Questions compiled by Leong Yee Pak

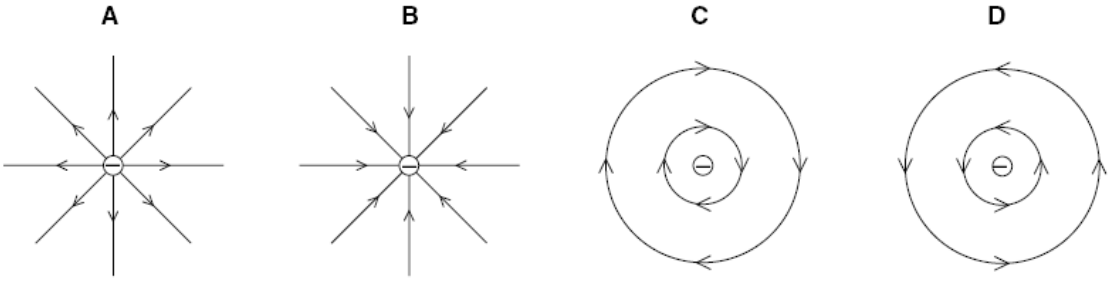
Electric Fields

17.1 concept of an electric field
17.2 Uniform electric fields

Concept of an electric field

***1 Nov 02 P1 Q37**

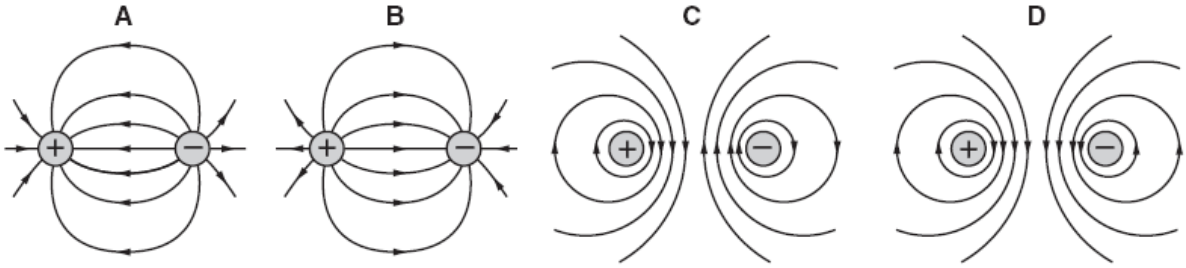
37 Which diagram shows the electric field pattern of an isolated negative point charge?



***2 Jun 03 P1 Q37**

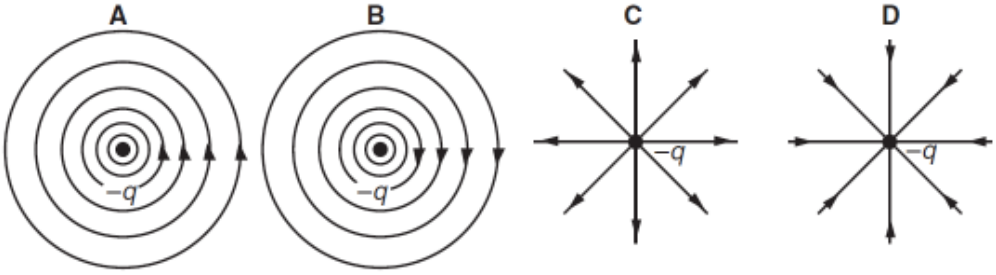
37 A positive charge and a negative charge of equal magnitude are placed a short distance apart.

Which diagram best represents the associated electric field?



***3 Nov 03 P1 Q35**

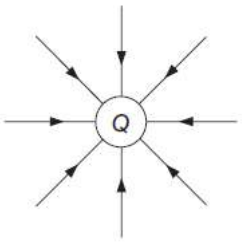
35 Which diagram represents the electric field of a negative point charge $-q$?



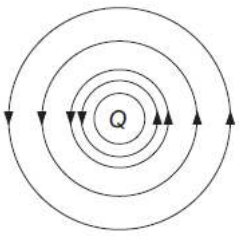
***4 June 05 P1 Q31**

31 Which diagram represents the electric field in the vicinity of a positive electric charge of magnitude Q?

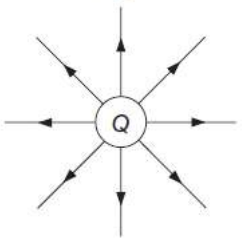
A



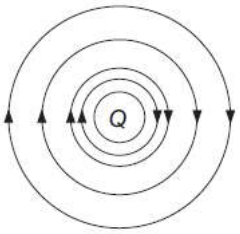
B



C



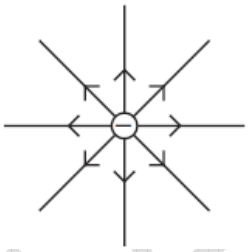
D



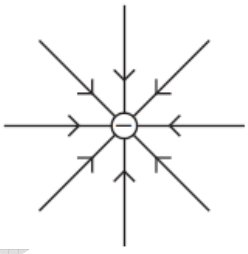
***5 Nov 06 P1 Q29**

29 Which diagram shows the electric field pattern of an isolated negative point charge?

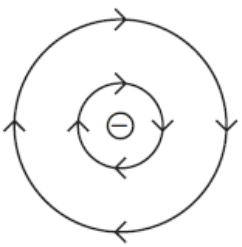
A



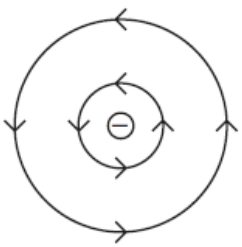
B



C



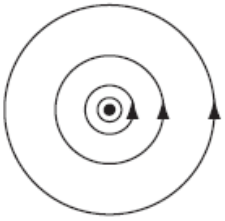
D



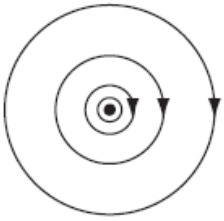
***6 June 07 P1 Q28**

28 Which diagram represents the electric field of a negative point charge, shown by ● ?

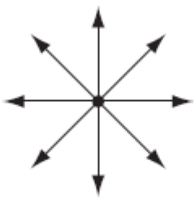
A



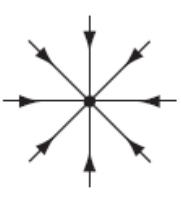
B



C

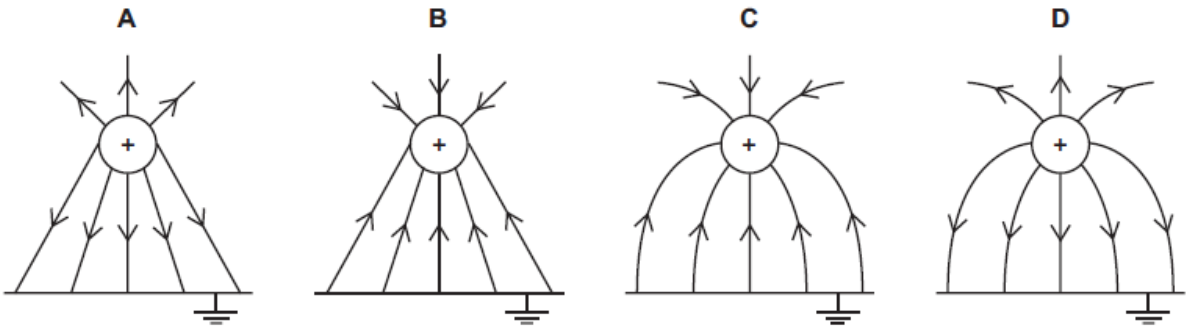


D



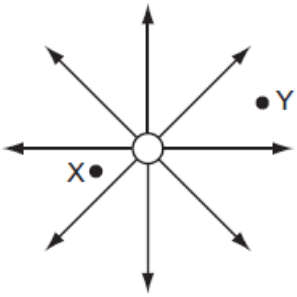
**7 Nov 07 P1 Q27

27 Which diagram shows the electric field between a positively charged metal sphere and an earthed metal plate?



**8 Nov 08 P1 Q29

29 The diagram shows the electric field near a point charge and two electrons X and Y.



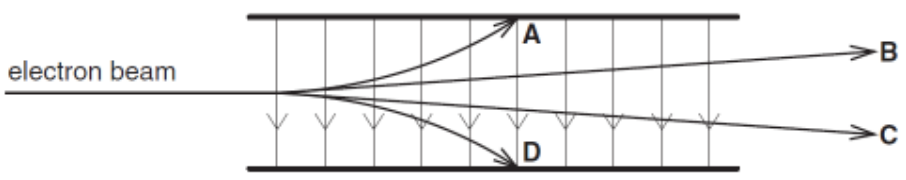
Which row describes the forces acting on X and Y?

	direction of force	magnitude of force on X
A	radially inwards	less than force on Y
B	radially inwards	greater than force on Y
C	radially outwards	less than force on Y
D	radially outwards	greater than force on Y

Uniform field

**1 Jun 02 P1 Q36

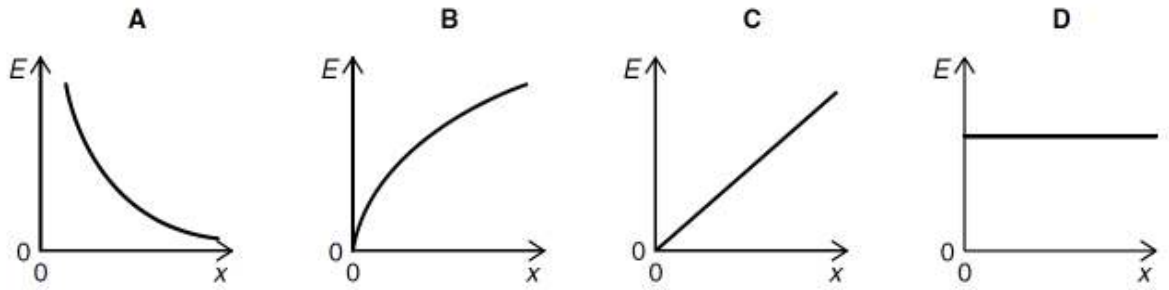
36 Which path shows a possible movement of an electron in the electric field shown?



**2 June 02 P1 Q37

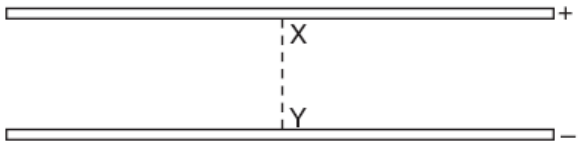
37 Two parallel conducting plates are connected to a battery, one plate to the positive terminal and the other plate to the negative. The plate separation is gradually increased, the plates remaining connected to the battery.

Which graph shows how the electric field E between the plates depends on the plate separation x?

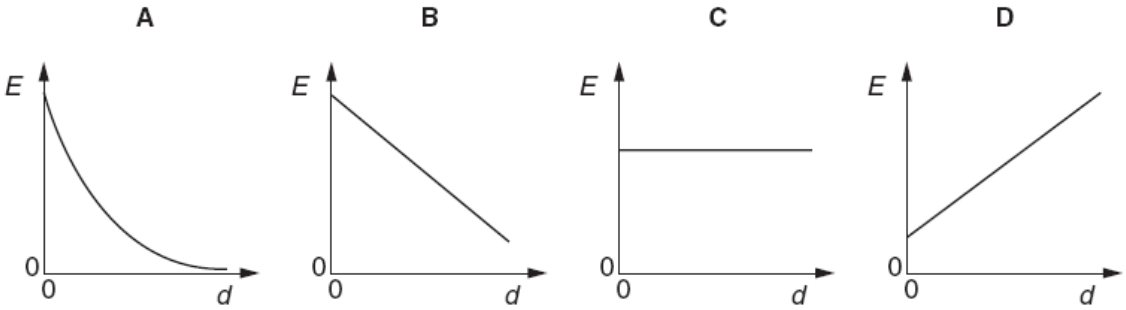


**3 June 03 P1 Q35

35 An electric field exists in the space between two charged metal plates.

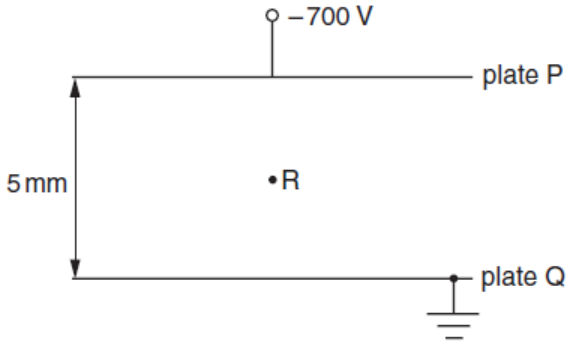


Which of the following graphs shows the variation of electric field strength E with distance d from X along the line XY?



**4 Jun 03 P1 Q36

36 The diagram shows two metal plates P and Q between which there is a potential difference of 700 V. Plate Q is earthed.



What is the magnitude and direction of the electric field at point R?

A $1.4 \times 10^2\,N\,C^{-1}$ from P towards Q

B $1.4 \times 10^2\,N\,C^{-1}$ from Q towards P

C $1.4 \times 10^5\,N\,C^{-1}$ from P towards Q

D $1.4 \times 10^5\,N\,C^{-1}$ from Q towards P

****5 Nov 03 P1 Q36**

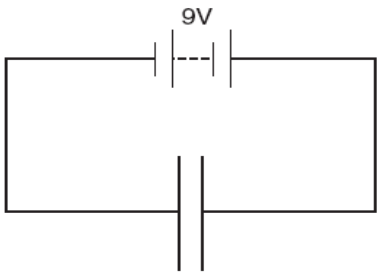
36 A potential difference V is applied between two parallel plates a small distance d apart, and produces an electric field of strength E between the plates.

What is the electric field strength between the plates when both V and d are doubled?

A $E/4$ **B** E **C** $2E$ **D** $4E$

****6 Nov 03 P1 Q37**

37 In the circuit below, the distance between the two parallel plates is 2.0×10^{-3} m. An electron is situated between the plates.



What is the force on the electron?

A 3.2×10^{-22} N

B 2.9×10^{-21} N

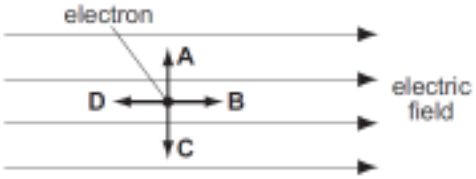
C 8.9×10^{-18} N

D 7.2×10^{-16} N

**7 June 04 P1 Q29

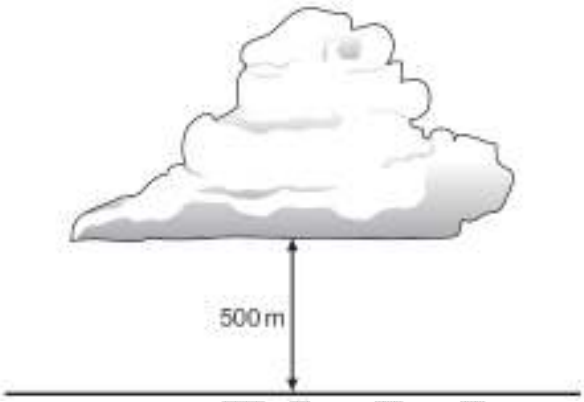
29 The diagram shows an electron in a uniform electric field.

In which direction will the field accelerate the electron?



**8 June 04 P1 Q30

30 The diagram shows a thundercloud whose base is 500 m above the ground.



The potential difference between the base of the cloud and the ground is 200 MV. A raindrop with a charge of 4.0×10^{-12} C is in the region between the cloud and the ground.

What is the electrical force on the raindrop?

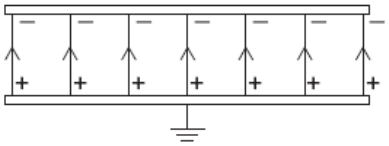
A 1.6×10^{-6} N **B** 8.0×10^{-4} N **C** 1.6×10^{-3} N **D** 0.40 N

**9 Nov 04 P1 Q29

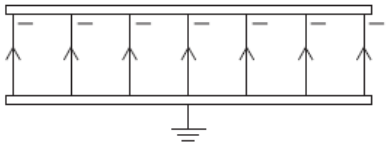
29 Two parallel, conducting plates with air between them are placed close to one another. The top plate is given a negative charge and the bottom one is earthed.

Which diagram best represents the distribution of charges and the field in this situation?

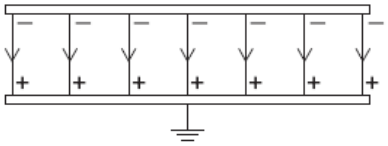
A



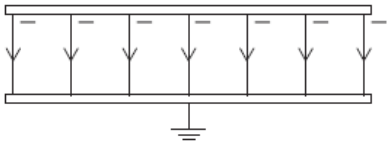
B



C



D



**10 Nov 04 P1 Q30

30 In a uniform electric field, which statement is correct?

A All charged particles experience the same force.

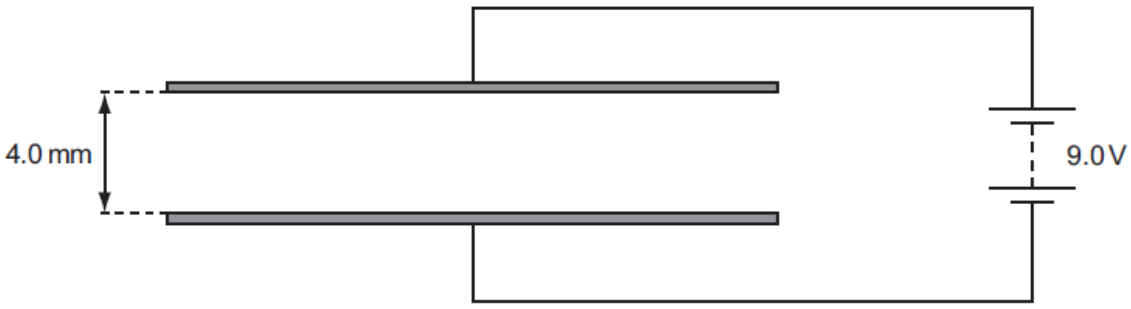
B All charged particles move with the same velocity.

C All electric field lines are directed towards positive charges.

D All electric field lines are parallel.

**11 June 05 P1 Q30

30 The diagram shows a pair of metal plates 4.0 mm apart connected to a 9.0 V battery.



What is the electric field between the plates?

A $4.4 \times 10^{-4}\,NC^{-1}$

B $3.6 \times 10^{-2}\,NC^{-1}$

C $36\,NC^{-1}$

D $2.3 \times 10^{3}\,NC^{-1}$

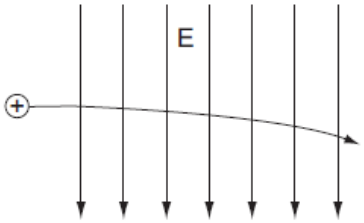
**12 Nov 05 P1 Q30

30 A positively charged particle is projected into a region of uniform electric field E.

Which diagram represents the motion of the particle in the electric field?

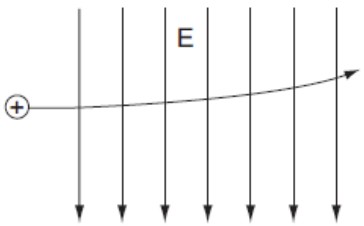
A

electric field in plane of the paper



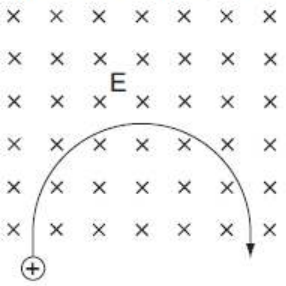
B

electric field in plane of the paper



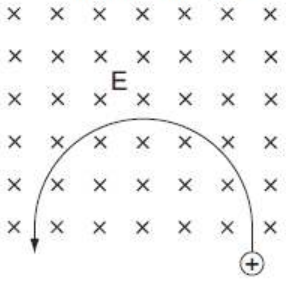
C

electric field into paper



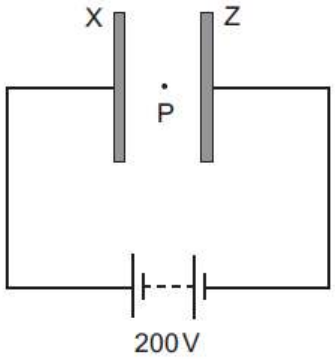
D

electric field into paper



**13 Nov 05 P1 Q31

31 Two large parallel plates X and Z are placed 5.0 mm apart and connected as shown to the terminals of a 200 volt d.c. supply.



A small oil drop at P carries one excess electron.

What is the magnitude of the electrostatic force acting on the oil drop due to the electric field between the plates?

A 6.4×10^{-15} N

B 6.4×10^{-18} N

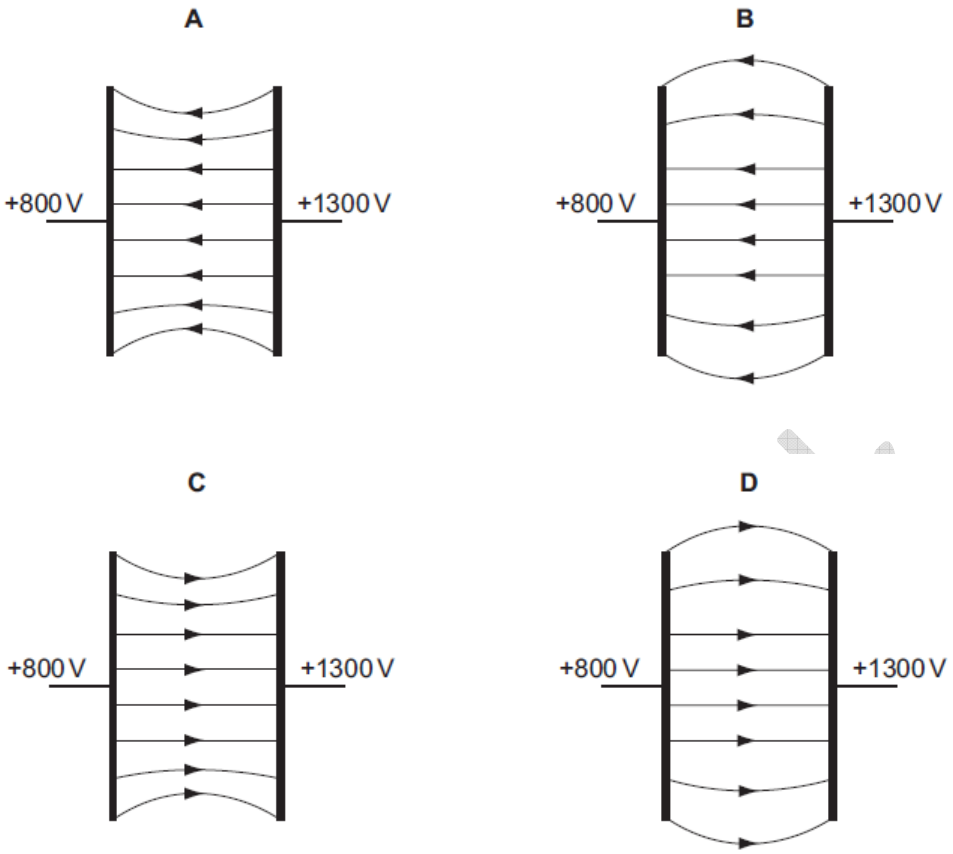
C 1.6×10^{-19} N

D 4.0×10^{-24} N

*14 June 06 P1 Q29

29 Two parallel metal plates are at potentials of +800 V and +1300 V.

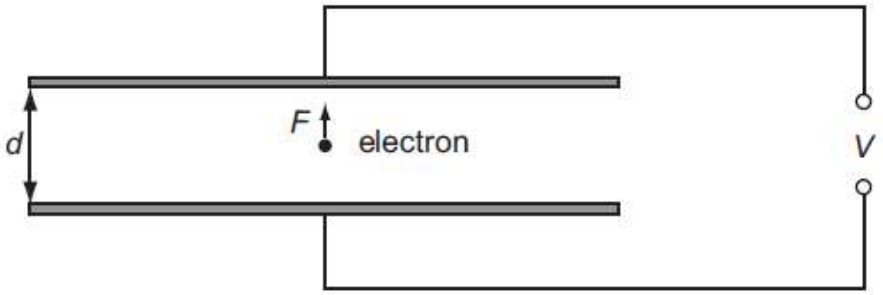
Which diagram best shows the electric field between the metal plates?



**15 June 06 P1 Q30

30 An electron of charge e is introduced between two metal plates a distance d apart.

A potential difference V is applied to the plates as shown in the diagram.

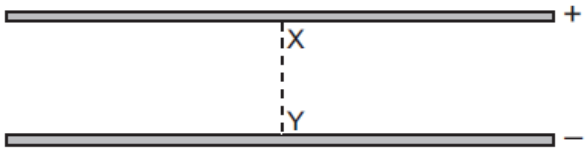


Which expression gives the electric force F on the electron?

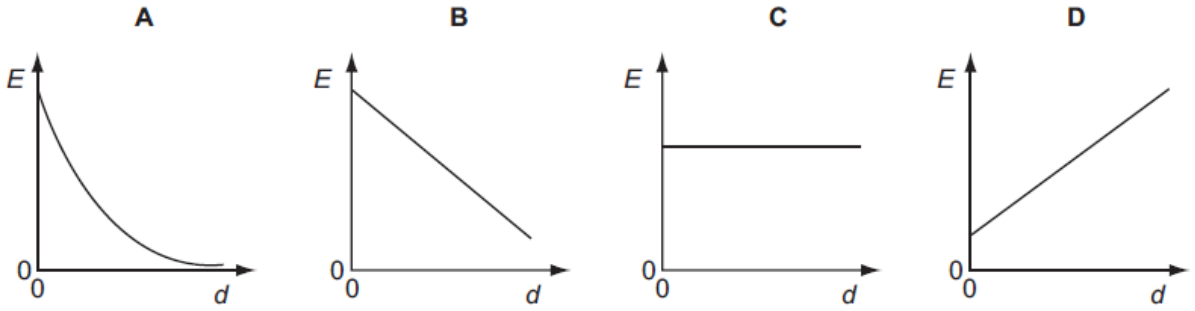
A $\frac{eV}{d}$ **B** eVd **C** $\frac{V}{ed}$ **D** $\frac{dV}{e}$

**16 Nov 06 P1 Q30

30 An electric field exists in the space between two charged metal plates.

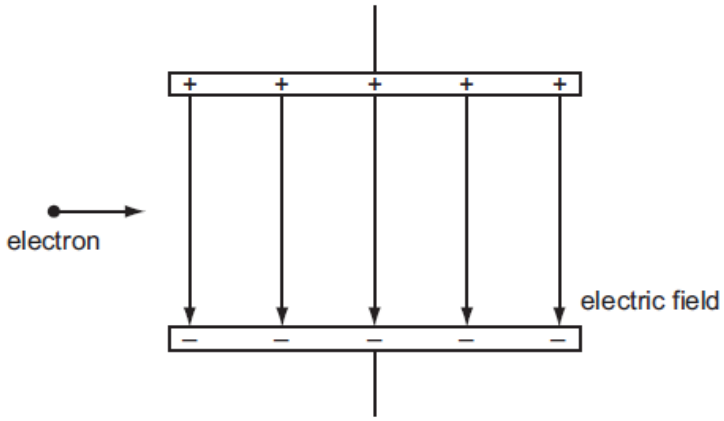


Which graph shows the variation of electric field strength E with distance d from X along the line XY?



**17 June 07 P1 Q29

29 An electron, travelling horizontally at constant speed in a vacuum, enters a vertical electric field between two charged parallel plates as shown.



What are the horizontal and vertical components of the motion of this electron when it is in the field?

	horizontal component of motion	vertical component of motion
A	constant speed	acceleration upwards
B	constant speed	acceleration downwards
C	acceleration to the right	acceleration downwards
D	acceleration to the right	acceleration upwards

**18 June 07 P1 Q30

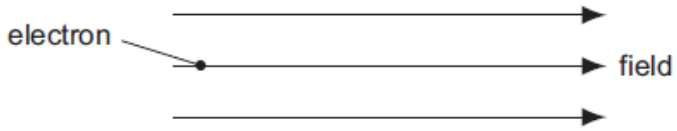
30 The electric field strength between a pair of parallel plates is E. The separation of the plates is doubled and the potential difference between the plates is increased by a factor of four.

What is the new electric field strength?

A E **B** $2E$ **C** $4E$ **D** $8E$

**19 Nov 07 P1 Q26

26 An electron is situated in a uniform electric field as shown in the diagram.



What is the direction of the electric force acting on the electron?

A downwards into the paper

B upwards out of the paper

C to the left

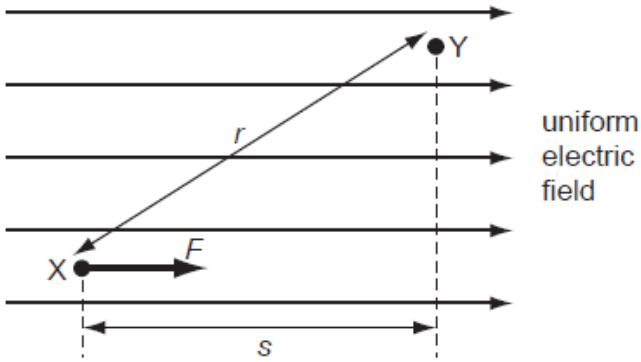
D to the right

***20 June 08 P1 Q16

16 A positive charge experiences a force *F* when placed at point X in a uniform electric field.

The charge is then moved from point X to point Y.

Distances *r* and *s* are shown on the diagram.



What is the change in the potential energy of the charge?

A decreases by *Fs*

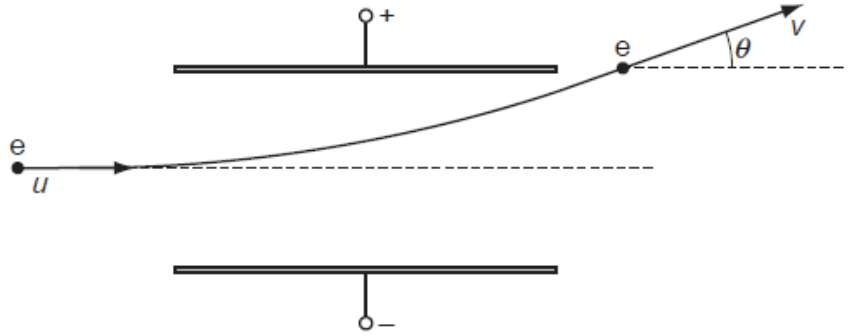
B increases by *Fs*

C decreases by *Fr*

D increases by *Fr*

**21 June 08 P1 Q30

30 An electron enters the space between two parallel charged plates with an initial velocity u.



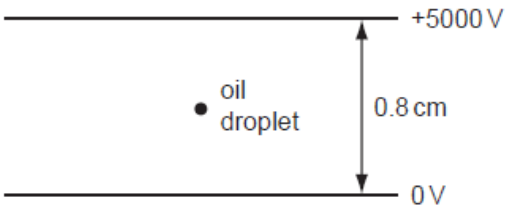
While in the electric field, its direction changes by θ and it emerges with a velocity v.

What is the relation between v and u?

A $v = \frac{u}{\cos\theta}$ **B** $v = u\cos\theta$ **C** $v = \frac{u}{\sin\theta}$ **D** $v = u\sin\theta$

**22 June 08 P1 Q31

31 The diagram shows an oil droplet that has become charged by gaining five electrons. The droplet remains stationary between charged plates.



What is the magnitude and direction of the electrostatic force on the oil droplet?

A 5.0×10^{-15} N upwards

B 5.0×10^{-15} N downwards

C 5.0×10^{-13} N upwards

D 5.0×10^{-13} N downwards

**23 Nov 08 P1 Q13

13 A particle is in a uniform field. The particle experiences a force in the opposite direction to the field.

Which field is the particle in, and on which property of the particle is the field acting?

	field	property of particle on which the field acts
A	electric	charge
B	electric	current
C	gravitational	mass
D	gravitational	weight

****24 Nov 08 P1 Q30**

30 A particle has a charge of 4.8×10^{-19} C. The particle remains at rest between a pair of horizontal, parallel plates having a separation of 15 mm. The potential difference between the plates is 660 V.

What is the weight of the particle?

A 2.1×10^{-14} N

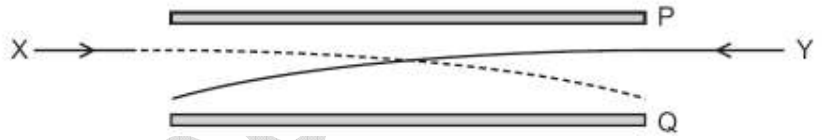
B 2.1×10^{-15} N

C 2.1×10^{-17} N

D 1.1×10^{-23} N

****25 June 09 P1 Q27**

27 The diagram shows the paths of two charged particles, X and Y, during their passage between a pair of oppositely charged metal plates, P and Q.



The plates are charged such that the electric field between them is directed from Q to P.

Which charges on X and Y will produce the observed paths?

	X	Y
A	–	–
B	–	+
C	+	–
D	+	+

****26 June 09 P1 Q28**

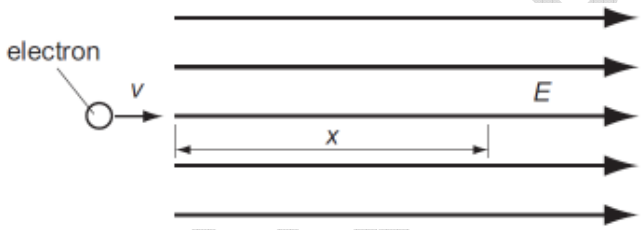
28 There is a potential difference between a pair of parallel plates.

Which values of potential difference and separation of the plates will produce an electric field strength of the greatest value?

	potential difference	separation
A	$2V$	$2d$
B	$2V$	$\frac{d}{2}$
C	$\frac{V}{2}$	$2d$
D	$\frac{V}{2}$	$\frac{d}{2}$

****27 June 09 P1 Q29**

29 The diagram shows an electron, with charge e, mass m, and velocity v, entering a uniform electric field of strength E.



The direction of the field and the electron's motion are both horizontal and to the right.

Which expression gives the distance x through which the electron travels before it stops momentarily?

A $x = \frac{mv}{E}$ **B** $x = \frac{mv}{Ee}$ **C** $x = \frac{mv^2}{2E}$ **D** $x = \frac{mv^2}{2Ee}$

Section B

Uniform field

1 Jun 02 P2 Q6

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

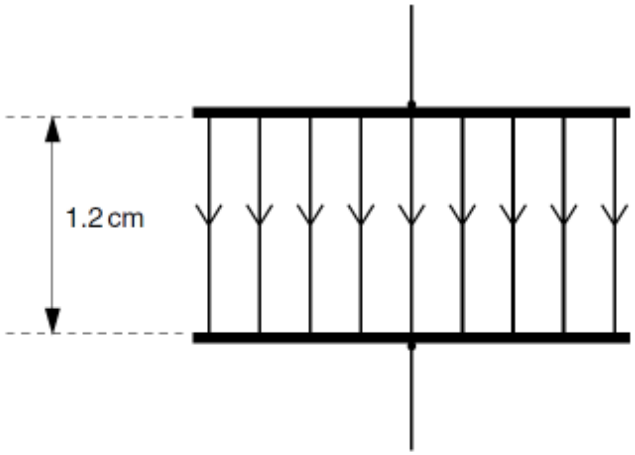


Fig. 6.1

The electric field between the plates is found to be 3.0×10^4 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 = ... m s^{-2} [3]

2 Nov 02 P2 Q6

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

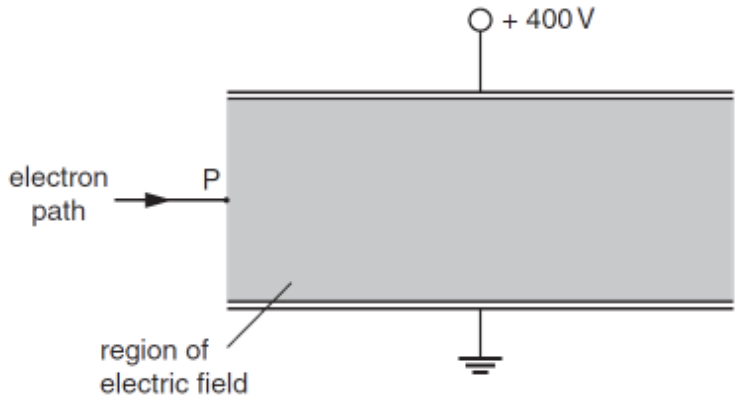


Fig. 6.1

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 = ... 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]

3 Nov 03 P2 Q5

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

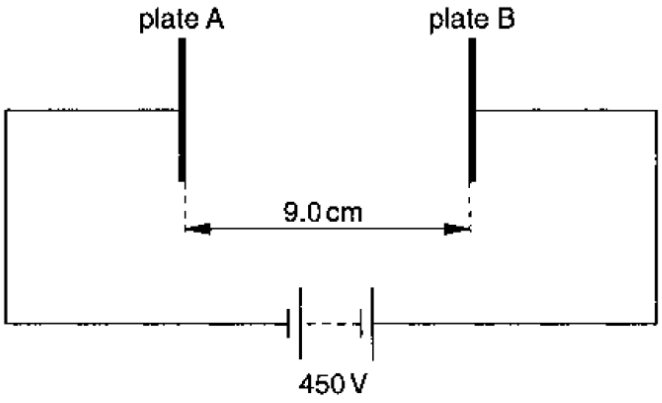


Fig. 5.1

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 = ... $N C^{-1}$
[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 7.2×10^{-17} 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]

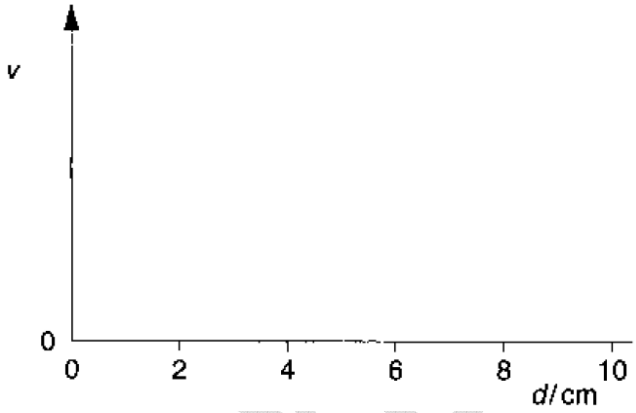


Fig. 5.2

4 June 05 P2 Q6

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

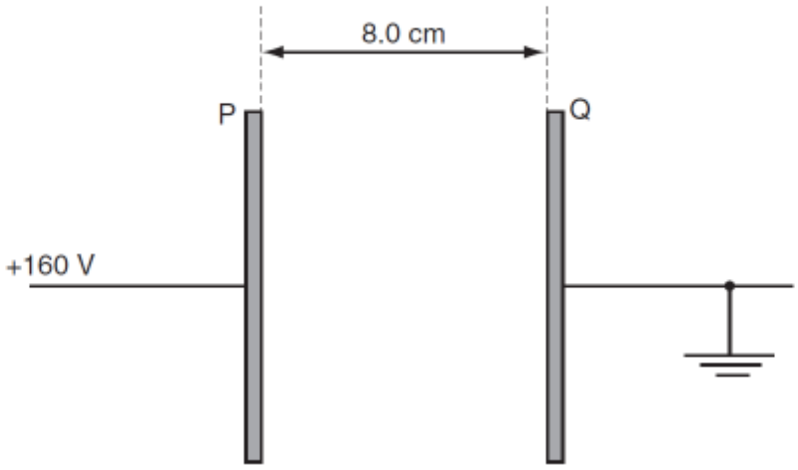


Fig. 6.1

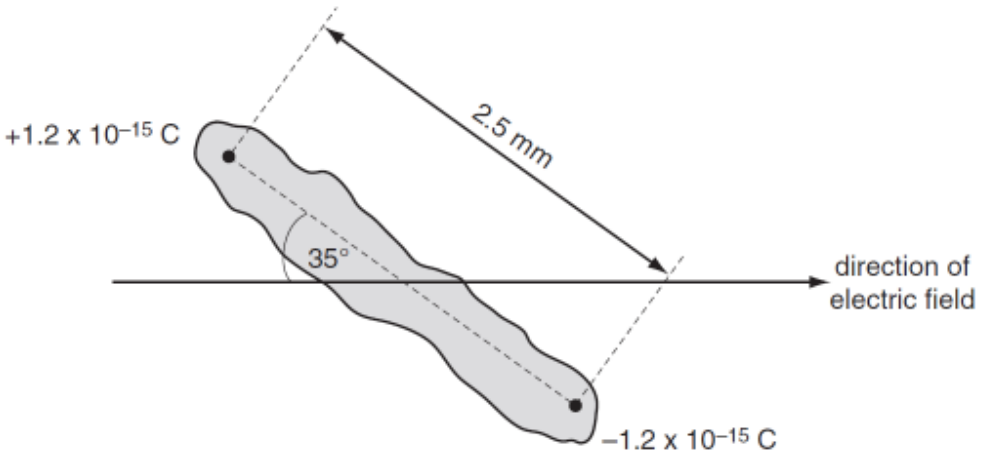
Plate Q is earthed and plate P is maintained at a potential of +160 V.

(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 2.0×10^3 V m^{-1}.

[1]

(b) A dust particle is suspended in the air between the plates. The particle has charges of $+1.2 \times 10^{-15}$ C and -1.2×10^{-15} 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.



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 Nov 05 P2 Q6

6 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.

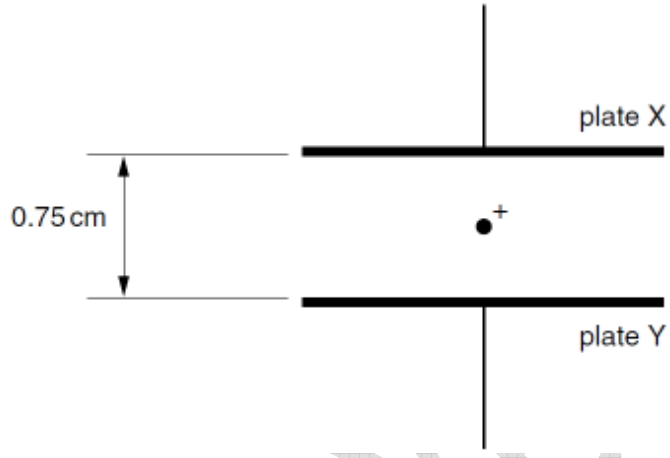


Fig. 6.1

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]

6 June 07 P2 Q2

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.

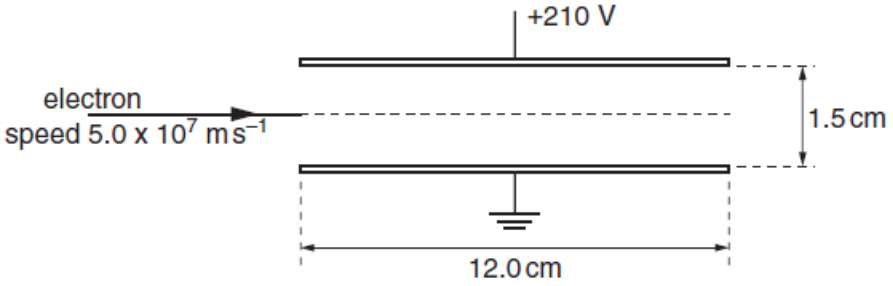


Fig. 2.1

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 5.0×10^7 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.

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.

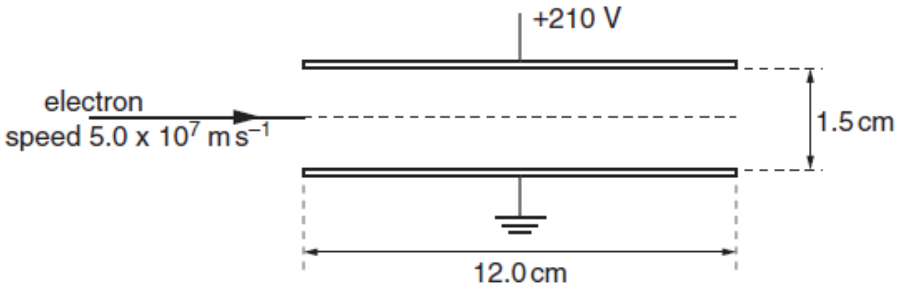


Fig. 2.1

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 5.0×10^7 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]

7

Nov 08 P2 Q4

4 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.

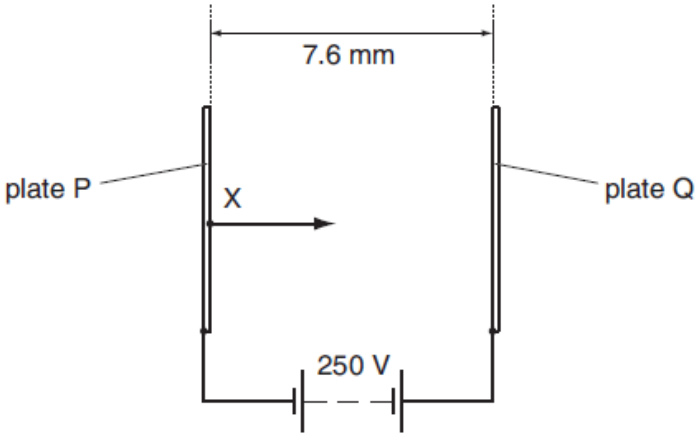


Fig. 4.1

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 = ...$m\,s^{-1}$ [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]

8 June 09 P2 Q6

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

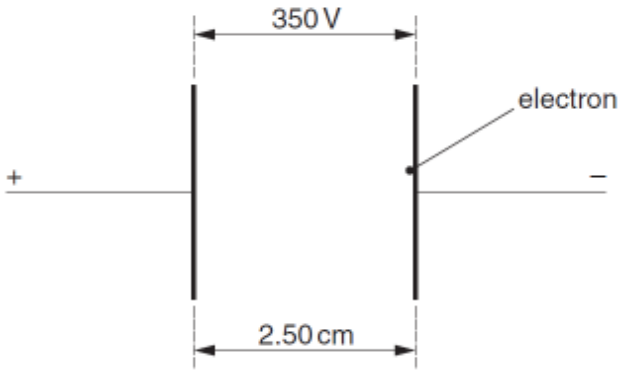


Fig. 6.1

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 = ... NC^{-1} [2]

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

[2]

(b) The electron accelerates horizontally across the space between the plates. Determine

(i) the horizontal acceleration of the electron,

acceleration = ... ms^{-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]