

Uniform Electric Fields

Question paper 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electric Fields
Sub Topic	Uniform Electric Fields
Paper Type	Theory
Booklet	Question paper 3

Time Allowed: 68 minutes

Score: /56

Percentage: /100

CHEMISTRY ONLINE

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Two parallel plates P and Q are separated by a distance of 7.6 mm in a vacuum. There is a potential difference of 250 V between the plates, as illustrated in Fig. 4.1.

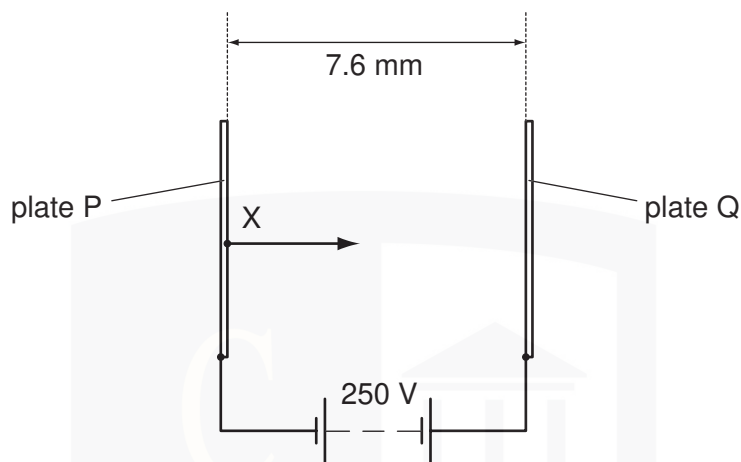


Fig. 4.1

Electrons are produced at X on plate P. These electrons accelerate from rest and travel to plate Q.

The electric field between the plates may be assumed to be uniform.

- (a) (i) Determine the force on an electron due to the electric field.

force = N [3]

- (ii) Show that the change in kinetic energy of an electron as it moves from plate P to plate Q is 4.0×10^{-17} J.

[2]

(iii) Determine the speed of an electron as it reaches plate Q.

speed =ms⁻¹ [2]

- (b) The positions of the plates are adjusted so that the electric field between them is not uniform. The potential difference remains unchanged.
State and explain the effect, if any, of this adjustment on the speed of an electron as it reaches plate Q.

.....
.....
.....
..... [3]

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— TUITION —

- 2 (a) Define *electric field strength*.

.....
.....[1]

- (b) Two flat parallel metal plates, each of length 12.0 cm, are separated by a distance of 1.5 cm, as shown in Fig. 2.1.

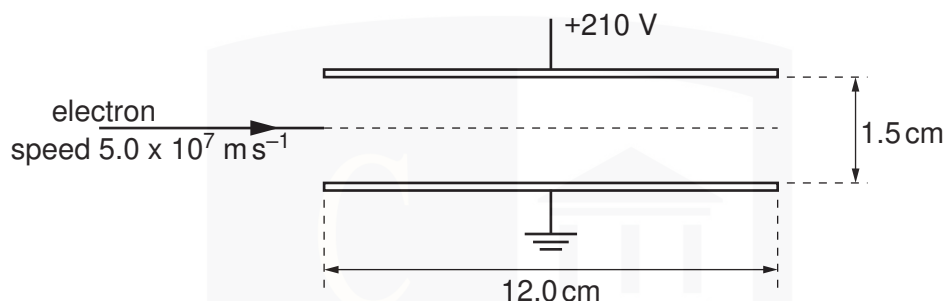


Fig. 2.1

The space between the plates is a vacuum.

The potential difference between the plates is 210 V. The electric field may be assumed to be uniform in the region between the plates and zero outside this region.

Calculate the magnitude of the electric field strength between the plates.

field strength = N C^{-1} [1]

- (c) An electron initially travels parallel to the plates along a line mid-way between the plates, as shown in Fig. 2.1. The speed of the electron is $5.0 \times 10^7 \text{ m s}^{-1}$.

For the electron between the plates,

- (i) determine the magnitude and direction of its acceleration,

acceleration = m s^{-2}

direction [4]

- (ii) calculate the time for the electron to travel a horizontal distance equal to the length of the plates.

time = s [1]

- (d) Use your answers in (c) to determine whether the electron will hit one of the plates or emerge from between the plates.

- 3 Two horizontal metal plates X and Y are at a distance 0.75 cm apart. A positively charged particle of mass 9.6×10^{-15} kg is situated in a vacuum between the plates, as illustrated in Fig. 6.1.

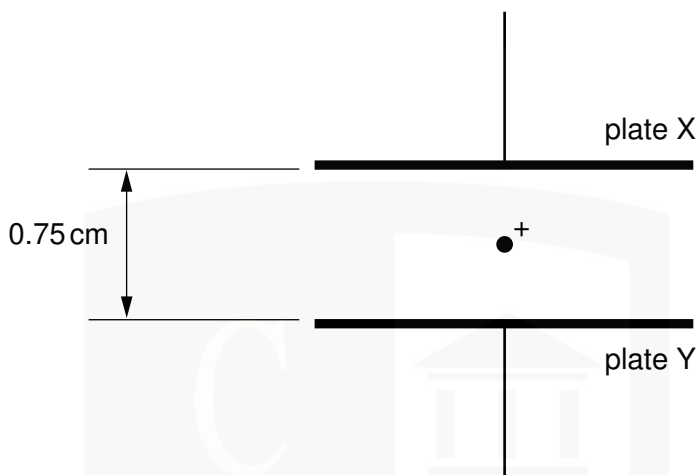


Fig. 6.1

The potential difference between the plates is adjusted until the particle remains stationary.

- (a) State, with a reason, which plate, X or Y, is positively charged.

.....
.....
..... [2]

- (b) The potential difference required for the particle to be stationary between the plates is found to be 630 V. Calculate

- (i) the electric field strength between the plates,

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

(ii) the charge on the particle.

charge = C [3]



- 4 Two parallel metal plates P and Q are situated 8.0 cm apart in air, as shown in Fig. 6.1.

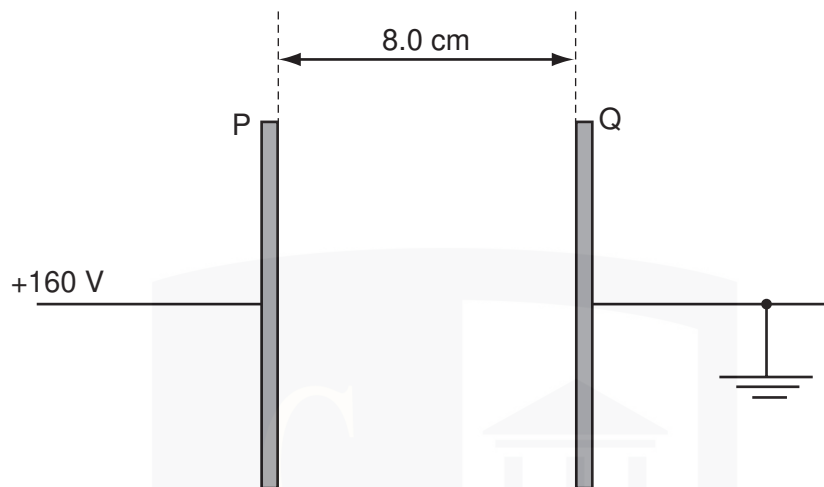


Fig. 6.1

Plate Q is earthed and plate P is maintained at a potential of +160 V.

- (a) (i) On Fig. 6.1, draw lines to represent the electric field in the region between the plates. [2]
- (ii) Show that the magnitude of the electric field between the plates is $2.0 \times 10^3 \text{ V m}^{-1}$.

[1]

CHEMISTRY ONLINE
— TUITION —

- (b) A dust particle is suspended in the air between the plates. The particle has charges of $+1.2 \times 10^{-15} \text{ C}$ and $-1.2 \times 10^{-15} \text{ C}$ near its ends. The charges may be considered to be point charges separated by a distance of 2.5 mm, as shown in Fig. 6.2.

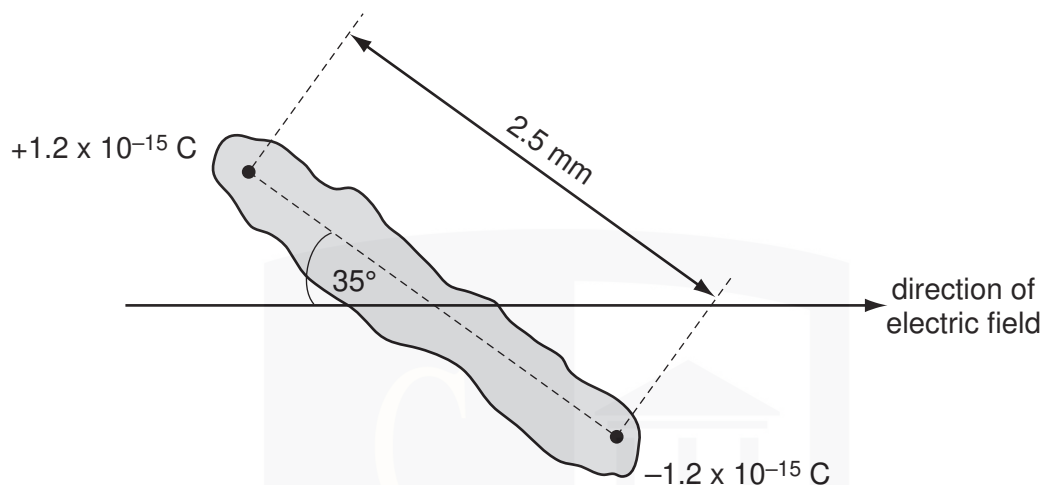


Fig. 6.2

The particle makes an angle of 35° with the direction of the electric field.

- (i) On Fig. 6.2, draw arrows to show the direction of the force on each charge due to the electric field. [1]
- (ii) Calculate the magnitude of the force on each charge due to the electric field.

force = N [2]

- (iii) Determine the magnitude of the couple acting on the particle.

couple = N m [2]

- (iv) Suggest the subsequent motion of the particle in the electric field.

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- 5 Two large flat metal plates A and B are placed 9.0 cm apart in a vacuum, as illustrated in Fig. 5.1.

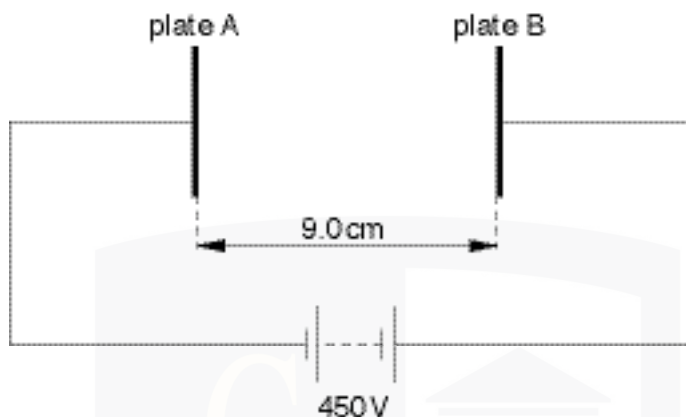


Fig. 5.1

A potential difference of 450 V is maintained between the plates by means of a battery.

- (a) (i) On Fig. 5.1, draw an arrow to indicate the direction of the electric field between plates A and B.
- (ii) Calculate the electric field strength between A and B.

field strength = NC⁻¹
[3]

- (b) An electron is released from rest at the surface of plate A.
- (i) Show that the change in electric potential energy in moving from plate A to plate B is $7.2 \times 10^{-17} \text{ J}$.

- (ii) Determine the speed of the electron on reaching plate B.

speed = m s^{-1}
[4]

- (c) On the axes of Fig. 5.2, sketch a graph to show the variation with distance d from plate A of the speed v of the electron. [1]

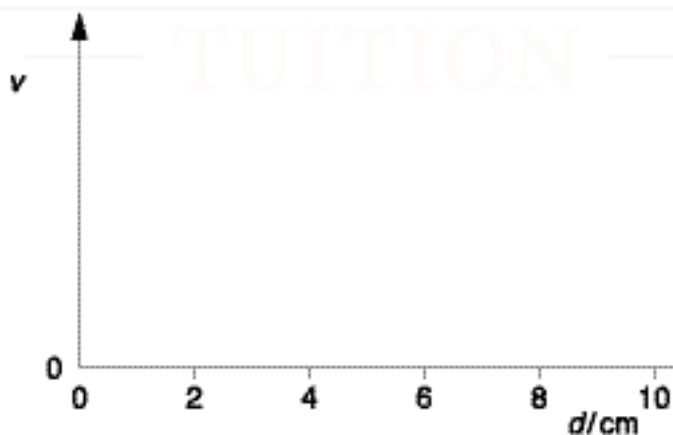


Fig. 5.2

- 6 An electron travelling horizontally in a vacuum enters the region between two horizontal metal plates, as shown in Fig. 6.1.

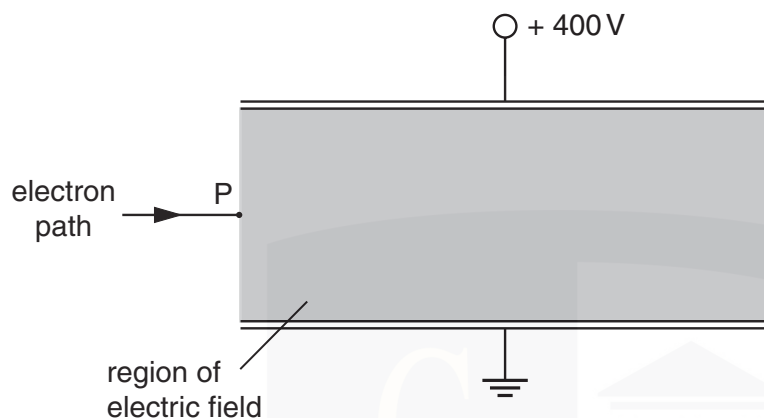


Fig. 6.1

The lower plate is earthed and the upper plate is at a potential of + 400 V. The separation of the plates is 0.80 cm.

The electric field between the plates may be assumed to be uniform and outside the plates to be zero.

- (a) On Fig. 6.1,
- (i) draw an arrow at P to show the direction of the force on the electron due to the electric field between the plates,
 - (ii) sketch the path of the electron as it passes between the plates and beyond them.
- [3]
- (b) Determine the electric field strength E between the plates.

$E = \dots\dots\dots \text{ V m}^{-1}$ [2]

(c) Calculate, for the electron between the plates, the magnitude of

(i) the force on the electron,

force = N

(ii) its acceleration.

acceleration = m s^{-2}
[4]

(d) State and explain the effect, if any, of this electric field on the horizontal component of the motion of the electron.

.....
.....
.....[2]