University of Anbar

College of Science

Department of Applied Geology

Fourth Year

Electromagnetics

جامعة الانبار

كلية العلوم

قسم علوم الفيزياء

المرحلة الرابعة

الكهرومغناطيسية

Electrical Field

Part one: Electric Field

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د . اسراء كامل احمد

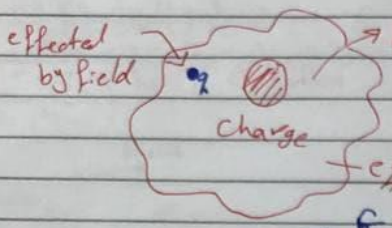
Part one in this Chapter: Electric Field

Electromagnetic
Dr. Israa kamil
march 2022

The fourth stage

Electric Field

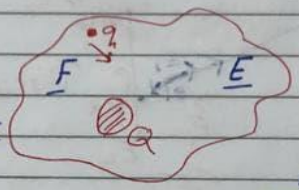
المجال الكهربائي



$\vec{F} = mg$

$[F = qE]$

Electric Force over q due to E

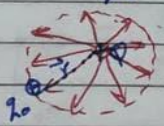


Point charge $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} \rightarrow E = \frac{F}{q_0}$

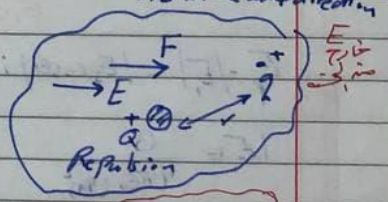
Coloumb Law

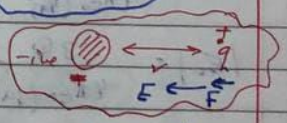
$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} = \frac{k q_1 q_2}{r^2}$

$F = \frac{qQ}{4\pi\varepsilon_0 r^2}$

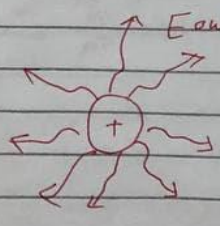


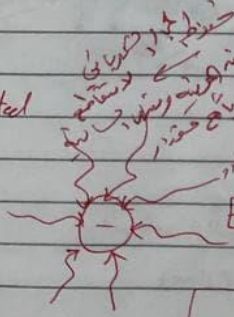
F, E in the same direction





Attraction





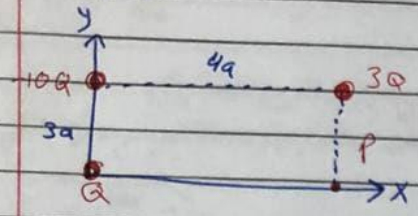
F, E in the same direction

E عكس اتجاه

Sing of q يعتمد على E

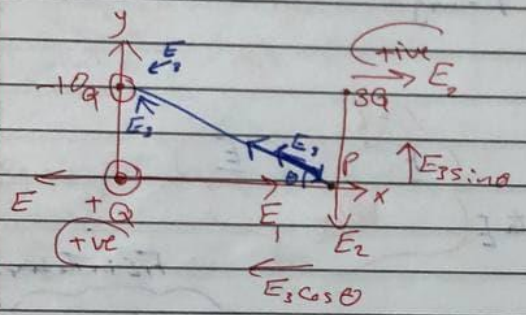
$$E = \frac{q}{4\pi\varepsilon_0 r^2}\hat{r}$$

Example:-



What is $\vec{E}$ at P ?

$$\vec{E}_P = \vec{E}_{Q_1} + \vec{E}_{Q_2} + \vec{E}_{Q_3}$$

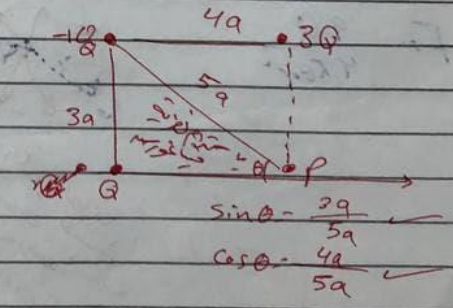


$$\vec{E}_P = |E_1| - |E_3\cos\theta|\,i + |E_3\sin\theta - E_2|\,j$$

$$|E_1| = \frac{Q}{4\pi\epsilon_0 (4a)^2}$$

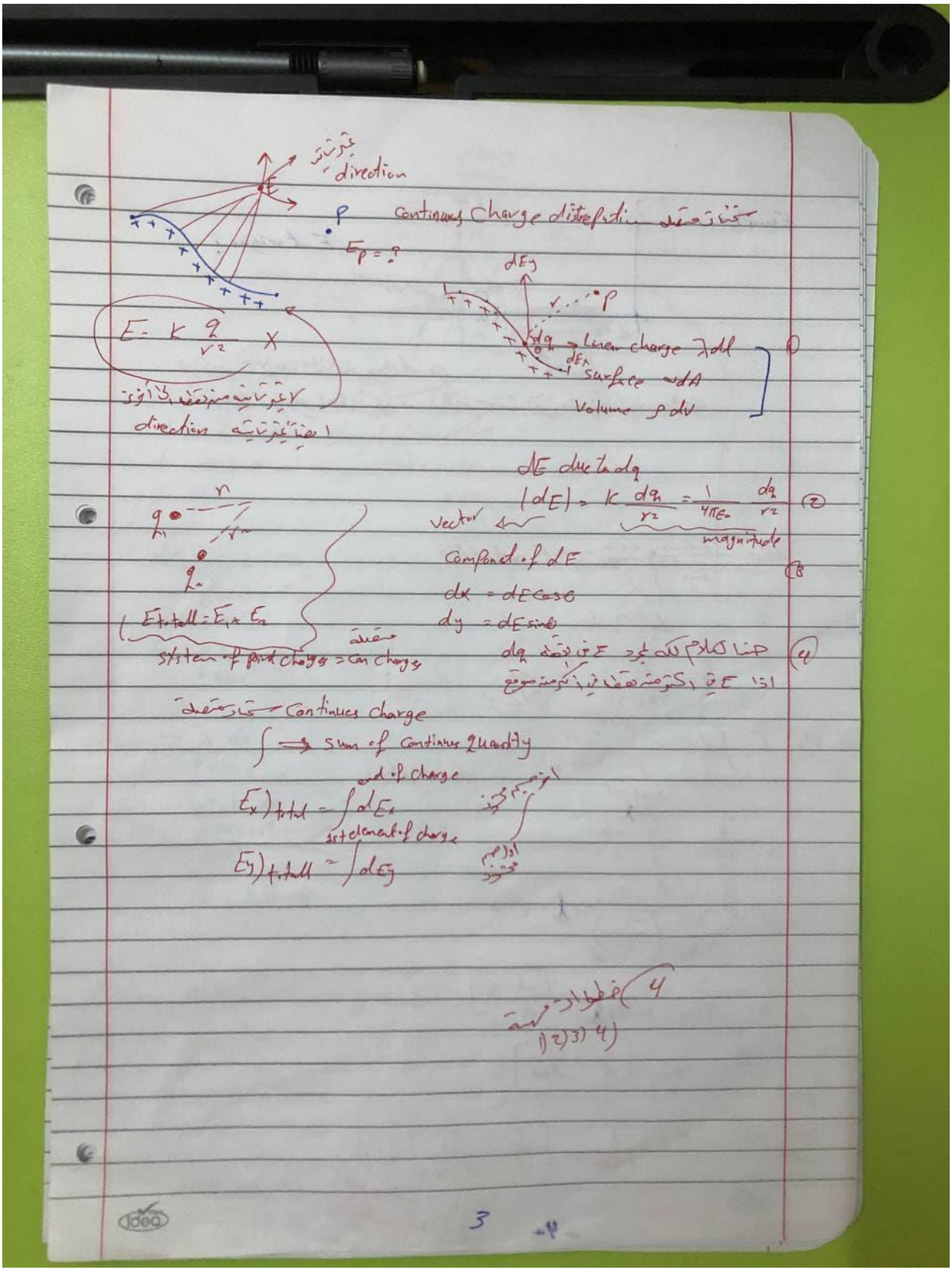
$$|E_2| = \frac{3Q}{4\pi\epsilon_0 (3a)^2}$$

$$|E_3| = \frac{-10Q}{4\pi\epsilon_0 (5a)^2}$$

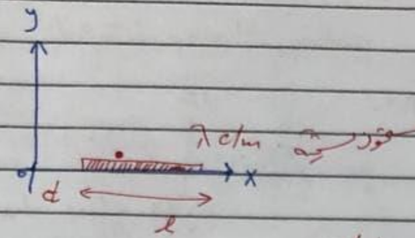


ثم نعمد ذلك بسم لتوضيح ما

(H.W)

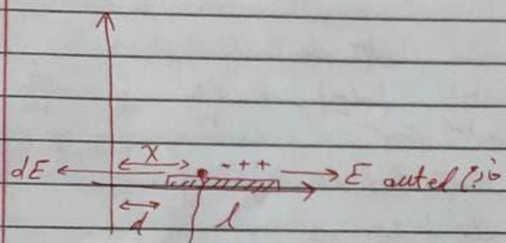

direction
P
$E_p = ?$
$E = K \frac{q}{r^2} \times$
continuous charge distribution
dE_y
r
P
dq → Linear charge λdl
dE
surface σdA
Volume ρdV
dE due to dq
$|dE| = K \frac{dq}{r^2} = \frac{1}{4\pi\varepsilon_0} \frac{dq}{r^2}$ (2)
vector
magnitude
Compound of dE
$dx = dE\cos\theta$
$dy = dE\sin\theta$ (3)
(4)
$E_{total} = E_1 + E_2$
system of point charges = can charge
continues charge
∫ ⟹ sum of continues quantity
$E_x)_{total} = \int dE_x$
$E_y)_{total} = \int dE_y$
1st element of charge
end of charge
1)2)3)4)

Example:



E at origin ?

لا يمكن التعامل معها على انها point charge
لانه سلك (وليه) ممكن تكون من أكثر من شحنة (موزعة عليه) ببعد مختلف



E acted (نا

$$dq = \lambda dx$$

$$dE = \frac{dq}{4\pi\epsilon_0 x^2} = \frac{\lambda dx}{4\pi\epsilon_0 x^2}$$

$$\text{total } E = \int dE = \int_{x_{start}=d}^{x=d+l} \frac{\lambda dx}{4\pi\epsilon_0 x^2}$$

التكامل حول dx

$$= \frac{\lambda}{4\pi\epsilon_0} \int_{d}^{d+l} \frac{dx}{x^2}$$

$$= \frac{\lambda}{4\pi\epsilon_0} \left(\frac{-1}{x}\right)_{d}^{d+l}$$

$$= \frac{\lambda}{4\pi\epsilon_0} \left[\frac{-1}{d+l} - \left(\frac{-1}{d}\right)\right]$$

$$E = \frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{d} - \frac{1}{l+d}\right]$$

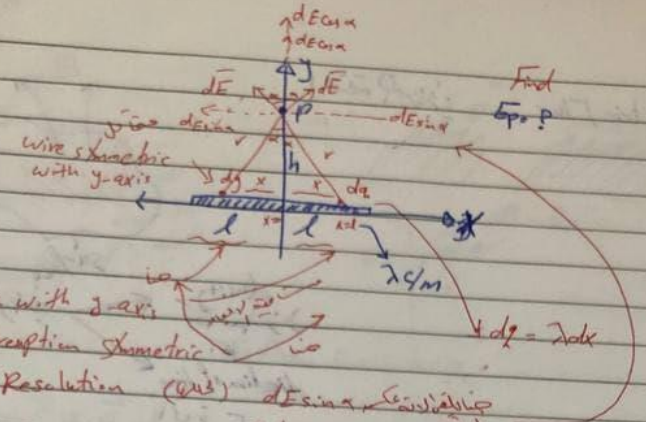
مقدار

Vector بالمقدار والاتجاه

$$E = \frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{d} - \frac{1}{l+d}\right] (-i)$$

اتجاهه عكس x-axis فيكون باتجاه $(-i)$

Example:-



∴ Symmetric with y-axis

∴ charge distraption Symmetric

2) dE make Resolution (Ox, Oy) $dE\sin\alpha$ $2dE\cos\alpha$

$$dE_{total} = 2dE\cos\alpha$$

Coulomb law — Geometry

$$dE = \frac{dq}{4\pi\varepsilon_0 r^2}$$

$$r = (x^2+h^2)^{1/2}$$

$$\cos\alpha = \frac{h}{r}$$

$$dE = \frac{\lambda\, dx}{4\pi\varepsilon_0 r^2}$$

$$dE_{tot} = \frac{2\lambda h\, dx}{4\pi\varepsilon_0 r^3}$$

$$E_{tot} = \int_{x=0}^{x=l} \frac{2\lambda h\, dx}{4\pi\varepsilon_0 (x^2+h^2)^{3/2}}$$

integration with respect to x

Unite Vector ... H.W

∴ Symmetric with y-axis

Reference:

1) INTRODUCTION to ELECTRODYNAMICS, Third Edition, David j.Griffths