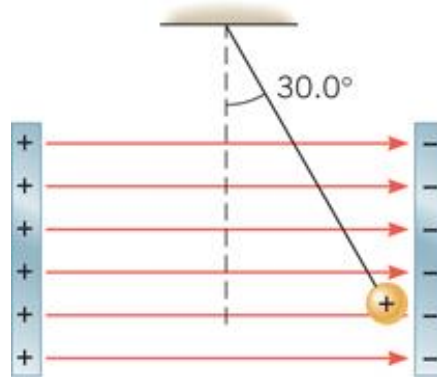
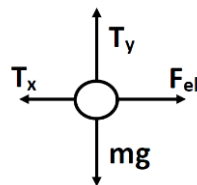


25. A small plastic ball with a mass of 6.50×10^{-3} kg and with a charge of $+0.150 \mu\text{C}$ is suspended from an insulating thread and hangs between the plates of a capacitor (see the drawing). The ball is in equilibrium, with the thread making an angle of 30.0° with respect to the vertical. The area of each plate is 0.0150 m^2 . What is the magnitude of the charge on each plate?



Free Body



$$\sum F_x = F_{el} - T_x = ma_x = 0$$

$$F_{el} = T_x = T \sin(\theta)$$

$$\sum F_y = T_y - mg = ma_y = 0$$

$$T_y = mg = T \cos(\theta)$$

$$T = \frac{mg}{\cos(\theta)}$$

$$F_{el} = T \sin(\theta) = \frac{mg}{\cos(\theta)} \sin(\theta) = mg \tan(\theta)$$

$$F_{el} = mg \tan(\theta) = q_{ball} E$$

$$E = \frac{mg}{q_{ball}} \tan(\theta) = \frac{\sigma}{\epsilon_0}$$

Solve for charge density

$$\sigma = \epsilon_0 \frac{mg}{q_{ball}} \tan(\theta) = \frac{Q_{cap}}{A}$$

$$Q_{cap} = \epsilon_0 A \frac{mg}{q_{ball}} \tan(\theta)$$

Q_{cap}

$$= \left(8.85 \times 10^{-12} \text{ C}^2 / (\text{Nm}^2) \right) (0.0150 \text{ m}^2) \frac{(6.50 \times 10^{-3} \text{ kg}) (9.80 \text{ m/s}^2)}{(0.150 \times 10^{-6} \text{ C})} \tan(30.0^\circ)$$

$$Q_{cap} = \left(1.3275 \times 10^{-13} \text{ C}^2 / \text{N} \right) \frac{(6.37 \times 10^{-2} \text{ N})}{(0.150 \times 10^{-6} \text{ C})} \tan(30.0^\circ)$$

$$Q_{cap} = 3.2548 \times 10^{-8} \text{ C}$$

$Q_{cap} = 3.25 \times 10^{-8} \text{ C}$

Dr. Donovan's Classes
Page

Dr. Donovan's PH 202
Homework Page

NMU Physics
Department Web Page

NMU Main Page

Please send any comments or questions about this page to ddonovan@nmu.edu

This page last updated on January 7, 2021