4 Two vertical metal plates in a vacuum are separated by a distance of 0.12 m. Fig. 4.1 shows a side view of this arrangement.

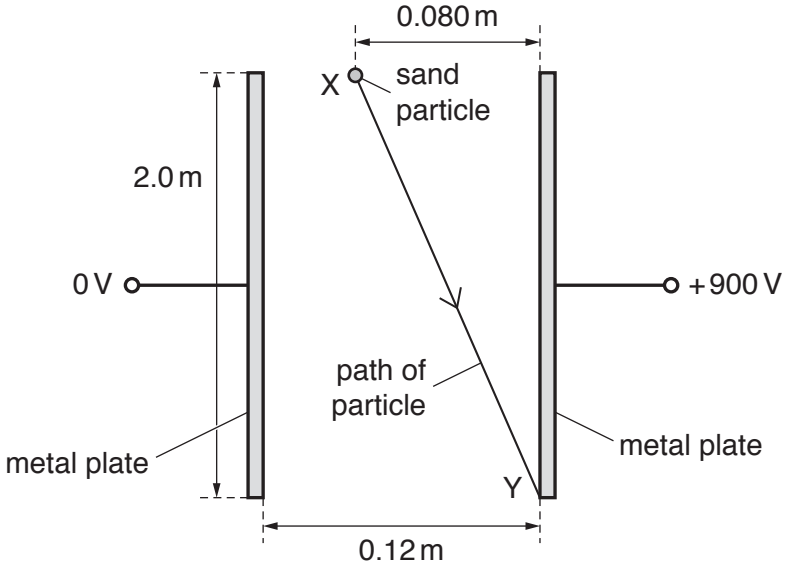

Fig. 4.1 (not to scale)

Each plate has a length of 2.0 m. The potential difference between the plates is 900 V. The electric field between the plates is uniform.

A negatively charged sand particle is released from rest at point X, which is a horizontal distance of 0.080 m from the top of the positively charged plate. The particle then travels in a straight line and collides with the positively charged plate at its lowest point Y, as illustrated in Fig. 4.1.

(a) Describe the pattern of the field lines (lines of force) between the plates.

.....

.....

.....[2]

(b) State the names of the **two** forces acting on the particle as it moves from X to Y.

.....[1]

(c) By considering the vertical motion of the sand particle, show that the time taken for the particle to move from X to Y is 0.64 s.

[2]

(d) Calculate the horizontal component of the acceleration of the particle.

horizontal component of acceleration = ... $m\,s^{-2}$ [2]

(e) **(i)** Calculate the magnitude of the electric field strength.

electric field strength = ... $N\,C^{-1}$ [2]

(ii) The sand particle has mass m and charge q. your answers in **(d)** and **(e)(i)** to determine the ratio $\frac{q}{m}$.

ratio = ... $C\,kg^{-1}$ [2]

(f) Another particle has a smaller magnitude of the ratio $\frac{q}{m}$ than the sand particle. This particle is also released from point X.

the movement of this particle, state the effect, if any, of the decreased magnitude of the ratio on:

(i) the vertical component of the acceleration

.....[1]

(ii) the horizontal component of the acceleration.

.....[1]

[Total: 13]