QUES 06:-

Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a fixed point by threads of length 'l'. What is the equilibrium separation when each thread makes a small angle 'θ' with the vertical ?

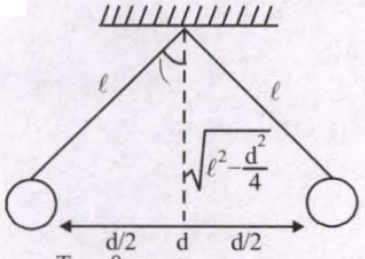
[July 27, 2021 (I)]

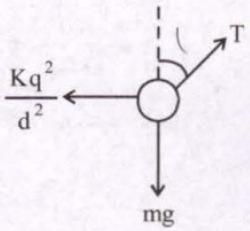
(a) $d = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{2}}$ (b) $d = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

(c) $d = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{\frac{1}{3}}$ (d) $d = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{\frac{1}{3}}$

SOL:-

(c)





$T\cos\theta = mg$ ..... (i)

Force due to charges $= \frac{kq^2}{d^2}$

$T\sin\theta = \frac{kq^2}{d^2}$ ..... (ii)

From (i) and (ii) we get

$$\tan\theta = \frac{\frac{kq^2}{d^2}}{mg}$$

as $\tan\theta \approx \sin\theta \approx \frac{d}{2\ell}$

$$\frac{kq^2}{mgd^2} = \frac{d}{2\ell}$$

$$\Rightarrow d^3 = \frac{2kq^2\ell}{mg}$$

$$\Rightarrow d = \left(\frac{2kq^2\ell}{mg}\right)^{1/3}$$