Raffles Institution
Year 5-6 Physics Department

2025 Year 6 H2 Physics Remedial
Chapter 13: Electric Fields

$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}, $e = 1.60 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg, $m_p = 1.67 \times 10^{-27}$ kg

1 Two ions **A** and **B** are separated by a distance of 5.00 mm in a vacuum, as shown in Fig. 1.1.

A has a charge of -4.80×10^{-19} C and **B** has a charge of $+1.60 \times 10^{-19}$ C. Point **X** is located 3.00 mm from **A** and 4.00 mm from **B**.

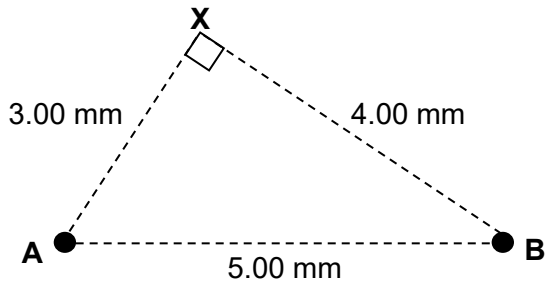

Fig. 1.1

(a) Calculate the magnitude of the resultant electric field strength at X. [2]

(b) Calculate the electric potential at X. [2]

2 **(a)** Define *electric field strength* at a point in an electric field. [1]

(b) Fig. 2.1 shows two isolated point charges **X** and **Y**. **X** carries a charge of $+3.2 \times 10^{-10}$ C, while **Y** carries a charge of -6.2×10^{-10} C. The two charges are 0.20 cm apart. Sketch on Fig. 2.1, the resultant electric field lines due to the two charges.

Fig. 2.1 [3]

(c) A test charge **T** of $+1.2 \times 10^{-10}$ C is placed 0.10 cm from **X** such that **XTY** forms a right angle as shown in Fig. 2.2.

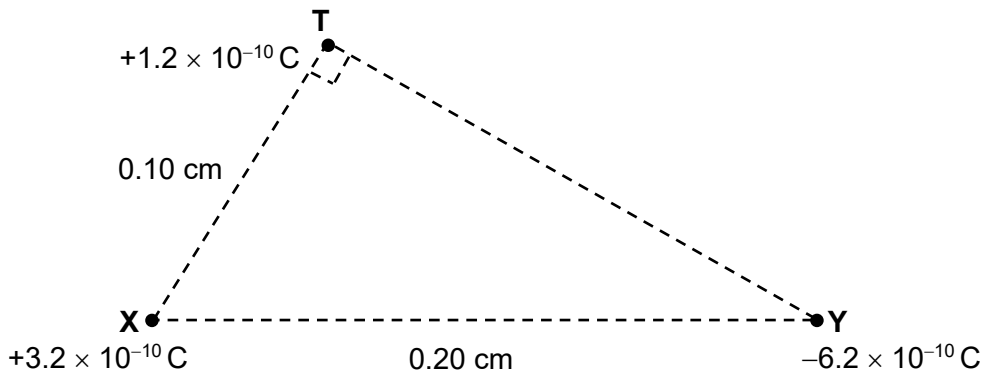

Fig. 2.2

(i) Calculate the magnitude of the net force, ***F***, acting on **T**. [3]

(ii) Indicate its general direction in Fig. 2.2 (Exact calculation for the direction is not required.)

[1]

[NYJC/Prelim 2014/P3/3]

3 **(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. 3.1.

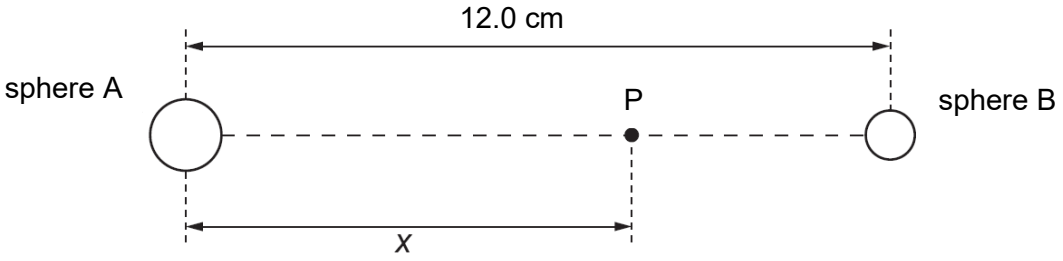

Fig 3.1 (not to scale)

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* from the centre of sphere A of the electric field strength *E* at point P is shown in Fig. 3.2.

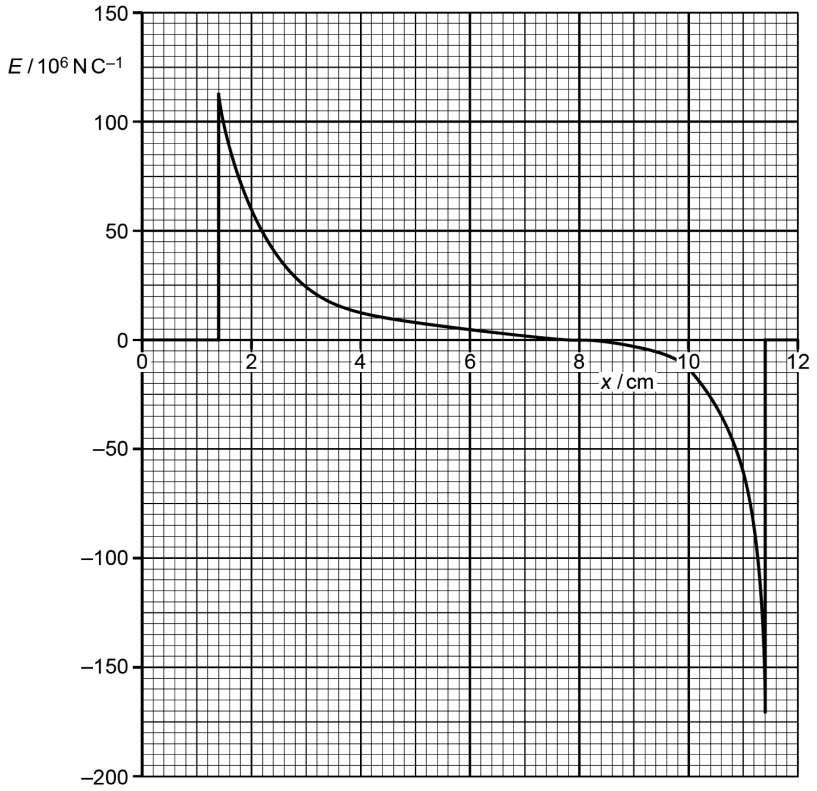

Fig 3.2

(i) Define *electric field strength*. [1]

(ii) State the evidence provided by Fig. 2.2 for the statements that

1. the spheres are conductors, [1]

2. the charges on the spheres are both positive. [2]

(iii) An α-particle is placed at rest at x = 4.0 cm on the line joining the centres of the spheres.

Describe what will happen to the α-particle. [2]

[AJC/Prelims 2014/P3/9(a)]

4 **(a)** Two vertical parallel metal plates X and Y are situated 3.20 cm apart in a vacuum, as shown in Fig. 4.1. Plate X is maintained at a potential of −600 V and plate Y is earthed.

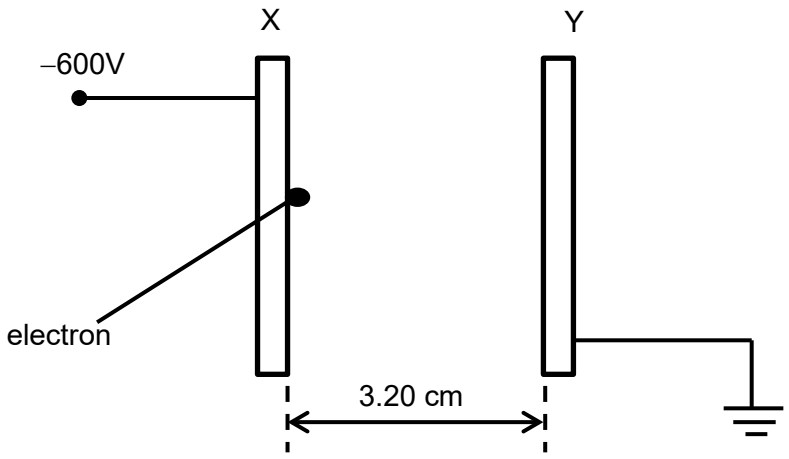

Fig. 4.1

An electron is initially at rest close to the negative plate and in the electric field between the plates.

(i) Define electric field strength. [2]

(ii) Calculate the magnitude of the electric field between the plates. [2]

(iii) The electron accelerates horizontally across the space between the plates. Determine the time taken for the electron to travel from plate X to Y. [3]

[RVHS/Prelim 2014/P2/2(part)]

5 **(c)** Fig. 5.3 shows part of a precipitation system used to collect dust particles in a chimney. It consists of two large parallel vertical plates maintained at potentials of +25 kV and −25 kV. Fig. 5.3 also shows the electric field lines between the plates.

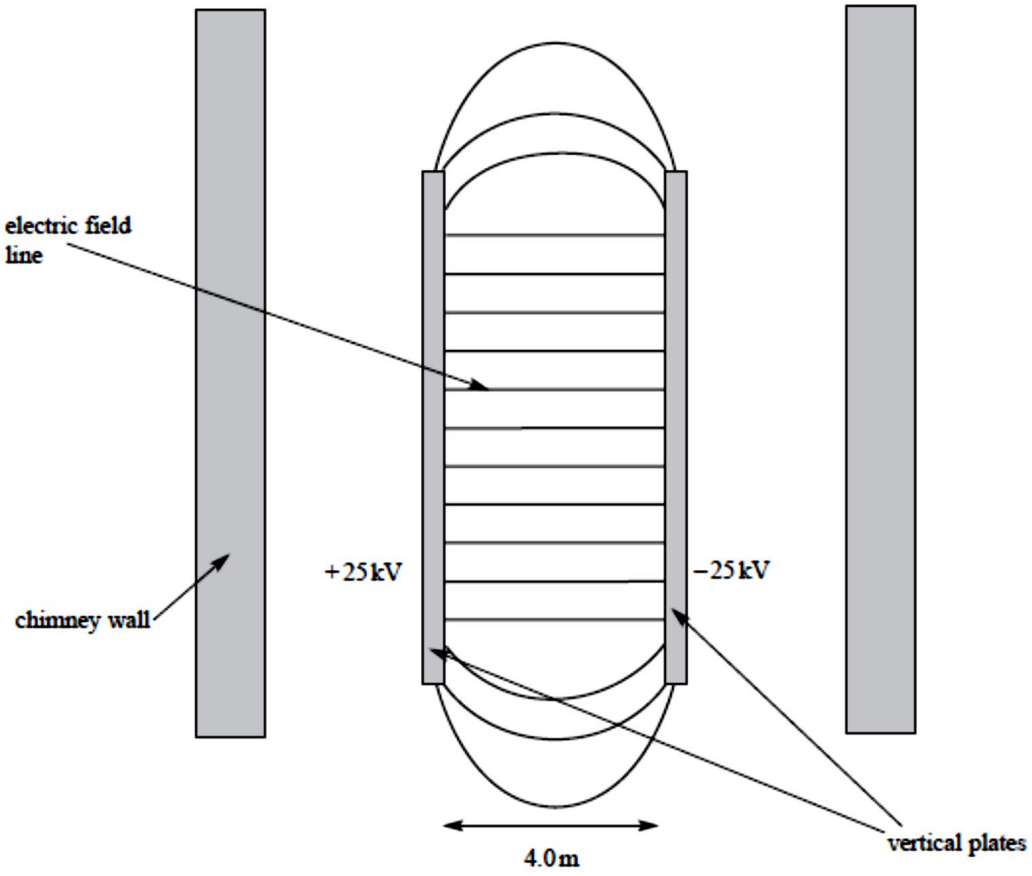

Fig. 5.3

(i) Add arrows to Fig. 5.3 to show the direction of the electric field. [1]

(ii) Explain what is meant by an *equipotential surface*. [1]

(iii) Draw and label on Fig. 5.3 equipotentials that correspond to potentials of −12.5 kV, 0 V, and +12.5 kV.

[2]

(iv) A small dust particle moves vertically up the centre of the chimney, midway between the plates.

1. The charge on the dust particle is +5.5 nC. Show that there is an electrostatic force on the particle of about 0.07 mN.

[2]

2. The mass of the dust particle is 1.2×10^{-4} kg and it moves up the centre of the chimney at a constant vertical speed of 0.80 m s^{-1}. Calculate the minimum length of the plates necessary for this particle to strike one of them. Ignore air resistance

[4]

[NJC/Prelim 2014/P3/5(part)]

6 **(a)** Define *electric field strength*. [2]

(b) A small charged sphere is suspended from a fine spring (made of an insulating material) between horizontal parallel metal plates as shown in Fig. 6.1.

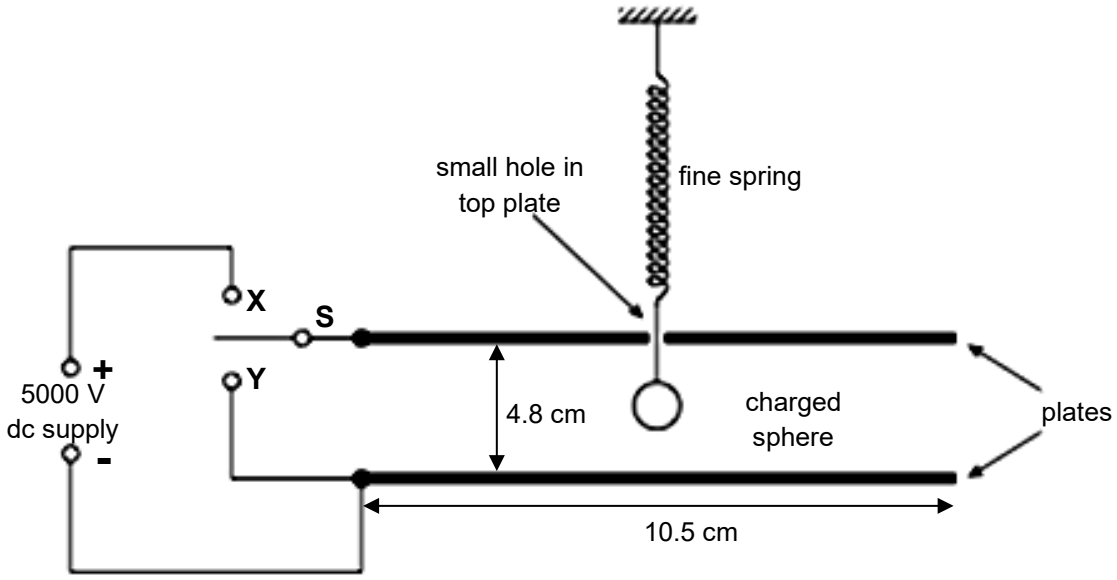

Fig. 6.1 (not to scale)

Initially, the plates are uncharged. Switch S is then set to position X. This causes the sphere to move vertically downwards so that eventually it comes to rest 18 mm below its original position.

(i) State the nature of the charge on the sphere. [1]

(ii) Given that the magnitude of the charge on the sphere is 41 nC, determine the spring constant of the spring.

[2]

(c) Switch S is now moved to position Y.

(i) State and explain the effect of this on the electric field between the plates. [2]

(ii) By considering the forces acting on the sphere, explain the subsequent motion of the sphere.

[3]

[HCI/Prelims 2014/P3/2]