TURBO
Continuous change

دفتر :

فيزياء 2

physics 2

الأسبوع 1-3

إعداد بتول مصلح

اللجنة الأكاديمية لقسم الهندسة الصناعية

2025

TurboIEG.Com

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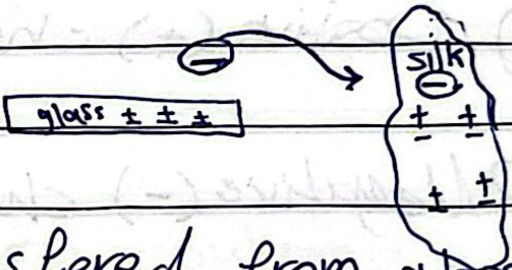
ch.23

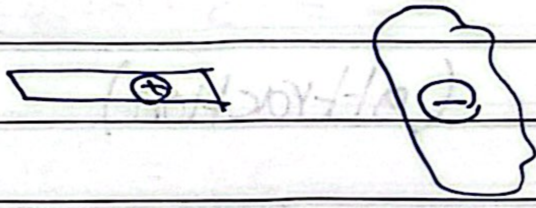
Electric fields

حرير

- Glass rod rubbed with silk



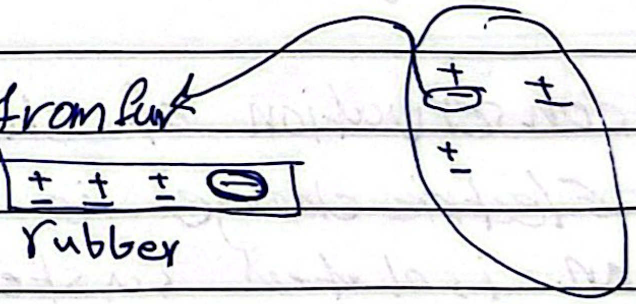
⟹ electrons are transfered from glass to silk



⟹ glass is positively charge

silk is negatively charge

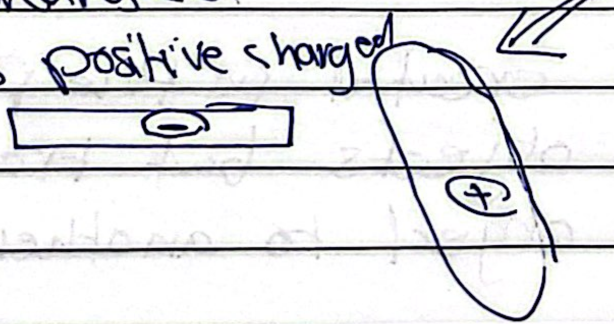
Rubber rod rubbed with fur



⟹ electrons are transfered from fur to rubber

⟹ Rubber is negatively charged

⟹ fur is positive charged



fur

(بيحسر e)

عنده قابلية الفقد

(بيعتمد عل طبيعة المادة)

تابع محاضرة (1) د.عنسانة

conclusion:-

There are two kinds of charges

1) Positive (+) charges like protons

② Negative (−) charges like electrons

(repulsion)

(attraction)

conclution:-

like charges repel ←⊕ ⊕→ ; ←⊖ ⊖→

unlike charges attracte $\overrightarrow{\oplus}\ \overleftarrow{\ominus}$

conservation of charge (مبدأ حفظ الشحنة):-

Electric charge is always conserved on an isolated system

- charge is not created in the process of rubbing two objects but transferred from one object to another.

تابع محاضرة (1) د. غسان

Quantization of charge ...

Electric charge exist in discrete packets :-

$$\underset{\text{charge}}{q} = \pm \overset{\text{integer}}{N} |e|$$

$|e| = 1.6 * 10^{-19}$ c c: coulomb

electron :- $q_e = -1.6 * 10^{-19}$ c $= -e$

proton :- $q_p = +1.6 * 10^{-19} = +e$

ex :- find the number of electron that an object of charge ($q = 4.8$ nC) losc

$$n = \frac{q}{e} = \frac{4.8 * 10^{-9} \text{ c}}{1.6 * 10^{-19} \text{c}} = 3 * 10^{10} \text{ electron}$$

classification of matorial

Material are classified in terms of the ability of electrons to move through into

1] conductors :- some of electrons are free (not bound)

e.g Aluminum, copper, silver

2] Insulaters : all the electrans are bound

e.g. glass, rubber, wood, plastic

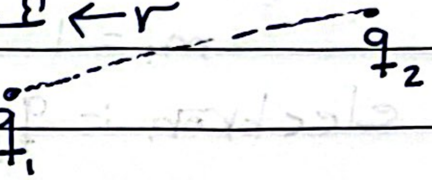
3] semiconductors :- electronic properties are somewhere betwen those of conductors and insulators

e.g. silicon, germanium

Coulomb's law

Point charges = charges of zero size

المسافة بين الشحنتين ← r



$$F_e = K_e \frac{|q_1||q_2|}{r^2}$$ coulomb's law

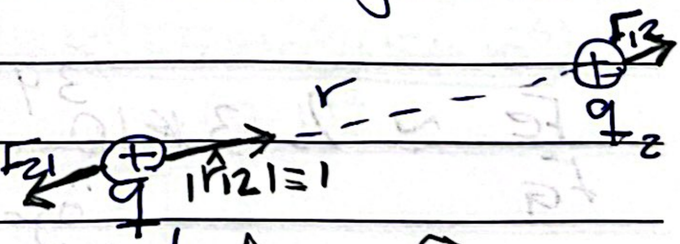
$$K_e = \frac{1}{4\pi\varepsilon_0} = 9*10^9 N . m^2/C^2$$

coulomb's constant

$\varepsilon_0 = 8.85*10^{-12} C^2/N.m^2$ = Permitivity of free spaces

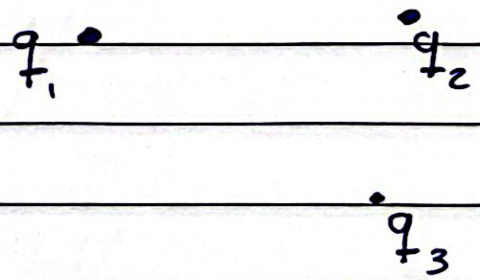
Fe: is attractive if the charges are of opposite sign

Fe: is repulsive if the charges are of the same sign



$$\vec{F}_{12} = -\vec{F}_{21} = K_e \frac{|q_1||q_2|}{r^2}\hat{r}_{12} \quad \hat{r}_{12} = \frac{\hat{r}}{|r|}$$

superposition principle

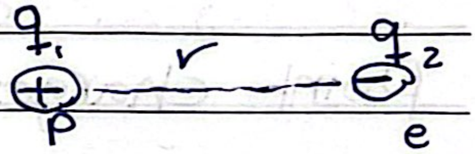


The resultant force on q_1 is the vector sum of the forces exerted onit by other changes

$$\vec{F}_1 = \vec{F}_{21} + \vec{F}_{31} + \vec{F}_{n1} + ----$$

محاضرة رقم "2" د. عسانة

ex 23.1



proton: $q_1 = 1.6 \times 10^{-19}$ C,

$m_1 = 1.67 \times 10^{-27}$ kg

electron :- $q_2 = -1.6 \times 10^{-19}$

$m_2 = 9.11 * 10^{-31}$ kg

$r = 5.3 * 10^{-11}$ m

$$F_e = k_e \frac{|q_1||q_2|}{r^2} = (9 \times 10^9) \frac{(1.6 * 10^{-19})(1.6 * 10^{-19})}{(5.3 * 10^{-11})^2}$$

$$= \boxed{8.2 * 10^{-8}} \; \underline{N}$$

هذا واجب "د. ن"

$$F_G = G \frac{m_1 m_2}{r^2} = \frac{(6.67 * 10^{-11})(1.67 * 10^{-27})(9.11 * 10^{-31})}{(5.3 * 10^{-11})^2}$$

$$= 3.6 * 10^{-47} \; \underline{\underline{N}}$$

$$\frac{F_e}{F_G} \approxeq 2.3 * 10^{39}$$

- القوة الكهربائية أكبر من قوة الجذب الكتلي بـ 10^{39} مرة لذلك لا نهتم بقوة الجذب الكتلي

$\longrightarrow$ F_G is negligible

ex 23.2 (في الـ رسمت في الدقيقة 29:11)

$q_1 = q_3 = 5\ \mu C = 5 * 10^{-6}\ C$

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

$a = 0.1\ m$

خالب محصلة القوة على q_3

ملاحظة $q_1 q_3$ نفس النوع بينهم تنافر $q_2 q_3$ عكس بعض تتجاذب

بالتالي

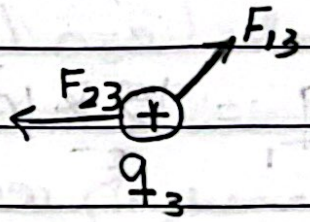
* بدايةً بنحسب قيمة F_{13} ، F_{23}

①

$$F_{13} = K_e \frac{|q_1||q_3|}{(\sqrt{2} * a)^2}$$

$$= \frac{(9 * 10^9)(5 * 10^{-6})(5 * 10^{-6})}{(2)(0.1)^2}$$

$$\boxed{F_{13} = 11\ N}$$



$$F_{23} = K_e \frac{|q_2||q_3|}{(a^2)} = \frac{(9 * 10^9)(5 * 10^{-6})(5 * 10^{-6})}{(0.1)^2}$$

$$\boxed{F_{23} = 9\ N}$$

- منحلل قوة F_{13} للمحور السيني والصادي

$F_{13x} = F_{13} \cos 45 = 11 * 0.71$

$= 7.9\ N$

$F_{13y} = F_{13} \sin 45 = 7.9\ N$

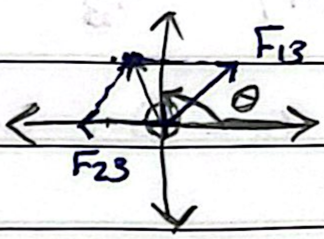
$F_{23x} = F_{23} \cos 180 = -9\ N$

$F_{3y} = 0$

$F_{3x} = F_{13x} + F_{23x} = -1.1$ N — تكملة السؤال ١

$F_{3y} = F_{13y} + \cancel{F_{23y}}^{0} = 7.9$ N

$\vec{F}_3 = (-1.1\,\hat{i} + 7.9\,\hat{j})$ N



$\theta = \tan^{-1} \dfrac{F_{3y}}{F_{3x}} = \tan^{-1}\left(\dfrac{7.9}{-1.1}\right) = 98°$

$F_3 = \sqrt{(-1.1)^2 + (7.9)^2} \cong 8$ N

ex 23.3 (برجو رسمة السؤال موجودة بالسلايدات وبالفيديو دقيقة (50:55))

$q_1 = 15 * 10^{-6}$ C $\qquad q_2 = 6 * 10^{-6}$ C

- هو طالب وين بيصفر المجال
- ما بيفرق موجبة ولا سالبة q_3

① لازم يكونوا $\vec{F}_{13}$ $\vec{F}_{23}$ متعاكسين

② لازم يتساووا بالمقدار

$\sum \vec{F}_3 = 0$

$F_{13} - F_{23} = 0 \longrightarrow F_{13} = F_{23}$

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

$$\frac{15 \cancel{* 10^{-6}}}{(2-x)^2} = \frac{6 \cancel{* 10^{-6}}}{x^2}$$

$$\frac{15}{4 - 4x + x^2} = \frac{6}{x^2} \qquad 15x^2 = 24 - 24x + 6x^2$$

$$-6x^2 \qquad\qquad -6x^2$$

~~[illegible]~~

محاضرة ٢ "د. غسان"

$9x^2 - 24x - 24 = 0$

$3x^2 - 8x - 8 = 0$ ✓

$\frac{-8 \pm \sqrt{8^2 * 3 * 8}}{6}$ $x = 0.775$ ، $x = -3.44$ ✗

ex. 23.4 1:03:58 (الرسمة في الدقيقة

كرتين مشحونات شحنة موجبة ال 2 نفس الكتلة

$m_1 = m_2 = 3*10^{-2}$ kg

$L = 15$ cm → 0.15 m $\theta = 5.0°$

(equilibrium)

سؤاله كم الشحنة على كل وحدة من الكرتين q

* حللنا قوة الشد اللي بتأثر على الكرة وبجبن عشانهم متزنين: $\Sigma F_x = 0$, $F_e = T\sin\theta \rightarrow ①$ ، $Mg = T\cos\theta \rightarrow ②$

منقسمهم على بعض مشان نتخلص من T

$$\cancel{T}\sin\theta = F_e$$

$$\cancel{T}\cos\theta = Mg$$

$$\tan\theta = \frac{F_e}{Mg}$$

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

$a = L\sin\theta$

$$F_e = Mg\tan\theta$$

$$\frac{k_e (q)^2}{(2a)^2} = Mg\tan\theta$$

$$q = \sqrt{\frac{4a^2 mg\tan\theta}{k_e}} = \sqrt{\frac{4L^2 Mg\sin^2\theta\tan\theta}{k_e}}$$

تعويض مباشر الآن

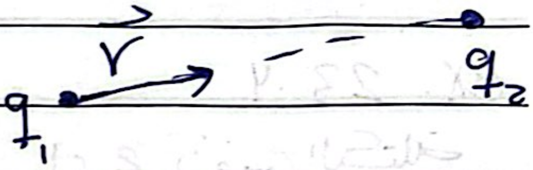
$$q = 4.4*10^{-8}\text{ C}$$

محاضرة "3" د. غسان

The electric field: المجال الكهربائي

The force between Two point charges is

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



- The electric force is a field force (can act through space with no physical contact).

- electric field exist in a region of space around charged object

- when an electric charge enters a region of electric fields, an electric force acts on it.

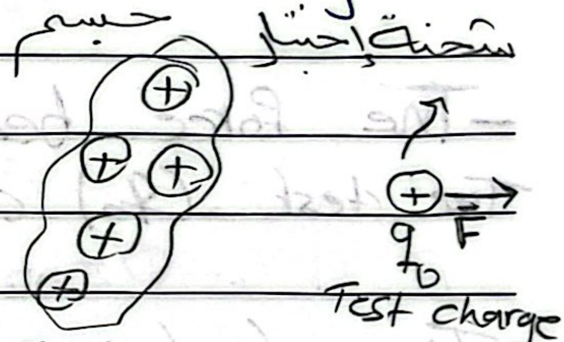
المجال الكهربائي :- هو القوة الذي يتأثر على وحدة الشحنات

المجال هو منطقة تؤثر على محتوياتها

The electric field [$\vec{E}$] is defined as the electric force acting on a positive test charge per unit charge

The electric field vector ($\vec{E}$) at a Point is defined as the electric force ($\vec{F}$) acting on a positive test charge (q_0) placed at that point divided by the test charge

$$\boxed{\vec{E} = \frac{\vec{F}}{q_0}}$$ definition of $\vec{E}$



The force $\vec{F}$ on a charge q Source placed in an electric field E is

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

دقيقة 25
توضيح مهم

SI unit of E is N/C

comments:

1) direction of $\vec{E}$ is that of the force on a positive test charge

2) $\bar{F} = q\bar{E}$ is valid for point charges

3) $\vec{E}$ is directed away from a positive charge $\bar{E}$ is directed toward a negative charge (see the figure in 30:09

4) The force on apositive charge is in The same direction of $\bar{E}$

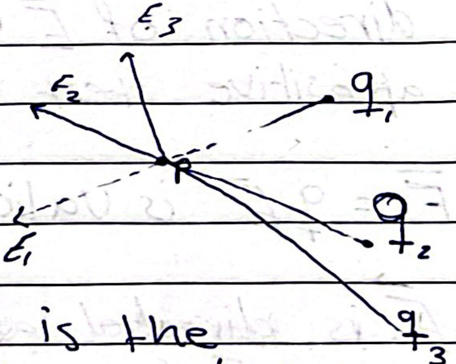
5) The force on a negative charge is in The opossite direction of $\bar{E}$

-The force between The source (q) and The test (q_0) charges is $F = K\frac{q\,q_0}{r^2}\hat{r}$

-The electric field is then
$$\bar{E} = \frac{F}{q} = K\frac{q}{r^2}\hat{r}$$

The electric field at a distance r from apoint charge q is

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



*The Total electric field due to a group of source charges is the vectro sum of the electric fields of all charges
$$E = \bar{E}_1 + \bar{E}_2 + \bar{E}_3 - - - -$$

---

ex. 23

$r_1 = r$

$r_2 = \sqrt{b}$

A) $E_1 =$

$E_2 = 1$

$E_{1x} = E$

$E_{1y} = $

$E_{2x} = E$

$E_{2y} = -E$

$E_x = E$

$=$

$E_y = E$

$K[$

ex.23.6 محاضرة "3" دقيقة 46:46

$r_1 = \sqrt{a^2 + y^2}$

$r_2 = \sqrt{b^2 + y^2}$

A) $E_1 = K \frac{q_1}{r_1^2} = \frac{K q_1}{a^2+y^2}$

$E_2 = K \frac{q_2}{r_2^2} = \frac{K q_2}{b^2+y^2}$

$E_{1x} = E_1 \cos\phi = \frac{K q_1}{a^2+y^2} \cos\phi$

$E_{1y} = E_1 \sin\phi = \frac{K q_2}{b^2+y^2} \sin\phi$

$E_{2x} = E_2 \cos\theta = \frac{K q_1}{a^2+b^2} \cos\theta$

$E_{2y} = -E_2 \sin\theta = -\frac{K q_2 \cos\theta}{b^2+y^2}$

$E_x = E_{1x} + E_{2x}$

$= K\left[\frac{q_1}{a^2+y^2}\cos\phi + \frac{q_2}{b^2+y^2}\cos\theta\right]$

$E_y = E_{1y} + E_{2y}$

$K\left[\frac{q_1 \sin\phi}{a^2+y^2} - \frac{q_2 \sin\theta}{b^2+y^2}\right]$

B) $|q_1| = |q_2| = q$

$a = b \Rightarrow \theta = \phi$

$$\boxed{E_x = \frac{2k\, q \cos\theta}{a^2+y^2}}$$

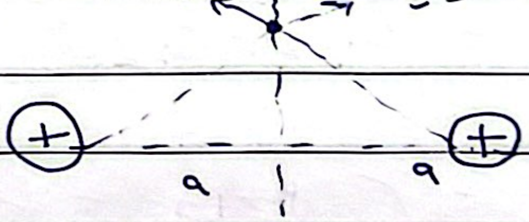
$$E_y = k\left[\frac{q \sin\theta}{a^2+y^2} - \frac{q \sin\theta}{a^2+y^2}\right]$$

$$\boxed{E_y = 0}$$

هذا يسمى dipole

(شحنة موجبة q وشحنة سالبة q

متساويات بالمسافة بينهم 2a)



محاضرة رقم "4"

- electric of a continous charge distributed

For a single point charge

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

- The electric field due to the charge element Δq_i at point P is

$$\Delta E_i = K \frac{\Delta q_i}{r_i^2} \hat{r}_i$$

The total electric field is

$$\bar{E} = \Delta \vec{E}_1 + \Delta \vec{E}_2 + \Delta \vec{E}_3 + \cdots$$

$$= K \left(\frac{\Delta q_1}{r_1^2} \hat{r} + \frac{\Delta q_2}{r_2^2} \hat{r} + \frac{\Delta q_2}{r_3^2} \hat{r} \right) \ldots$$

بدي اجمع الاقسام الصغيرة مشان يطلع معي ع حال الكهربائي

if we make the element very small $(\Delta q_i \rightarrow 0)$ $\bar{E} = K \lim_{\Delta q \to 0} \sum \frac{\Delta q_i}{r_i^2} = K \int \frac{dq}{r^2} \hat{r}$

The electric field due to acontinuous charge distribation is given

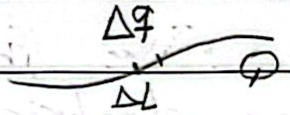
$$\bar{E} = K \int \frac{dq}{r^2} \hat{r}$$

شرح

There are Thee kinds of charge distribution

1) linear charge distribution

Define the linear charge density, λ :



$$\lambda = \frac{\Delta q}{\Delta L} = \frac{dq}{dL}$$

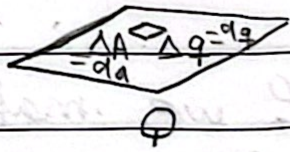
$[\lambda] = C/m$

if the charge Q is uniformly distributed along the line, then $\lambda = \frac{dq}{dL} = \frac{Q}{L} = \underline{const}$

$dq = \lambda * dl$

2) surface charge distribution

Define the surface charge density σ :- → $\boxed{\text{sigma}}$



(σ : charge per unit area)

$$\sigma = \frac{\Delta q}{\Delta A} = \frac{dq}{dA}$$

Area

$[\sigma] = C/m^2$

if the charge is uniformly distributed Through the surface Then

$\sigma = \frac{dq}{dL} = \frac{Q}{A}$ = نسبة ثابتة
constant

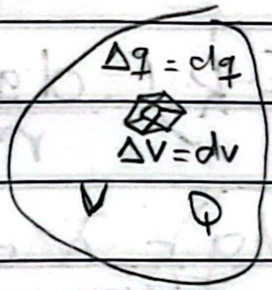
$dq = \sigma \, dA$

يتبع

$dq = \sigma dA$

③ volume charge distribution

Define The volume charge density, ρ: $\longrightarrow \boxed{\text{رو}}$



(ρ : charge per unit volume

$$\rho = \frac{\Delta q}{\Delta V} = \frac{dq}{dV}$$

volume

$[\rho] = C/m^3 \swarrow$

if the charge is unifurmly distributed Thraugh The volume Then

$$\rho = \frac{dq}{dV} = \frac{Q}{V} = \text{constant}$$ (نسبة ثابتة)

$dq = \rho dV$

*** in summary

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

$dq = \lambda dL$ = linear charge

$dq = \sigma dA$ = surface charge

$dq = \rho dv$ = volume charge

يتبع

ex : 23.5 43:31 دقيقة رقم

$\lambda = \frac{Q}{L} = \text{constant} \triangleq \text{uniform}$

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

$\boxed{dq} = \lambda \, dL = \frac{Q}{L} \, dx \rightarrow$

* * $\boxed{r = x}$ *

r = بعد عنصر الشحنة عن النقطة الي بحسب عندها المجال.

$$E = k \int \frac{dq}{r^2} = K \int_a^{L+a} \frac{\frac{Q}{L} \, dx}{x^2}$$

$$E = K \frac{Q}{L} \int_a^{L+a} \frac{dx}{x^2} \qquad \frac{KQ}{L} \left(\frac{-1}{x} \right) \Big|_a^{L+a}$$

$$E = \frac{Ka}{L} \left[\frac{1}{a} - \frac{1}{L+a} \right]$$

* ليش الحدود من (a) الى (L+a)

اسأل حالك أنا بالأصل على مين بتكامل ؟ بتكامل على الشحنة والشحنة هاي موجودة عال Rod . طيب الـ Rod احداثياته من وين لوين يبلش احداثياته عن النقطة a وبتخلص عند نقطة L+a وهاي هي حدود التكامل

ex : 23.8 في دقيقة 57:02

Q is uniform Linear (سلك رفيع)

Vertical component cancel.

$dE_y = 0$

$dE_x = dE \cos\theta$

dE : The electric field due to the charge element dq

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

$\cos\theta = \frac{x}{\sqrt{x^2+a^2}}$

$$dE_x = dE \cos\theta$$

$$= K \frac{dQ}{r^2} \cos\theta$$

$$dE_x = K \frac{d\theta}{x^2+a^2} \frac{x}{\sqrt{x^2+a^2}}$$

$$\int dE_x = \int \frac{Kx \, dq}{(x^2+a^2)^{\frac{3}{2}}}$$

$$E_x = \frac{Kx}{(x^2+a^2)^{\frac{3}{2}}} \underbrace{\int dq}_{Q} = \frac{KQx}{(x^2+a^2)^{\frac{3}{2}}} \quad E_y = 0 \quad E_z = 0$$

$$E = E_x \hat{i} + \overset{0}{\underline{E_y \hat{j}}} + \overset{0}{\underline{E_z \hat{k}}} = E_x \hat{i}$$

$$\bar{E} = \frac{KQx}{(y^2+a^2)} \hat{i}$$

if $X = 0 \rightarrow E = 0$ (at the center of a uniform charged ring

محاضرة "5" دكتور غسان

Ex: 23.9 عندي Disk عليه شحنة $\boxed{\sigma}$ وبده نحسب المجال الكهربائي على بعد x من مركزها ال Disk
(x عامودي على ال Disk)

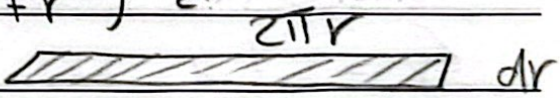
The field due to a ring of radius a and total charge Q is

$$E = \frac{kQx}{(a^2+x^2)^{\frac{3}{2}}}$$

For the charge element dq (ring of radius r and charge dq):

$$dq \longleftrightarrow Q \quad , \quad r \longleftrightarrow a \; , \; dE \longleftrightarrow E$$

$$dE = \frac{k\,dq\,x}{(x^2+r^2)^{\frac{3}{2}}} = \frac{kx\;dq}{(x^2+r^2)^{\frac{3}{2}}}$$



$$dq = \sigma\, dA$$

$$\sigma\, 2\pi r\, dr$$

$dA = (2\pi r)\, dr$

$= 2\pi r dr$

$$\int dE = \int_0^R \frac{2kx\sigma\pi r}{(x^2+r^2)^{\frac{3}{2}}}$$

$\boxed{\sigma \text{ is uniform}}$

$$E = \pi k\sigma x \int_0^R \frac{2r\,dr}{(x^2+r^2)^{\frac{3}{2}}}$$

فراشي طبق ماعدا ال R

$$\pi k\sigma x \left[\frac{(x^2+r^2)^{-\frac{1}{2}}}{-\frac{1}{2}}\right]_0^R$$

$$E = 2\pi k\sigma x\left[\frac{1}{x} - \frac{1}{\sqrt{x^2+R^2}}\right]$$

if x is $<< 1$ (x is very small)

* رح نحكي عنها بالشابتر الجاي

Electric field Lines :-

≡ Graphical representation of the electric field

• properties of electric field lines :

1] the electric field $\vec{E}$ is tangent to field line

2] Number of field lines per unit area through a surface perpendicular to the lines is $\overset{\text{تناسب}}{\text{proportional}}$ to the magnitude of $|\vec{E}|$

Density of lines at A > density of lines at B

$E_A > E_B$

3] field lines are directed away from a positive charge

4] Field Lines are directed toward a negative charge

* يوجد رسومات توضيحية في المحاضرة لكل مسة

5] Number of lines leaving a positive charge or approaching a negative charge is to the magnetude of the charge

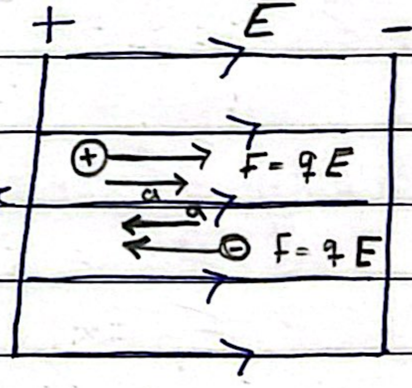
6] No two field Lines can cross

* ما بيزبط يتقاطعو ، لأنه لو فرضنا انهم تقاطعو
هنا بصير انه في اكثر من اتجاه لنفس المجال
وهذا غير ممكن .

Motion of a charged in a uniform electric field :

E is uniform

The force on the charge q is $\bar{F} = q\bar{E}$



Newton's 2nd law

$\bar{F} = m\bar{a} = qE$

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

comments:

- if $\bar{E}$ = constant (uniform) ⇒ $\bar{a} = \frac{qE}{m}$ = const

Then, The kinematic equation can be used

$$v_{xf} = V_{xi} + at$$

$$x_f - x_i = V_{xi} t + \frac{1}{2} a_x t^2$$

$$V_{xf}^2 = U_{xi}^2 + 2ax(x_f - x_i)$$

and same for y-component

- if q is positive ⇒ $\vec{a}$ is indirection of $\bar{E}$
- if q is negative → $\bar{a}$ is opposit of E

$\boxed{\text{ex. 23.10}}$

E = const ⟶ $\bar{a}$ = const

$E_x = E$, $E_y = 0$ | $x_i = x_A = 0$

$V_i = U_A = 0$ | $x_f = x_B = \underline{\underline{d}}$

$U_f = U_B = ??$

A) Partical under constant acceleration

$qE = ma$ $\quad \vec{a} = \frac{qE}{m}$ $\quad a_x = \frac{qE}{m}$

$\boxed{a_y = 0}$ ماشي بشكل افقي

$$V_f^2 = \cancel{V_i^2} + 2a_x(x_f - x_i)$$

$$U_B^2 = 2\frac{qE}{m}(d)$$

$$V_B^{\cancel{2}} = \sqrt{\frac{2qEd}{m}}$$

تكملة المحاضرة الخامسة

B) Non-isolated system

system $\equiv$ charge

external force = electric force = $F = qE$

$W_{ext} = K_f - K_i$

$F \Delta x \cos\theta = \frac{1}{2} m v_B^2 - \cancel{\frac{1}{2} m v_A^2}$

$qEd = \frac{1}{2} m v_B^2$

$v_B = \sqrt{\frac{2qEd}{m}}$

$\boxed{\text{ex. } 23.11} \longrightarrow$ ارجع نهاية المحاضرة،

الصورة التوضيحية 1:13.06

$q = -1.6 * 10^{-19}\ C$

$m = 9.11 * 10^{-31}\ kg$

$\bar{E} = (200\hat{j})\ N/C$

$E_x = 0 \quad E_y = 200\ N/C$

$v_i = 3 * 10^6\ m/s$

$v_{xi} = 3 * 10^6 \quad v_{yi} = 0$

$L = 0.1\ m$

Ⓐ $qE = ma \quad \bar{a} = \frac{qE}{m}$

$\bar{a}_x = 0 \longrightarrow$ لأن E_x صفر

$a_y = \frac{qE_y}{m} = -\frac{(1.6 * 10^{-19})(200)}{(9.11 * 10^{-31})} = -3.51 * 10^{13}\ m/s^2$

Ⓑ $a_x = 0 \rightarrow v_x$ const

$x_f - x_i = v_x t \quad t = \frac{x_f - x_i}{v_x} = \frac{L}{v_x} = 3.33 * 10^{-8}$

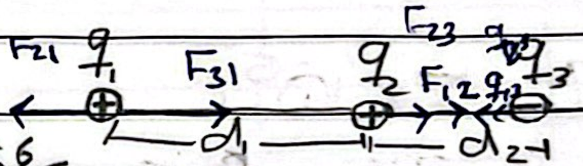
Ⓒ $y_i = 0$ ، $y_f = ??$ $t = 3.33 * 10^{-8}$ ، $y_f = -1.95 * 10^{-2}\ m$

$y_f - y_i = v_{yi}t +$

محاضرة رقم "6"

problems

$\boxed{23.12}$



$q_1 = 6\,\mu C = 6 * 10^{-6}\,C$

$q_2 = 1.5\,\mu C = 1.5 * 10^{-6}\,C$

$q_3 = -2\,\mu C = -2 * 10^{-6}\,C$

$d_1 = 3\,cm = 0.03\,m$

$d_2 = 2\,cm = 0.02\,m$

$$F_{12} = F_{21} = k \frac{q_1 q_2}{d_1^2} = 89.5\,N$$

$$F_{13} = F_{31} = k \frac{q_1 q_3}{(d_1 + d_2)^2} = 43.2\,N$$

$$F_{23} = F_{32} = k \frac{q_2 q_3}{d_2^2} = 67.4\,N$$

Ⓐ بدة القوة ع محصلة على q_1

$(F_{31} - F_{21})\hat{i} = -(46.3)\hat{i}\;N$

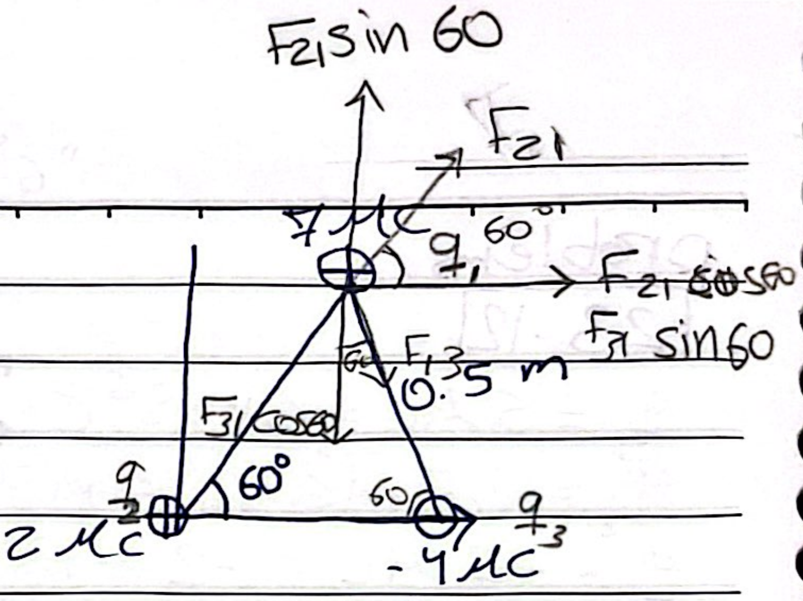
Ⓑ يجاد محصلة القوة على q_2

$(F_{23} + F_{12})\hat{i} = (157\,\hat{i})\;N$

Ⓒ يجاد محصلة القوة على q_3

$(F_{13} + F_{23})\hat{i} = -111\,\hat{i}\;N$

23.15



$q_1 = 7 * 10^{-6}$ C

$q_2 = 2 * 10^{-3}$ C

$q_3 = -4 * 10^{-6}$ C

$d = 0.5$ m

$$F_{21} = k\frac{q_1 q_2}{(0.5)^2} = 0.504\ N$$

$$F_{31} = k\frac{q_1 q_3}{(0.5)^2} - 1.008\ N$$

$F_{21x} = -F_{21} \cos 60 = 0.252\ N$

$F_{21y} = F_{21} \sin 60 = 0.436 N$

$F_{31x} = F_{31} \cos 60 = 0.504 N$

$F_{31y} = -F_{31} \sin 60 = -0.872 N$

$F_{1x} = F_{21x} + F_{31x} = 0.776\ N$

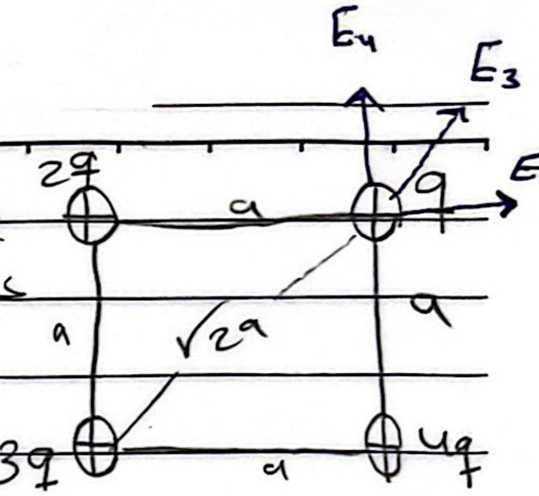
$F_{1y} = F_{21y} + F_{31y} = -0.436 N$

$\vec{F_1} = (0.776\ \hat{i} - 0.436\ \hat{j})\ N$

$F = \sqrt{(0.776)^2 + (-0.436)^2} = 0.89 N$

$\theta = \tan^{-1}\left(\frac{-0.436}{0.776}\right) = -30^\circ$ or 330° في الربع الرابع

$\boxed{23.25}$ احسب المجال الكهربائي عند الشحنة q ؟



$E_2 = K\frac{2q}{a2} = 2\frac{kq}{a^2}$

$E_3 = 3\frac{kq}{2a2}$

* لا نحسب مجال عند شحنة الشحنة تتحول لـ نقطة كأن q غير موجودة

$E_4 = \frac{4kq}{a^2}$

$E_{2x} = E_2 = \frac{2kq}{a^2}$ / $E_{4x} = \frac{4kq}{a^2}$

$E_{3x} = E_3 = \frac{3}{2}\frac{1}{\sqrt{2}}\frac{kq}{a^2}$ / $E_{3y} = \frac{3}{2}\frac{1}{\sqrt{2}}\frac{kq}{a^2}$

$\frac{2kq}{q^2} + \cancel{\frac{4kq}{a2}} + \frac{3}{2}\frac{1}{\sqrt{2}}\frac{kq}{a^2} = E_x$

$E_x = 3.06\frac{kq}{a^2}$

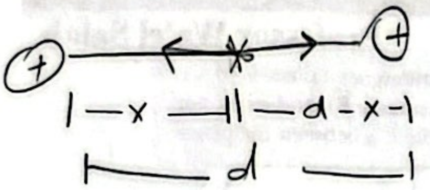
$E_y = \overset{0}{\cancel{E_{2y}}} + \cancel{E_{3y}} + E_{4y} = \frac{3}{2} * \frac{1}{\sqrt{2}}\frac{kq}{a2} + \frac{4kq}{a2}$

$E_y = 5.06\frac{kq}{a^2}$

$\bar{E} = E_x\hat{i} + E_y\hat{j}$

$\frac{kq}{a^2}(3.06\hat{i} + 5.06\hat{j})$

$\boxed{23-13}$



$d = 1.5\ m$

ⓐ $\vec{F}_{31} + F_{32} = 0$

$F_{31} = -F_{32}$

$|\vec{F}_{31}| = |\vec{F}_{32}|$

$$\frac{\cancel{k} q_1 q_3}{r_{13}^2} = \frac{\cancel{k} q_2 q_3}{r_{23}}$$

$$\frac{3q}{x^2} = \frac{q}{(4.5 - x)^2}$$

$2x^2 \cdot 9x - 6.75 = 0$

$x = 0.98m$

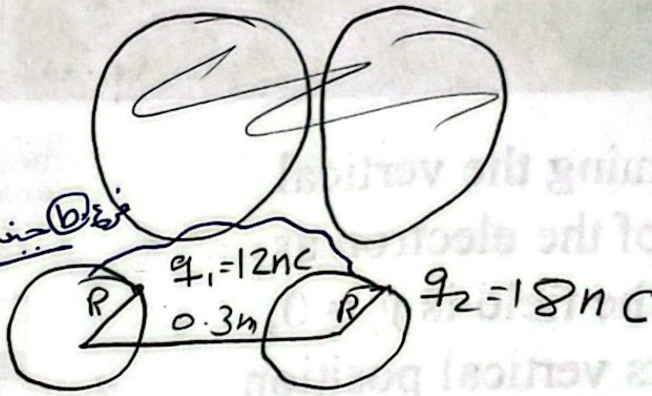
(طلعت برا ما يصير) $x = 3.55m$ ✗

ⓑ yes لأنه محصلة القوى الي عليه صفر

stable

$\boxed{23.21}$

كرتين متماثلات تماماً
لهم نفس صفة الغض



فرع ⓑ جنباسلاء

$q_1 = 12nC$

$q_2 = 18nC$

ⓐ $F = \frac{k q_1 q_2}{r_{12}^2} = 2.16 \times 10^{-7} N$

attractive

ⓑ $q_1 + q_2 = q_2' + q_1'$

(لازم ناخذ الاشارات بعين الاعتبار)

$= q' + q' = 2q'$

$= -3 \times 10^{-9} C$

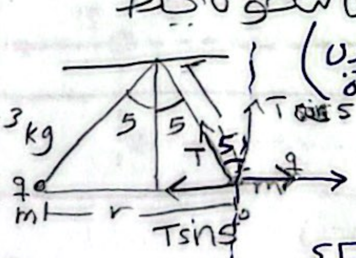
$\boxed{23.16}$

حالة السكون بالكتلة

(تحليل القوى الموجودة)

$m = 2g$
$= 2 \times 10^{-3} kg$

$q = 7.2nC$



FBD

تكملة السؤال

$\sin\theta = \frac{r/2}{L}$

$\sin 5° = \frac{r}{2L}$

$L = 0.29m$

$\sum \vec{F} = 0$

$\sum F_y = 0$

$T \cos 5° = mg$

$\sum F_x = 0$

$F = T \sin 5° \rightarrow ①$

$F = 0.2 \times 10^{-3} \times 10 \times \tan 5$

$F = 1.75 \times 10^{-4} N$

$\frac{F}{mg} = \tan 5°$

$F = \frac{k q^2}{r^2}$

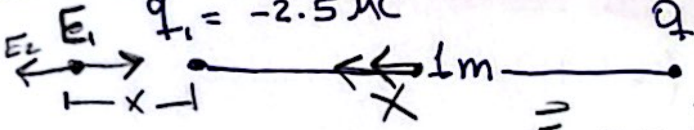
$F = mg \tan 5°$

$1.75 \times 10^{-4} = \frac{9 \times 10^9 \times (7.2 \times 10^{-9})^2}{r^2}$

$\boxed{r = 0.516\ m}$

$\boxed{23.29}$

$q_1 = -2.5\,\mu C$ $q_2 = 6\,\mu C$ (انعدام المجال)



$$\bar{E}_1 + \bar{E}_2 = 0 \longrightarrow \vec{E}_1 = -\vec{E}_2$$

$$|\bar{E}_1| = |E_2|$$

$$\frac{Kq_1}{x^2} = \frac{Kq_2}{(1+x)^2}$$

$$\frac{2.5\cancel{\times 10^{-6}}}{x^2} = \frac{6\cancel{\times 10^{-6}}}{(1+x)^2}$$

$$3.5x^2 - 5x - 2.5 = 0 \;/ \times 2$$

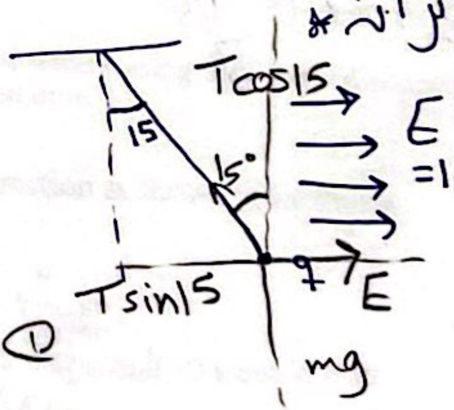
$$7x^2 - 10x - 5 = 0$$

$$= 1.82\,m$$

$$= 0.392\,m\times$$

$\boxed{23.33}$ $m = 2g$

حالة اتزان



$E = 1.\times 10^3\,V/C$ uniform electric field

$$\Sigma F = 0$$

$$\Sigma F_x = 0$$

$$T\sin\theta = qE \longrightarrow ①$$

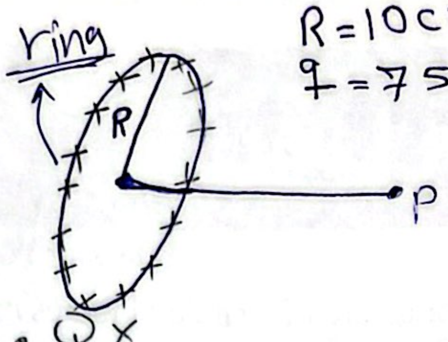
$$T\cos\theta = mg \longrightarrow 2$$

$$\tan\theta = \frac{qE}{mg}$$

$$q = \frac{mg}{E}\tan\theta$$

$$q = \frac{2\times 10^{-3}\times 10\times\tan 15}{1\times 10^3}$$

$\boxed{23.39}$



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

$$E_P = \frac{1}{4\pi\epsilon} \cdot \frac{Qx}{[x^2+R^2]^{\frac{3}{2}}}$$

X = 1 cm

$$E_P(x = 1\,cm) = \frac{9*10^9 * 75*10^{-6} * 1*10^{-2}}{(1*10^{-2}+(0.1)^2)^{\frac{3}{2}}}$$

$$= 6.65*10^6$$

$\boxed{23.45}$

سلك طوله 14 cm
ثنيناه على شكل نصف
دائرة

$q = -7.5 \mu C$

Find the magnitude and direction

$$\vec{E}_p = \frac{2K\lambda}{R}(-i)$$

R = 0.044 m

$$\lambda = \frac{Q}{L} = \frac{7.5*10^{-6}}{0.14} = 53.57*10^{-6}$$

ⓐ ~~2*~~ $E_p = \frac{2*10^9 * 53.57*10^{-6}}{0.044}$

$E_p = 2.19*10^7$ N/C

$\boxed{b}$ $E_p = 2.19*10^7$

23.51
52
53

شحنة موجبة/سالبة
(تسارعها / سرعتها
النهائية / الطاقة
الحركية / الابتدائية