18. Electric Fields

18.1 Electric fields and field lines

Paper 4

Question Paper

1 **(a)** Define electric field.

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.....

..... [2]

(b) Fig. 5.1 shows two parallel conducting plates that are in a vacuum. The plates are separated by a distance of 6.7 cm and have a potential difference (p.d.) of 430 V between them.

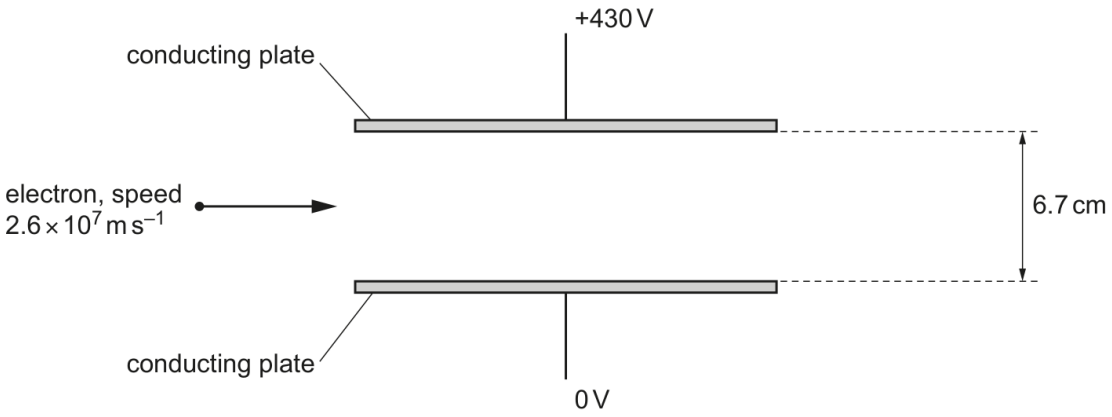


Fig. 5.1

(i) On Fig. 5.1, draw four field lines to represent the electric field between the plates. [2]

2 **(b)** Fig. 6.1 shows an isolated hollow conducting sphere that is positively charged.

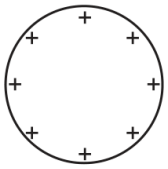


Fig. 6.1

On Fig. 6.1, draw field lines to represent the electric field outside the sphere. [3]

3 **(a)** **(ii)** Define electric field.

.....

..... [1]

(c) Assume that the Earth is a uniform conducting sphere of mass 5.98×10^{24} kg.
The surface of the Earth carries a charge of -4.80×10^{5} C that is evenly distributed.

(ii) State how the direction of the electric field at the surface of the Earth compares with the direction of the gravitational field.

..... [1]

4 **(c)** One of the oil droplets in **(b)** is now placed between two horizontal metal plates, as shown in Fig. 5.1.

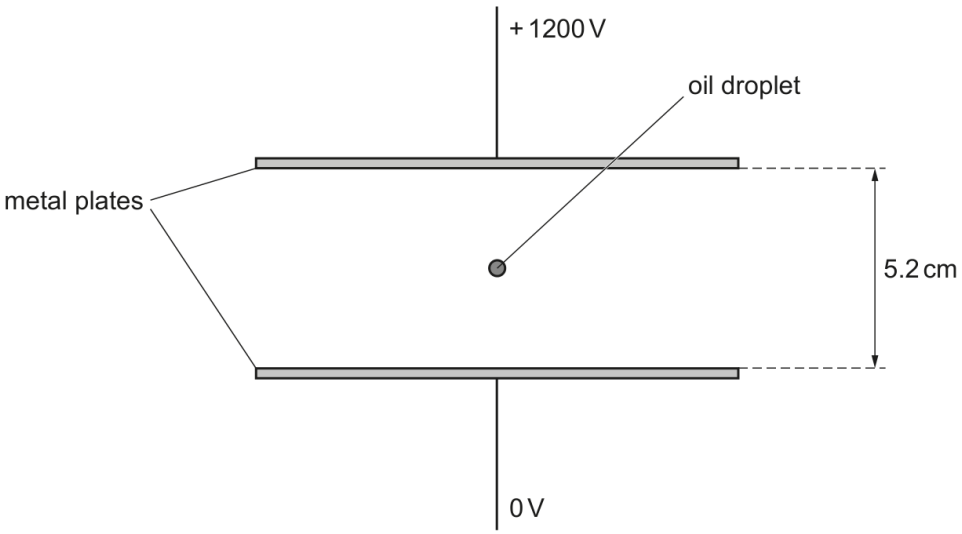


Fig. 5.1 (not to scale)

A potential difference (p.d.) of 1200 V is applied between the plates, with the top plate at the higher potential. The oil droplet is stationary and in equilibrium.

(i) State the sign of the charge on the oil droplet.

..... [1]

(ii) On Fig. 5.1, draw four lines to represent the electric field between the plates. [3]

5 A sphere of mass 1.6×10^{-10} kg has a charge of +0.27 nC. The sphere is in a uniform electric field that acts vertically upwards, as shown in the side view in Fig. 2.1.

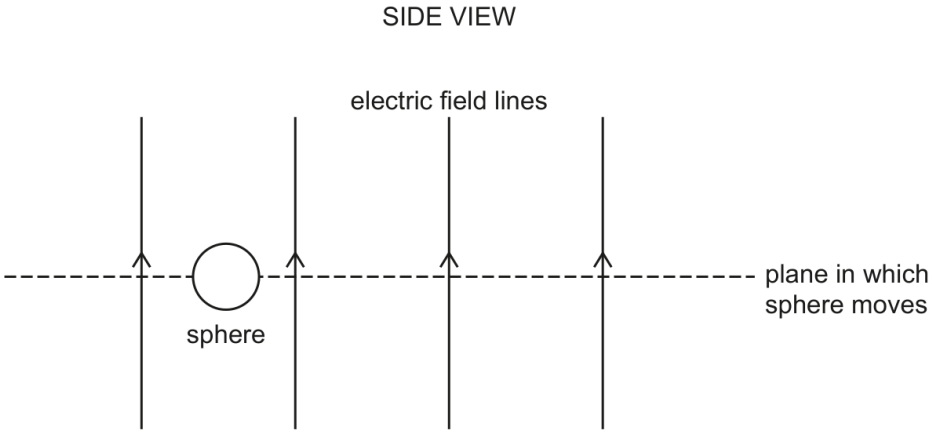


Fig. 2.1

The force exerted on the sphere by the electric field causes the sphere to remain at a fixed vertical height in a horizontal plane.

There is a uniform magnetic field in the region of the electric field. The sphere moves at a speed of $0.78\,m\,s^{-1}$ in the horizontal plane. The magnetic field causes the sphere to move in a circular path of radius 3.4 m, as shown in the view from above in Fig. 2.2.

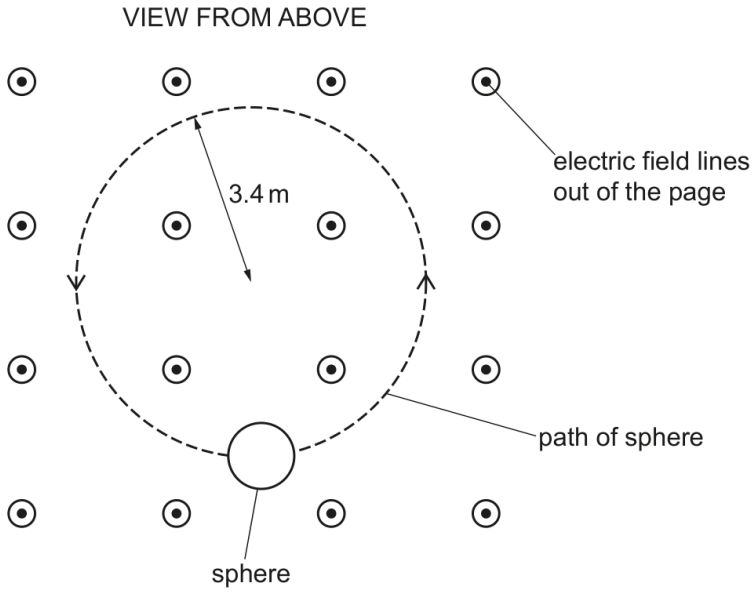


Fig. 2.2

(b) Calculate the strength of the uniform electric field.

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

6 **(a)** State what is indicated by the direction of an electric field line.

.....

..... [2]

(b) Fig. 4.1 shows a pair of parallel metal plates with a potential difference (p.d.) of 2400 V between them.

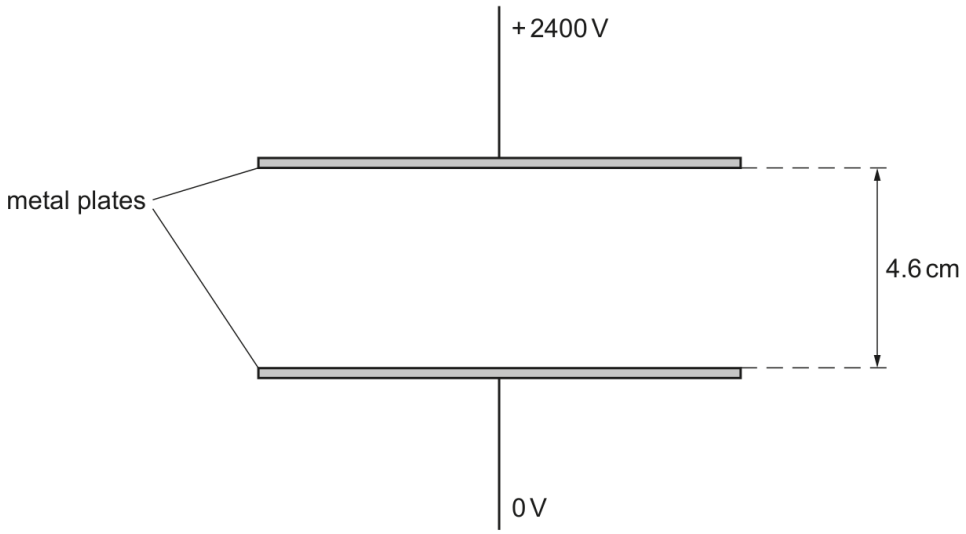


Fig. 4.1

The plates are separated by a distance of 4.6 cm. The plates are in a vacuum.

(i) On Fig. 4.1, draw five lines to represent the electric field in the region between the plates. [3]

7 A metal sphere of radius *R* is isolated in space.

Point P is a distance *x* from the centre of the sphere, as illustrated in Fig. 7.1.

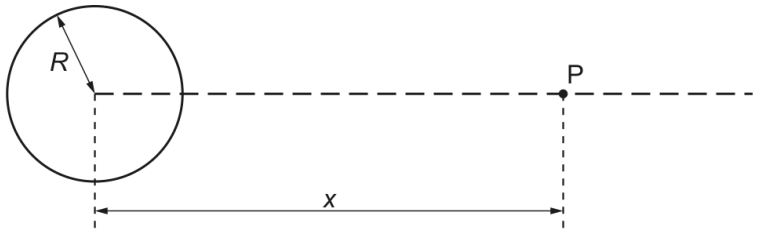


Fig. 7.1

The variation with distance *x* of the electric field strength *E* due to the charge on the sphere is shown in Fig. 7.2.

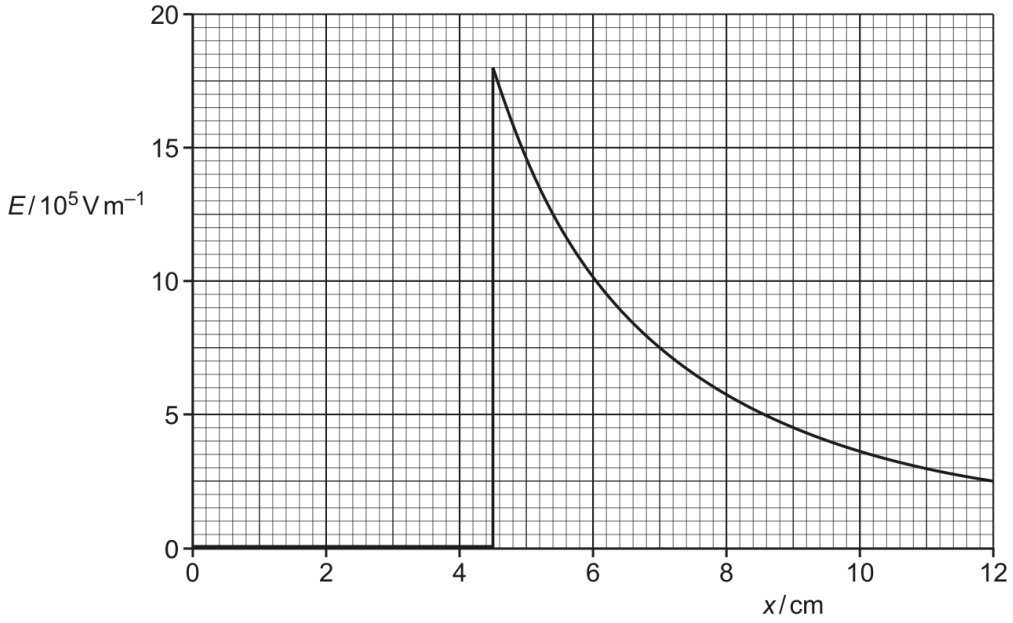


Fig. 7.2

(a) State what is meant by *electric field strength*.

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..... [2]

(c) An α-particle is situated a distance 8.0 cm from the centre of the sphere.

Calculate the acceleration of the α-particle.

acceleration = ... $m\,s^{-2}$ [3]

8 **(b)** A uniform electric field is now applied in the same region as the magnetic field.

The electron passes undeviated through the region of the two fields, as illustrated in Fig. 9.2.

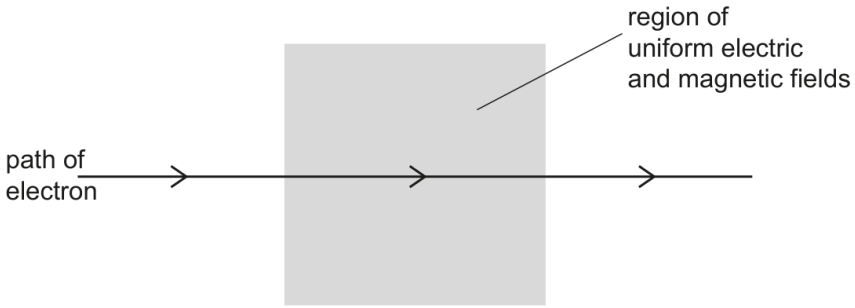


Fig. 9.2

(i) On Fig. 9.2, mark with an arrow the direction of the uniform electric field. [1]

9 **(a)** **(i)** State what is meant by a *field of force*.

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..... [2]

10 **(a)** State what is meant by *electric field strength*.

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..... [2]

11 (c) An electron is situated at point P.

Without calculation, state and explain the variation in the magnitude of the acceleration of the electron as it moves from the position where $x = 3\,\text{cm}$ to the position where $x = 7\,\text{cm}$.

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..... [4]