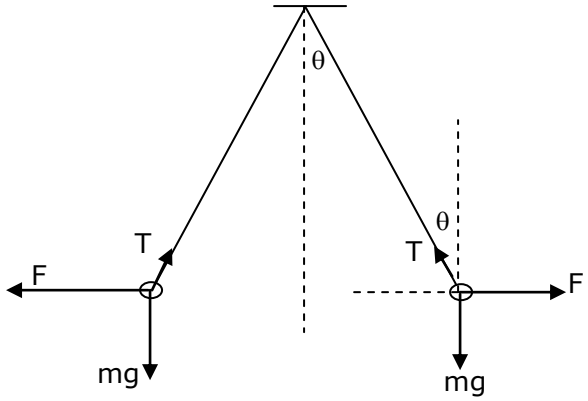
Q- Two tiny identical metal balls each of mass 10g and carrying equal positive charges are suspended from "weightless" insulated strings each of 1m length. The balls repel each other and come to an equilibrium position with each string making an angle of 37^0 to the vertical.
(a) Draw a sketch of the arrangement and indicate all the forces acting.



(b) Find the tension in each string.
The forces acting on each ball in equilibrium are i) The weight of the ball mg ii) The electrostatic force between the balls F and iii) The tension in the strings T

Let the length of the strings L = 1 m and the angle the strings makes with vertical is $\theta = 37^0$. Resolving the tension in the string T in vertical and horizontal directions the vertical component of the tension will be T*cos θ

As the ball is in equilibrium the vertical forces must balance and hence vertical component of the tension will balance the weight of the ball and thus we get

$T \cos\theta = mg$
Or $T = mg/\cos\theta = (0.01kg*9.8\ m/s^2)/(\cos 37^0)$
Or $T = 0.098/0.799 = 0.1225$ N.

(c) Calculate the charge on each ball.
Let the charge on each ball be q. The distance between the two balls in equilibrium position will be x = 2*L*sin θ, hence the force F between the two balls according to Coulomb's law is given by

$$F = \frac{q^2}{4\pi \in_0 x^2} = \frac{9*10^9 * q^2}{(2*L\sin\theta)^2}$$

Now this force is balanced by the horizontal component of tension T sin θ we have

$$F = \frac{9*10^9 * q^2}{(2*L\sin\theta)^2} = T\sin\theta$$

Or $$q^2 = \frac{(2*L\sin\theta)^2}{9*10^9} * T\sin\theta$$

Gives $$q = \sqrt{\frac{4L^2 * T\sin^3\theta}{9*10^9}}$$

Substituting the values we have

$$q = \sqrt{\frac{4*1.0^2 * 0.1225 * 0.218}{9*10^9}} = 3.44*10^{-6}\ \text{C} = 3.44 \text{ micro-Coulomb.}$$