Problem 1 (from MIT text book)

Two tiny conducting balls of identical mass m and identical charge q hang from non-conducting threads of length l. Each ball forms an angle θ with the vertical axis, as shown in Figure 2.15.9. Assume that θ is so small that $\tan\theta \approx \sin\theta$.

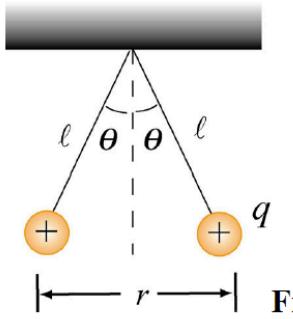

Figure 2.15.9

(a) Show that, at equilibrium, the separation between the balls is

$$r = \left(\frac{q^2 \ell}{2\pi\varepsilon_0 mg} \right)^{1/3}$$

This is a rather difficult problem from the math point of view, because you still do not know the sin or tan functions. But the condition that

$$\tan\theta \approx \sin\theta$$

is equivalent to say that the gravitation force is much greater than the Coulomb force, i.e.,

$$mg >> q^2/4\pi\varepsilon_0 r^2$$

Use this simplification to derive the above answer. You can solve this problem! It combines both the mechanics and electrostatics.