eléctrico?

25. En las esquinas de un cuadrado de lado a, como se muestra en la figura P23.25, existen cuatro partículas cargadas. Determine (a) el campo eléctrico en la ubicación de la carga q y (b) la fuerza eléctrica total ejercida sobre q.

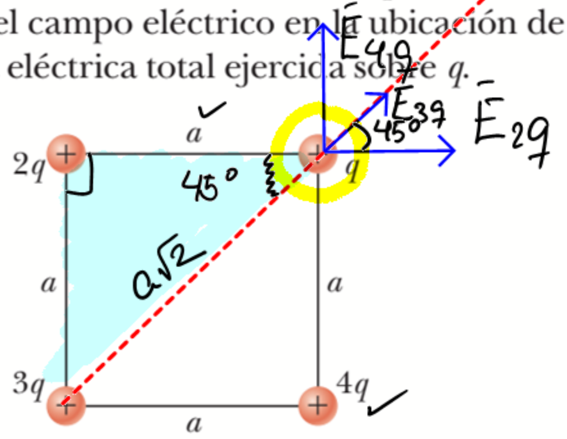


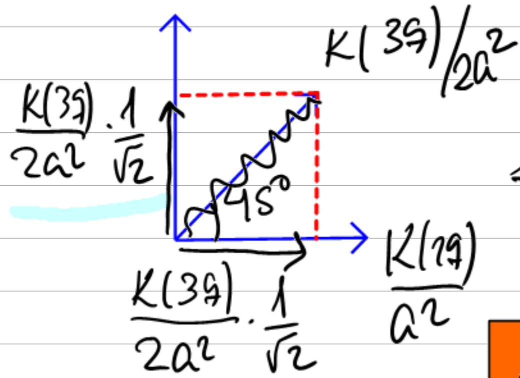
Figura P23.25

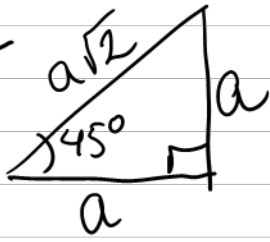
$$E_{2q} = \frac{K(2q)}{a^2}$$

$$E_{4q} = \frac{K(4q)}{a^2}$$

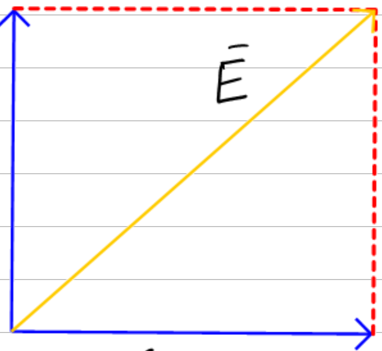
$$E_{3q} = \frac{K(3q)}{(a\sqrt{2})^2}$$

$K(4q)/a^2$



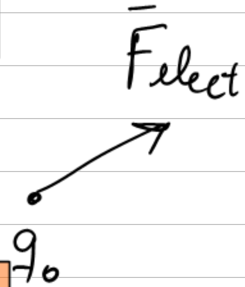


$$\frac{kq}{a^2}\left(4 + \frac{3}{2\sqrt{2}}\right) = E_y$$



$$\frac{kq}{a^2}\left(2 + \frac{3}{2\sqrt{2}}\right) = E_x$$

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



$$\bar{E} = \frac{\bar{F}_{elec}}{q_0}$$

$$\vec{E} = \frac{\bar{F}_{elec}}{q}$$

$$\vec{F}_{elec} = q\bar{E} = \boxed{q\left(E_x \hat{i} + E_y \hat{j}\right)}$$

36. Considere el "dipolo eléctrico" que se ilustra en la figura P23.36. Demuestre que el campo eléctrico en un punto *distante* sobre el eje $+x$ es $E_x \approx 4k_e qa/x^3$.

$\boxed{x >> a}$

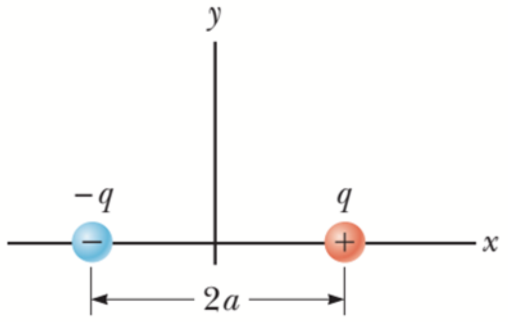


Figura P23.36

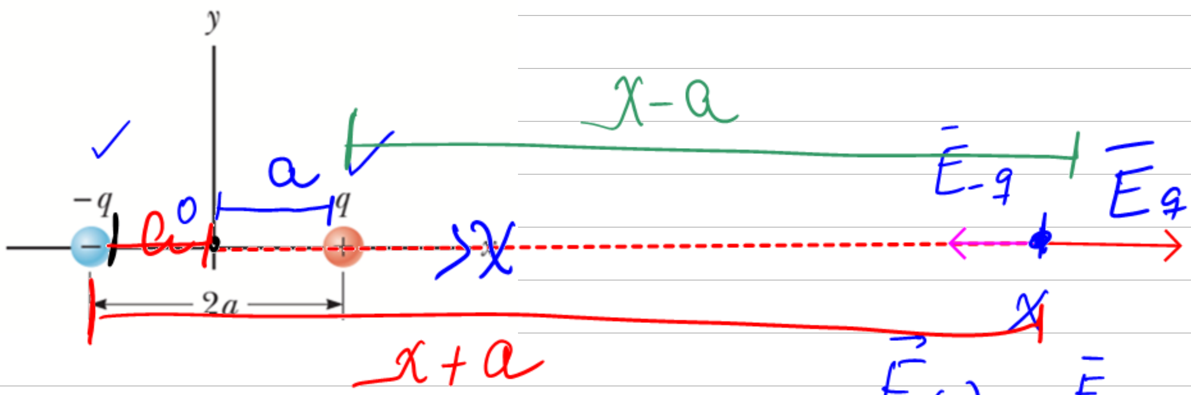
935 922 561

1m

$-q$ q

um

10^{-6} m



$$\vec{E}(x) = \bar{E}_q + \bar{E}_{-q}$$

$$\vec{E}(x) = E_q\,\hat{i} + E_{-q}(-\hat{i})$$

$$\boxed{\vec{E}(x) = (E_q - E_{-q})\,\hat{i}}$$

$$\vec{E}(x) = \left(\frac{Kq}{(x-a)^2} - \frac{Kq}{(x+a)^2}\right)\hat{i} = Kq\left\{\frac{1}{(x-a)^2} - \frac{1}{(x+a)^2}\right\}\hat{i}$$

$$\vec{E}(x) = Kq\left\{\frac{(x+a)^2 - (x-a)^2}{(x-a)^2(x+a)^2}\right\}\hat{i}$$

Identidad de Legendre:

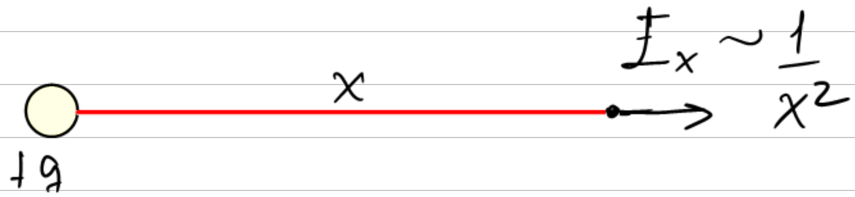
$$\vec{E}(x) = kq\frac{4xa}{[(x-a)(x+a)]^2}\hat{i} = kq\frac{4xa}{(x^2-a^2)^2}\hat{i}$$

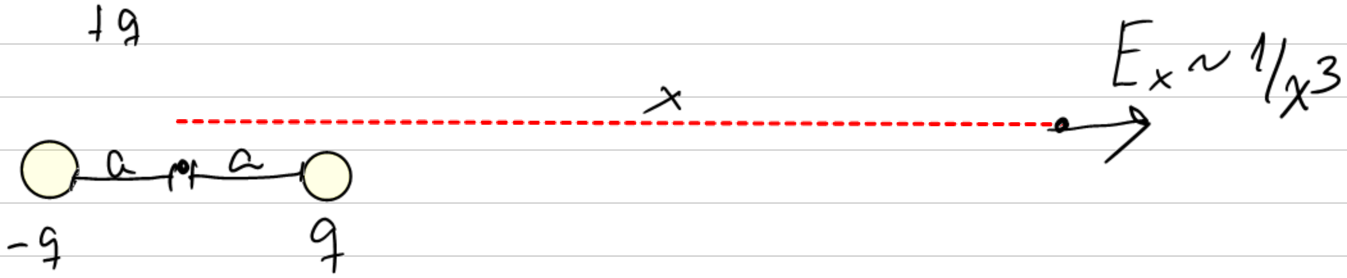
Si $x >> a \Rightarrow x^2 - a^2 \approx x^2$

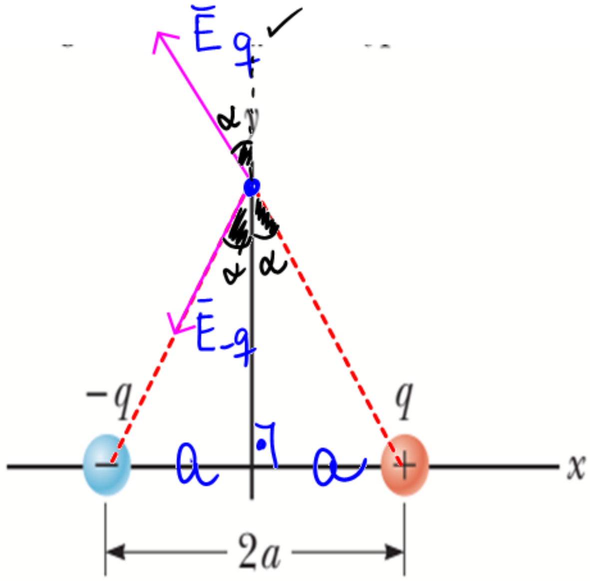
$$\vec{E}(x) = kq\frac{4xa}{(x^2)^2}\hat{i} = kq\frac{4xa}{x^4}\hat{i}$$

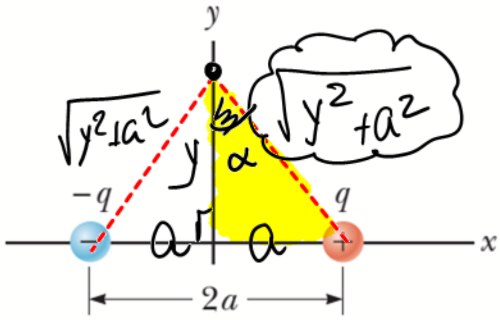
$$\boxed{\vec{E}(x) = kq\frac{4a}{x^3}\hat{i}}$$

$E_x \approx 4k_e qa/x^3.$





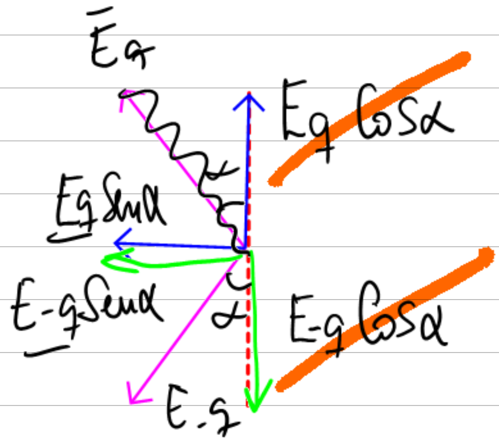




$$\boxed{\operatorname{Sen}\alpha = \frac{a}{\sqrt{y^2+a^2}}}$$

$$E_q = \frac{Kq}{(\sqrt{y^2+a^2})^2} = \frac{Kq}{y^2+a^2}$$

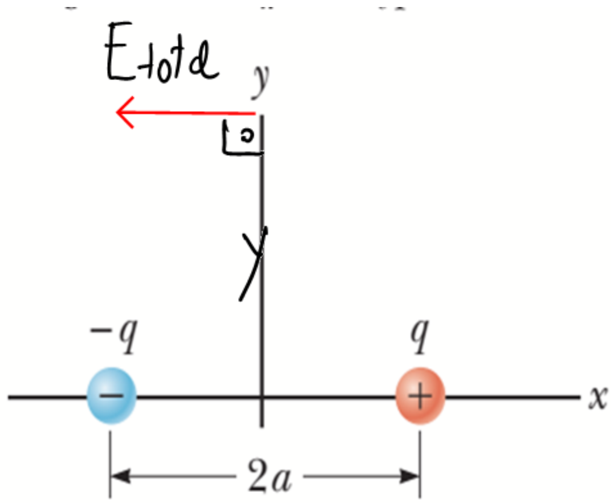
$$E_{-q} = \frac{Kq}{(\sqrt{y^2+a^2})^2} = \frac{Kq}{y^2+a^2}$$



$$2E_q \operatorname{Sen}\alpha$$

$$2 \times \frac{Kq}{(y^2+a^2)} \times \frac{a}{(y^2+a^2)^{1/2}}$$

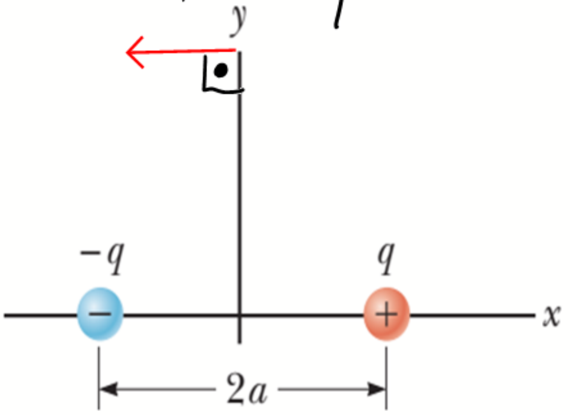
$$\boxed{2\,\frac{kq\,a}{(y^2+a^2)^{3/2}}}$$

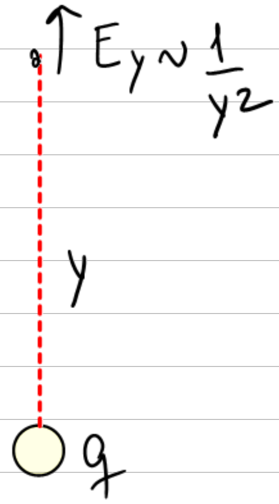


Si $y \gg a$, $y^2+a^2 \approx y^2$

$$\boxed{E_{total} \approx 2kq\,\frac{a}{y^3}}$$

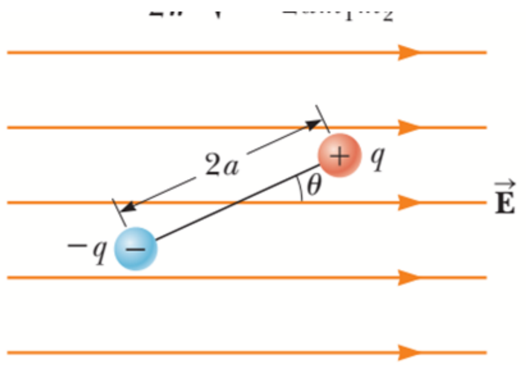
$E(y) \sim 1/y^3$



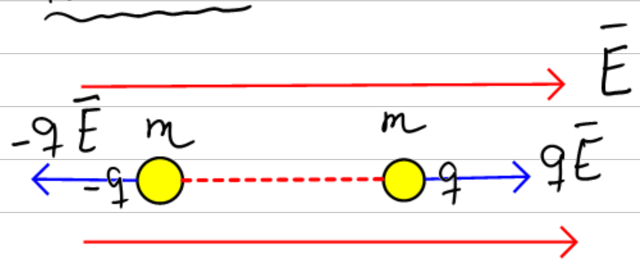


87. Problema de repaso. Un dipolo eléctrico en un campo eléctrico uniforme se desplaza ligeramente de su posición de equilibrio, como se observa en la figura P23.87, donde θ es pequeña. La separación entre cargas es $2a$, y cada una de las dos partículas tiene masa m. (a) Suponiendo que el dipolo es liberado de su posición, demuestre que su orientación angular exhibe un movimiento armónico simple con una frecuencia

$$f = \frac{1}{2\pi}\sqrt{\frac{qE}{ma}}$$

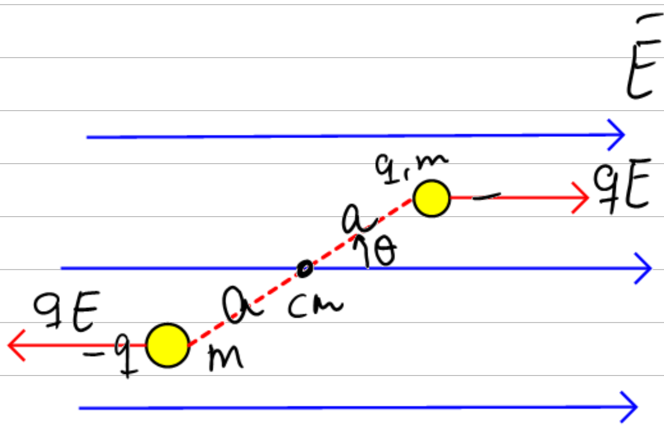


Análisis:

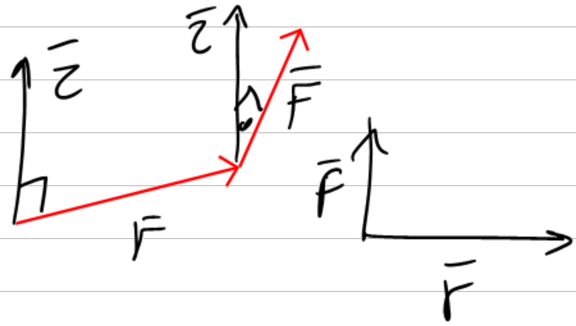


$\bar F_{elec} = q\bar E$ $\qquad$ $\bar F_{nete} = 0$

$-q\bar E$ $\qquad$ $a_{sist} = 0$ Equilibrio



- $\boxed{\theta < \frac{\pi}{18}}$, $\boxed{\operatorname{Sen}\theta \approx \theta}$
- $\sum \bar F = 0 \Rightarrow a_{CM} = 0$ Equilibrio traslacional
- $\sum \bar \tau_{CM} \neq 0$

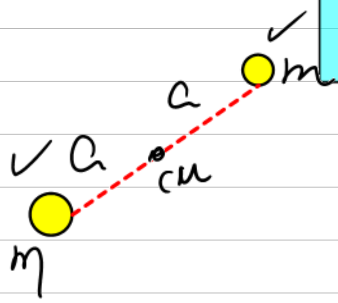


$$\boxed{\sum \tau_{CM} = -(qE)(a\,\text{Sen}\theta)}$$

Segunda Ley de Newton para rotación:

$$\sum \bar{\tau}_{CM} = I_{CM}\,\bar{\alpha}$$

$$\boxed{-qE(a\,\text{Sen}\theta) = 2ma^2\alpha}$$



$$x \to v \to a \qquad \theta \to \omega \to \alpha$$

$$I_{CM} = 2ma^2$$

$$-qE(a\,\text{Sen}\theta) = 2ma^2\alpha$$

$$-qEa\theta = 2ma^2\alpha$$

$$\boxed{\alpha = -\frac{qE}{2ma}\theta}$$

M.A.S.

$a = -\text{cte}\,x$

M.A.S.

aceleración angular

desplazamiento angular

$$\omega^2 = \frac{qE}{2ma} \Rightarrow \omega = \sqrt{\frac{qE}{2ma}} \Rightarrow \boxed{f = \frac{1}{2\pi}\sqrt{\frac{qE}{2ma}}}$$