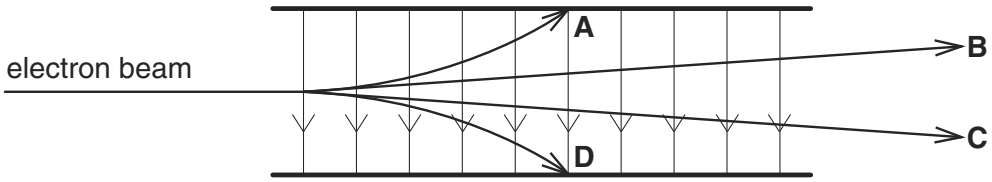
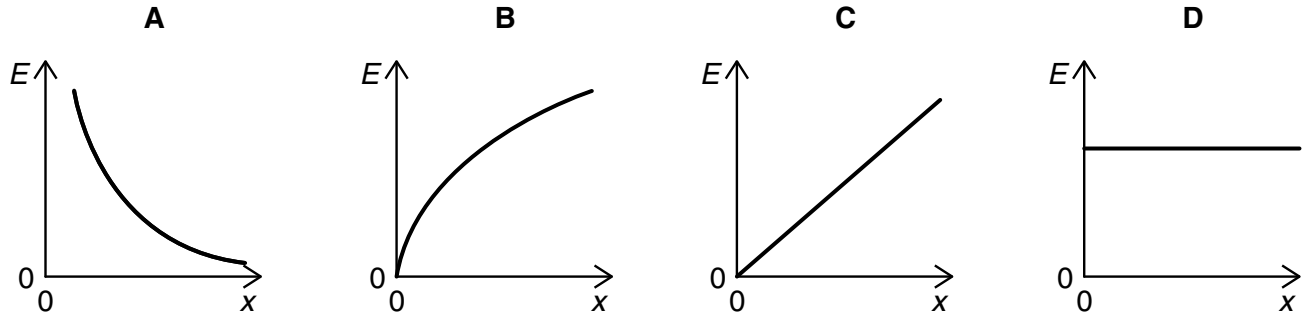
**36** Which path shows a possible movement of an electron in the electric field shown? 9702/1/M/J/02

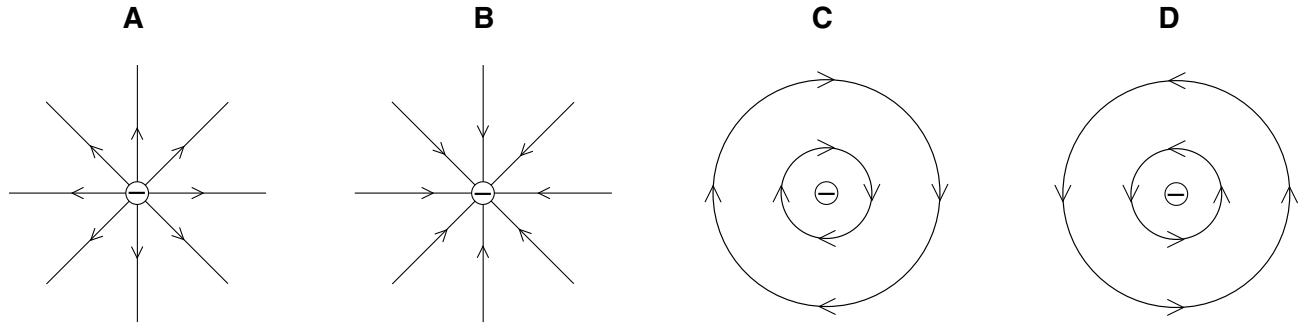



**37** Two parallel conducting plates are connected to a battery, one plate to the positive terminal and the other plate to the negative. The plate separation is gradually increased, the plates remaining connected to the battery. 9702/1/M/J/02

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

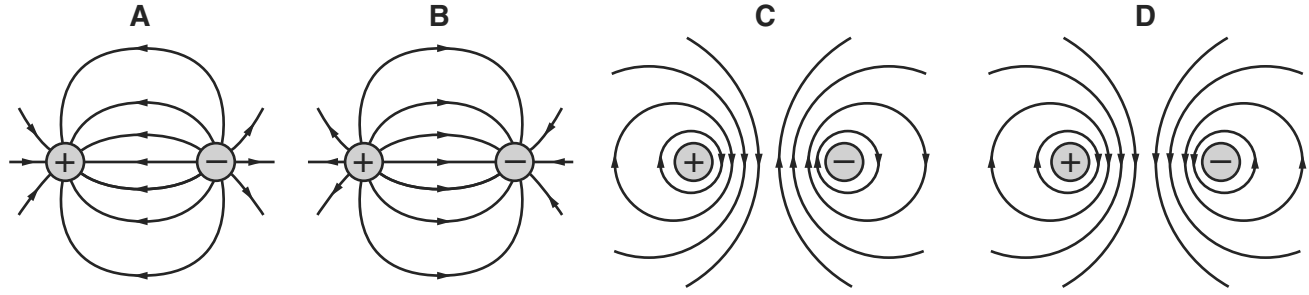



**37** Which diagram shows the electric field pattern of an isolated negative point charge? 9702/1/O/N/02

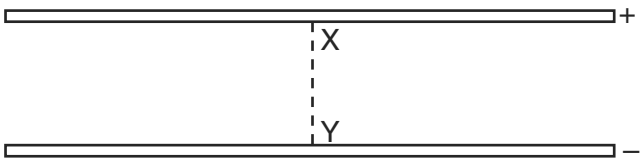



**37** A positive charge and a negative charge of equal magnitude are placed a short distance apart. 9702/01/M/J/03

Which diagram best represents the associated electric field?

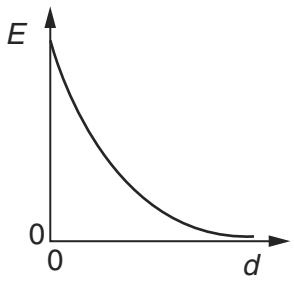


**35** An electric field exists in the space between two charged metal plates. 9702/01/M/J/03

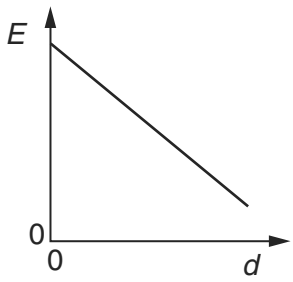



Which of the following graphs shows the variation of electric field strength *E* with distance *d* from X along the line XY?

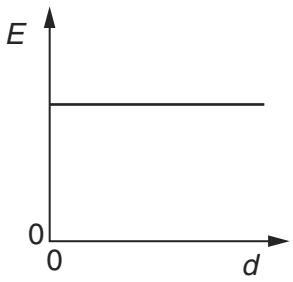
**A**



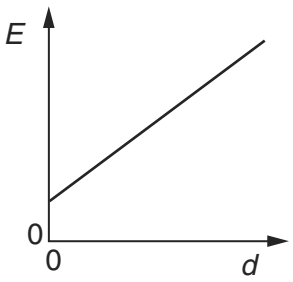

**B**



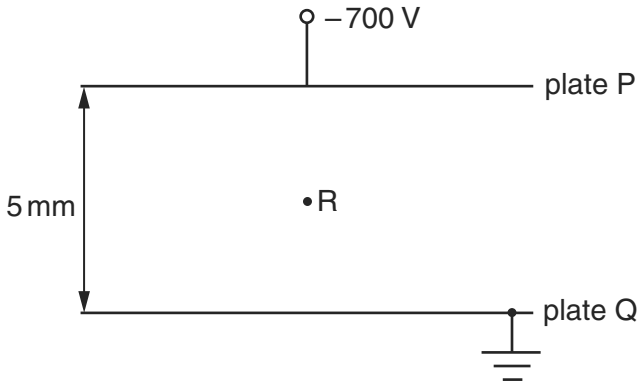

**C**




**D**




**36** The diagram shows two metal plates P and Q between which there is a potential difference of 700 V. Plate Q is earthed. 9702/01/M/J/03




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

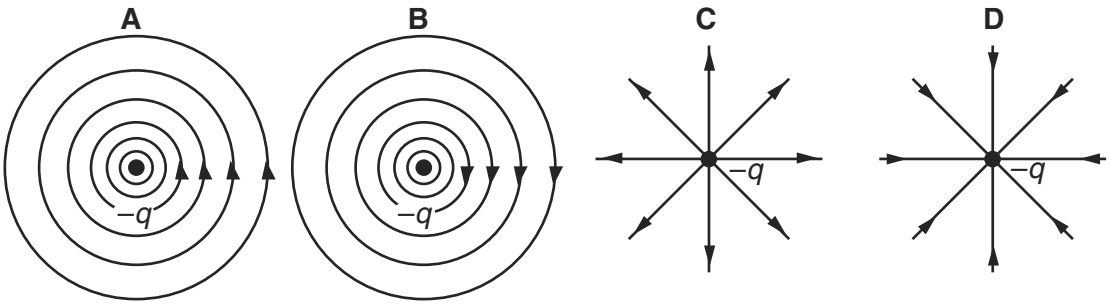
**30** The electric field strength between a pair of parallel plates is *E*. The separation of the plates is doubled and the potential difference between the plates is increased by a factor of four.

9702/01/M/J/07

What is the new electric field strength?

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

**35** Which diagram represents the electric field of a negative point charge $-q$? 9702/01/O/N/03

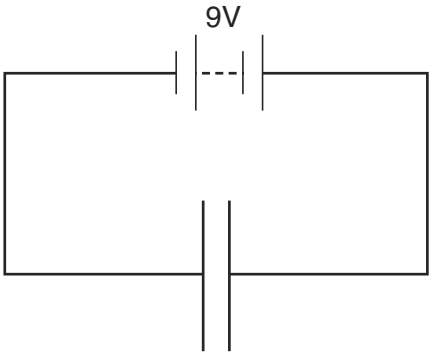



**36** A potential difference $V$ is applied between two parallel plates a small distance $d$ apart, and produces an electric field of strength $E$ between the plates. 9702/01/O/N/03


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

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

**37** In the circuit below, the distance between the two parallel plates is $2.0 \times 10^{-3}$ m. An electron is situated between the plates. 9702/01/O/N/03




What is the force on the electron?

**A** $3.2 \times 10^{-22}$ N

**B** $2.9 \times 10^{-21}$ N

**C** $8.9 \times 10^{-18}$ N

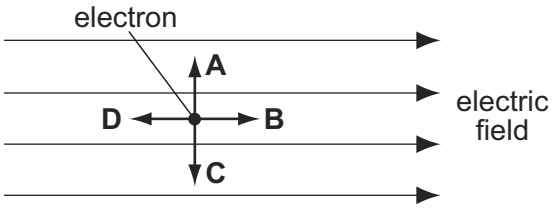
**D** $7.2 \times 10^{-16}$ N

**32** What is an equivalent unit to 1 volt? 9702/01/M/J/04

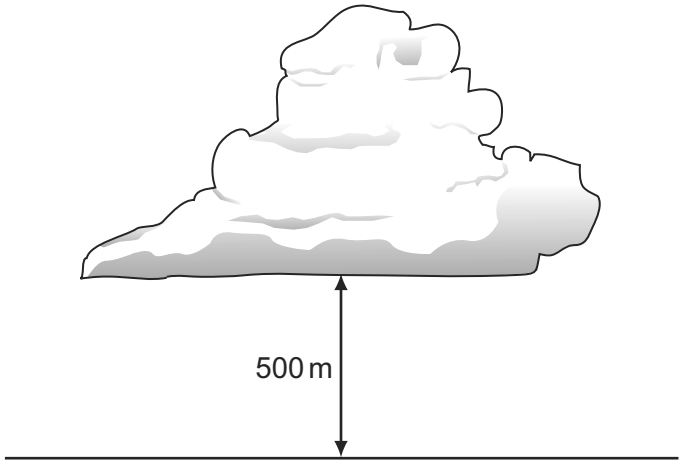
**A** $1\,JA^{-1}$ **B** $1\,JC^{-1}$ **C** $1\,WC^{-1}$ **D** $1\,Ws^{-1}$

**29** The diagram shows an electron in a uniform electric field. 9702/01/M/J/04

In which direction will the field accelerate the electron?




**30** The diagram shows a thundercloud whose base is 500 m above the ground. 9702/01/M/J/04



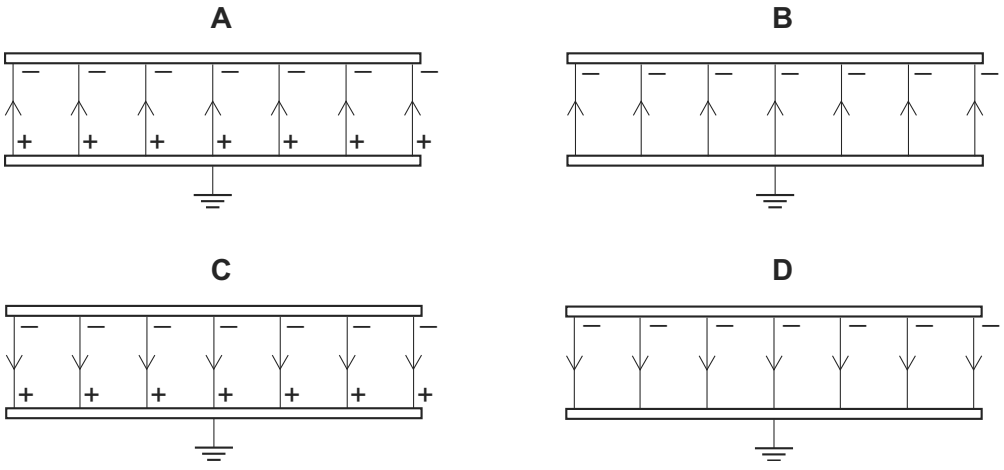

The potential difference between the base of the cloud and the ground is 200 MV. A raindrop with a charge of $4.0 \times 10^{-12}$ C is in the region between the cloud and the ground.

What is the electrical force on the raindrop?

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

**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. 9702/01/O/N/04

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



**30** In a uniform electric field, which statement is correct? 9702/01/O/N/04

**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.

**31** Which of the following describes the electric potential difference between two points in a wire that carries a current? 9702/01/O/N/04

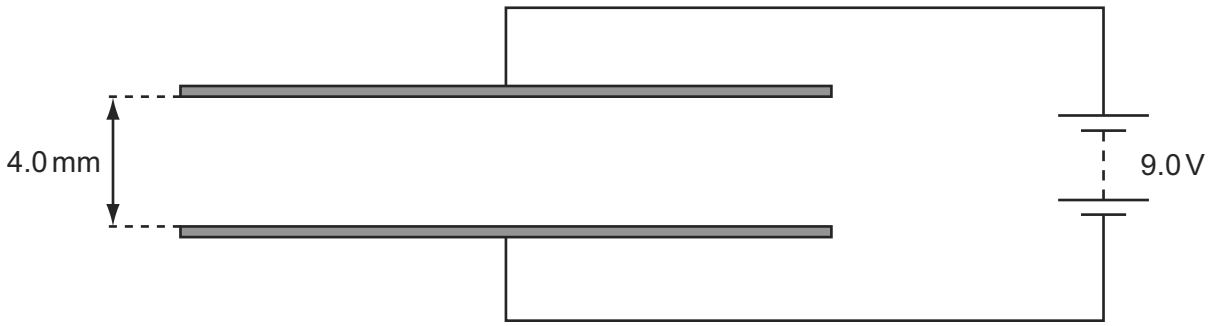
**A** the force required to move a unit positive charge between the points

**B** the ratio of the energy dissipated between the points to the current

**C** the ratio of the power dissipated between the points to the current

**D** the ratio of the power dissipated between the points to the charge moved

**30** The diagram shows a pair of metal plates 4.0 mm apart connected to a 9.0 V battery. 9702/01/M/J/05




What is the electric field between the plates?

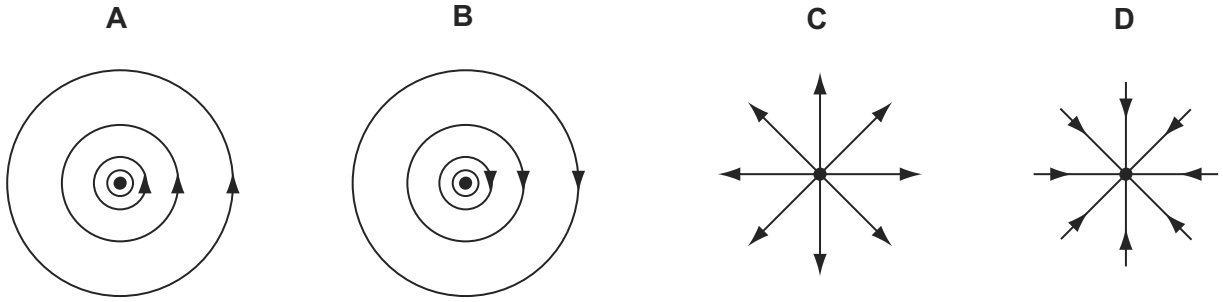
**A** $4.4 \times 10^{-4}\,\mathrm{N\,C^{-1}}$

**B** $3.6 \times 10^{-2}\,\mathrm{N\,C^{-1}}$

**C** $36\,\mathrm{N\,C^{-1}}$

**D** $2.3 \times 10^{3}\,\mathrm{N\,C^{-1}}$

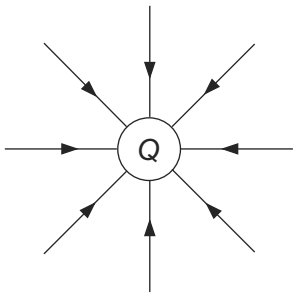
**28** Which diagram represents the electric field of a negative point charge, shown by ● ? 9702/01/M/J/07



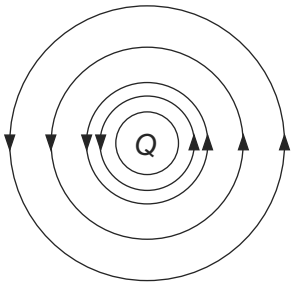
**31** Which diagram represents the electric field in the vicinity of a positive electric charge of magnitude *Q*?

9702/01/M/J/05

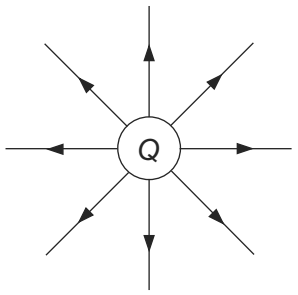
**A**



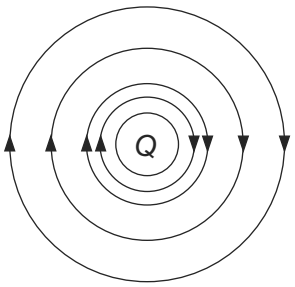

**B**




**C**




**D**

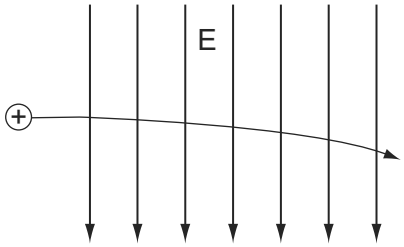



**30** A positively charged particle is projected into a region of uniform electric field E. 9702/01/O/N/05

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

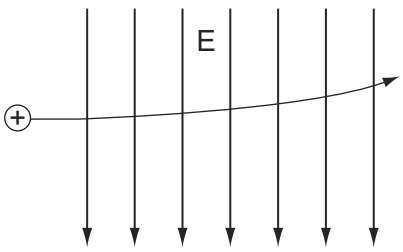
**A**

electric field in plane of the paper



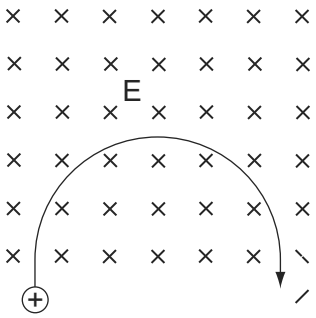

**B**

electric field in plane of the paper



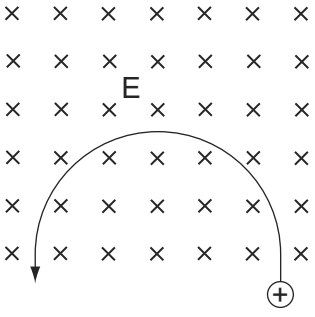

**C**

electric field into paper

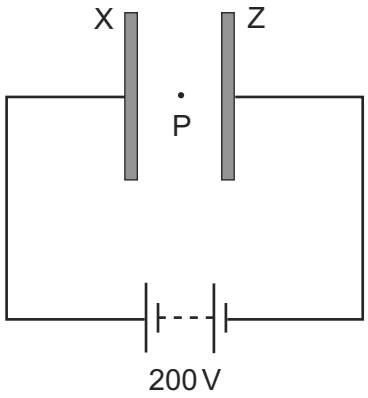



**D**

electric field into paper



**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. 9702/01/O/N/05




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?

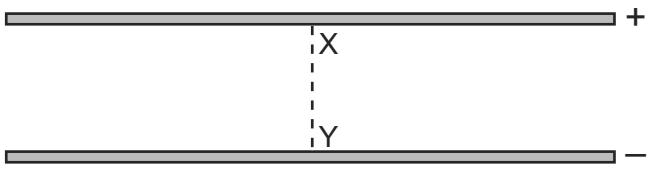
**A** $6.4 \times 10^{-15}$ N

**B** $6.4 \times 10^{-18}$ N

**C** $1.6 \times 10^{-19}$ N

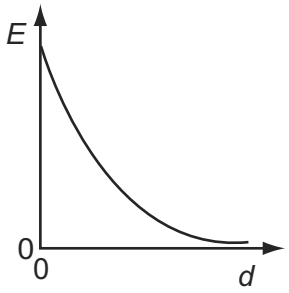
**D** $4.0 \times 10^{-24}$ N

**30** An electric field exists in the space between two charged metal plates. 9702/01/O/N/06

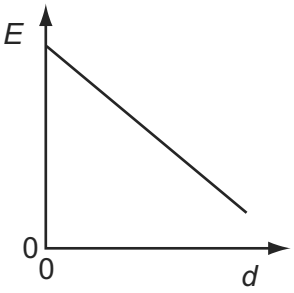



Which graph shows the variation of electric field strength *E* with distance *d* from X along the line XY?

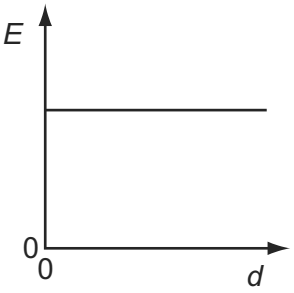
**A**



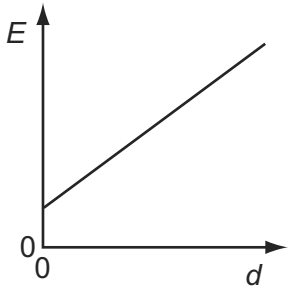

**B**




**C**



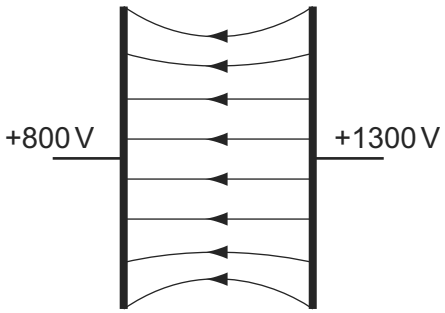

**D**



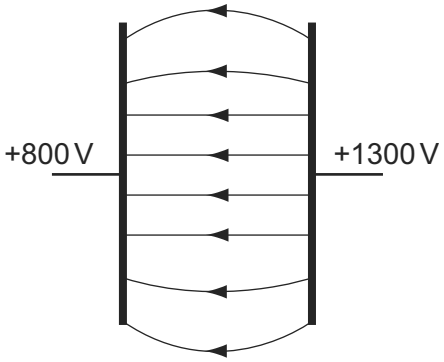
**29** Two parallel metal plates are at potentials of +800 V and +1300 V. 9702/01/M/J/06

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

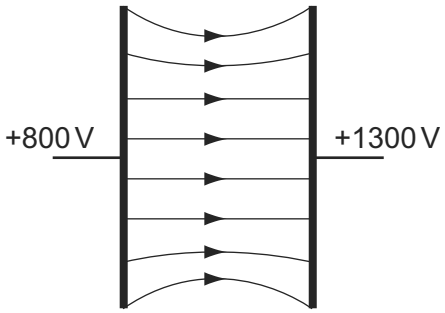
**A**



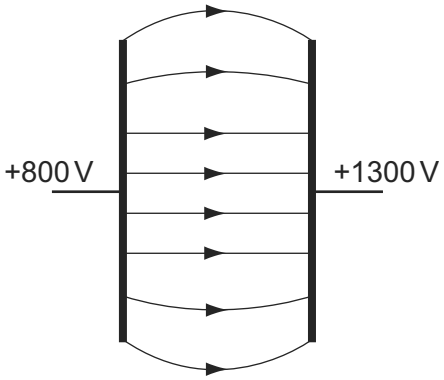

**B**




**C**

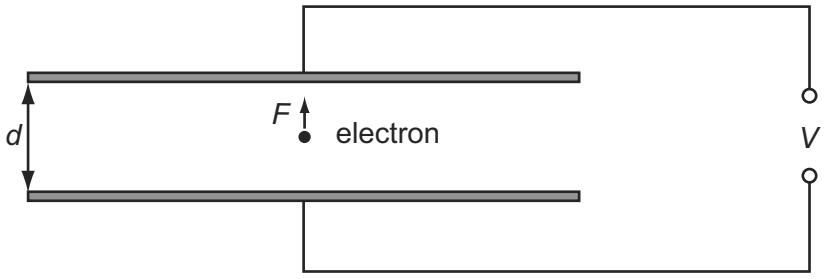



**D**




**30** An electron of charge *e* is introduced between two metal plates a distance *d* apart. 9702/01/M/J/06

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

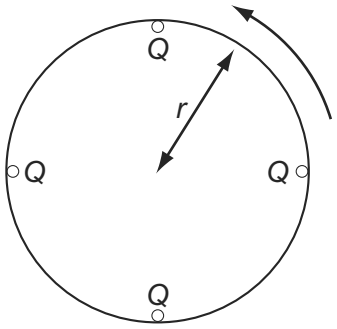



Which expression gives the electric force *F* on the electron?

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

**31** Four point charges, each of charge $Q$, are placed on the edge of an insulating disc of radius $r$. 9702/01/O/N/06

The frequency of rotation of the disc is $f$.

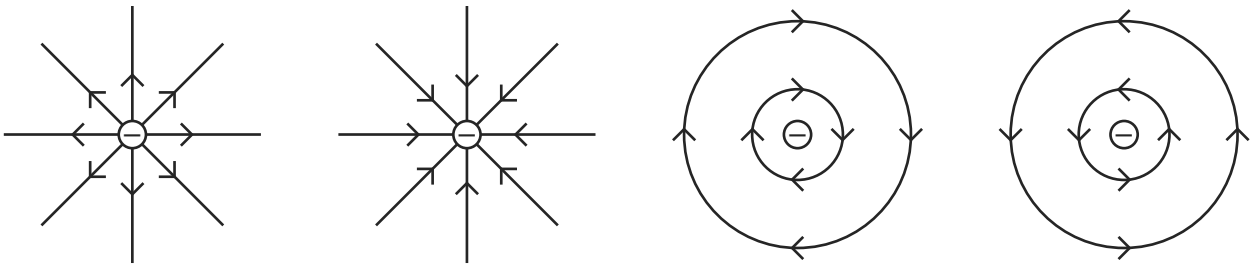



What is the equivalent electric current at the edge of the disc?

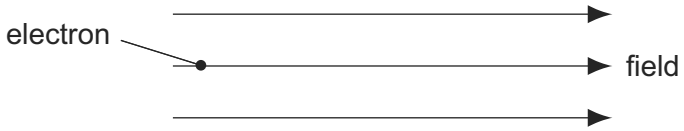
**A** $4Qf$ **B** $\frac{4Q}{f}$ **C** $8\pi rQf$ **D** $\frac{2Qf}{\pi r}$

**29** Which diagram shows the electric field pattern of an isolated negative point charge? 9702/01/O/N/06

**A** **B** **C** **D**



**26** An electron is situated in a uniform electric field as shown in the diagram. 9702/01/O/N/07




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

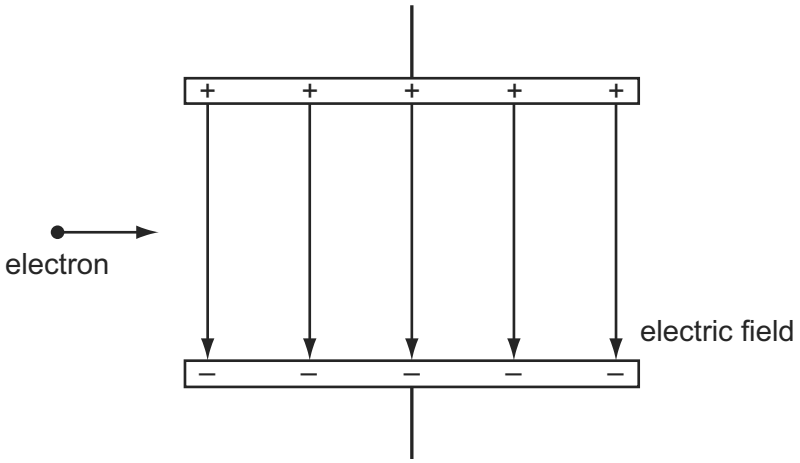
**A** downwards into the paper

**B** upwards out of the paper

**C** to the left

**D** to the right

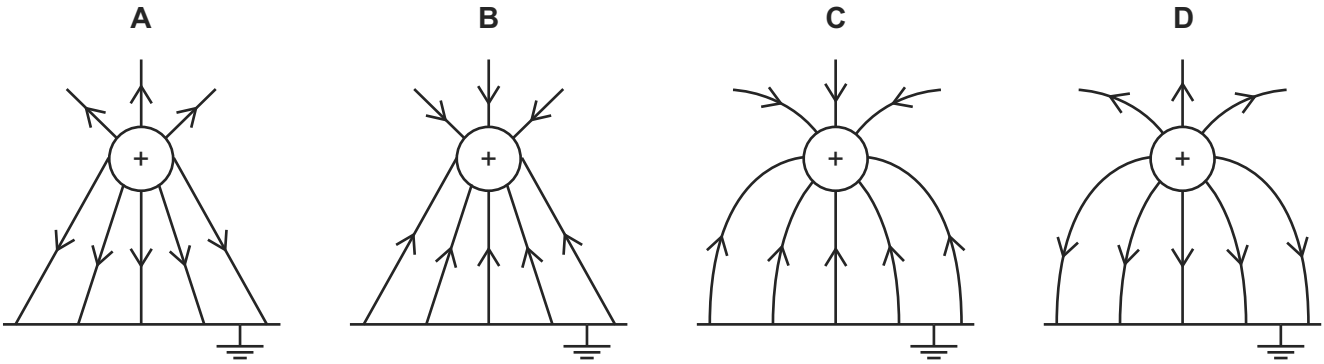
**29** An electron, travelling horizontally at constant speed in a vacuum, enters a vertical electric field between two charged parallel plates as shown. 9702/01/M/J/07




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

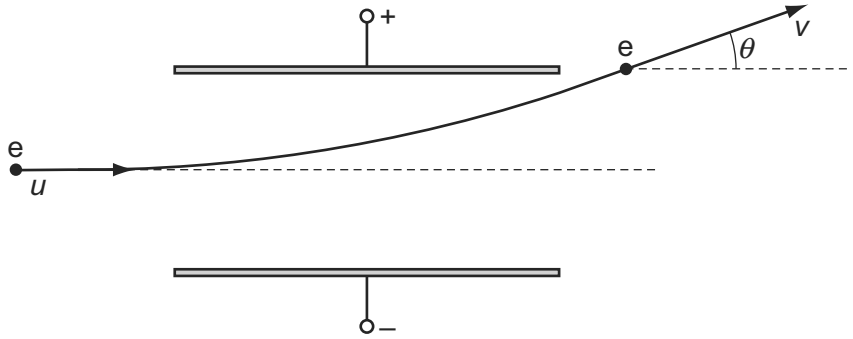
| | horizontal component of motion | vertical component of motion |
|---|---|---|
| **A** | constant speed | acceleration upwards |
| **B** | constant speed | acceleration downwards |
| **C** | acceleration to the right | acceleration downwards |
| **D** | acceleration to the right | acceleration upwards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

**27** Which diagram shows the electric field between a positively charged metal sphere and an earthed metal plate? 9702/01/O/N/07



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

9702/01/M/J/08




While in the electric field, its direction changes by $\theta$ 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** $v = u\sin\theta$

**28** Which electrical quantity would be the result of a calculation in which energy transfer is divided by charge?

9702/01/O/N/07

**A** current

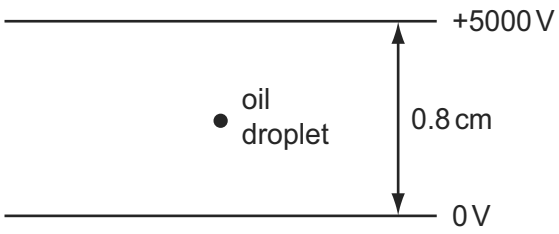
**B** potential difference

**C** power

**D** resistance

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

9702/01/M/J/08




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

**A** $5.0 \times 10^{-15}$ N upwards

**B** $5.0 \times 10^{-15}$ N downwards

**C** $5.0 \times 10^{-13}$ N upwards

**D** $5.0 \times 10^{-13}$ N downwards

**30** A particle has a charge of $4.8 \times 10^{-19}$ 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. 9702/01/O/N/08

What is the weight of the particle?

**A** $2.1 \times 10^{-14}$N

**B** $2.1 \times 10^{-15}$N

**C** $2.1 \times 10^{-17}$N

**D** $1.1 \times 10^{-23}$N

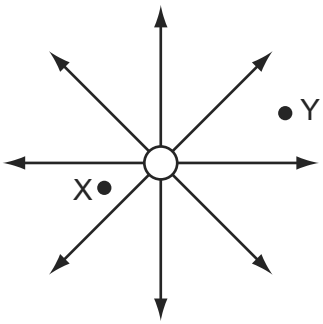
**27** A small charge $q$ is placed in the electric field of a large charge $Q$. 9702/11/O/N/09

Both charges experience a force $F$.

What is the electric field strength of the charge $Q$ at the position of the charge $q$?

**A** $\frac{F}{Qq}$ **B** $\frac{F}{Q}$ **C** $FqQ$ **D** $\frac{F}{q}$

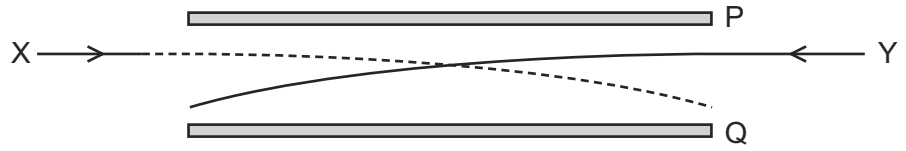
**29** The diagram shows the electric field near a point charge and two electrons X and Y. 9702/01/O/N/08




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 |

**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. 9702/01/M/J/09




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** | + | + |

**28** There is a potential difference between a pair of parallel plates. 9702/01/M/J/09

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** | $\frac{V}{2}$ | $\frac{d}{2}$ |

**29** The electric field at a certain distance from an isolated alpha particle is $3.0 \times 10^{7}\,\text{N C}^{-1}$. 9702/11/O/N/09

What is the force on an electron when at that distance from the alpha particle?

**A** $4.8 \times 10^{-12}\,\text{N}$

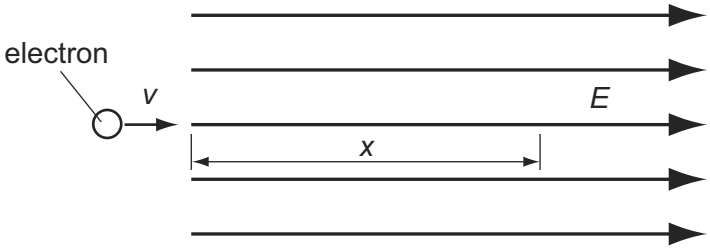
**B** $9.6 \times 10^{-12}\,\text{N}$

**C** $3.0 \times 10^{7}\,\text{N}$

**D** $6.0 \times 10^{7}\,\text{N}$

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

9702/01/M/J/09



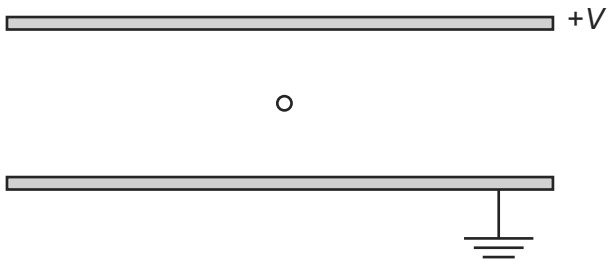

The direction of the field and the electron's motion are both horizontal and to the right.

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** $x = \frac{mv^2}{2Ee}$

**28** The diagram shows two parallel horizontal metal plates held at a potential difference $V$.

9702/11/O/N/09




A small charged liquid drop, midway between the plates, is held in equilibrium by the combination of its weight and the electric force acting on it.

The acceleration of free fall is $g$ and the electric field strength is $E$.

What is the ratio of the charge to mass of the drop, and the polarity of the charge on the drop?

| | $\frac{\text{charge}}{\text{mass}}$ | polarity |
|---|---|---|
| **A** | $\frac{g}{E}$ | positive |
| **B** | $\frac{g}{E}$ | negative |
| **C** | $\frac{E}{g}$ | positive |
| **D** | $\frac{E}{g}$ | negative |

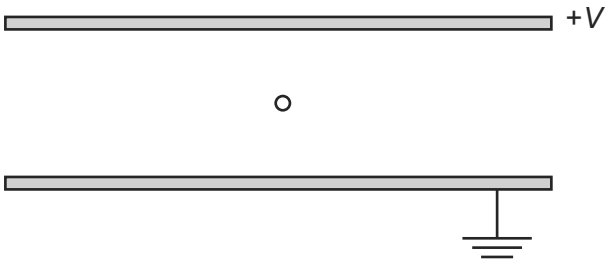
**26** A small charge $q$ is placed in the electric field of a large charge $Q$. 9702/12/O/N/09

Both charges experience a force $F$.

What is the electric field strength of the charge $Q$ at the position of the charge $q$?

**A** $\frac{F}{Qq}$ **B** $\frac{F}{Q}$ **C** $FqQ$ **D** $\frac{F}{q}$

**27** The diagram shows two parallel horizontal metal plates held at a potential difference $V$. 9702/12/O/N/09




A small charged liquid drop, midway between the plates, is held in equilibrium by the combination of its weight and the electric force acting on it.

The acceleration of free fall is $g$ and the electric field strength is $E$.

What is the ratio of the charge to mass of the drop, and the polarity of the charge on the drop?

| | $\frac{\text{charge}}{\text{mass}}$ | polarity |
|---|---|---|
| **A** | $\frac{g}{E}$ | positive |
| **B** | $\frac{g}{E}$ | negative |
| **C** | $\frac{E}{g}$ | positive |
| **D** | $\frac{E}{g}$ | negative |

**28** The electric field at a certain distance from an isolated alpha particle is $3.0 \times 10^7\,\text{N C}^{-1}$.

What is the force on an electron when at that distance from the alpha particle? 9702/12/O/N/09

**A** $4.8 \times 10^{-12}\,\text{N}$

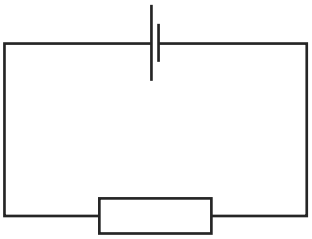
**B** $9.6 \times 10^{-12}\,\text{N}$

**C** $3.0 \times 10^7\,\text{N}$

**D** $6.0 \times 10^7\,\text{N}$

**29** A cell is connected to a resistor. 9702/12/O/N/09

At any given moment, the potential difference across the cell is less than its electromotive force.



Which statement explains this?

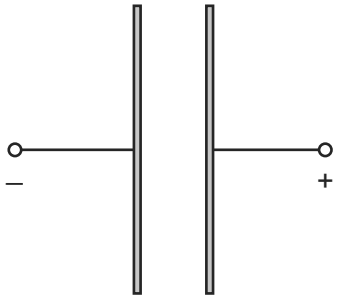
**A** The cell is continually discharging.

**B** The connecting wire has some resistance.

**C** Energy is needed to drive charge through the cell.

**D** Power is used when there is a current in the resistor.

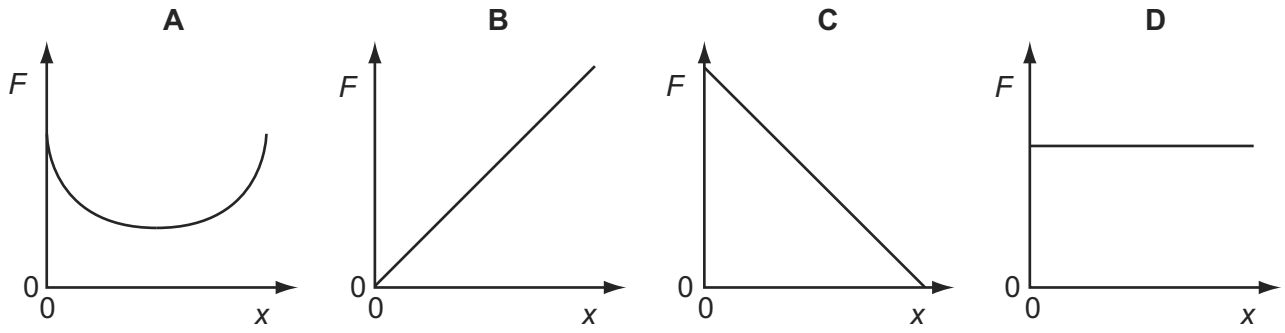
**28** Two oppositely-charged parallel plates are arranged as shown. 9702/11/M/J/10



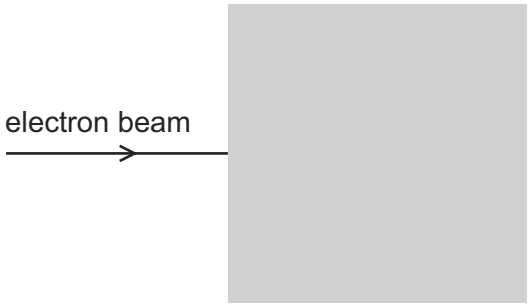

An electron is released from rest from the surface of the negatively-charged plate.

The electron travels from the negatively-charged plate towards the positively-charged plate.

Which graph shows how the force *F* on the electron varies with its distance *x* from the negative plate?



**29** In the diagram, the shaded area represents a uniform electric field directed away from the observer (at right-angles into the plane of the paper). 9702/11/M/J/10




A horizontal beam of electrons enters the field, travelling from left to right.

In which direction is this beam deflected by the field?

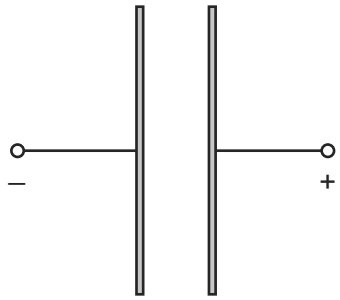
**A** upwards (in the plane of the paper)

**B** downwards (in the plane of the paper)

**C** away from the observer

**D** towards the observer

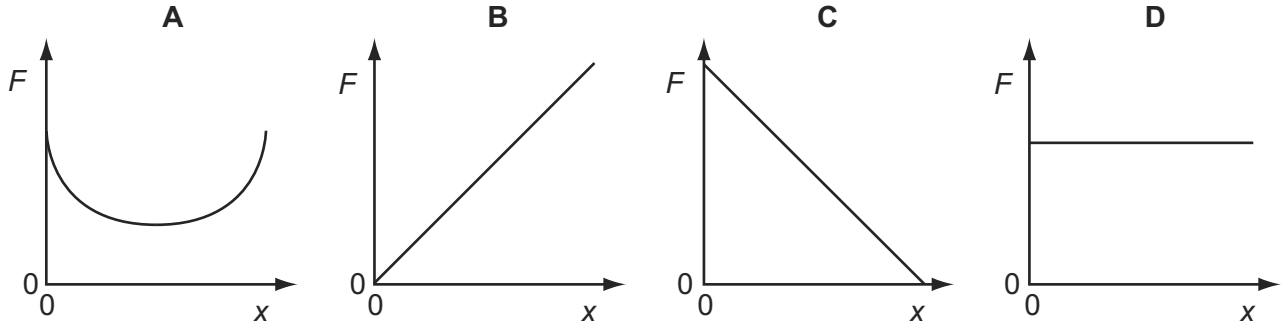
**26** Two oppositely-charged parallel plates are arranged as shown. 9702/12/M/J/10



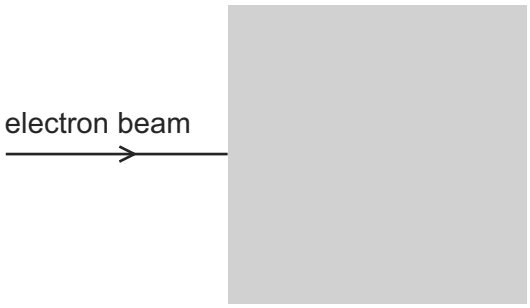

An electron is released from rest from the surface of the negatively-charged plate.

The electron travels from the negatively-charged plate towards the positively-charged plate.

Which graph shows how the force *F* on the electron varies with its distance *x* from the negative plate?



**27** In the diagram, the shaded area represents a uniform electric field directed away from the observer (at right-angles into the plane of the paper). 9702/12/M/J/10




A horizontal beam of electrons enters the field, travelling from left to right.

In which direction is this beam deflected by the field?

**A** upwards (in the plane of the paper)

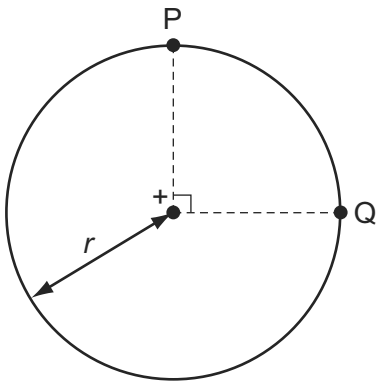
**B** downwards (in the plane of the paper)

**C** away from the observer

**D** towards the observer

**28** The diagram shows two points P and Q which lie, 90° apart, on a circle of radius *r*. 9702/12/M/J/10

A positive point charge at the centre of the circle creates an electric field of magnitude *E* at both P and Q.




Which expression gives the work done in moving a unit positive charge from P to Q?

**A** 0 **B** $E \times r$ **C** $E \times \left(\frac{\pi r}{2}\right)$ **D** $E \times (\pi r)$

**32** When will 1 C of charge pass a point in an electrical circuit? 9702/12/M/J/12

**A** when 1 A moves through a potential difference of 1 V

**B** when a power of 1 W is used for 1 s

**C** when the current is 5 mA for 200 s

**D** when the current is 10 A for 10 s

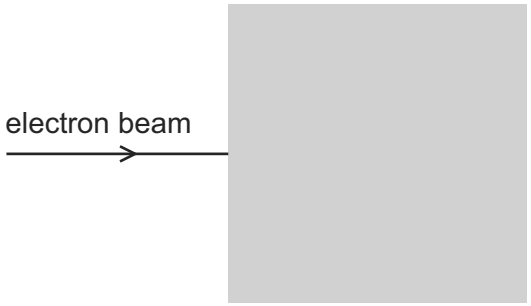
**29** Which row describes the circumstances under which forces act on a charged particle in a uniform electric field?

9702/12/M/J/10

| | charged particle | direction of force |
|---|---|---|
| **A** | moving charges only | parallel to the field |
| **B** | stationary charges only | perpendicular to the field |
| **C** | stationary and moving charges | parallel to the field |
| **D** | stationary and moving charges | perpendicular to the field |

**26** In the diagram, the shaded area represents a uniform electric field directed away from the observer (at right-angles into the plane of the paper).

9702/13/M/J/10




A horizontal beam of electrons enters the field, travelling from left to right.

In which direction is this beam deflected by the field?

**A** upwards (in the plane of the paper)

**B** downwards (in the plane of the paper)

**C** away from the observer

**D** towards the observer

**28** An electron is in an electric field of strength $5 \times 10^4$ V m$^{-1}$. The field is the only influence on the electron.

9702/11/O/N/10

The mass and charge of an electron are known.

Which quantity can be calculated without any more information?

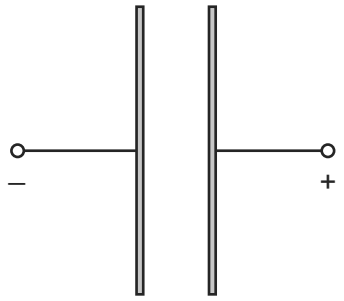
**A** the force on the electron

**B** the momentum of the electron

**C** the kinetic energy of the electron

**D** the speed of the electron

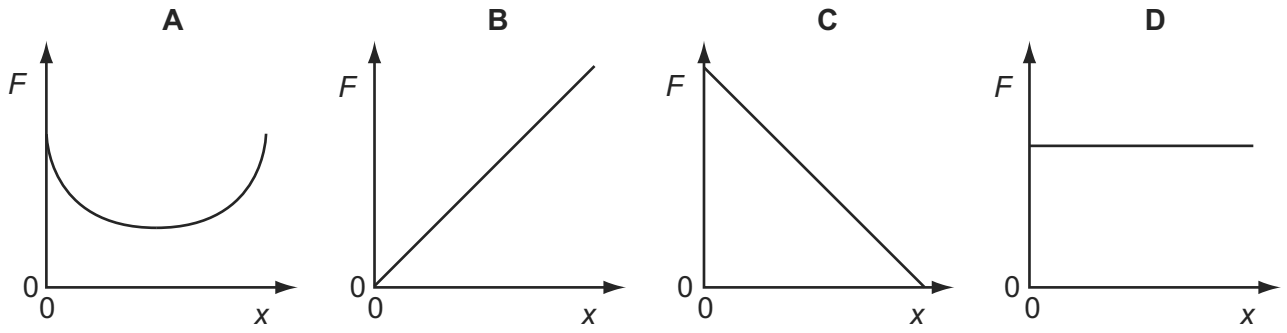
**27** Two oppositely-charged parallel plates are arranged as shown. 9702/13/M/J/10



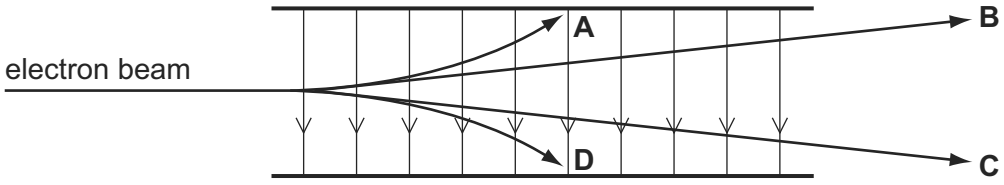

An electron is released from rest from the surface of the negatively-charged plate.

The electron travels from the negatively-charged plate towards the positively-charged plate.

Which graph shows how the force *F* on the electron varies with its distance *x* from the negative plate?




**30** Which path shows a possible movement of an electron in the electric field shown? 9702/12/O/N/11

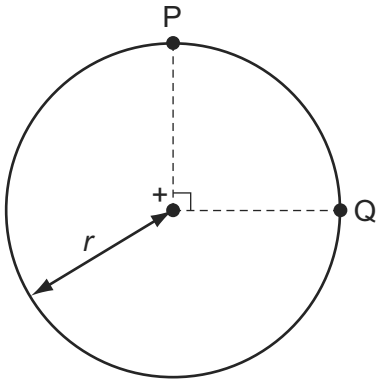



**28** Which row describes the circumstances under which forces act on a charged particle in a uniform electric field? 9702/13/M/J/10

| | charged particle | direction of force |
|---|---|---|
| **A** | moving charges only | parallel to the field |
| **B** | stationary charges only | perpendicular to the field |
| **C** | stationary and moving charges | parallel to the field |
| **D** | stationary and moving charges | perpendicular to the field |

**29** The diagram shows two points P and Q which lie, 90° apart, on a circle of radius *r*. 9702/13/M/J/10

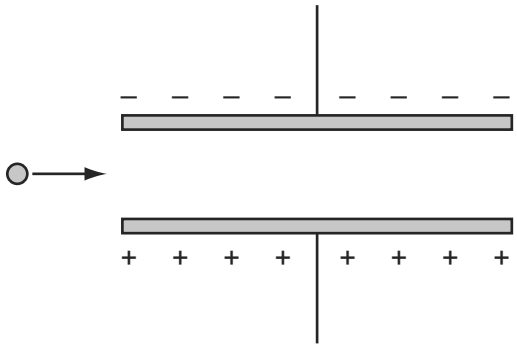
A positive point charge at the centre of the circle creates an electric field of magnitude *E* at both P and Q.




Which expression gives the work done in moving a unit positive charge from P to Q?

**A** 0 **B** $E \times r$ **C** $E \times \left(\frac{\pi r}{2}\right)$ **D** $E \times (\pi r)$

**30** The diagram shows a charged particle as it approaches a pair of charged parallel plates in a vacuum. 9702/13/M/J/11

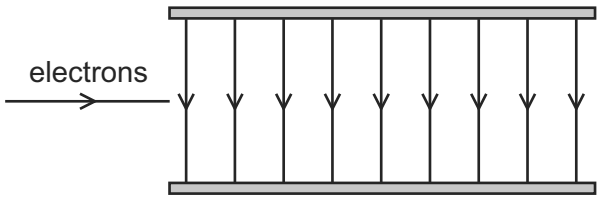



Which row describes the horizontal and vertical components of its motion as it travels between the plates?

| | horizontal component | vertical component |
|---|---|---|
| **A** | constant acceleration | constant acceleration |
| **B** | constant acceleration | constant velocity |
| **C** | constant velocity | constant acceleration |
| **D** | constant velocity | constant velocity |

**29** Electrons are accelerated and then directed into the uniform electric field between two parallel plates in a vacuum.

9702/11/O/N/10




What best describes the shape of the path followed by the electrons in the field?

**A** a downwards curve along a line that is part of a circle

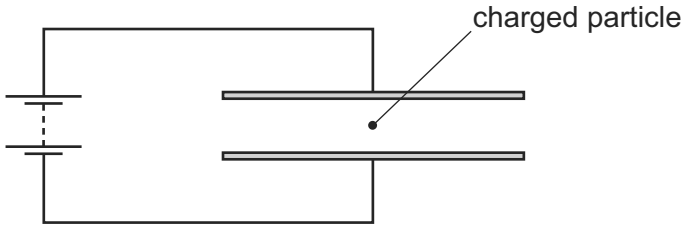
**B** a downwards curve along a line that is **not** part of a circle

**C** an upwards curve along a line that is part of a circle

**D** an upwards curve along a line that is **not** part of a circle

**30** A charged particle is in the electric field between two horizontal metal plates connected to a source of constant potential difference, as shown. There is a force $F$ on the particle due to the electric field.

9702/11/O/N/10




The separation of the plates is doubled.

What will be the new force on the particle?

**A** $\frac{F}{4}$ **B** $\frac{F}{2}$ **C** $F$ **D** $2F$

**32** What describes the electric potential difference between two points in a wire that carries a current?

9702/12/M/J/11

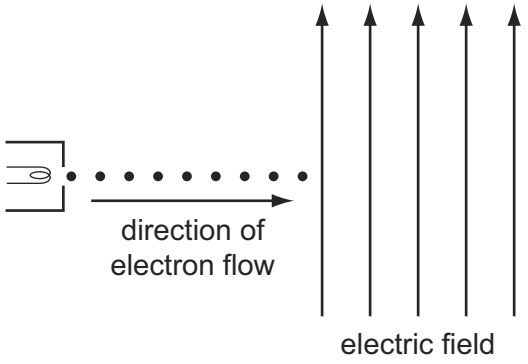
**A** the force required to move a unit positive charge between the points

**B** the ratio of the energy dissipated between the points to the current

**C** the ratio of the power dissipated between the points to the current

**D** the ratio of the power dissipated between the points to the charge moved

**28** The diagram shows a vertical uniform electric field in a vacuum. 9702/12/O/N/10

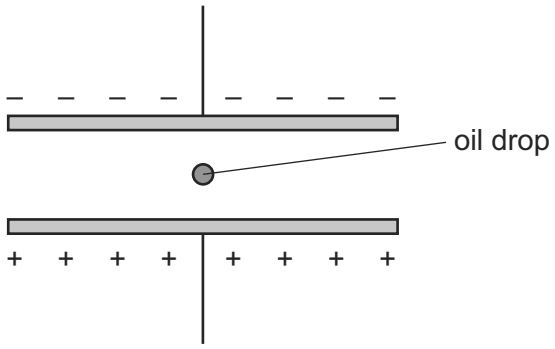



An electron gun injects a beam of electrons horizontally into the field.

Which changes, if any, have occurred to the path and speed of the electrons by the time the beam leaves the field?

| | path of electrons | speed of electrons |
|---|---|---|
| **A** | deflected downwards | increased |
| **B** | deflected downwards | unchanged |
| **C** | deflected upwards | increased |
| **D** | deflected upwards | unchanged |

**29** A very small oil drop of mass $m$ carries a charge $+q$. 9702/12/O/N/10




The potential difference across the plates is $V$ and the separation is $d$.

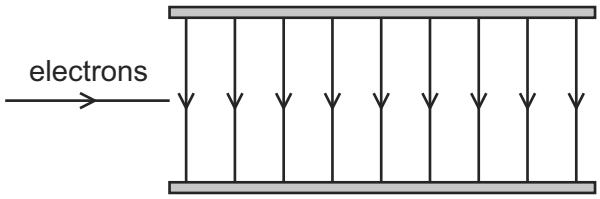
The weight of the drop is balanced by the electric force. (Buoyancy forces may be considered to be negligible.)

Which formula gives the charge on the drop?

**A** $q = \frac{mgd}{V}$ **B** $q = \frac{mgV}{d}$ **C** $q = \frac{Vd}{mg}$ **D** $q = \frac{V}{mgd}$

**28** Electrons are accelerated and then directed into the uniform electric field between two parallel plates in a vacuum.

9702/13/O/N/10




What best describes the shape of the path followed by the electrons in the field?

**A** a downwards curve along a line that is part of a circle

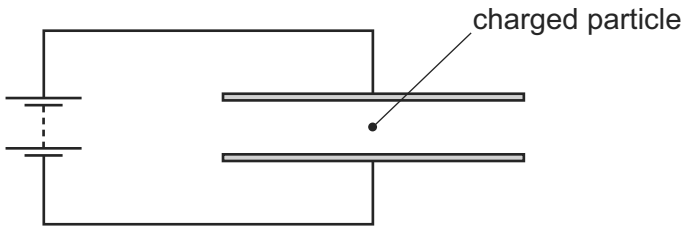
**B** a downwards curve along a line that is **not** part of a circle

**C** an upwards curve along a line that is part of a circle

**D** an upwards curve along a line that is **not** part of a circle

**29** A charged particle is in the electric field between two horizontal metal plates connected to a source of constant potential difference, as shown. There is a force $F$ on the particle due to the electric field.

9702/13/O/N/10




The separation of the plates is doubled.

What will be the new force on the particle?

**A** $\frac{F}{4}$ **B** $\frac{F}{2}$ **C** $F$ **D** $2F$

**30** An electron is in an electric field of strength $5 \times 10^4$ V m$^{-1}$. The field is the only influence on the electron.

9702/13/O/N/10

The mass and charge of an electron are known.

Which quantity can be calculated without any more information?

**A** the force on the electron

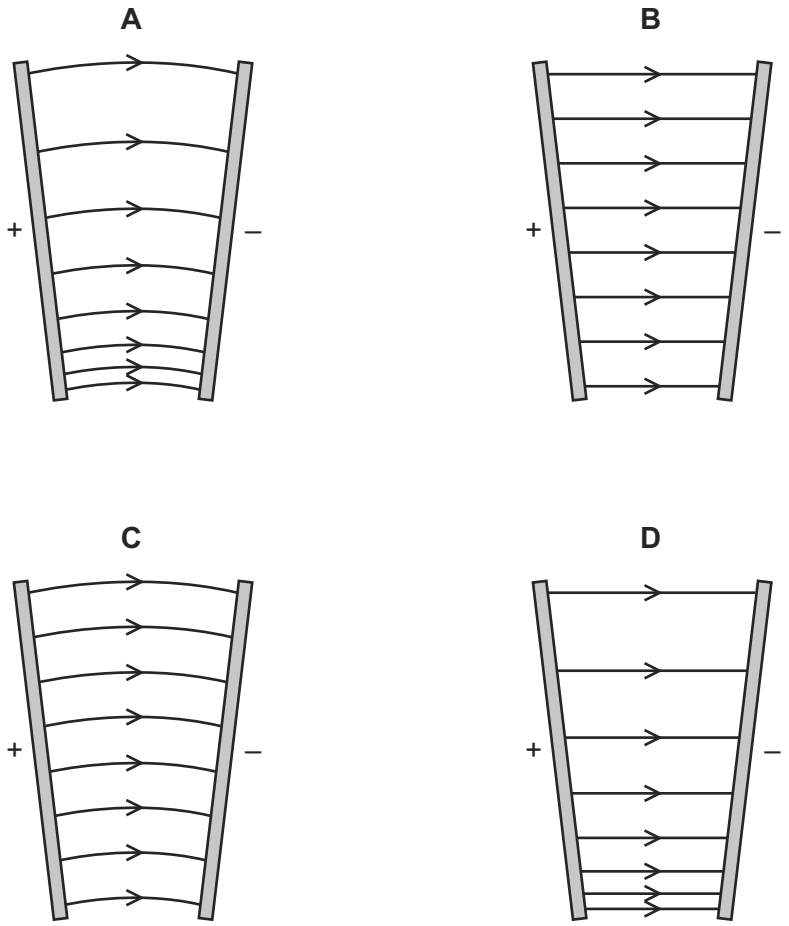
**B** the momentum of the electron

**C** the kinetic energy of the electron

**D** the speed of the electron

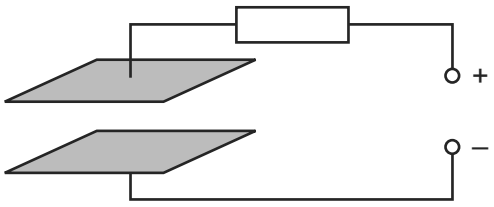
**28** A potential difference is applied between two metal plates that are **not** parallel. 9702/11/M/J/11

Which diagram shows the electric field between the plates?




**30** The diagram shows two parallel metal plates connected to a d.c. power supply through a resistor.

9702/12/M/J/11




There is a uniform electric field in the region between the plates.

Which change would cause a **decrease** in the strength of the electric field?

**A** a small increase in the distance between the plates

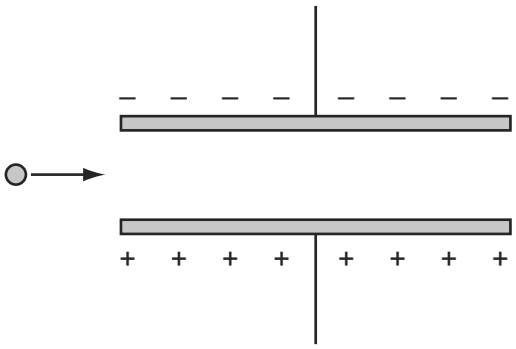
**B** a small increase in the potential difference between the plates

**C** a small increase in the value of the resistor

**D** a small increase to the area of both plates

**29** The diagram shows a charged particle as it approaches a pair of charged parallel plates in a vacuum.

9702/11/M/J/11



Which row describes the horizontal and vertical components of its motion as it travels between the plates?

| | horizontal component | vertical component |
|---|---|---|
| **A** | constant acceleration | constant acceleration |
| **B** | constant acceleration | constant velocity |
| **C** | constant velocity | constant acceleration |
| **D** | constant velocity | constant velocity |

**30** Two parallel plates, a distance 25 mm apart, have a potential difference between them of 12 kV.

9702/11/M/J/11

What is the force on an electron when it is in the uniform electric field between the plates?

**A** $4.8 \times 10^{-20}$ N

**B** $7.7 \times 10^{-20}$ N

**C** $4.8 \times 10^{-17}$ N

**D** $7.7 \times 10^{-14}$ N

**31** A battery is marked 9.0 V.

9702/13/M/J/11

What does this mean?

**A** Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.

**B** The battery supplies 9.0 J to an external circuit for each coulomb of charge.

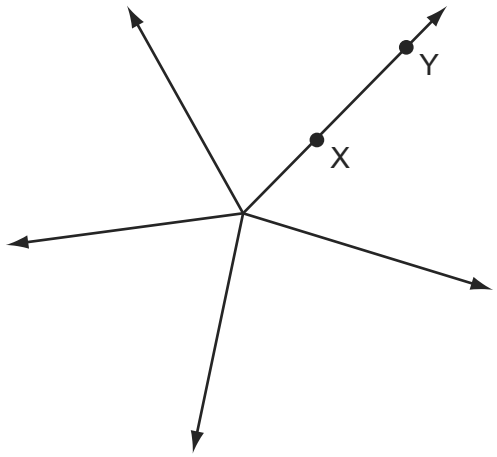
**C** The potential difference across any component connected to the battery will be 9.0 V.

**D** There will always be 9.0 V across the battery terminals.

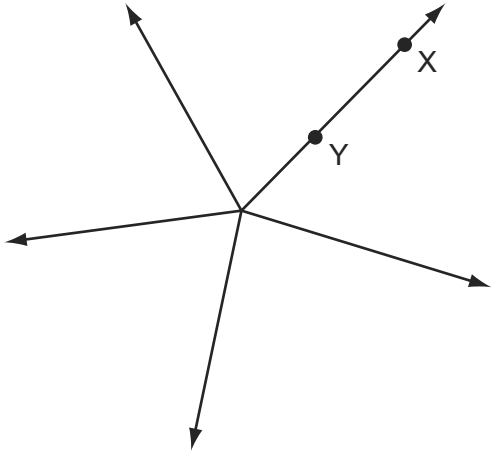
**31** In each electric field diagram, a positively charged particle is moved from X to Y. 9702/12/M/J/11

In which diagram would the particle experience an increasing repulsive force?

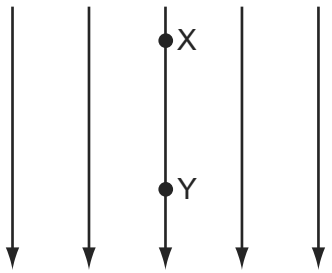
**A**



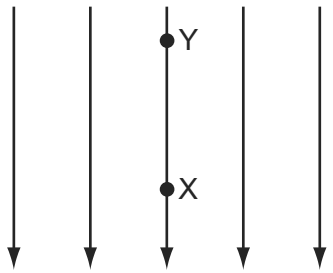

**B**



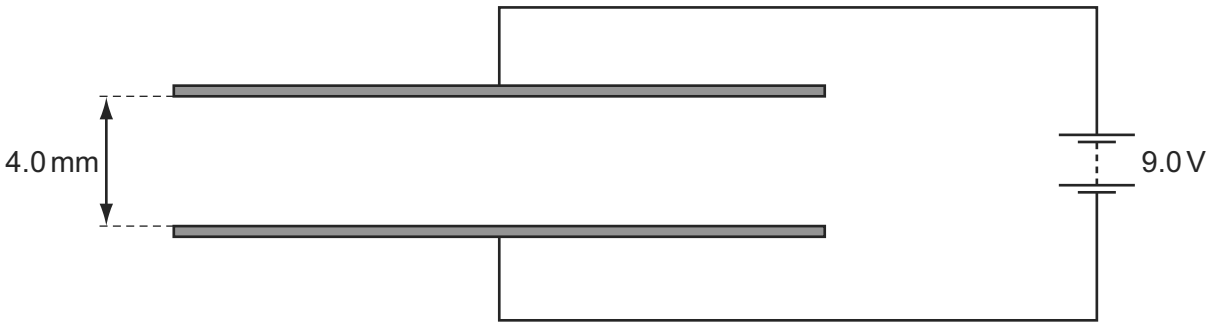

**C**




**D**




**29** The diagram shows a pair of parallel metal plates 4.0 mm apart connected to a 9.0 V battery. 9702/12/O/N/11




What is the electric field strength between the plates?

**A** $4.4 \times 10^{-4}\,\text{N C}^{-1}$

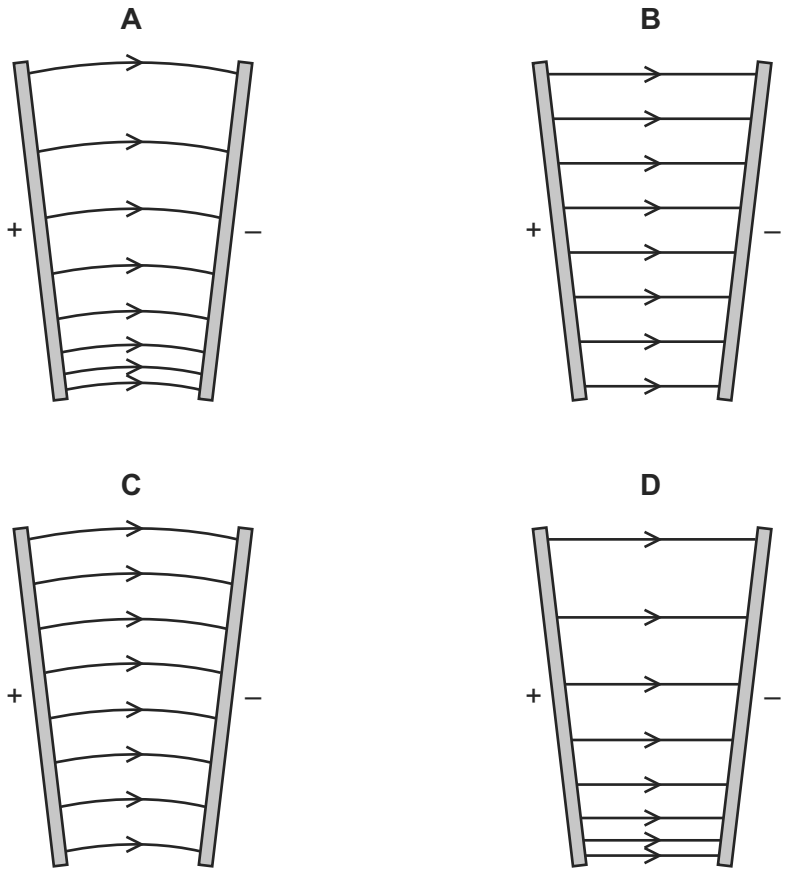
**B** $3.6 \times 10^{-2}\,\text{N C}^{-1}$

**C** $36\,\text{N C}^{-1}$

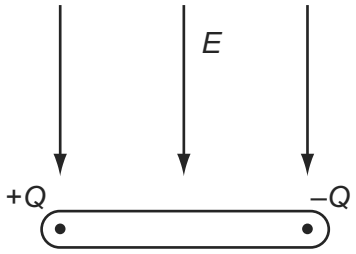
**D** $2.3 \times 10^{3}\,\text{N C}^{-1}$

**29** A potential difference is applied between two metal plates that are **not** parallel. 9702/13/M/J/11

Which diagram shows the electric field between the plates?




**32** The diagram shows an insulating rod with equal and opposite point charges at each end. An electric field of strength *E* acts on the rod in a downwards direction. 9702/11/O/N/11



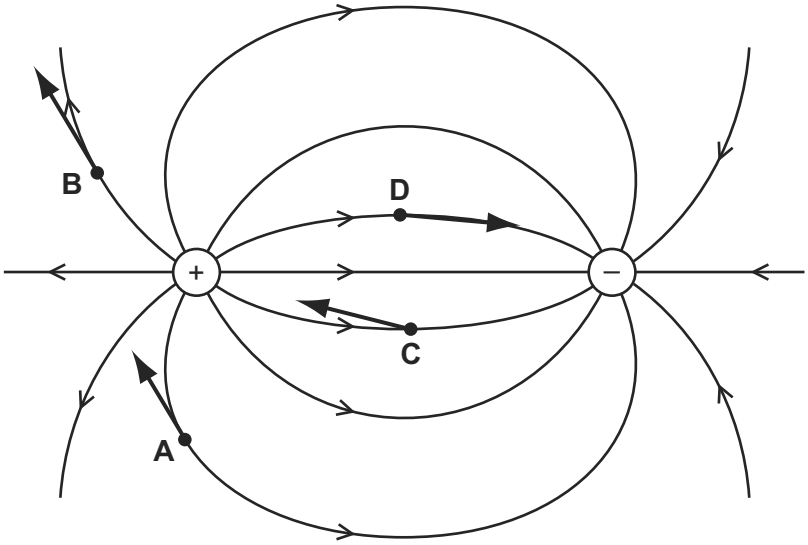

Which row is correct?

| | resultant force | resultant torque |
|---|---|---|
| **A** | zero | clockwise |
| **B** | downwards | clockwise |
| **C** | zero | anti-clockwise |
| **D** | downwards | anti-clockwise |

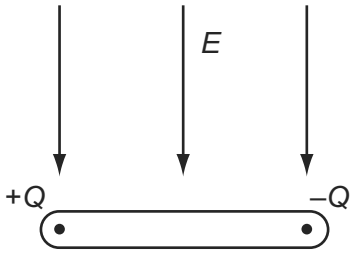
**31** The diagram shows a non-uniform electric field near a positively charged and a negatively charged sphere. 9702/12/O/N/11

Four electrons, **A**, **B**, **C** and **D**, are shown at different positions in the field.

On which electron is the direction of the force on the electron shown correctly?




**31** The diagram shows an insulating rod with equal and opposite point charges at each end. An electric field of strength *E* acts on the rod in a downwards direction. 9702/13/O/N/11

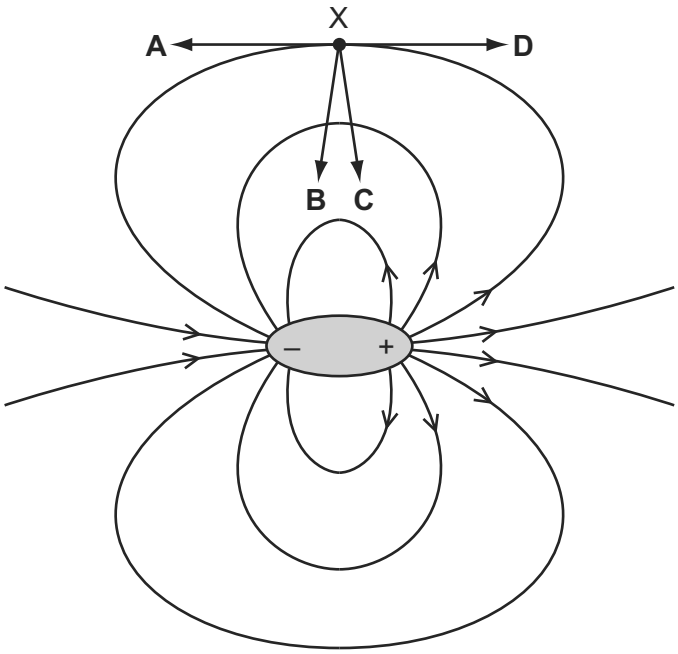



Which row is correct?

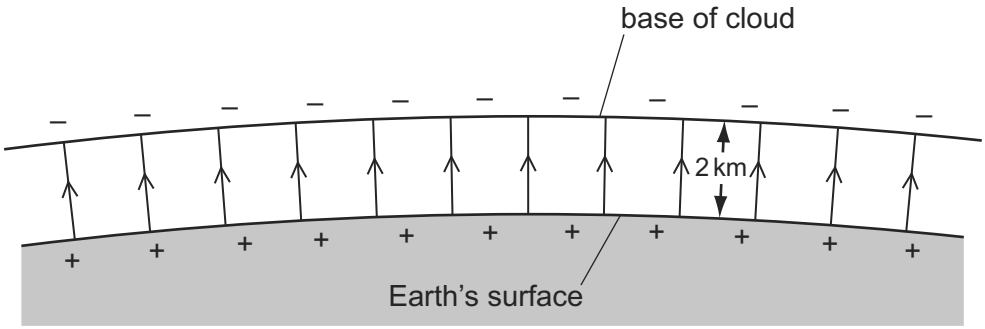
| | resultant force | resultant torque |
|---|---|---|
| **A** | zero | clockwise |
| **B** | downwards | clockwise |
| **C** | zero | anti-clockwise |
| **D** | downwards | anti-clockwise |

**31** A dipole is a pair of one negative charge and one positive charge of equal magnitude. The electric field of a dipole is shown below. 9702/11/M/J/12

In which direction does the force act on an electron when at point X?



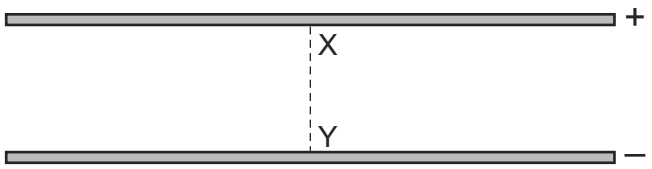

**32** Lightning can occur between a charged cloud and the Earth's surface when the electric field strength in the intervening atmosphere reaches 25 kN C$^{-1}$. The diagram shows the electric field between the base of a cloud and the Earth's surface. 9702/11/M/J/12




What is the minimum potential difference between the Earth and the base of a cloud, 2 km high, for lightning to occur?

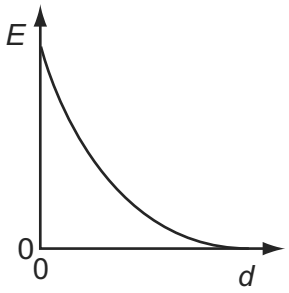
**A** 12.5 MV **B** 25 MV **C** 50 MV **D** 100 MV

**31** An electric field exists in the space between two charged metal plates. 9702/12/M/J/12

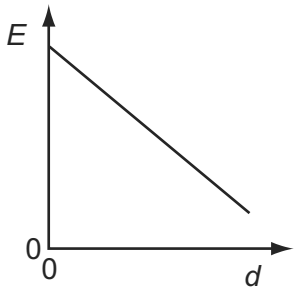



Which graph shows the variation of electric field strength $E$ with distance $d$ from X along the line XY?

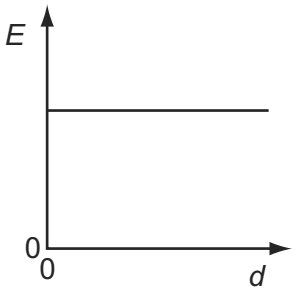
**A**



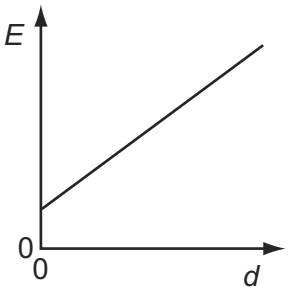

**B**




**C**




**D**




**32** Two horizontal parallel plate conductors are separated by a distance of 5.0 mm in air. The lower plate is earthed and the potential of the upper plate is +50 V. 9702/13/O/N/11

What is the electric field strength $E$ at a point midway between the plates?

**A** $1.0 \times 10^4\,\text{V m}^{-1}$ downwards

**B** $1.0 \times 10^4\,\text{V m}^{-1}$ upwards

**C** $2.0 \times 10^4\,\text{V m}^{-1}$ downwards

**D** $2.0 \times 10^4\,\text{V m}^{-1}$ upwards

**31** Two horizontal parallel plate conductors are separated by a distance of 5.0 mm in air. The lower plate is earthed and the potential of the upper plate is +50 V. 9702/11/O/N/11

What is the electric field strength $E$ at a point midway between the plates?

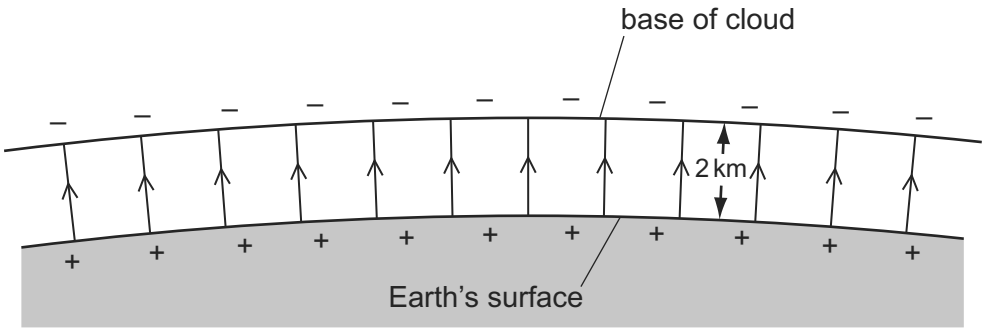
**A** $1.0 \times 10^4\,\text{V m}^{-1}$ downwards

**B** $1.0 \times 10^4\,\text{V m}^{-1}$ upwards

**C** $2.0 \times 10^4\,\text{V m}^{-1}$ downwards

**D** $2.0 \times 10^4\,\text{V m}^{-1}$ upwards

**33** Lightning can occur between a charged cloud and the Earth's surface when the electric field strength in the intervening atmosphere reaches 25 kN C$^{-1}$. The diagram shows the electric field between the base of a cloud and the Earth's surface. 9702/13/M/J/12

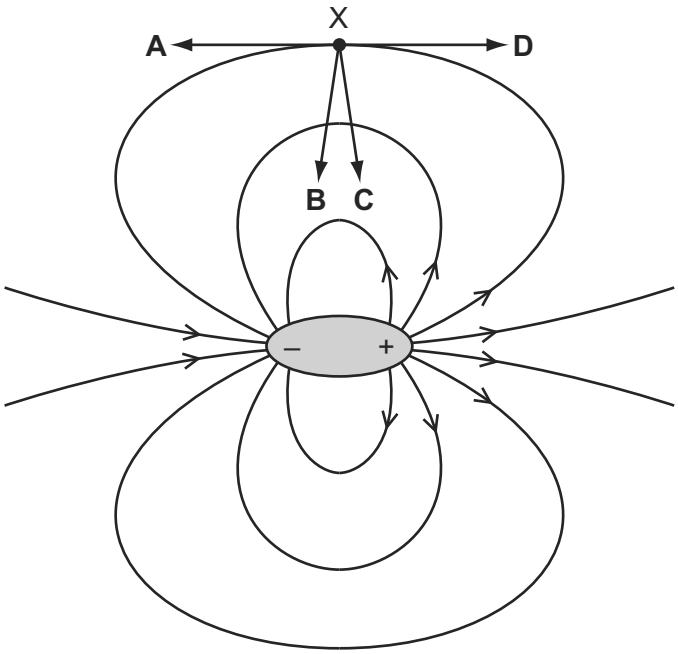



What is the minimum potential difference between the Earth and the base of a cloud, 2 km high, for lightning to occur?

**A** 12.5 MV **B** 25 MV **C** 50 MV **D** 100 MV

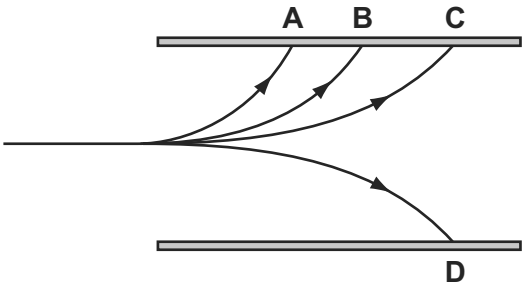
**31** A dipole is a pair of one negative charge and one positive charge of equal magnitude. The electric field of a dipole is shown below. 9702/13/M/J/12

In which direction does the force act on an electron when at point X?



**33** A single proton travelling with a constant horizontal velocity enters a uniform electric field between two parallel charged plates. In the diagram, **B** shows the path taken by the proton.

Which path is taken by a helium nucleus that enters the electric field at the same point and with the same velocity as the proton? 9702/12/O/N/12




**32** A charged particle moves in a uniform electric field between two parallel metal plates.

To calculate the force acting on the particle due to the electric field, which quantity is **not** required?

**A** particle charge 9702/12/O/N/12

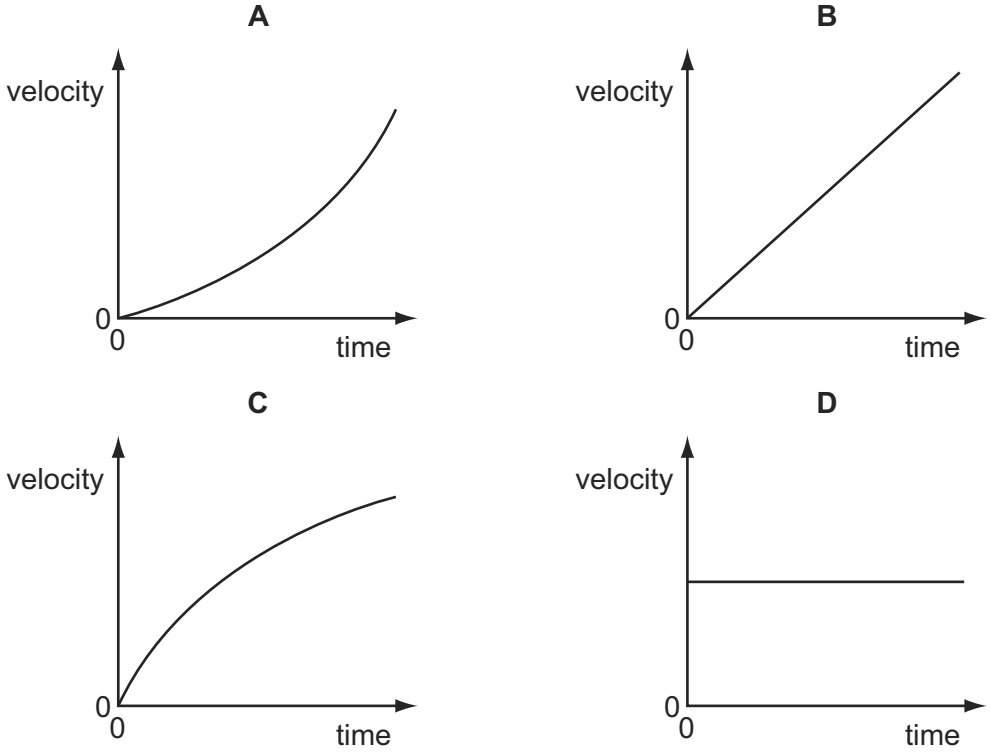
**B** particle speed

**C** plate separation

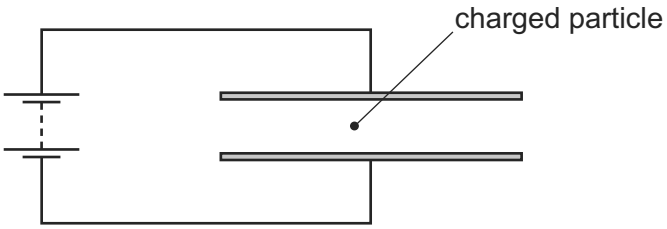
**D** potential difference between the plates

**30** An electron is initially at rest in a uniform electric field. 9702/11/O/N/12

Which graph shows the variation with time of the velocity of the electron?



**31** A charged particle is in the electric field between two horizontal metal plates connected to a source of constant potential difference, as shown. 9702/11/O/N/12




There is a force $F$ on the particle due to the electric field.

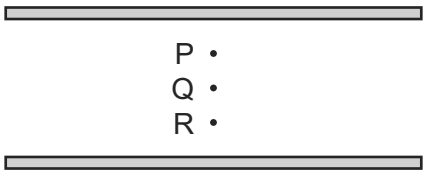
The separation of the plates is doubled.

What will be the new force on the particle?

**A** $\frac{F}{4}$ **B** $\frac{F}{2}$ **C** $F$ **D** $2F$

**30** The diagram shows two parallel plates. 9702/13/O/N/12

The plates are charged so that there is an electric field between them. P, Q and R are points which are $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of the distance from the top plate to the bottom plate.




What is the electric field strength at point P?

**A** the same as that at point Q

**B** twice that at point R

**C** half that at point R

**D** one third that at point Q

**31** A positive charge of $2.6 \times 10^{-8}$ C is in an electric field of constant field strength 300 000 V m$^{-1}$.

How much work must be done on the charge in order to move it a distance of 4.0 mm in the opposite direction to the direction of the field? 9702/13/O/N/12

**A** $3.1 \times 10^{-5}$ J

**B** $2.0 \times 10^{-3}$ J

**C** $3.1 \times 10^{-2}$ J

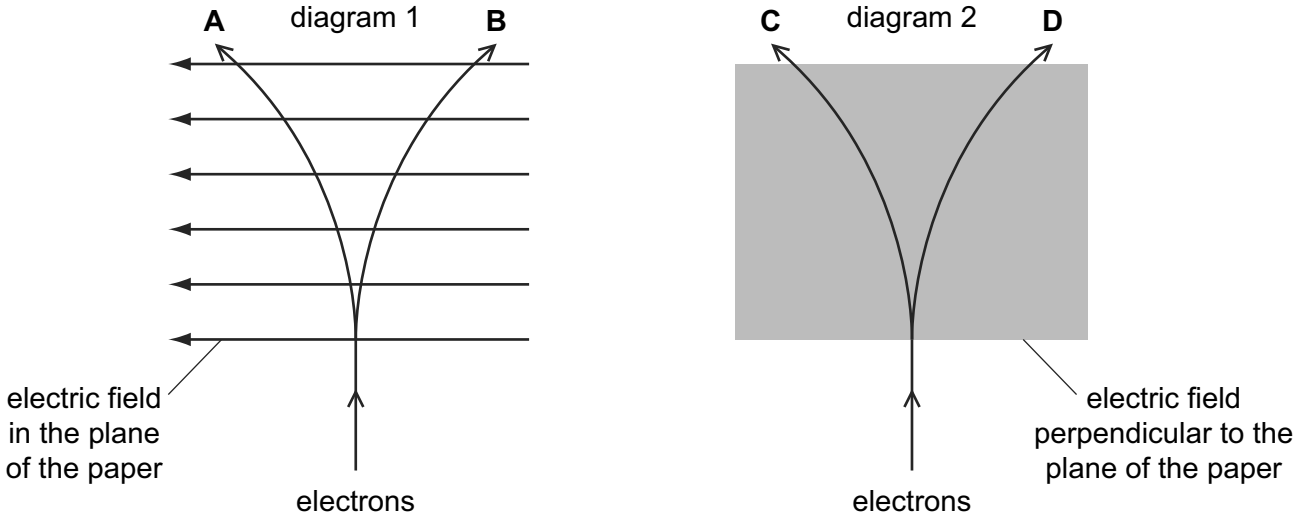
**D** 2.0 J

**30** A beam of electrons is directed into an electric field and is deflected by it. 9702/11/M/J/13

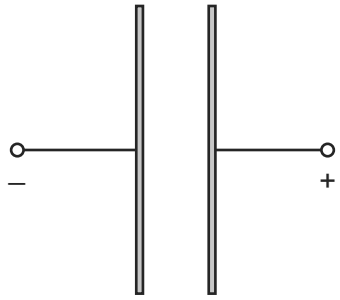
Diagram 1 represents an electric field in the plane of the paper.
Diagram 2 represents an electric field directed perpendicular to the plane of the paper.

The lines **A**, **B**, **C** and **D** represent possible paths of the electron beam. All paths are in the plane of the paper.

Which line best represents the path of the electrons inside the field?



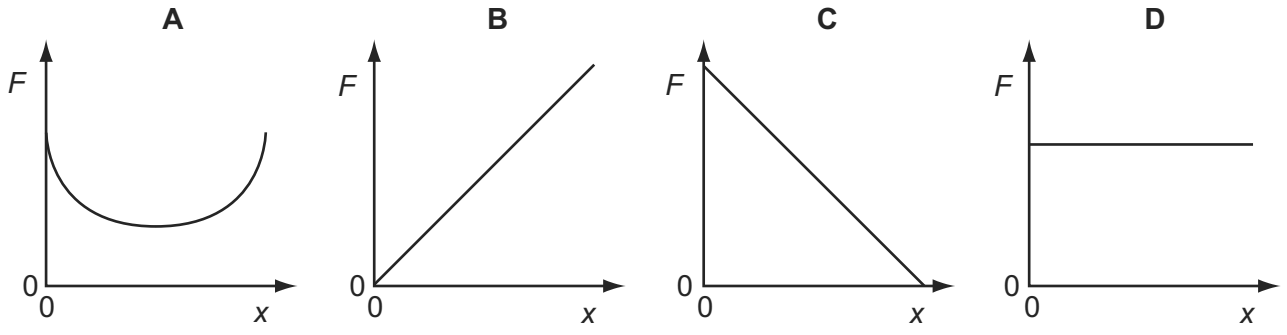

**31** Two oppositely-charged parallel plates are arranged as shown. 9702/11/M/J/13




An electron is released from rest from the surface of the negatively-charged plate.

The electron travels from the negatively-charged plate towards the positively-charged plate.

Which graph shows how the force *F* on the electron varies with its distance *x* from the negative plate?



**30** Two conducting layers of a liquid crystal display of a calculator are 8 μm apart. A 1.5 V cell is connected across the conducting layers when the calculator is switched on. 9702/12/M/J/13

What is the electric field strength between the layers?

**A** $1.2 \times 10^{-5}\,\text{V m}^{-1}$

**B** $0.19\,\text{V m}^{-1}$

**C** $12\,\text{V m}^{-1}$

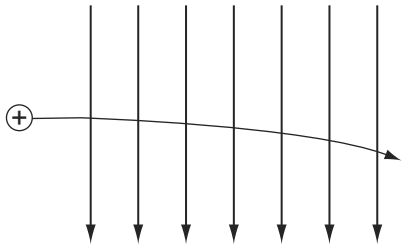
**D** $1.9 \times 10^{5}\,\text{V m}^{-1}$

**31** A positively-charged particle is projected into a uniform electric field. 9702/12/M/J/13

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

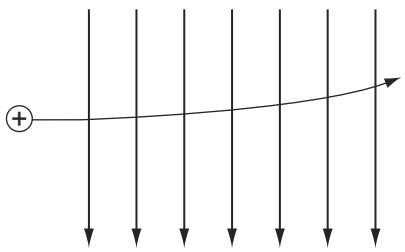
**A**

electric field in plane of the paper



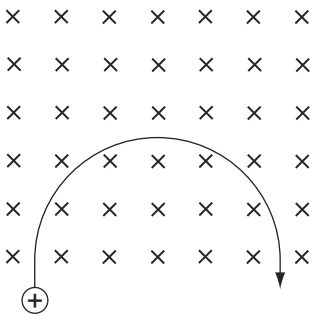
**B**

electric field in plane of the paper



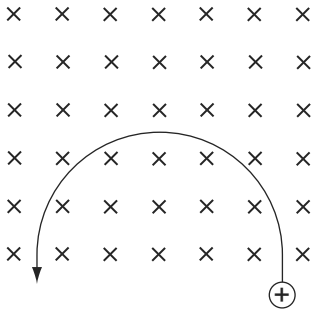
**C**

electric field into paper



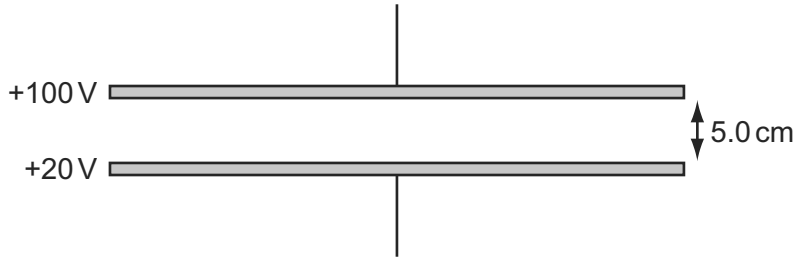
**D**

electric field into paper



**29** Two metal plates are held horizontal and parallel, 5.0 cm apart. The plates are at potentials of +100 V and +20 V.

9702/13/M/J/13




What is the force experienced by an electron in the electric field between the plates?

**A** $2.6 \times 10^{-18}$ N

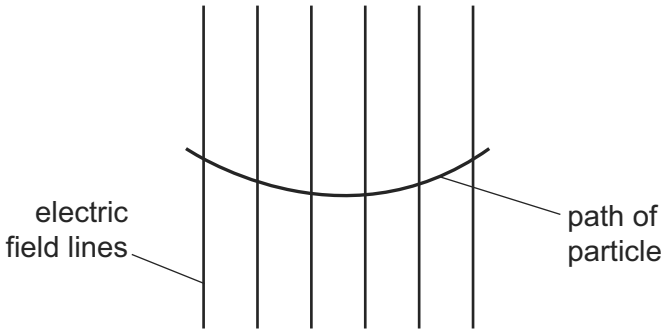
**B** $3.8 \times 10^{-18}$ N

**C** $2.6 \times 10^{-16}$ N

**D** $3.8 \times 10^{-16}$ N

**30** The diagram shows the path of a charged particle through a uniform electric field, having vertical field lines.

9702/13/M/J/13




What could give a path of this shape?

**A** a positive charge travelling left to right in a field directed downwards

**B** a positive charge travelling right to left in a field directed downwards

**C** a negative charge travelling right to left in a field directed upwards

**D** a negative charge travelling left to right in a field directed downwards

**31** A small charge $q$ is placed in the electric field of a large charge $Q$.

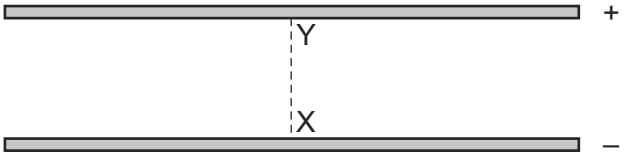
9702/13/O/N/13

Both charges experience a force $F$.

What is the electric field strength of the charge $Q$ at the position of the charge $q$?

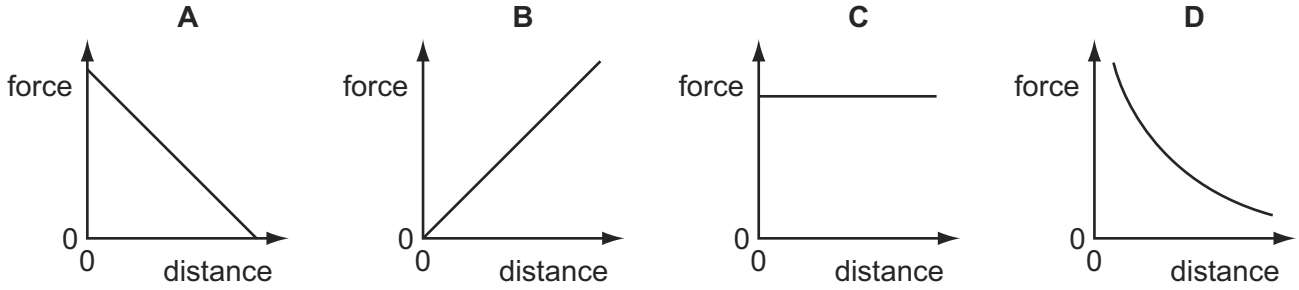
**A** $\frac{F}{Qq}$ **B** $\frac{F}{Q}$ **C** $FqQ$ **D** $\frac{F}{q}$

**30** Two charged parallel metal plates produce an electric field. 9702/13/O/N/13

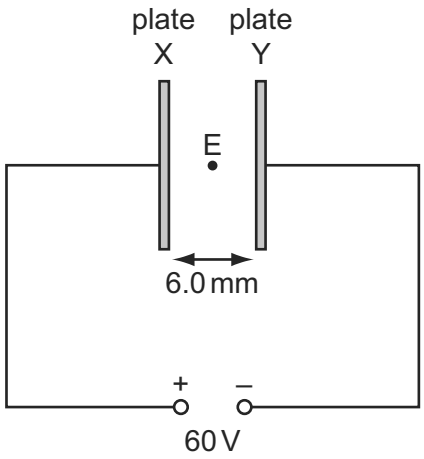



A charged particle moves from X to Y.

Which graph shows the variation of the force on the particle with distance from X along the line XY?




**31** Two vertical conducting plates X and Y are positioned so that they are separated by a distance of 6.0 mm in air. A 60 V d.c. supply is connected as shown. 9702/11/O/N/13




What is the electric field strength at E, a point midway between the plates?

**A** $1.0 \times 10^4\,\text{V m}^{-1}$ towards X

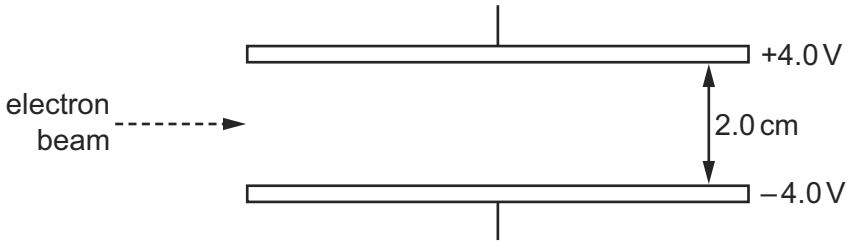
**B** $1.0 \times 10^4\,\text{V m}^{-1}$ towards Y

**C** $2.0 \times 10^4\,\text{V m}^{-1}$ towards X

**D** $2.0 \times 10^4\,\text{V m}^{-1}$ towards Y

**28** A horizontal beam of electrons is passed between two horizontal parallel plates, 2.0 cm apart, as shown.

9702/11/M/J/14




The upper plate has an electrical potential of +4.0 V, and the lower plate has an electrical potential of –4.0 V.

What is the force on each electron when between the plates?

**A** $3.2 \times 10^{-17}$ N downwards

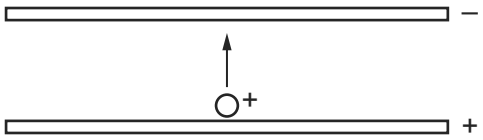
**B** $3.2 \times 10^{-19}$ N upwards

**C** $6.4 \times 10^{-19}$ N downwards

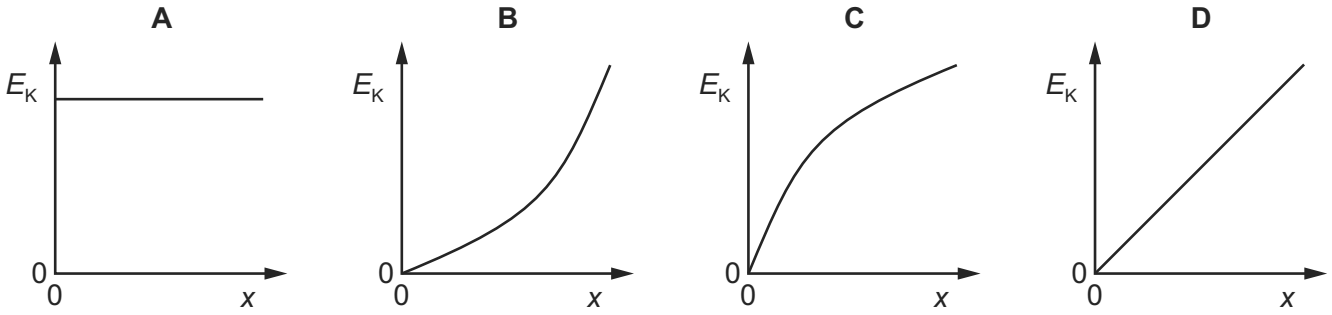
**D** $6.4 \times 10^{-17}$ N upwards

**29** Two oppositely-charged horizontal metal plates are placed in a vacuum. A positively-charged particle starts from rest and moves from one plate to the other plate, as shown.

9702/12/M/J/14

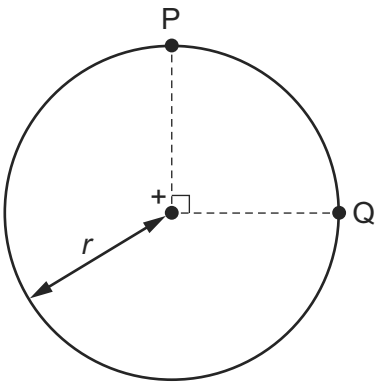



Which graph shows how the kinetic energy $E_K$ of the particle varies with the distance $x$ moved from the positive plate?



**29** The diagram shows two points P and Q which lie 90° apart on a circle of radius *r*. 9702/11/M/J/14

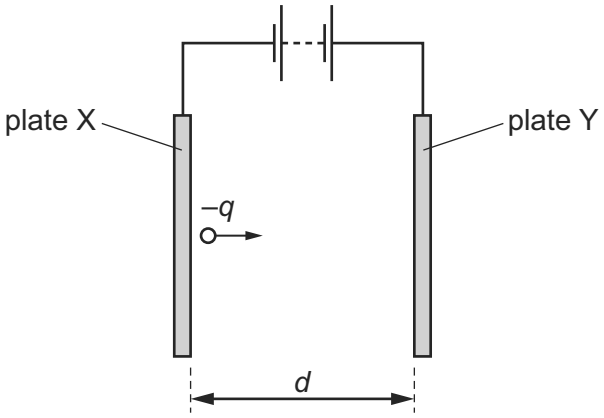
A positive point charge at the centre of the circle creates an electric field of magnitude *E* at both P and Q.




Which expression gives the work done in moving a unit positive charge from P to Q?

**A** 0 **B** $E \times r$ **C** $E \times \left(\frac{\pi r}{2}\right)$ **D** $E \times (\pi r)$

**32** Two parallel plates X and Y are separated by a distance *d* in a vacuum. There is a potential difference between the plates so that a uniform electric field is produced. 9702/13/M/J/14




A charge –*q* moves from rest from the surface of plate X and travels towards plate Y.

When the charge reaches plate Y it has kinetic energy *K*.

Which expression gives the electric field strength between the plates?

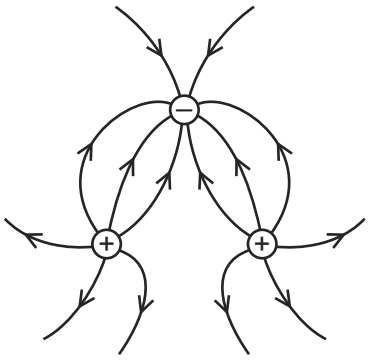
**A** $\frac{q}{Kd}$ **B** $\frac{qd}{K}$ **C** $\frac{K}{qd}$ **D** $\frac{Kd}{q}$

**28** Two positive charges and one negative charge, all of equal magnitude, are set at the corners of an equilateral triangle.

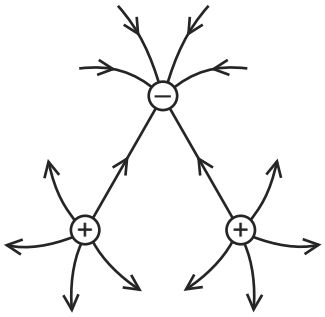
9702/12/M/J/14

Which diagram best represents the electric field surrounding the charges?

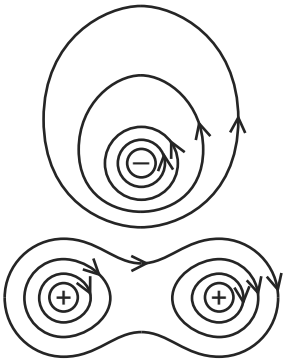
**A**



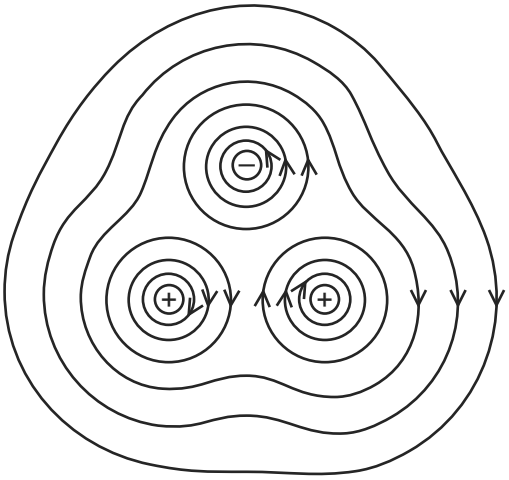
**B**



**C**



**D**



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

9702/11/O/N/13

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 |

**32** Two parallel metal plates have a potential difference between them of 12 V. The distance between the plates is 1.0 mm.

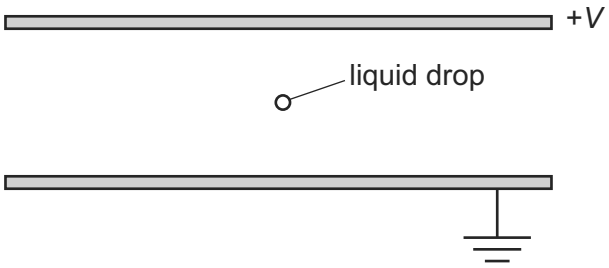
9702/11/O/N/13

What are the electric field strength between the plates and the work done on a charge of +3.9 μC to move the charge from the negative plate to the positive plate?

| | electric field strength / N C$^{-1}$ | work done / J |
|---|---|---|
| **A** | 12 | $4.7 \times 10^{-5}$ |
| **B** | 12 | 47 |
| **C** | 12 000 | $4.7 \times 10^{-5}$ |
| **D** | 12 000 | 47 |

**28** The diagram shows two parallel horizontal metal plates. There is a potential difference *V* between the plates.

9702/11/O/N/14



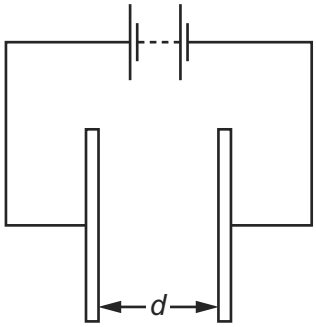

A small charged liquid drop, midway between the plates, is held in equilibrium by the combination of its weight and the electric force acting on it.

The acceleration of free fall is *g* and the electric field strength is *E*.

What is the polarity of the charge on the drop, and the ratio of charge to mass of the drop?

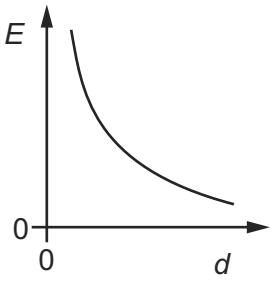
| | polarity | $\frac{\text{charge}}{\text{mass}}$ |
|---|---|---|
| **A** | negative | $\frac{E}{g}$ |
| **B** | negative | $\frac{g}{E}$ |
| **C** | positive | $\frac{E}{g}$ |
| **D** | positive | $\frac{g}{E}$ |

**29** The diagram shows two metal plates connected to a constant high voltage. 9702/11/O/N/14

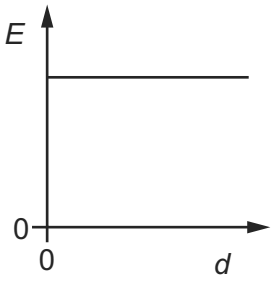



Which graph shows the variation of the electric field strength *E* midway between the two plates as the distance *d* between the two plates is increased?

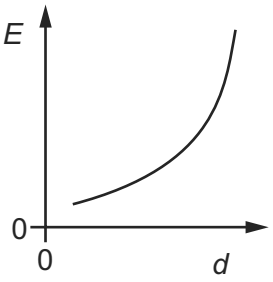
**A**



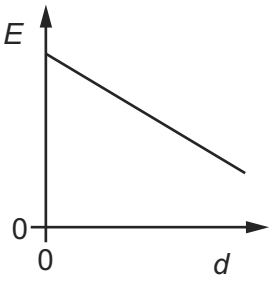

**B**



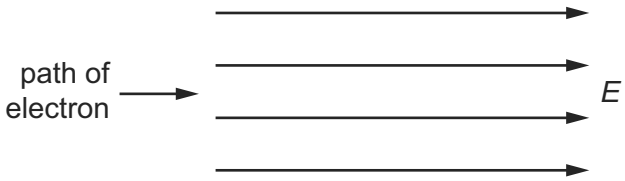

**C**




**D**




**31** An electron enters a region of space where there is a uniform electric field *E* as shown. 9702/13/M/J/14



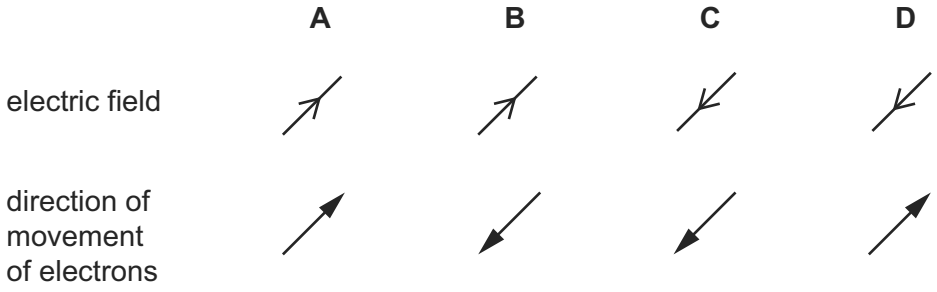

Initially, the electron is moving parallel to, and in the direction of, the electric field.

What is the subsequent path and change of speed of the electron?

| | path of electron | speed of electron |
|---|---|---|
| **A** | linear | decreases |
| **B** | linear | increases |
| **C** | parabolic | decreases |
| **D** | parabolic | increases |

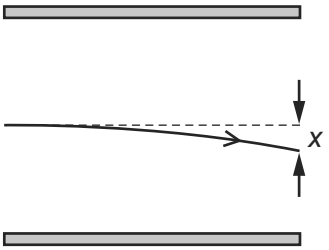
**31** Regions of unbalanced charge are produced inside a cloud as shown. 9702/13/O/N/14


For the region X, which diagram correctly represents the direction of the electric field and the initial direction in which electrons would move?




**32** The path of an electron with initial speed $v$ in the uniform electric field between two parallel plates is shown.

9702/13/O/N/14




The vertical deflection $x$ is measured at the right-hand edge of the plates.

The distance between the plates is halved. The potential difference between the plates remains the same.

What will be the new deflection of the electron with the same initial speed $v$?

**A** $x$ **B** $\sqrt{2}x$ **C** $2x$ **D** $4x$

**31** Which unit is **not** used in either the definition of the coulomb or the definition of the volt?

9702/12/M/J/15

**A** ampere

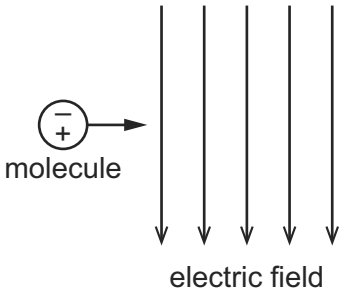
**B** joule

**C** ohm

**D** second

**30** A molecule behaves as an electric dipole consisting of two equal point charges, of opposite sign, separated by a fixed distance. The molecule moves with constant horizontal velocity as it enters a vertical uniform electric field, as shown.

9702/13/M/J/15




The positive and negative charges of the molecule enter the field at the same time.

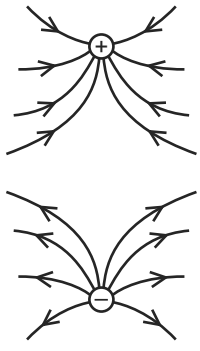
Which row describes the velocity of the molecule in the field?

| | horizontal component of velocity | vertical component of velocity |
|---|---|---|
| **A** | constant | increases |
| **B** | constant | zero |
| **C** | increases | increases |
| **D** | increases | zero |

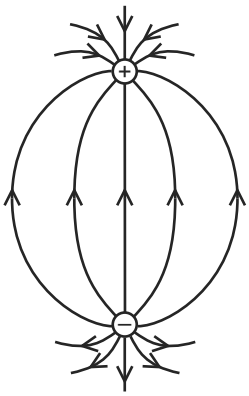
**31** Which diagram best represents the electric field between two point charges of equal magnitude and opposite sign?

9702/13/M/J/15

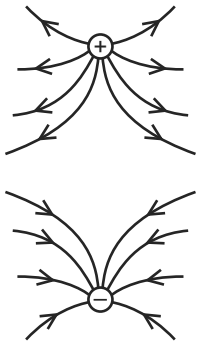
**A**



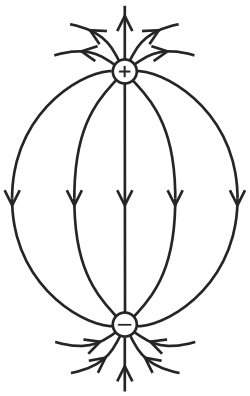
**B**



**C**



**D**



**31** Two parallel metal plates, a distance of 2 mm apart, have a potential difference of 1000 V across them.

9702/11/M/J/15

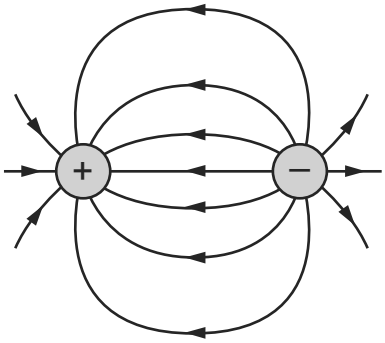
What is the electric field strength between the plates?

**A** $500\,V\,m^{-1}$ **B** $50\,000\,V\,m^{-1}$ **C** $50\,000\,N\,C^{-1}$ **D** $500\,000\,N\,C^{-1}$

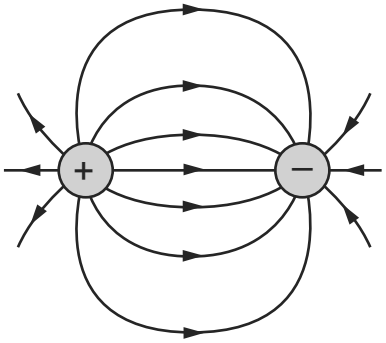
**29** A positive charge and a negative charge of equal magnitude are placed a short distance apart.

Which diagram best represents the associated electric field? 9702/12/M/J/15

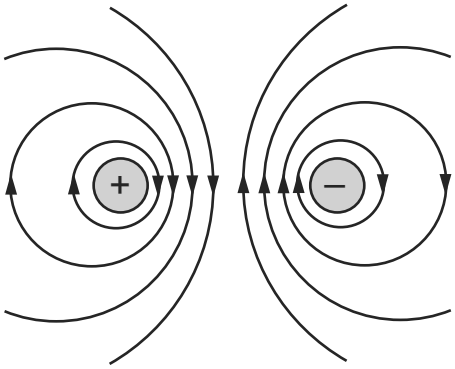
**A**



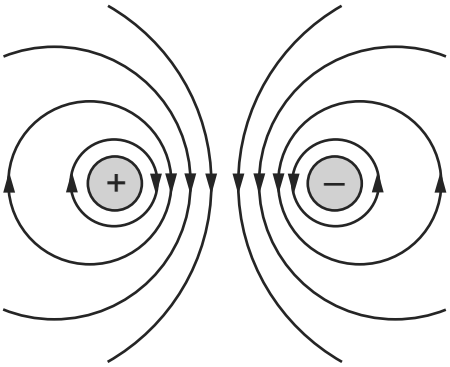

**B**



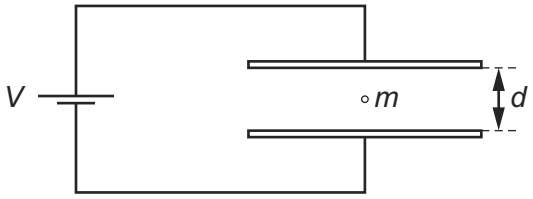

**C**




**D**




**30** A charged oil drop of mass *m*, with *n* excess electrons, is held stationary in the uniform electric field between two horizontal plates separated by a distance *d*. 9702/12/M/J/15




The voltage between the plates is *V*, the elementary charge is *e* and the acceleration of free fall is *g*.

What is the value of *n*?

**A** $\frac{eV}{mgd}$ **B** $\frac{mgd}{eV}$ **C** $\frac{meV}{gd}$ **D** $\frac{gd}{meV}$