{,}2}\ v$

(3) $r = R$

$E\Big|_{r=14cm} = \frac{ke\,Q}{r^2} = \frac{9*10^{9} * 26*10^{-6}}{(0{,}14)2}$

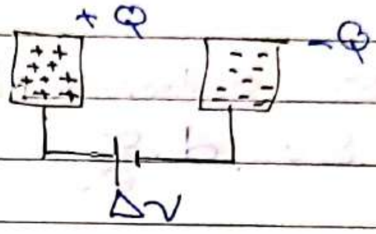
$V = \frac{ke\,Q}{r} = \frac{9*10^{9} * 26*10^{-6}}{0{,}14}$

NOTEBOOK

Subject Ch. 26 - Capacitance Date No.

Dielectrics. العوازل الكهربائية

(1) Definition of Capacitance:



we definite the Capacitance as :-

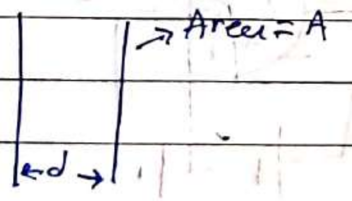
$$C = \frac{Q}{\Delta V}$$

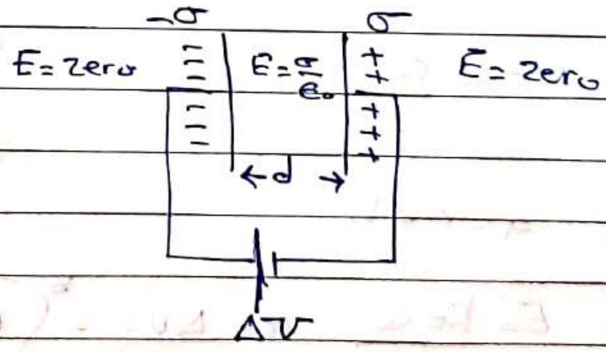
$$[C] = \frac{[Q]}{[V]} = \frac{C}{V} = \text{Farad} = F$$

pF =
nF =
μF =
mF =

→ How to Calculate the Capacitance

Ex: 1 Parallel plate Capacitor





A: Area.

d: Separtion (distance) between the Plates

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

$\left|\frac{\sigma}{\epsilon_0}\right|$ $\rightarrow d \leftarrow$

ΔV = distance * electric field

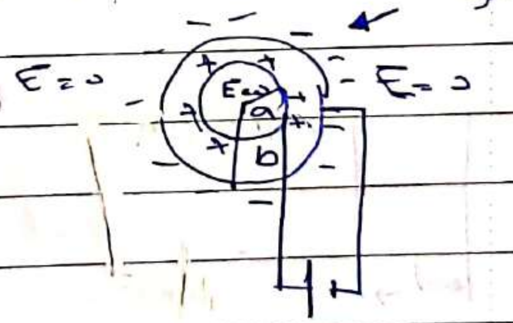
$$\Delta V = d \cdot \frac{\sigma}{\epsilon_0} \quad , \quad \sigma = \frac{Q}{Area}$$

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

$$C = \frac{\cancel{Q}}{\frac{d \cancel{Q}}{\epsilon_0 A}} \Rightarrow C_{Parall} = \frac{\epsilon_0 A}{d} \Leftarrow \text{حفظ}$$

المواسع لا يعتمد على الشحنة

Ex.2 spherical Capacitor. كرة



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

$a < r < b$

$$E = \frac{k_e Q}{r^2} \Rightarrow \Delta V_{a \to b} = -\int_a^b E\,dr = -\int_a^b E\,dr$$

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

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

$$|\Delta V| = \frac{k_e Q (b-a)}{ab}$$

NOTEBOOK

$$C = \frac{Q}{\Delta V} = \frac{\cancel{Q}}{\frac{K_e \cancel{Q} (b-a)}{ab}}$$

$$C_{spher} = \frac{ab}{K_e (b-a)} = \frac{4\pi\epsilon_0 ab}{(b-a)}$$

→ Isolated sphere: كرة معزولة

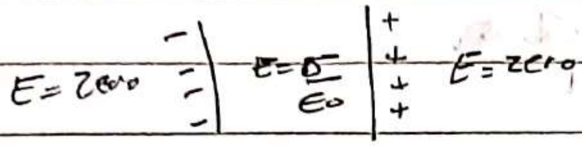
$$C = \frac{4\pi\epsilon_0 ab}{(b-a)}$$

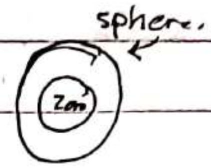
$$\boxed{C = 4\pi\epsilon_0 a}$$

water dorplet قطرة ماء.

Iso

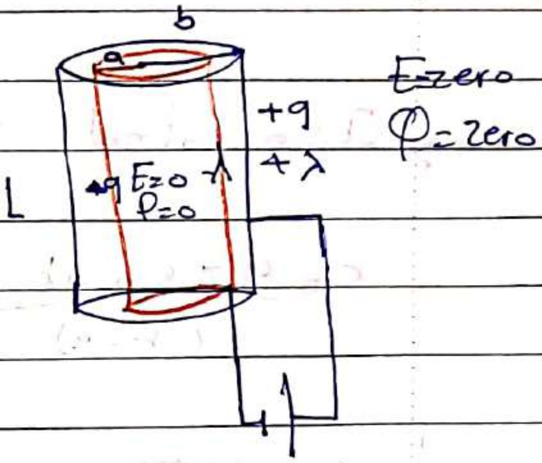
Subject Date الاربعاء ٢٠٢١/٨/٤ No. 14





The cylinderical Cap.

Ex.3



$a \leq r \leq b$

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

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

$\Delta V_{ab} = -\int_a^b E\,dr = 2k_e\lambda \int_a^b \frac{dr}{r}$

$\Delta V = 2k_e\lambda \left[\ln r\right]_a^b$

$\Delta V = 2k_e\lambda \left[\ln b - \ln a\right]$

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

$C = \frac{Q}{\Delta V} = \frac{\cancel{\lambda} \ell}{2k_e \cancel{\lambda} \ln\left|\frac{b}{a}\right|} = \frac{L}{2k_e \ln\left|\frac{b}{a}\right|}$ #

Capacitance Per unite Length

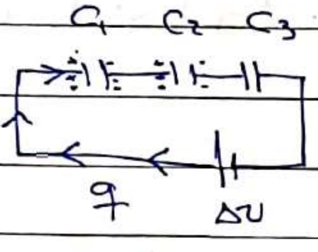
$\frac{C}{\lambda} = \frac{1}{2k_e \ln\left|\frac{b}{a}\right|}$

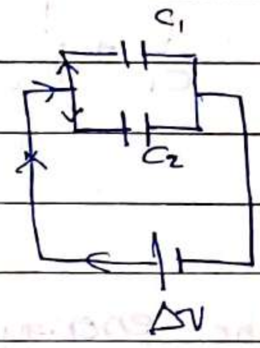
(1) Series Combindiion

توصيل توالي

(2) Parallel Combination

توصيل توازي .





التوصيل على التوالي الشحنة متساوية
وتساوي الشحنة المكافئة لكن فرق الجهد يوزع على المواسعات
ويكون مجموع فرق الجهد لكل المواسعات يساوي جهد البطارية

فرق الجهد متساوي
لكن الشحنة توزع .

Series	Parallel
(1) The Charge on each capaitor	(1) The Charge on each Capaitor
$q_1 = q_2 = q_3 = q_{eq}$	$q_{eq} = q_1 + q_2$
2) The P.d across each Capacitor	(2) The P.d across each Capacitor
$\Delta V = \Delta V_1 + \Delta V_2 + \Delta V_2$	$\Delta V = V_1 = V_2$.

Series

(3) Equivillent Capacitance

مكافئة السعة

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

Parallel

(3) Equivillent Capacitance.

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

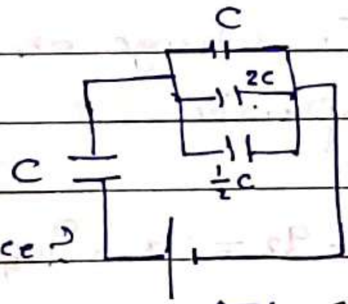
The energy stored in a Capacitor

$$\Rightarrow U = \frac{Q^2}{2C} \qquad Q = C\Delta V$$

$$\Rightarrow U = \frac{1}{2} C (\Delta V)^2 = \frac{1}{2} Q \Delta V$$

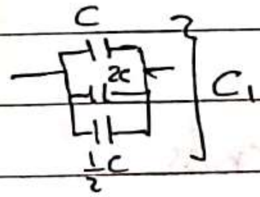
Ex.1

$C = 6\,\mu F$



(1) Find The Equivillent Capacitance?

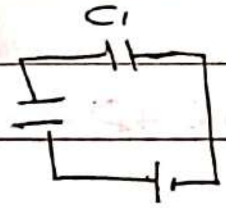
$\Delta V = 27\,V$



$$C_1 = C + 2C + \frac{1}{2}C$$

$$C_1 = 6 + 12 + 3$$

$$\boxed{C_1 = 21\,\mu F}$$



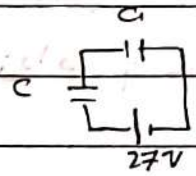
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C} = \frac{1}{21} + \frac{1}{6} = \frac{27}{126}\,C$$

$\Delta V = 27\,V$

$$\boxed{C_{eq} = \frac{126}{27}\,\mu F}$$

$$Q_{eq} = C_{eq}\, \Delta V$$

$$Q_{eq} = \frac{126}{\cancel{27}} \cdot \cancel{27} = 126\ \mu C$$

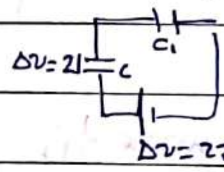


$$Q_c = Q_{c_1} = 126\ \mu C$$

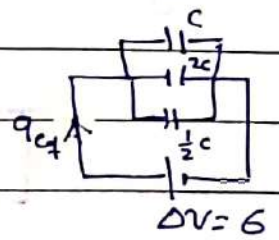
$$\Delta V_c = \frac{Q_c}{C_c} = \frac{126}{6} = 21\ V$$

$$\Delta V_{C_1} = \frac{Q_{c_1}}{C_{c_1}} = \frac{126}{21} = 6\ V$$

$$U_c = \frac{Q_c^2}{2C_c} = \frac{(126 * 10^{-6})^2}{2 * 6 * 10^{-6}} = 1323\ \mu J$$



$$\Delta V_{C_1} = \Delta V_C = \Delta V_{2C} = \Delta V_{\frac{1}{2}C} = 6\ V$$



$$Q_C = C_c\, \Delta V_c = 6 * 6 = 36\ \mu C$$

$$Q_{2C} = C_{2C}\, \Delta V = 12 * 6 = 72\ \mu C$$

$$Q_{\frac{1}{2}C} = C_{\frac{1}{2}C}\, \Delta V = 3 * 6 = 18\ \mu C$$

$$U = \frac{Q_{c_1}^2}{2C_1} = \frac{(126 * 10^{-6})^2}{2 * 21 * 10^{-6}} = 166698\ \mu C$$

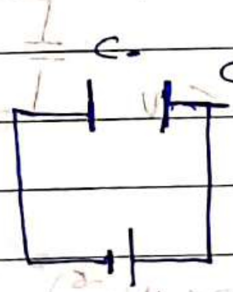
Subject Date No.

Capacitor with Dielectric

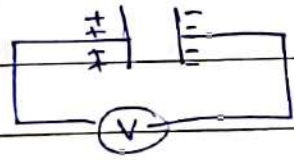
ثنائية التكهرب

عند اضافة مادة ثنائية التكهرب بين الواح
سوف تزداد الطاقة

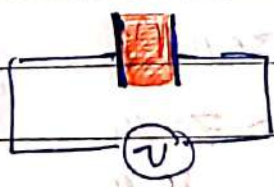
(1) Connecting the Capacitor in air with P.d



$Q_0 = C_0 \Delta V_0$



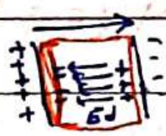
(2) Disconnecting the capacitor from the battery inserting a dielectric matrial inside the Capacitor.



$Q = Q_0$

$\Delta V = \frac{\Delta V_0}{K}$, $K > 1$

$\Downarrow$



$E_{net} < E_0$

$E_{net} = E_0 - E_d$

$\Delta V_{net} < \Delta V_0$

Subject Date No.

$$Q = CV$$

$$C = \frac{Q}{\Delta V} = \frac{Q_0}{\frac{\Delta V_0}{K}} = \frac{K Q_0}{\Delta V_0} = K C_0$$

$$C = K C_0$$

$K_{air} = 1$, Ingeral $K > 1$

$K_{water} = 80$

$K_{paper} = 3.7.$

The energy Stored in The Capacitor.

$$U_0 = U_i = \frac{Q_0^2}{2C_0}$$

$$U_f = \frac{Q_f^2}{2C_f} = \frac{1}{K}\left(\frac{Q_0^2}{2C_0}\right) = \frac{U_0}{K} \; ; K > 1$$

The work required to inserst the dielectric matrial inside the Capacitor

$$W = -\Delta U = -(U_f - U_i)$$

$$= U_i - U_f$$

$$= U_0 - \frac{U_0}{K}$$

$$= U_0\left(1 - \frac{1}{K}\right)$$