5 **(a)** Two small charged metal spheres A and B are situated in a vacuum. The distance between the centres of the spheres is 12.0 cm, as shown in Fig. 5.1.

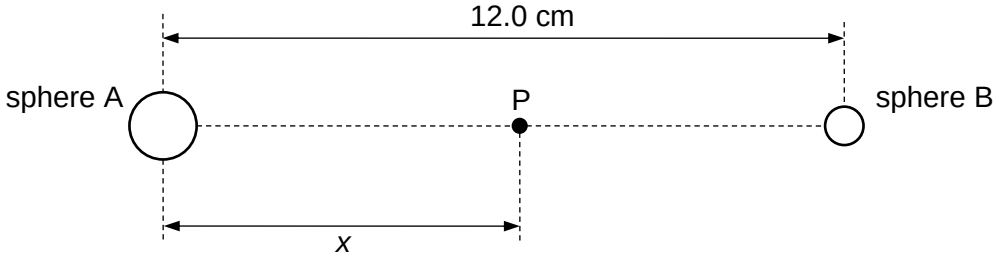

Fig. 5.1

The charge on each sphere may be assumed to be a point charge at the centre of the sphere. Point P is a movable point that lies on the line joining the centres of the spheres and is distance *x* from the centre of sphere A.

The variation with distance *x* of the electric field strength *E* at point P is shown in Fig. 5.2.

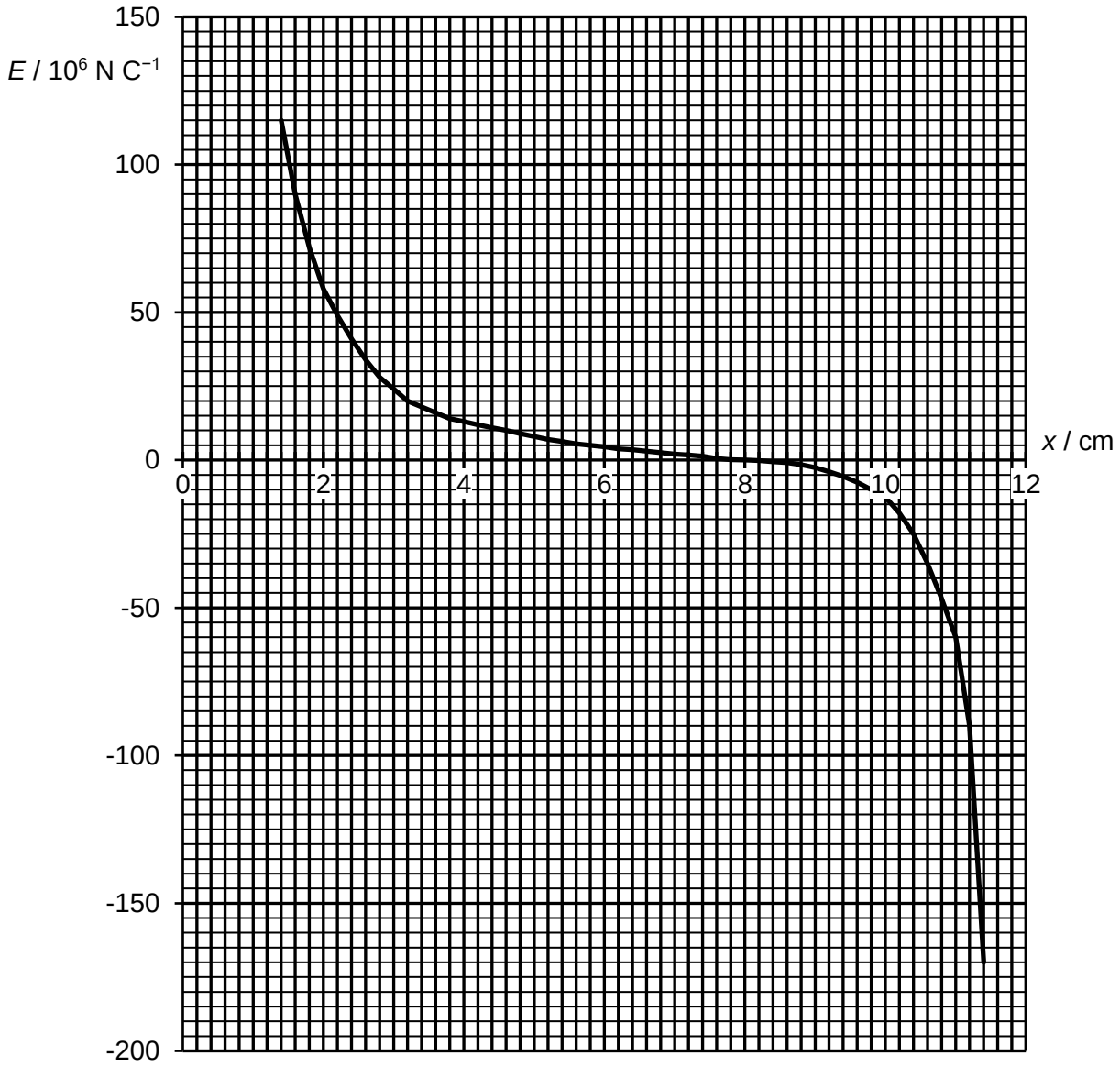

Fig. 5.2

(i) Explain whether the charges have the same, or opposite, signs.

……

……

……

…… [2]

(ii) Determine the ratio $\frac{\text{charge on sphere A}}{\text{charge on sphere B}}$.

Explain your working.

ratio = ……..……[3]

(b) Two long parallel plates are set a distance of 5.0 cm apart in vacuum as shown in Fig 5.3. The top plate is at a potential of –200 V and the bottom plate is at a potential of –100 V.

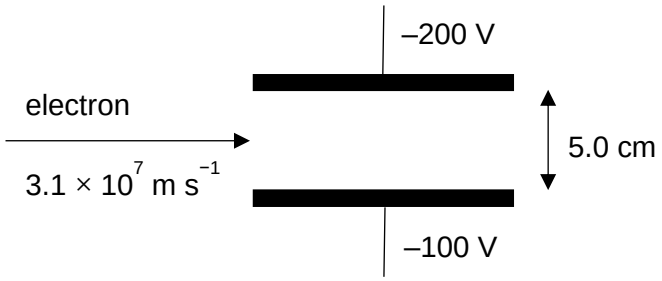

Fig. 5.3

An electron is projected horizontally at a speed of 3.1×10^7 m s^{-1}, mid-way between the plates.

(i) Determine the magnitude and direction of the electric field strength.

magnitude = ……N C^{-1} [1]

direction = ……[1]

(ii) Determine the magnitude of the acceleration of the electron.

magnitude of acceleration = ……m s^{-2} [2]

(iii) Determine the change in potential energy of the electron from the point of entry until it reaches one of the plates.

change in potential energy = …….. J [2]

[Total: 11]

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