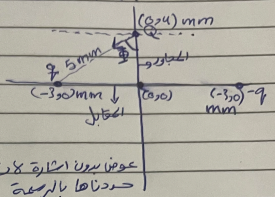
الموضوع : التاريخ / / ٢٠١

$q = -2\,\mu C$ Find the force on Q?

$Q = 10\,\mu C$



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

$F_{+q} = 9\times10^9 \frac{(2\times10^{-6})(10\times10^{-6})}{(5\times10^{-3})^2} \rightarrow$ عوض بدون اشارة لانو حددناها بالرسمة

$\cancel{\ldots} * (\sin\theta\,\hat{i} - \cos\theta\,\hat{j}) \rightarrow$ المقابل مقابل لـ x-axis

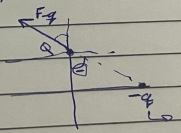
$\frac{3}{5}$ $\frac{4}{5}$ المجاور مقابل لـ y-axis

$F_{+q} = \frac{36}{25}(-3-4\hat{j})\ KN$

$pC = 10^{-12}\,C$
$nC = 10^{-9}\,C$
$\mu C = 10^{-6}\,C$
$mC = 10^{-3}\,C$
$KN = 10^{3}\,N$
$MN = 10^{6}\,N$

$\vec{F}_{-q} = 9\times10^9 \frac{(2\times10^{-6})(10\times10^{-6})}{(5\times10^{-3})^2} * (\sin\theta\,\hat{i} + \cos\theta\,\hat{j})$ $\frac{3}{5}$ $\frac{4}{5}$

$= \frac{36}{25}(-3\hat{i}+4\hat{j})\ KN$



تنافر لأن شحنة q اصبحت موجبة (سالب من الشحنة وسالب من السؤال)

$F_{net} = \frac{36}{25}(-6\hat{i}+0\hat{j})$

$= \frac{216}{25}(-\hat{i})\ KN \leftarrow$ في اتجاه (-x)

The Electric Field : $\vec{E}$

$\vec{F}_{Q \to q_0} = k_e \frac{Q q_0}{r^2} \hat{r}$

q_0 : test charge

Q

We define the electric field $\vec{E} = \frac{\vec{F}_{q_0}}{q_0}$

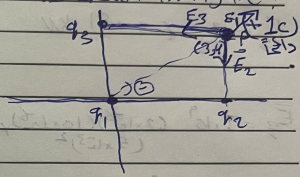
$\vec{E} = k_e \frac{Q}{r^2} \hat{r}$

→ Find the electric field at point B as shown in figure ?

$q_1 = 25\ nc$

$q_2 = -8\ nc$

$q_3 = -27\ nc$



$\vec{E}_1 = k_e \frac{q_1}{r^2} \hat{r}$

$\vec{E}_1 = 9\times10^9 \times \frac{25\times10^{-9}}{(5\times10^{-2})^2} \left(\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\right) = \frac{90}{5}(3\hat{i}+4\hat{j})\ KN$

$\vec{E}_2 = \frac{9\times10^9 \times 8\times10^{-9}}{(4\times10^{-2})^2}(-\hat{j})$

$\vec{E}_3 = \frac{9\times10^9 \times 27\times10^{-9}}{(3\times10^{-2})^2}(-\hat{i})$

$\vec{E}_p = 216(-\hat{i}) + 27(+\hat{j})$

التاريخ _____ اليوم _____ موضوع الدرس _____

(5) what is the x-component of the electric field?

$= 216(-\hat{i}) = -216$



بسهل هاي

(6) what is the force on a charge $\boxed{q = -5\,nC}$ located at point P?

اتجاه القوة عكس اتجاه المجال في السالب

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

$= (216 \times 5\hat{i} - 27 \times 5\hat{j})\ \mu N$

عكسنا الاشارة

CH: 23 The electric field

Repulsive: تنافر , attractive: تجاذب

→ The charge is quantized: مكمم. The charge on an object is a multiple of the charges of the electrons charge

① $q = Ne$ $e = -1.6 \times 10^{-19} C$: electron charge

$N = \pm 0, \pm 1, \pm 2 \ldots$ $+e = +1.6 \times 10^{-19} C$: proton's charge

② The charge is conserved محفوظة

$q_i = q_1 + q_2$ (before: q_1, -6)

$q_f = q_1' + q_2'$ (after)

The charge is conserved $q_f = q_i$

- special case: Two identical object

يعني الكمية بعد التوصيل متساوية

$q_1 = q_2 = \frac{q_{1i} + q_{2i}}{2}$

موضوع الدرس _____ اليوم _____ التاريخ / /

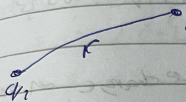
The Colomb's law (قانون كولوم)

(q_1, q_2 point charges)

r: is the distance

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

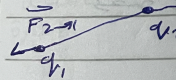
$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 = k_e$



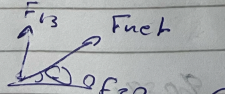
$F \propto \frac{q_1 q_2}{r^2} \Rightarrow F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r^2}$

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

Newton's 3rd law



$\vec{F}_{1\to 2} = -\vec{F}_{2\to 1}$ بمقدار متساوي

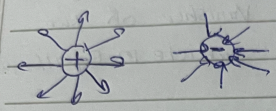


$F_{net} = \sqrt{F_{12}^2 + F_{13}^2}$

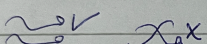
$\theta = \tan^{-1}\left(\frac{y}{x}\right)$

The $\vec{E}$ - field lines properties.

1) the electric field lines emerge from +ve charges and terminate into the -ve charge

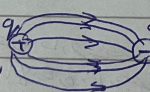


→ the electric field lines do not intersect



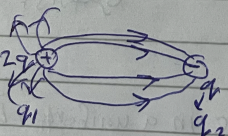
→ the electric field lines number is proportional to the charge $N \propto Q$

Ex:-

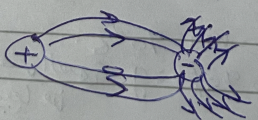


* What is the ratio between q_1 and q_2

$\frac{q_1}{q_2} = \frac{N_1}{N_2} = \frac{6}{6} = \frac{1}{1}$

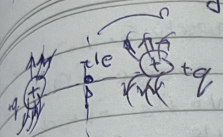


$\frac{q_1}{q_2} = \frac{N_1}{N_2} = \frac{8}{4} \Rightarrow q_1 = 2q_2$



$\frac{q_1}{q_2} = \frac{4}{12} \Rightarrow \frac{q_1}{q_2} = \frac{1}{3}$

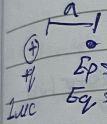
منطقة انعدام مجال

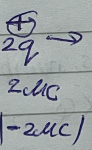


* Find the point where the electric field vanisher or the particle in equilibrium

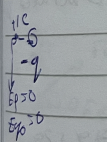
$E_p = 0$
$F_{net} = 0$ $\Big\} \rightarrow F_{q_0} = q_0 E$

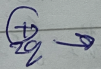
point (P) is the place where the eletric vanishes
يتلاشى





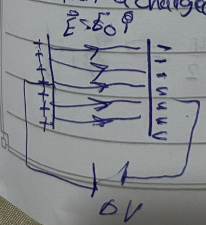
* ينعدم المجال بين شحنتين متشابهتين بالإشارة بينهما واقرب إلى الصغرى بدون إشارة





* ينعدم المجال خارج شحنتين مختلفتين بالإشارة خارجهما واقرب إلى الصغرى

∴ Motion a charged particle in a uniform $\vec{E}$-field:



$F_e = ma = q_0 E_0$

$q = q_0 E_0 = g$

موتحطي نفس القيمة ال a احسبها من القانون

يمنع استخدام قانون $E = \frac{kq}{r^2}$ هون

Sigma

① $v = v_0 + at$

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

③ $v^2 = v_0^2 + 2a\Delta x$

$W = \Delta K = \frac{1}{2} m(v_f^2 - v_i^2)$

* The $\vec{E}$ Field a continous charge distribution

الحقل الكهربائي لتوزيع المستمر

Charge density

- 3D
  - sphere
  - cylinder
  - * volume charge density
  - $\rho = \frac{\text{charge}}{\text{volume}}$ (c/m^3)
- 2D surface charge density
  - $\sigma = \frac{\text{charge}}{\text{Area}}$
- 1D

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$

$m = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x}$

$= F'(x) = x_2 = x_1$

$x_1 \neq x_2$

① charged sphere; insulating sphere



R: Radius

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

rho: $\rho = \frac{\text{mass}}{\text{volume}}$

② Insulating cylinder

a: radius

L: length



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

Sigma

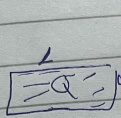
موضوع الدرس _____ اليوم _____ التاريخ / /

→ 2D : surface charge density

الطول والعرض الكبير من السمك

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

① * Plate, Plane



$\sigma = \frac{Q}{L\,w}$ $\boxed{C/m^2}$

② charge disk قرص

دائرة مليان من الداخل



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

→ 1D : linear charge density

الطول الكبير بكثير من نصف القطر

$\lambda = \frac{Q}{L}$ $\boxed{C/m}$

Ex: ~~Rod~~ charge rod OR charge line

and charge Ring → حلقة فارغة من الداخل

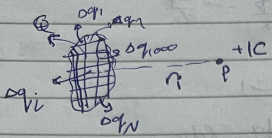


$\lambda = \frac{Q}{2\pi R}$ → للمحيط

permitter

circunference

موضوع الدرس _____ اليوم _____ التاريخ / /



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

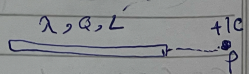
$$E_{total} = \sum_{i=1}^{N} \Delta E_i$$

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

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

→ linear charge density [Rod, line] سلك

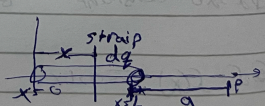
$$\lambda = \frac{Q}{L}$$



$$dE = k_e \frac{dq}{r^2}$$

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

$$= k_e \int_{charge} \frac{dq}{(a+L-x)^2}$$



* علاقة عكسية بين x و dq

كل ما اقتربنا من P زاد المجال

المسافة من straip إلى الشحنة النقطية

$\int \frac{dx}{x^2} = \frac{-1}{x}$ $\int \frac{dx}{(a-x)^2} = \frac{1}{a-x}$

موضوع الدرس _____ اليوم _____ التاريخ / /

$\lambda = \frac{Q}{A} = \frac{q/2}{L/2} = \frac{q/100}{L/100} = \frac{Dq}{Dx} \rightarrow \frac{dq}{dx}$

$\lambda = \frac{q}{x}$ متغير

$q = \lambda x$ اشتق

$\frac{dq}{dx} = \lambda \rightarrow dq = \lambda dx$

$E_p = Ke \int_0^L \frac{\lambda dx}{(a+L-x)^2}$

$= \frac{Ke\lambda}{(a+L-x)} \Big|_0^L$ عوض $\rightarrow \frac{Ke\lambda}{a} - \frac{Ke\lambda}{a+L} = Ke\lambda\left[\frac{1}{a} - \frac{1}{a+L}\right]$

حفظ

توحيد مقام $\rightarrow$ $\boxed{E_p = \frac{K\lambda L}{a(a+L)}}$ $= \frac{Ke\,Q}{a(a+L)} \rightarrow \lambda = \frac{Q}{L}$

* اذا كانت λ متغيرة نستخدم تكامل الة حاسبة

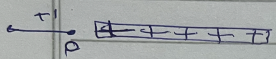
وحتى لما تكون ثابتة عصاد القانون

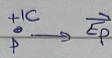
$E_p = \frac{Ke\lambda}{(a+L-x)^2} \Big|_0^L$

① $\lambda = \lambda_0 = \text{constant}$ $E_p = \frac{Ke\lambda L}{a(a+L)}$

② $\lambda = \lambda(x) = 0.1x$

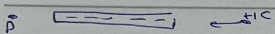
موضوع الدرس _____ اليوم _____ التاريخ / /





$\vec{E_p} = E_0 \hat{i}$ مبتعد (outward)

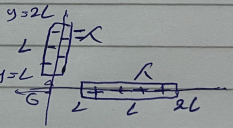
$E_p = E_0(-\hat{i})$ outward



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

inwards

Example



Finde the eletric feild at the orgen O

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

ⓐ $\frac{Ke\lambda}{2L}(\hat{i}+\hat{j})$ ⓑ $\frac{Ke\lambda}{2L}(-\hat{i}-\hat{j})$ ⓒ $\frac{Ke\lambda}{2L}(-\hat{i}+\hat{j})$ ✓