

Exercícios

24/02/10

$$1) q = \frac{kqQ}{d^2} = \frac{ke^2}{Gm_{\text{emp}} d^2} = \frac{8,98755 \cdot 10^9 \cdot 1,602177^2 \cdot 10^{-38}}{667 \cdot 10^{-13} \cdot (9,11 \cdot 10^{-31})^2 \cdot (1860 \cdot 9,11 \cdot 10^{-31})} = 2,3 \cdot 10^{39}$$

2) $v = 1L$

a) $Q_p = +ne = \frac{1}{224} \cdot 1,6 \cdot 10^{-19} \cdot 6,02 \cdot 10^{23} = 8600 C$

b) $F = \frac{kqQ}{d^2} = \frac{9 \cdot 10^9 \cdot 4600^2}{1} = 6,7 \cdot 10^{17} N$
 $= 6,8 \cdot 10^{16} \text{ kgf}$

c) $F = mg$

$m = 6,8 \cdot 10^{16} \text{ kg}$ é a massa cujo peso na superfície da Terra equivale a essa força
 massa de um dióxido de carbono

3) $d_0 = 0,5 \cdot 10^{-10} \text{ m}$

a) $f = ?$

$$m_e \omega^2 d = \frac{ke^2}{d^2} \quad f = \frac{e}{2\pi d} \sqrt{\frac{k}{m_e d}}$$

$$m_e 4\pi^2 f^2 = \frac{ke^2}{d^3}$$

$$f = \frac{1}{2\pi} \cdot \frac{1,6 \cdot 10^{-19}}{0,5 \cdot 10^{-10}} \sqrt{\frac{9 \cdot 10^9}{9,11 \cdot 10^{-31} \cdot \frac{1}{2} \cdot 10^{-10}}} = 7,2 \cdot 10^{15} \text{ Hz} \approx \text{freq luz visível}$$

b) $v = 2\pi f d = 2261946,7 \text{ m/s}$

$v < \frac{1}{100} c \rightarrow \tilde{n}$ - relativístico

Não se pode usar mecânica clássica

4) $\oplus - \ominus - - \oplus$

a)

$F_x = 0$
 $F_y = -\frac{2kqQ}{\left(\frac{y}{\sin \theta}\right)^2} \sin \theta = -\frac{2kqQ}{d^2} \cdot \frac{y}{d} = -\frac{2kqQ}{d^3} y$ (MHS)
 Restável

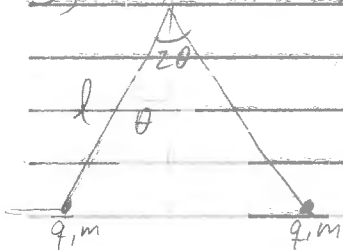


$$F = -\frac{kqQ}{(d-x)^2} + \frac{kqQ}{(d+x)^2}$$

$$F = kqQ \left[\frac{1}{(d+x)^2} - \frac{1}{(d-x)^2} \right] < 0$$

⇒ instável, já que a carga negativa se chocará com uma das Qs

5)



a) $k\frac{q^2}{l^2} + k\frac{q^2}{l^2} \tan \theta$
 $4l^2 \text{sen}^2 \theta \cdot \text{háb} \text{sen} \theta$

$$q^2 \cos \theta = 4l^2 \text{sen}^3 \theta \text{mg} \cdot 4\pi \epsilon_0$$

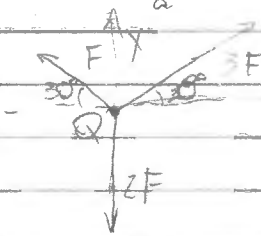
$$q^2 \cos \theta = 16\pi \epsilon_0 l^2 \text{mg} \text{sen}^3 \theta \quad \text{cqd}$$

b) $q^2 \cos 30^\circ = \frac{1}{9 \cdot 10^9} \cdot \frac{1}{25} \cdot 10^{-3} \cdot 9,8 \cdot \text{sen}^3 30^\circ$

$$q = \frac{2}{15} \cdot 10^{-6} \cdot \sqrt{9,8 \cdot \text{sen}^3 30^\circ} \cdot \sqrt{\text{tg} 30^\circ}$$

$$q = 1,8 \cdot 10^{-7} \text{ C} = 0,18 \mu\text{C}$$

6) $F = \frac{3kqQ}{a^2}$ $F(2q) = \frac{6kqQ}{a^2}$ $F(3q) = \frac{9kqQ}{a^2}$



$$F_y = F \text{sen} 30^\circ + 3F \text{sen} 30^\circ - 2F$$

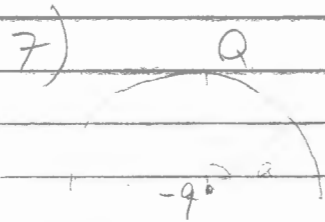
$$\sum F_y = 0$$

$$F_x = (3F - F) \cos 30^\circ = F\sqrt{3}$$

$$|R| = F\sqrt{3} = \frac{3kqQ}{a^2} \sqrt{3}$$

$$d = \frac{a\sqrt{3}}{3} - \frac{a}{\sqrt{3}}$$

$$R = \frac{3kqQ}{a^2} \sqrt{3}$$

7)  $\lambda = \frac{Q}{\pi a}$ F_x se anula dos 2 lados
 $F = F_x$
 $\lambda = \frac{dQ}{dl} = \frac{dQ}{a d\theta}$

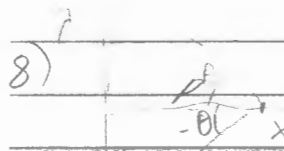
$$d\vec{F} = -\frac{kq dQ}{a^2} (\cos \theta \hat{i}) = -\frac{kq \lambda a d\theta}{a^2} \cos \theta$$

$$F = -\frac{kq \lambda}{a} \int_{-\pi/2}^{\pi/2} \cos \theta d\theta$$

$$F = -\frac{kq \lambda}{a} (\sin \frac{\pi}{2} - \sin(-\frac{\pi}{2}))$$

$$F = -\frac{kq \lambda}{a} \cdot 2 = -\frac{2kq Q}{\pi a^2}$$

$$F = -\frac{2qQ}{2\pi \epsilon_0 a^2} = -\frac{qQ}{\pi \epsilon_0 a^2}$$

8)  F_x se anula pela simetria
 $F = F_x$

$$dF = \frac{kq dQ}{p^2 + y^2} \cos \theta$$

$$\lambda = \frac{Q}{\pi p}$$

$$\lambda = \frac{dQ}{dy}$$

$$F = \int_{-\pi/2}^{\pi/2} \frac{kq \lambda dy}{p^2 + y^2} \cos \theta$$

$$2 \cos^2 \theta = 1 + \cos 2\theta$$

$$y = p \tan \theta \quad F = \int_{-\pi/2}^{\pi/2} \frac{kq \lambda p \sec^2 \theta d\theta}{p^2 + p^2 \tan^2 \theta} \cos \theta \quad \cos 2\theta = 1 - \sin^2 \theta$$

$$dy = p \sec^2 \theta d\theta \quad F = \int_{-\pi/2}^{\pi/2} \frac{kq \lambda}{p + p \tan^2 \theta} \sec \theta d\theta$$

$$F = \frac{kq \lambda}{p} \int_{-\pi/2}^{\pi/2} \cos \theta d\theta = \frac{q \lambda}{\pi \epsilon_0 p} \int_{-\pi/2}^{\pi/2} \cos \theta d\theta = \frac{q \lambda}{2\pi \epsilon_0 p}$$

$y \ll d$

25102110

$$q) \quad \cancel{m} \ddot{y} + \frac{2kqQ}{\sqrt{y^2 + \frac{d^2}{4}}} \cdot \frac{y}{\sqrt{y^2 + \frac{d^2}{4}}} = \cancel{y} mg$$

$$\omega = \sqrt{\frac{4kqQ}{\pi \epsilon_0 d^3}} = 2 \sqrt{\frac{qQ}{\pi \epsilon_0 d^3}}$$