

1)

Two horizontal metal plates are situated 1.2 cm apart, as illustrated in Fig. 6.1.

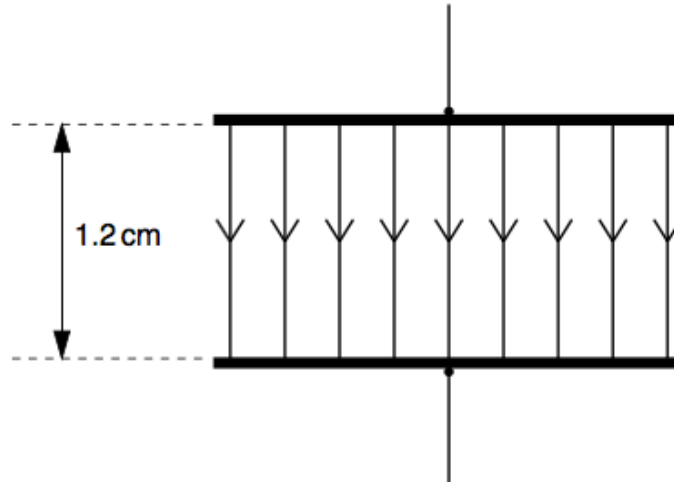


Fig. 6.1

The electric field between the plates is found to be  $3.0 \times 10^4 \text{ N C}^{-1}$  in the downward direction.

- (a) (i) On Fig. 6.1, mark with a + the plate which is at the more positive potential.
- (ii) Calculate the potential difference between the plates.

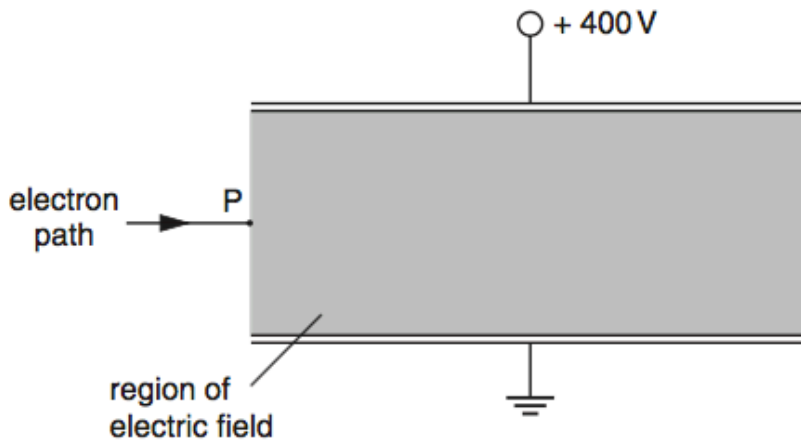
potential difference = ..... V [3]

- (b) Determine the acceleration of an electron between the plates, assuming there is a vacuum between them.

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

2)

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 = .....  $\text{m s}^{-2}$   
[4]

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

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

3)

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

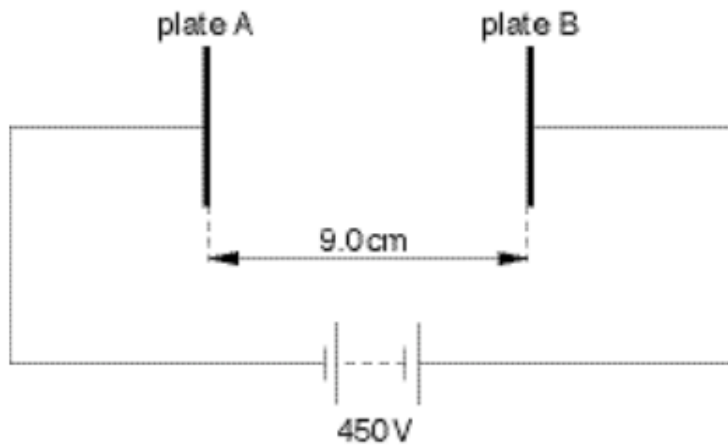


Fig. 5.1

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 = .....  $\text{N C}^{-1}$   
[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 = .....  $\text{m s}^{-1}$   
[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]

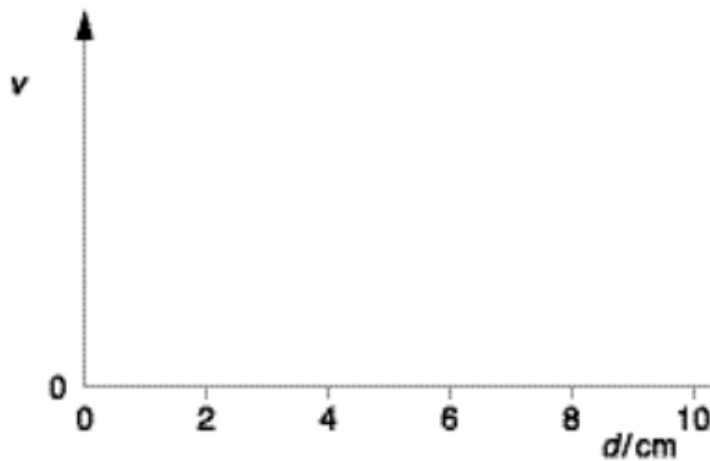


Fig. 5.2

4)

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

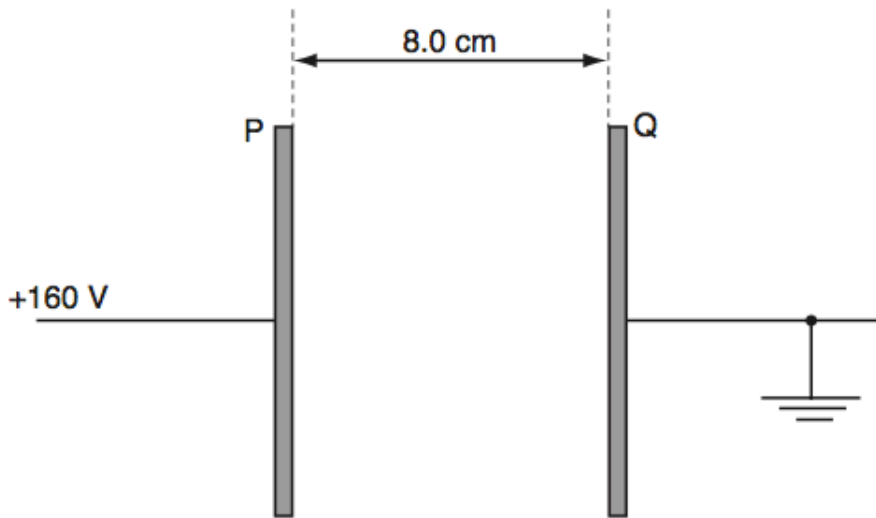


Fig. 6.1

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]

- (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.

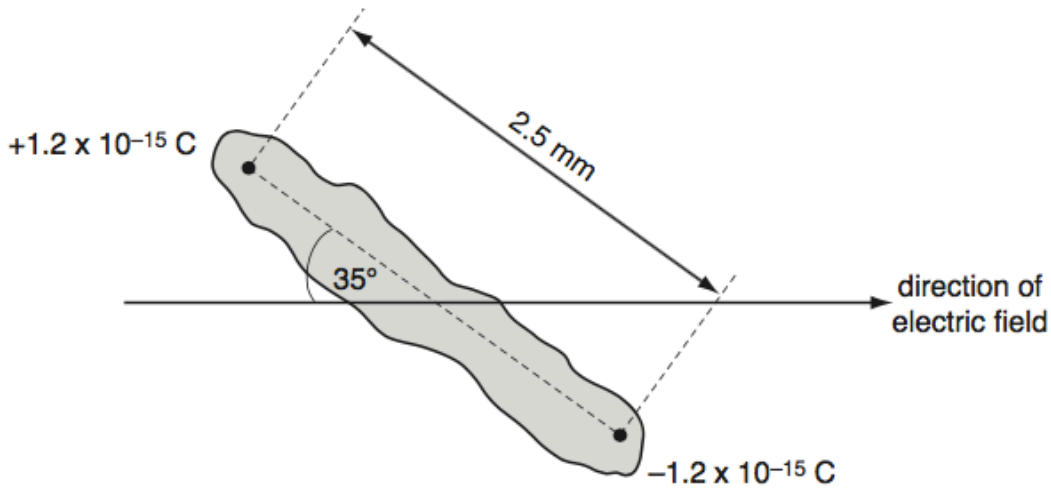


Fig. 6.2

The particle makes an angle of  $35^\circ$  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.

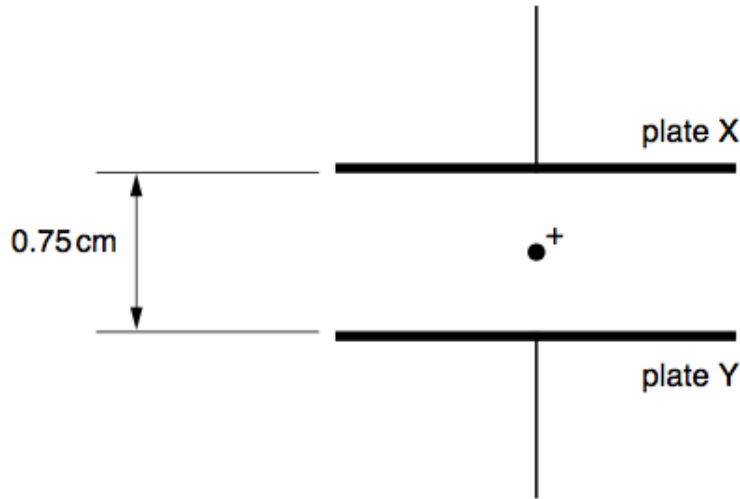
couple = ..... N m [2]

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

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

5)

Two horizontal metal plates X and Y are at a distance 0.75 cm apart. A positively charged particle of mass  $9.6 \times 10^{-15}$  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<sup>-1</sup> [2]



(ii) the charge on the particle.

charge = ..... C [3]

6)

(a) Define *electric field strength*.

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

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

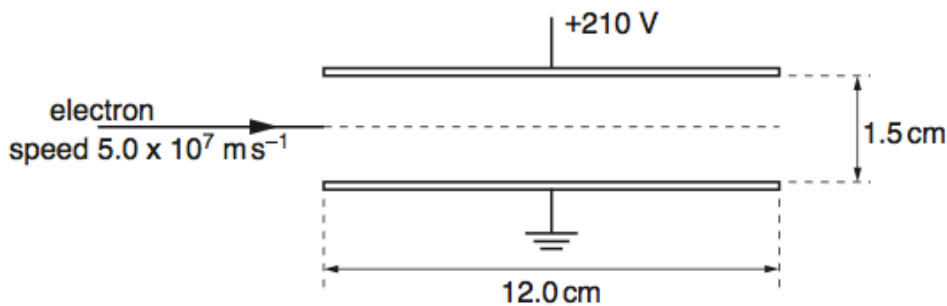


Fig. 2.1

The space between the plates is a vacuum.  
 The potential difference between the plates is 210V. 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<sup>-1</sup> [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 = .....  $\text{m s}^{-2}$

direction ..... [4]

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

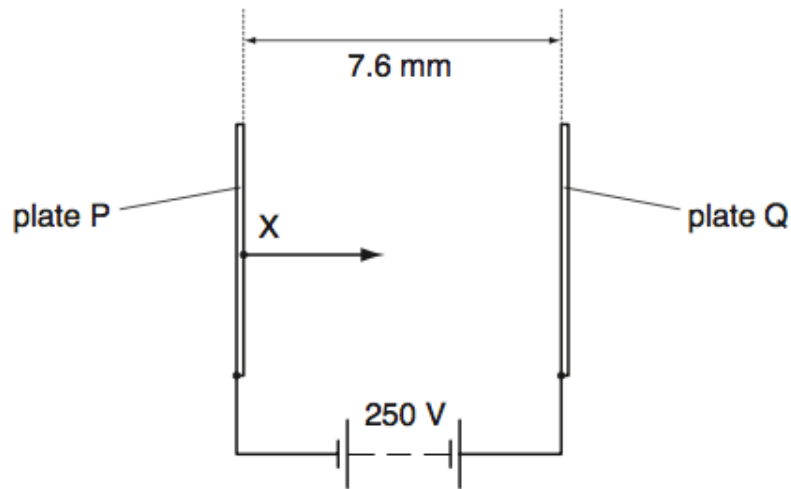
time = ..... s [1]

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

[3]

7)

Two parallel plates P and Q are separated by a distance of 7.6 mm in a vacuum. There is a potential difference of 250V 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  $4.0 \times 10^{-17}$  J.

[2]

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

speed = .....ms<sup>-1</sup> [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]

8)

Two vertical parallel metal plates are situated 2.50cm apart in a vacuum. The potential difference between the plates is 350V, as shown in Fig. 6.1.

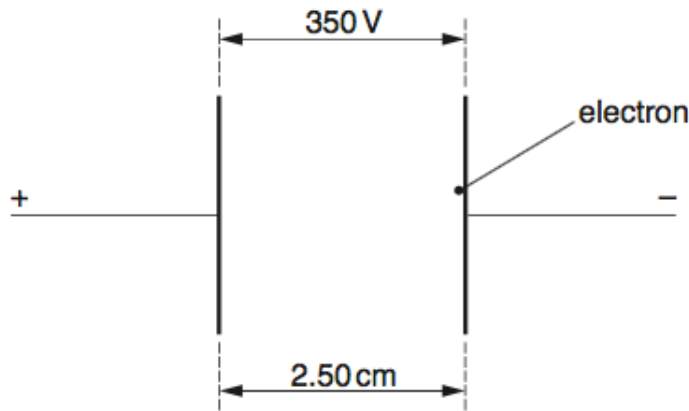


Fig. 6.1

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

(a) (i) Calculate the magnitude of the electric field between the plates.

electric field strength = .....  $\text{NC}^{-1}$  [2]

(ii) Show that the force on the electron due to the electric field is  $2.24 \times 10^{-15} \text{ N}$ .

[2]

- (b)** The electron accelerates horizontally across the space between the plates. Determine
- (i)** the horizontal acceleration of the electron,

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

- (ii)** the time to travel the horizontal distance of 2.50 cm between the plates.

time = ..... s [2]

- (c)** Explain why gravitational effects on the electron need not be taken into consideration in your calculation in **(b)**.

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

9)

The Millikan oil-drop experiment enabled the charge on the electron to be determined.

(a) State a fundamental property of charge that was suggested by this experiment.

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

(b) Two parallel metal plates P and Q are situated in a vacuum. The plates are horizontal and separated by a distance of 5.4 mm, as illustrated in Fig. 7.1.

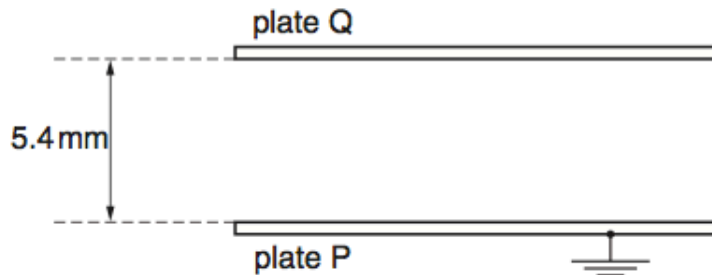


Fig. 7.1

The lower plate P is earthed. The potential difference between the plates can be varied. An oil droplet of mass  $7.7 \times 10^{-15}$  kg is observed to remain stationary between the plates when plate Q is at a potential of +850V.

(i) Suggest why plates P and Q must be parallel and horizontal.

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

(ii) Calculate the charge, with its sign, on the oil droplet.

charge = ..... C [3]

- (c) The procedure in (b) was repeated for three further oil droplets. The magnitude of the charge on each of the droplets was found to be  $3.2 \times 10^{-19} \text{ C}$ ,  $6.4 \times 10^{-19} \text{ C}$  and  $3.2 \times 10^{-19} \text{ C}$ .

Explain what value these data and your answer in (b)(ii) would suggest for the charge on the electron.

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