

Coulomb law

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The problem:

Two small spheres of identical masses and charges are hung on two strings of a length L . Show that for small angles the horizontal distance between the masses is:

$$x = \left(\frac{q^2 L}{2\pi\epsilon_0 m g} \right)^{1/3} \quad (1)$$

The solution:

We write two force equations one for the vertical axis (where θ is the angle of the string relatively to the vertical):

$$T \cos \theta = mg \quad (2)$$

and another one for the horizontal axis (x is the distance between the masses):

$$T \sin \theta = \frac{kq^2}{x^2} \quad (3)$$

Divide the equations and use the following formulas:

$$\tan \theta = \frac{Kq^2}{mgx^2} \quad (4)$$

$$k = \frac{1}{4\pi\epsilon_0} \quad (5)$$

$$\sin \theta = \frac{x/2}{L} \simeq \tan \theta \quad (6)$$

where in the last equation we used the the small angles. Then

$$\frac{x}{2L} = \frac{q^2}{4\pi\epsilon_0 m g x^2} \quad (7)$$

$$x = \left(\frac{q^2 L}{2\pi\epsilon_0 m g} \right)^{1/3} \quad (8)$$