4 **(a)** State Coulomb's law.

……

……

…… [1]

(b) A charged sphere X is supported on an insulating stand. A second charged sphere Y is suspended by an insulating thread so that sphere Y is in equilibrium at the position shown in Fig. 4.1.

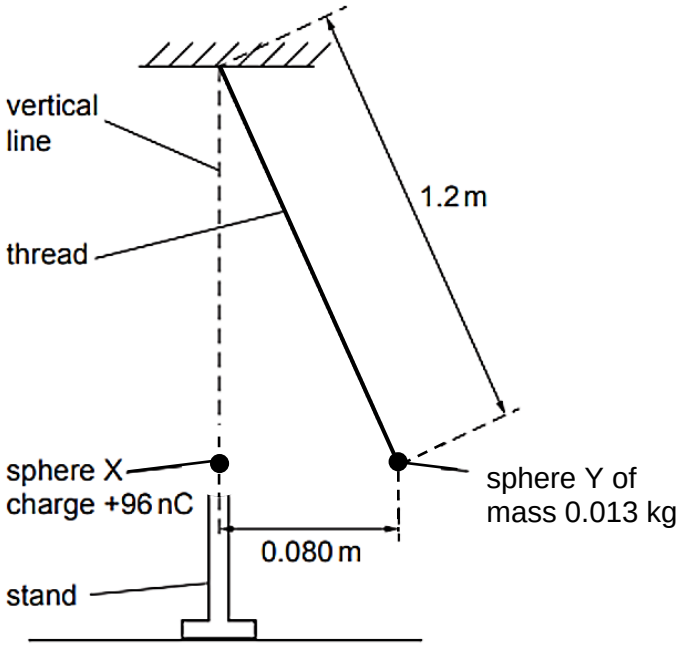

Fig. 4.1

The charge on sphere X is +96 nC and the mass of sphere Y is 0.013 kg.
Assume that the spheres behave as point charges.

The length of the thread is 1.2 m and the centres of sphere X and sphere Y are separated horizontally by a distance of 0.080 m.

(i) Show that the charge on sphere Y is +63 nC.

[2]

(ii) Hence, determine the net potential at the mid-point between sphere X and sphere Y.

potential = ……... V [2]

(c) An electron, with a speed of 2.0×10^7 m s^{-1}, enters the region between two parallel plates P and Q, that are separated by a distance of 18 mm, as shown in Fig. 4.2. The length of the parallel plate is 20 cm.

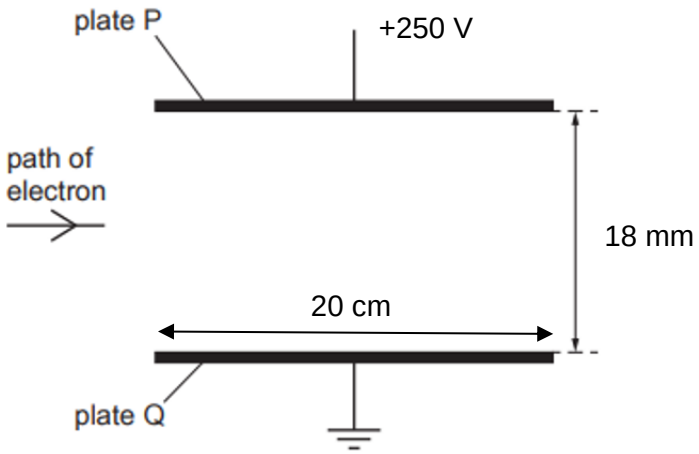

Fig. 4.2 (not to scale)

The space between the plates is a vacuum.

The potential difference between the plates is 250 V. The electric field may be assumed to be uniform in the region between the plates and zero outside this region.

(i) Show that the acceleration of the electron within the parallel plate is 2.4×10^{15} m s^{-2}.

[2]

(ii) Determine the speed with which the electron leaves the parallel plates.

speed = …….. m s^{-1} [3]

(iii) State and explain the difference in the path if a proton enters the parallel plates with the same initial velocity instead of the electron.

……..……

……..……

……. [2]

[Total: 12]