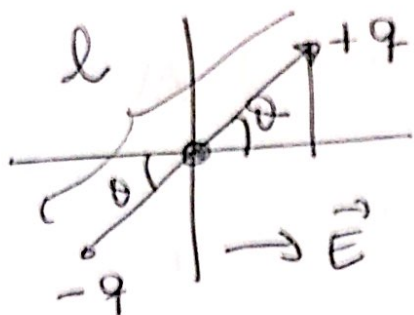


(1)



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

$U = -qE \cdot x$ (para que $\vec{F} = -\frac{\partial U}{\partial x}$)
 $\therefore U = -\int F dx = -qE \int dx = -qEx$

Si $x=0$ en el pto medio entre las cargas

$x_1 = \frac{l}{2} \cos \theta$ y $x_2 = -\frac{l}{2} \cos \theta$

Como $q_1 = q_2 = q$

$U = -q_1 E \cdot \frac{l}{2} \cos \theta - q_2 E \frac{l}{2} \cos \theta$

$U = -qE \frac{l}{2} \cos \theta - qE \frac{l}{2} \cos \theta = -qEl \cos \theta$

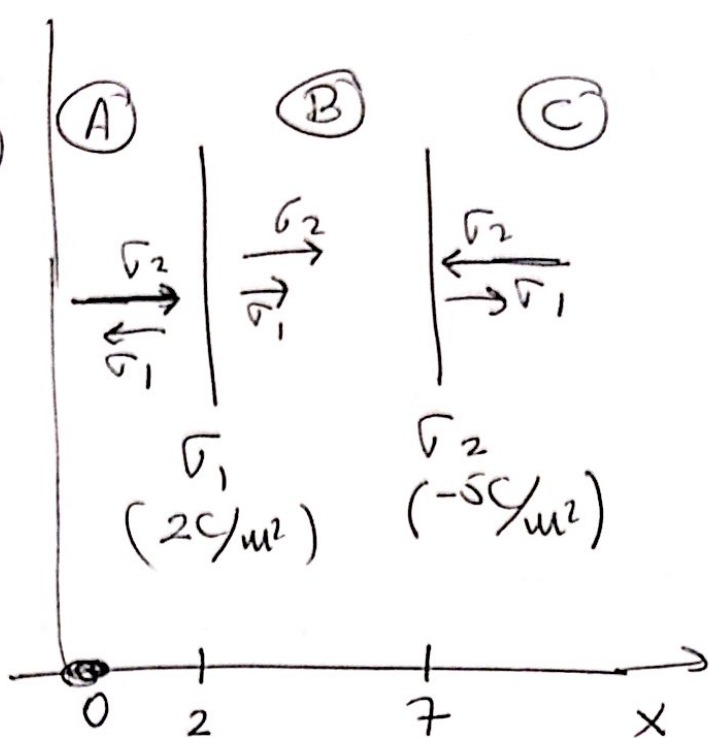
$|\vec{p}| = ql$

$U = -\vec{p} \cdot \vec{E}$

mínima U cuando $\theta = 0$ (lo más negativa posible)

Cuando $\theta = 0$ se minimiza la energía $\rightarrow$ posición más estable.

2b.2



a) $E_{A,B,C}$?

b) ΔV ?

c) q (7C) en (4,0,0)
 F ?

d) W mover q
de (4,0,0) a (6,0,0)
?

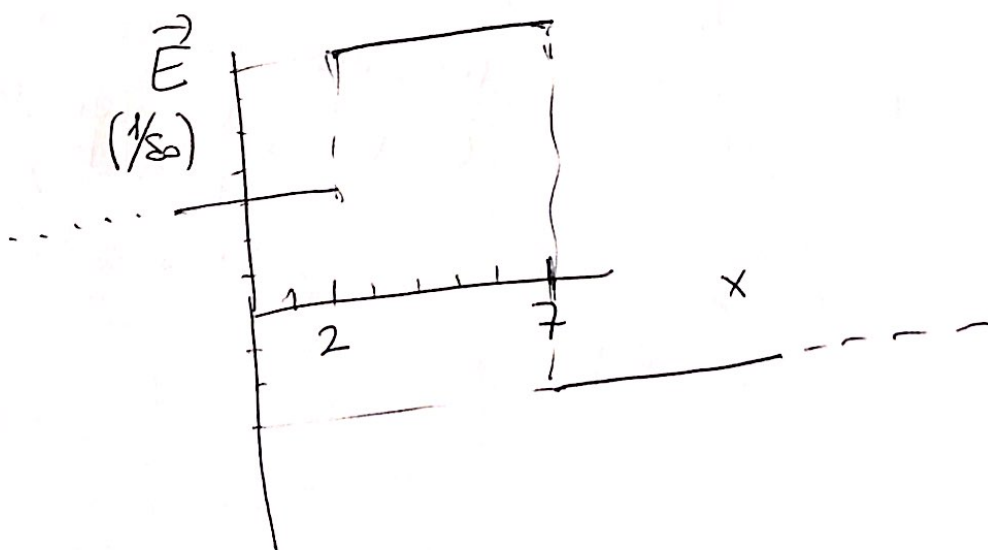
a) E_A ? E_B ? E_C ? $E \perp x$

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

(A) $-\infty < x < 2$ $\vec{E}_{rA} = \left(\frac{-\sigma_1}{2\epsilon_0} + \frac{\sigma_2}{2\epsilon_0} \right) \hat{i} = \frac{3}{2\epsilon_0} \hat{i} \text{ N/C}$

(B) $2 < x < 7$ $\vec{E}_{rB} = \left(\frac{\sigma_1}{2\epsilon_0} + \frac{\sigma_2}{2\epsilon_0} \right) \hat{i} = \left(\frac{2}{2\epsilon_0} + \frac{5}{2\epsilon_0} \right) \hat{i} = \frac{7}{2\epsilon_0} \hat{i} \text{ N/C}$

(C) $7 < x < \infty$ $\vec{E}_{rC} = \left(\frac{\sigma_1}{2\epsilon_0} - \frac{\sigma_2}{2\epsilon_0} \right) \hat{i} = \left(\frac{2}{2\epsilon_0} - \frac{5}{2\epsilon_0} \right) \hat{i} = \frac{-3}{2\epsilon_0} \hat{i} \text{ N/C}$



b) $\vec{E} = -\nabla V$

26.2

$$(E_x, E_y, E_z) = - \left(\frac{\partial V}{\partial x}, \frac{\partial V}{\partial y}, \frac{\partial V}{\partial z} \right)$$

$$E_x = -\frac{\partial V}{\partial x} \rightarrow E_x = -\frac{dV}{dx}, \quad V = -\int E_x dx$$

$$V = -\int_2^7 E_{\sigma B} dx = -\int_2^7 \frac{7}{2\epsilon_0} dx = -\frac{7}{2\epsilon_0} x \Big|_2^7 = -\left(\frac{7 \cdot 7}{2\epsilon_0} - \frac{7 \cdot 2}{2\epsilon_0} \right)$$

$$V = \frac{1}{2\epsilon_0} (49 - 14) = \underline{\underline{-\frac{35}{2\epsilon_0} V}}$$

c) $q = 7C$ en $(4, 0, 0)$

En $(4, 0, 0)$ estamos en la región B

$$\vec{E}_B = \frac{7}{2\epsilon_0} \hat{i} \text{ N/C}$$

$$\underline{\underline{\vec{F} = q \vec{E} = 7 \cdot \frac{7}{2\epsilon_0} \hat{i} = \frac{49}{2\epsilon_0} \hat{i} \text{ N}}}$$

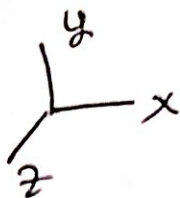
d) $W(4, 0, 0) \rightarrow (6, 0, 0)$

$$W = q \Delta V = q (V_{x=6} - V_{x=4})$$

$$\underline{\underline{W = \int_0^1 F \cdot dr = F \cdot \Delta x = q E \Delta x = 7 \cdot \frac{7}{2\epsilon_0} \cdot 2 = \frac{49}{\epsilon_0} J}}$$

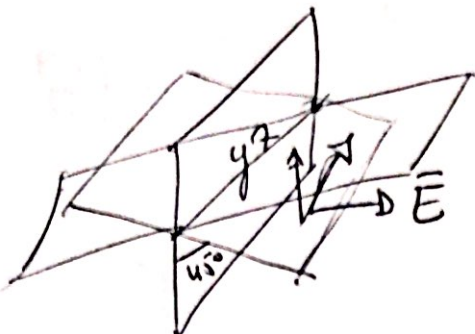
↓
ya que F de no $f(x)$ y $\perp \frac{dr}{(dx)}$

3)



$\vec{E}$ de $\vec{E}_i$

Flujo de E en $y^z = 2 \text{ Vm}^2$



$$\phi_{yz} = \vec{E} \cdot \vec{S} = ES = 2$$

a) Si giramos 45°

$\vec{E}$ y $\vec{S}$ 45°

$$\phi = E \cdot S \cdot \cos 45^\circ = 2 \frac{\sqrt{2}}{2} = \sqrt{2}$$

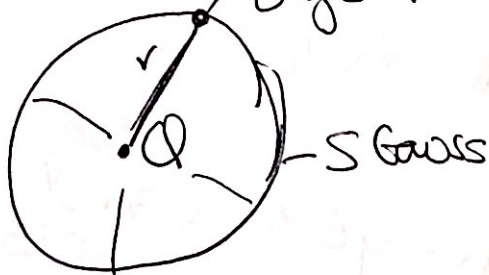
b) Si giramos 90°

$\vec{E}$ y $\vec{S}$ 90°

$$\phi = E \cdot S \cos 90^\circ = 0 \text{ W}$$

4) Gauss

a) q puntual Q



$$\oint E \cdot dS = E \int dS = \frac{Q}{\epsilon_0}$$

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

$$E \cdot S = \frac{Q}{\epsilon_0}$$

$$S \text{ esfera} = 4\pi r^2$$

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

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

(2b.3)

b) Esfera uniformemente cargada R, Q .

Ahora $q(r)$, cuando $r=R \rightarrow q=Q$ total

Hay que ver la carga proporcional a cualquier radio

$$\boxed{q(r)} = \frac{Q V_r}{V_R} = Q \frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi R^3} = \frac{Q r^3}{R^3}$$

ya que $\frac{Q}{\frac{4}{3}\pi R^3} = \frac{q(r)}{\frac{4}{3}\pi r^3}$ porque $\rho = \frac{Q}{V}$ cte

Si $r > R$, superficie gaussiana esfera de radio R ,

$$\oint E ds = 4\pi r^2 E = \frac{q(r)}{\epsilon_0} \quad \text{en general}$$

$$\text{Si } r \geq R \quad 4\pi R^2 E = \frac{Q}{\epsilon_0} \rightarrow$$

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

$$\text{Si } r \leq R \quad 4\pi r^2 E = \frac{Q r^3 / R^3}{\epsilon_0} \rightarrow$$

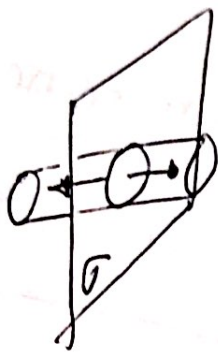
$$\boxed{E(r) = \frac{Q r^3 / R^3}{\epsilon_0} / 4\pi r^2 = \frac{Q r^3}{4\pi r^2 R^3 \epsilon_0} = \frac{Q r}{4\pi R^3 \epsilon_0}}$$

c) Si es una esfera hueca y toda la carga Q está en la superficie

$$\rho(r) \begin{cases} 0 & \text{si } r < R \\ Q & \text{" } r \geq R \end{cases}$$

$$E(r) \begin{cases} 0 & \text{si } r < R \\ \frac{Q}{4\pi\epsilon_0 r^2} & r \geq R \end{cases}$$

d)



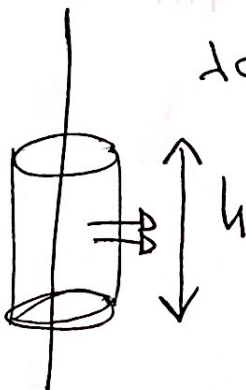
cte $Q = \sigma S$

$$\oint E dS = 2SE = \frac{Q}{\epsilon_0} = \frac{\sigma S}{\epsilon_0}$$

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

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

e)



cte, $Q = \lambda h$

$\vec{E} \parallel \vec{S}$ en las tapas $\vec{E} \perp \vec{S}$

$$\oint E dS = E \cdot S = \frac{Q}{\epsilon_0}$$

$S = 2\pi r h$ (S lateral)

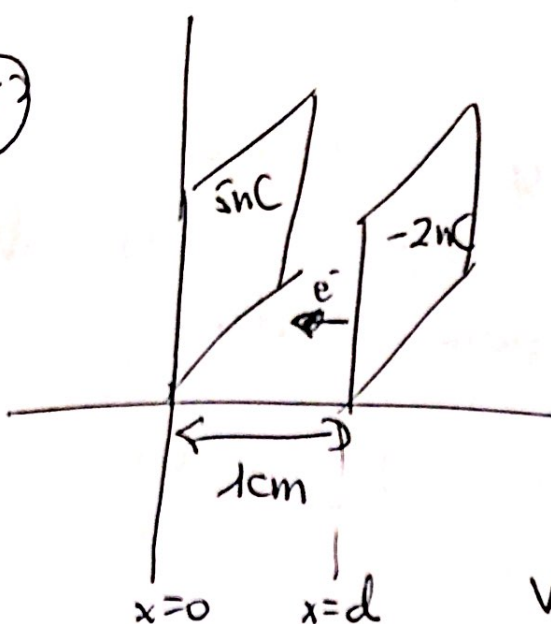
$$E 2\pi r h = \frac{\lambda h}{\epsilon_0}$$

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

a distancia r del hilo)

(53)

(2b.4)



$$S = 20 \text{ cm}^2$$

$$V_f e^- ?$$

$$V(x) = \frac{\sigma x}{2\epsilon_0} \text{ de un plano}$$

$$V(x) = V_1(x) + V_2(x) = \frac{\sigma_1 |x|}{2\epsilon_0} + \frac{\sigma_2 |d-x|}{2\epsilon_0}$$

$$\Delta V = V(0) - V(d) = \frac{\sigma_2 d}{2\epsilon_0} - \frac{\sigma_1 d}{2\epsilon_0} = \frac{(\sigma_2 - \sigma_1) d}{2\epsilon_0}$$

La diferencia de potencial entre las 2 placas
la diferencia de energía potencial de un e^-
entre las placas será

$$\Delta U = q \Delta V = -|e| \Delta V$$

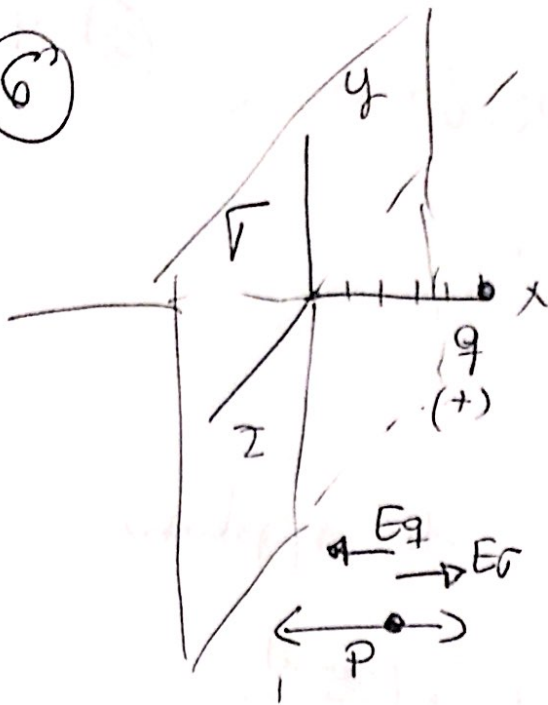
$$\frac{1}{2} m_e v_e^2 = |e| \frac{(\sigma_1 - \sigma_2) d}{2\epsilon_0} \Rightarrow v = \sqrt{\frac{2|e|(\sigma_1 - \sigma_2)d}{2\epsilon_0 m_e}}$$

$$\sigma_1 = \frac{Q_1}{S} = \frac{5 \cdot 10^{-9} \text{ C}}{20 \cdot 10^{-4} \text{ m}^2} = 2.5 \cdot 10^{-6} \text{ C/m}^2$$

$$\sigma_2 = \frac{Q_2}{S} = \frac{-2 \cdot 10^{-9} \text{ C}}{20 \cdot 10^{-4} \text{ m}^2} = -10^{-6} \text{ C/m}^2$$

$$v_e = 2.4 \cdot 10^6 \text{ m/s } (-\hat{i})$$

6)



$q(3C) (5,0,0)$
 $\sigma 7C/m^2$
 plano infinito

a) $P(x,0,0)$ y $(3,0,0)$

$\vec{E}_P?$

b) $V_P?$

c) $\vec{F}_{q\sigma}?$

a) $\vec{E}(x) = \vec{E}_{\text{plano}} + \vec{E}_{\text{carga}}$

$$\vec{E}(x) = \frac{\sigma}{2\epsilon_0} \hat{u}_x - \frac{q}{4\pi\epsilon_0 (x-x_0)^2} \hat{u}_x \quad x_0 = 5m$$

$$\vec{E}(x) = \left(\frac{7}{2 \cdot 885 \cdot 10^{-12}} - \frac{3}{4\pi \cdot 885 \cdot 10^{-12} (x-5)^2} \right) \hat{i}$$

$$\vec{E}(x) = 3'95 \cdot 10^{11} - \frac{2'7 \cdot 10^{10}}{(x-5)^2} \quad N/C$$

$$\text{En } (3,0,0), |\vec{E}| = 3'95 \cdot 10^{11} - \frac{2'7 \cdot 10^{10}}{4} = \underline{\underline{3'88 \cdot 10^{11} N/C}}$$

sentido + $(1,0,0)$

$$\boxed{\vec{E} (3'88 \cdot 10^{11}, 0, 0)}$$

b) $V_p?$

$$V = V_{\text{plano}} + V_{\text{carga}}$$

$$V(0,0,0) = 0 !!$$

Origen de potenciales!

$$V_{\text{plano}} = -\frac{\sigma}{2\epsilon_0} |x| + C_1$$

$$V_q = \frac{q}{4\pi\epsilon_0 |x-x_0|} + C_2$$

Si queremos que $V(0,0,0) = 0 \rightarrow \boxed{C_1 = 0}$

$$V_q = 0 = \frac{q}{4\pi\epsilon_0 |x-x_0|} + C_2 = 0 \quad \frac{q}{4\pi\epsilon_0 5} + C_2 = 0$$

$$\Rightarrow \boxed{C_2 = -\frac{q}{4\pi\epsilon_0 5}}$$

$$V(x) = -\frac{\sigma}{2\epsilon_0} |x| + \frac{q}{4\pi\epsilon_0 |x-5|} - \frac{q}{4\pi\epsilon_0 5}$$

Para $(3,0,0)$

$$\boxed{V(3,0,0) = -\frac{\sigma}{2\epsilon_0} 3 + \frac{q}{4\pi\epsilon_0 \cdot 2} - \frac{q}{4\pi\epsilon_0 \cdot 5}}$$

$$= -1.19 \cdot 10^{12} + 1.35 \cdot 10^{10} - 5.4 \cdot 10^9 \text{ V} = \boxed{-1.18 \cdot 10^{12} \text{ V}}$$

c) F que ejerce el plano sobre la carga

$$\vec{F}_{\pi \rightarrow q} = q E_{\text{plano}} = \frac{q\sigma}{2\epsilon_0} \hat{u}_x = \frac{3 \cdot 7}{2 \cdot 8.85 \cdot 10^{-12}} \hat{u}_x$$

$$= 1.19 \cdot 10^{12} \hat{u}_x \text{ N}$$

Por la 3 Ley de Newton

$$F_q \text{ sobre el plano} = -F_{\text{plano sobre carga}}$$

$$\boxed{\vec{F}_{\pi \rightarrow q} = -1.19 \cdot 10^{12} \hat{u}_x \text{ N}}$$