1 **(a)** With reference to electric field lines, explain why, for points outside an isolated charged spherical conductor, the charges on the sphere may be considered to act as a point charge at its centre.

.....

.....

..... [1]

(b) Two vertical metal plates in a vacuum have a separation of 4.0 cm. A potential difference of 2.0×10^2 V is applied between the plates. Fig. 1.1 shows a side view of this arrangement.

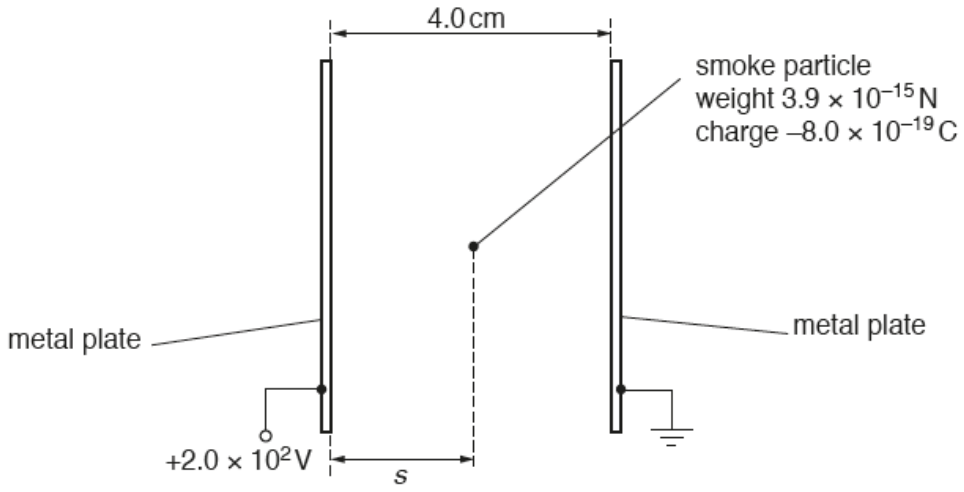

Fig. 1.1

An isolated smoke particle is in the uniform electric field between the plates. The particle has weight 3.9×10^{-15} N and charge -8.0×10^{-19} C.

(i) On Fig. 1.1, draw labelled arrows to show the directions of the two forces acting on the smoke particle. [1]

(ii) The resultant force acting on the smoke particle is *F*.

Determine

1. the magnitude of *F,*

F = ... N [3]

2. The angle of F to the horizontal.

angle = ... ° [1]

(c) (i) The electric field in **(b)** is switched on at time t = 0 when the particle is at a horizontal displacement s = 2.0 cm from the left-hand plate. At time t = 0 the horizontal velocity of the particle is zero. The particle is then moved by the electric field until it hits a plate at time $t = T$.

On Fig. 1.2, sketch the variation with time t of the horizontal displacement s of the particle from the left-hand plate.

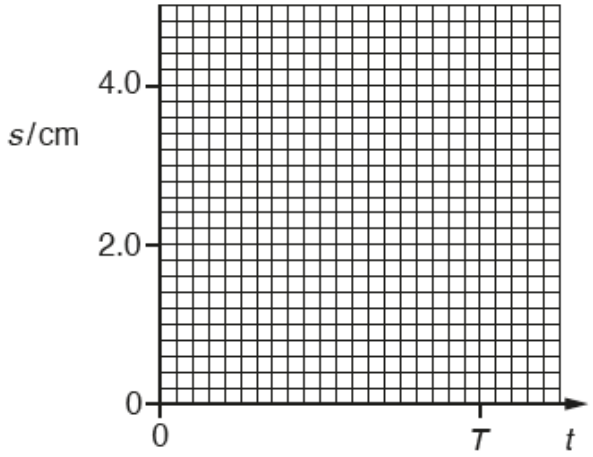

Fig. 1.2

[2]

(ii) Determine the time T.

T = ... s [2]

[Total: 10]