2 Fig. 2.1 shows a small conducting sphere suspended from a long insulating thread between two metal plates M and M' that are 0.0500 m apart. The plates are connected to a 5.0×10^3 V battery. The sphere has a radius of 0.0025 m and a mass of 1.0 g.

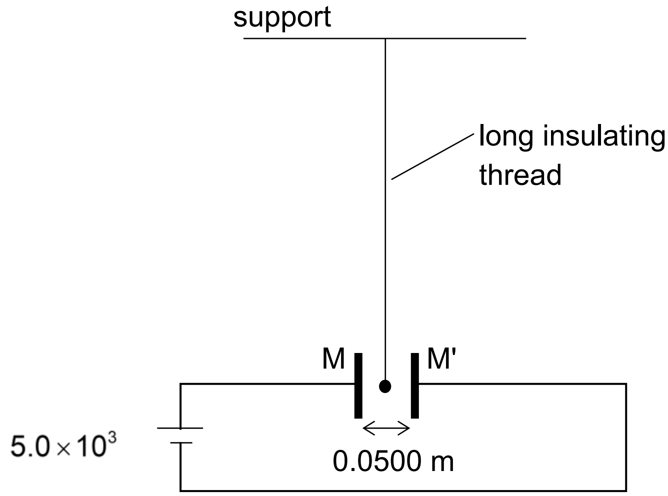

Fig. 2.1

The sphere is given an initial displacement such that the sphere touches M. It then moves rapidly to M', touches it, and returns rapidly to M again. This process repeats itself.

(a) State and explain why an initial displacement to touch one of the plates is necessary for the process to start.

………

………

………... [2]

(b) When the sphere touches either plate, it acquires a potential that is equal to the potential difference between the plates.

The electrical potential on the surface of a charged conducting sphere can be determined by assuming that all its charges are accumulated at the centre of the sphere.

Show that the charge on the sphere when it touches M is $50\pi\varepsilon_o$.

[1]

(c) If the electric field between the plates is uniform, calculate the magnitude of the electrostatic force acting on the sphere.

force =………..……….. N [1]

(d) As a long thread is used, the motion of the sphere is nearly horizontal and is due to electrostatic force only. Determine the time taken for the sphere to move from M to M'.

time taken =………………. s [3]

(e) When the battery is removed from Fig. 2.1, the plates remain equally but oppositely charged. The sphere is totally discharged and given an initial displacement to enable it to reach one of the plates. State and explain how the time taken to move from one plate to the other will change.

……..

……..

……..

……..

…… [3]

[Total: 10]