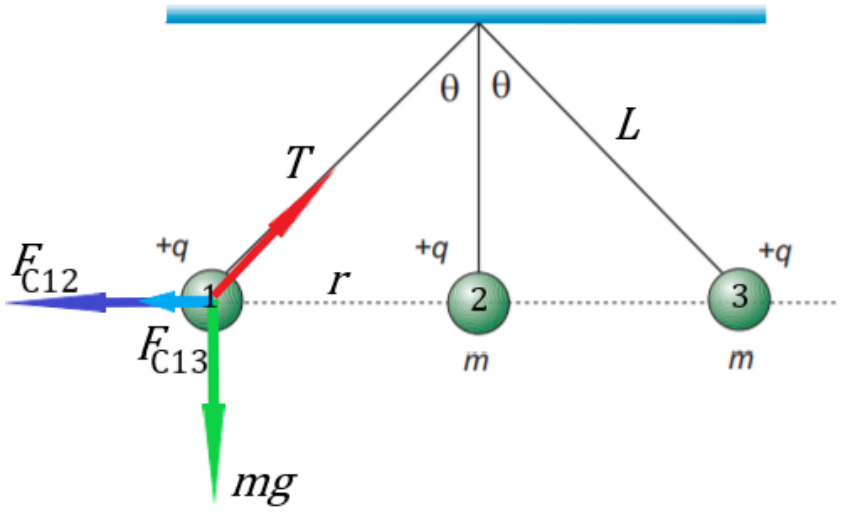
Answer on Question #81698 - Physics - Electric Circuits

Three identical point charges, with mass m=0.10kg, hang from three strings, as shown below. if l =30.0cm and 0=45, what is the value of q?

Solution

As shown in figure 1, left and right charges are balanced by Coulomb's force, force of gravity and tension.



Since the charges hang symmetrically, write equilibrium equations for the ball 1 according to the Newton's second law for Ox and Oy axes:

$$Ox: \ -\frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{r^2}-\frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{(2r)^2}+T\sin\theta=0,$$

$$Oy: \ -mg+T\cos\theta=0,$$

$$T=\frac{mg}{\cos\theta}.$$

From the first equation ($r=L\sin\theta$):

$$T\sin\theta=\frac{5}{4}\cdot\frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{r^2}=\frac{5q^2}{16\pi\varepsilon_0 r^2}=\frac{5q^2}{16\pi\varepsilon_0(L\sin\theta)^2},$$

Substitute T:

$$mg\tan\theta=\frac{5q^2}{16\pi\varepsilon_0(L\sin\theta)^2},$$

$$q=4L\sin\theta\cdot\sqrt{\frac{\pi\varepsilon_0 mg\tan\theta}{5}}=4\cdot0.3\cdot0.707\cdot\sqrt{\frac{3.14\cdot8.85\cdot10^{-12}\cdot0.1\cdot9.8\cdot1}{5}}=1.98\cdot10^{-6}\ \text{C}$$

Answer

$q=1.98\ \mu\text{C}$