4 **(a)** For any point outside a spherical conductor, the charge on the sphere may be considered to act as a point charge at its centre. By reference to electric field lines, explain this.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(b) Two point charges A and B are separated by a distance of 12 cm in a vacuum, as shown in Fig. 4.1.

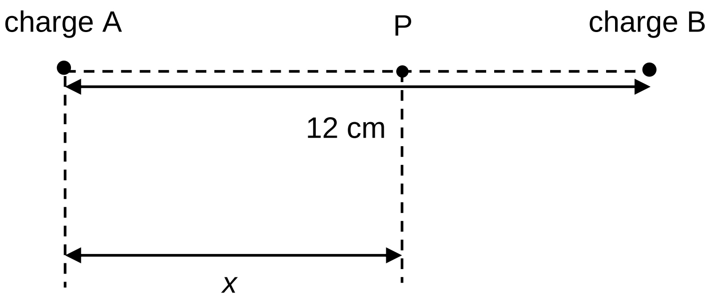

Fig. 4.1

The charge of A is $+2.0 \times 10^{-9}$ C.

A point P lies on the line joining charges A and B. Its distance from charge A is x.

The variation with x of the electric potential V at point P is shown in Fig 4.2.

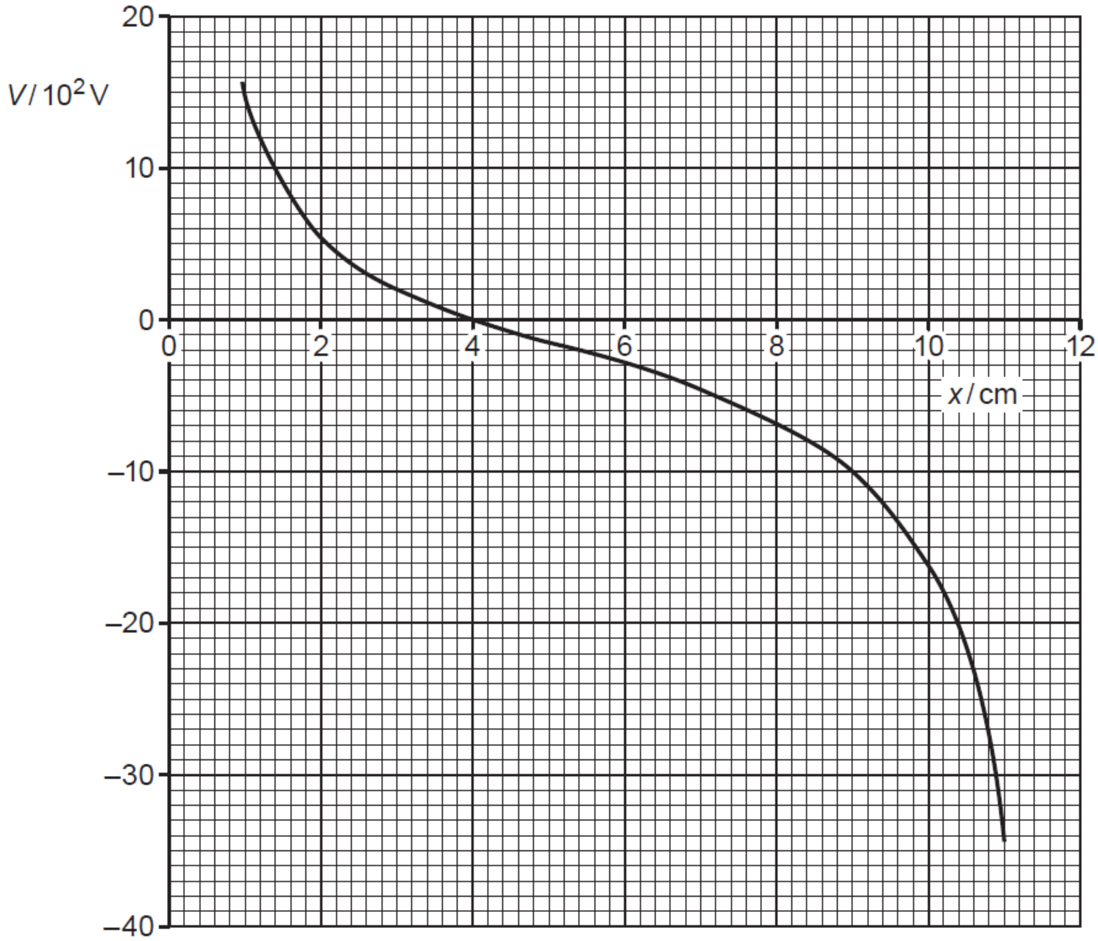

Fig 4.2

(i) Use Fig. 4.2 to determine:

1. the charge of B,

charge = …………………………….C [2]

2. the change in electric potential when point P moves from the position where x = 9.0 cm to the position where x = 3.0 cm.

change = …………………………….V [1]

(ii) An α-particle moves along the line joining the centres of the two charges in Fig 4.1.

The α-particle moves from the position where x = 9.0 cm and just reaches the position where x = 3.0 cm.

Use your answer in **(b)(i)2** to calculate the speed of the α-particle at the position where x = 9.0 cm.

speed = …………………………….m s^{-1} [2]

(iii) Using Fig. 4.2, state the distance x at which the electric field strength is the least.

x = …………………………….cm [1]

(iv) Determine the magnitude of the electric field strength at the position in **(b)(iii).**

electric field strength = …………………………….V m^{-1} [2]

[Total: 10]