1. Two parallel metal plates of separation a carry equal and opposite charges.

$E = \frac{V}{d}$ $\quad d = a$

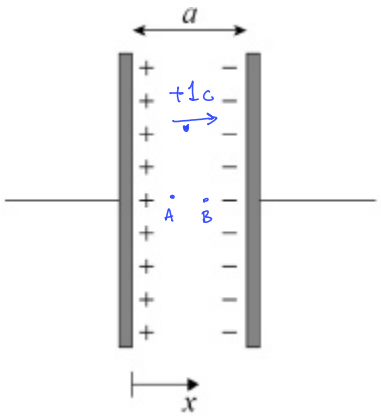
Uniform field
↳ strength same everywhere

$E_A = E_B$

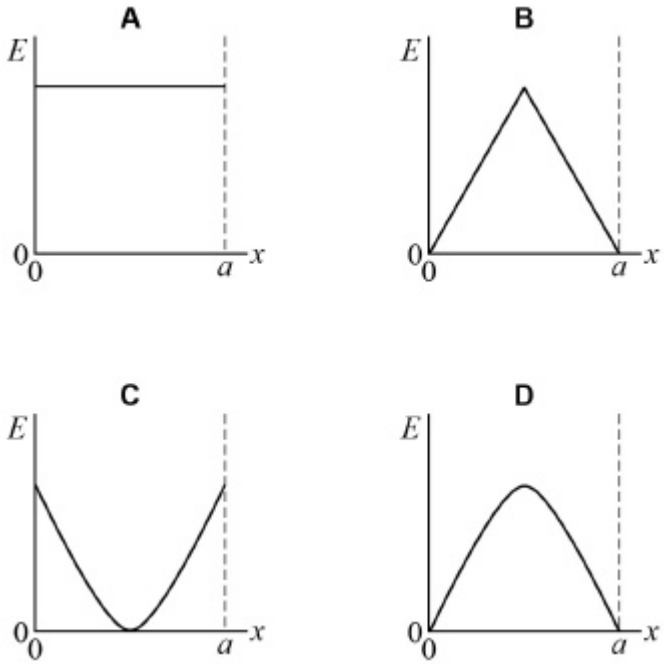
$V_A > V_B$

Radial

$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$



Which graph best represents how the electric field strength E varies with the distance x in the space between the two plates?



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

2. A particle of mass m and charge q is accelerated through a potential difference V over a distance d.

What is the average acceleration of the particle?

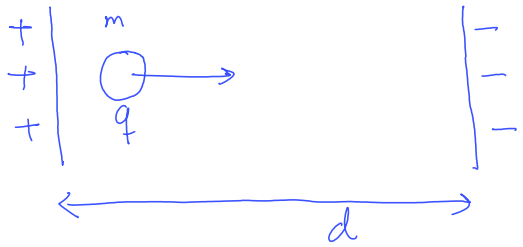
A $\frac{qV}{md}$ ⬭

B $\frac{mV}{qd}$ ⬭

C $\frac{V}{mqd}$ ⬭

D $\frac{dV}{mq}$ ⬭

PD = V



$F = ma$

$F = EQ \rightarrow F = \frac{Vq}{d}$

$E = \frac{V}{d}$

$\frac{Vq}{d} \div \frac{m}{1} = \frac{Vq}{d} \times \frac{1}{m}$

$a = \frac{F}{m} = \frac{Vq}{md} \rightarrow A$

(Total 1 mark)

3. An electron on the surface of the Earth is placed in an electric field of strength 5000 N C^{-1}.

What is $\left(\frac{\text{electric force}}{\text{gravitational force}}\right)$ for the electron?

$E = 5000\ N/C$ $e = 1.6 \times 10^{-19}\ C$

A 1.1×10^{-14} ⬭

B 2.9×10^{-10} ⬭

C 3.4×10^{9} ⬭

D 9.0×10^{13} ⬭

$F = EQ = 5000 \times 1.6 \times 10^{-19}$

$F = gm = 9.81 \times 9.11 \times 10^{-31}$

ratio $= 8.95 \times 10^{13} \rightarrow D$

(Total 1 mark)

4. An α particle makes a head−on collision with a gold nucleus containing 79 protons. The distance of closest approach of the α particle to the nucleus is 4.0×10^{-14} m.

What electrostatic force acts on the gold nucleus when at this separation?

A 9.1×10^{-11} N ⬭

B 23 N ⬭

C 290 N ⬭

D 1.4×10^{20} N ⬭

$\alpha = 2p + 2n$

$Au = 79\ p$

$F = \frac{1}{4\pi\varepsilon_0} \frac{Q_1 Q_2}{r^2} = \frac{1}{4\pi\varepsilon_0} \frac{2 \times 79 \times (1.6 \times 10^{-19})^2}{(4 \times 10^{-14})^2}$

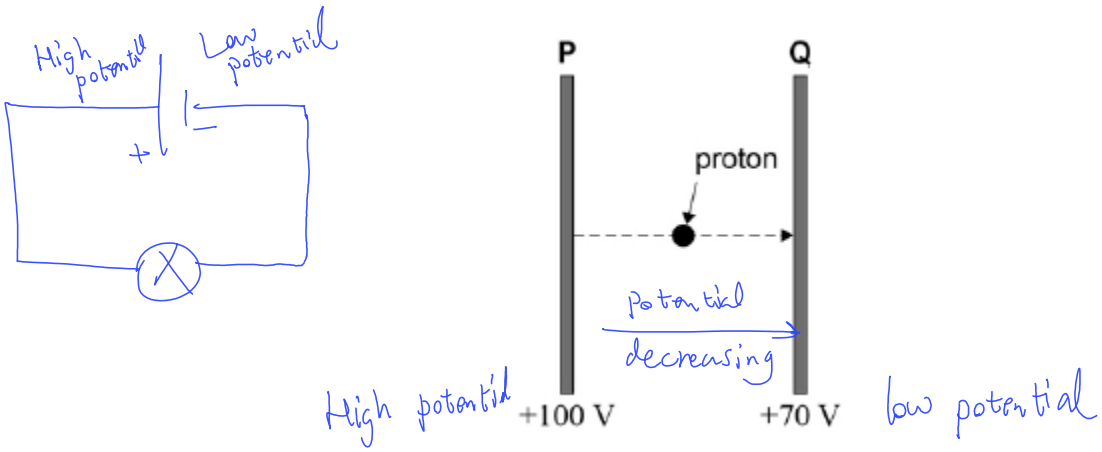
8.85×10^{-12}

Permitivity of free space

$\rightarrow F = 23\ N \rightarrow B$

(Total 1 mark)

5. Two fixed parallel metal plates **P** and **Q** are at constant electrical potentials of +100 V and +70 V respectively. A proton travelling from **P** to **Q** experiences a force F due to the electric field between **P** and **Q**, and a change of potential energy of ΔE_p.



Which line, **A** to **B**, in the table gives the direction of F and the value of ΔE_p?

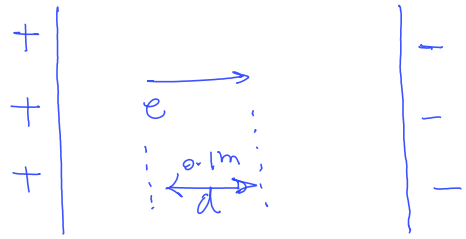
	Direction of F	**ΔE_p**	
A	towards **P**	+30 eV	⬭
B	towards **Q** ✓	+30 eV	⬭
C	towards **Q** ✓	−30 eV ✓	⬭
D	towards **P**	−30 eV	⬭

(Total 1 mark)

6. An electron moves through a distance of 0.10 m parallel to the field lines of a uniform electric field of strength 2.0 kN C^{-1}.

What is the work done on the electron?

E = 2 kN/C



A zero ⬭

B 1.6×10^{-17} J ⬭

C 3.2×10^{-17} J ⬭

D 1.6×10^{-21} J ⬭

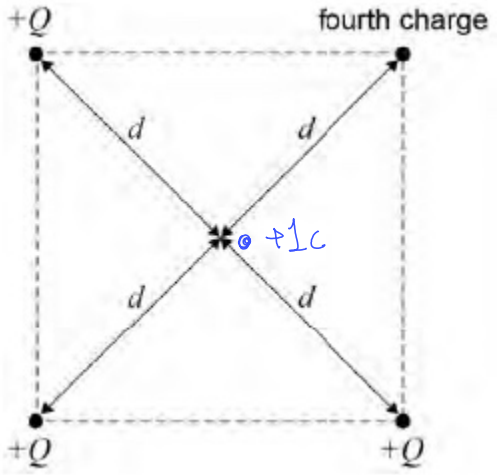
$V = \frac{W}{Q} \rightarrow W = VQ$

$E = \frac{V}{d} \rightarrow V = Ed = 2000 \times 0.1 = 200$ volts

$W = 200 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-17}$ J

(Total 1 mark)

7. Four positive charges are fixed at the corners of a square as shown.



The total potential at the centre of the square, a distance d from each charge, is $\frac{5Q}{4\pi\varepsilon_o d}$

Three of the charges have a charge of +Q

What is the magnitude of the fourth charge?

A $-\frac{7Q}{4}$ ⬭

B Q ⬭

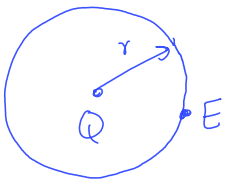
C $\sqrt{2}Q$ ⬭

D $2Q$ ⬭

(Total 1 mark)

8. A charged spherical conductor has a radius r. An electric field of strength E exists at the surface due to the charge.

What is the potential of the spherical conductor?



A $r^2 E$ ⬭

B $r E^2$ ⬭

C $\frac{E}{r}$ ⬭

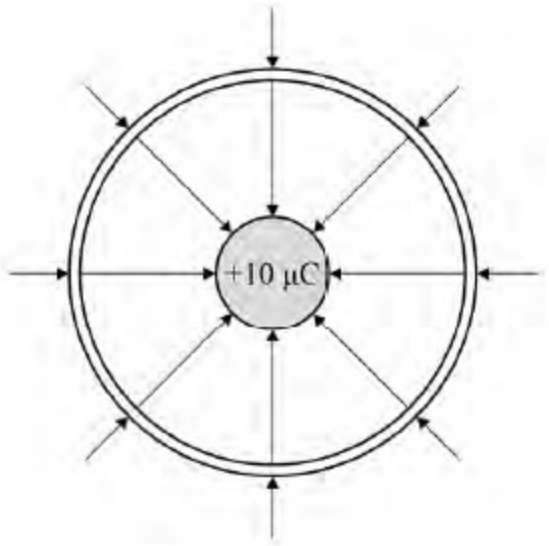
D $r E$ ⬭

(Total 1 mark)

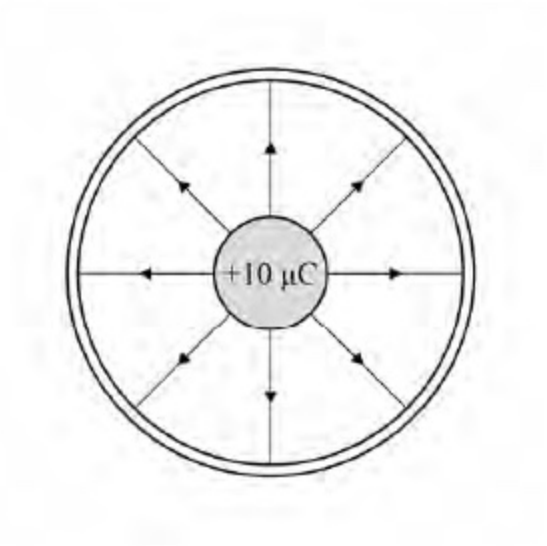
9. A conducting sphere holding a charge of +10 μC is placed centrally inside a second uncharged conducting sphere.

Which diagram shows the electric field lines for the system?

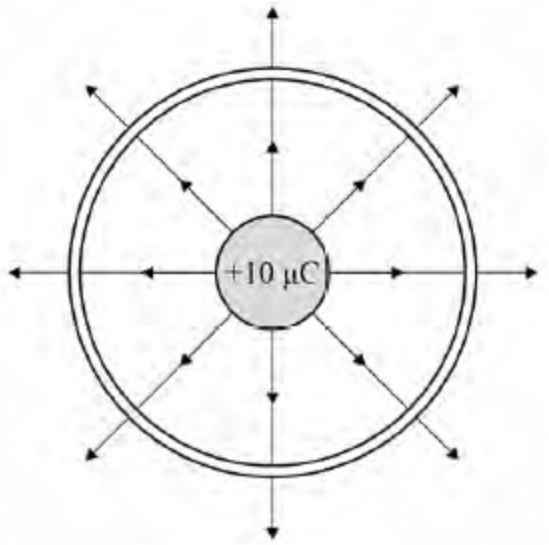
A



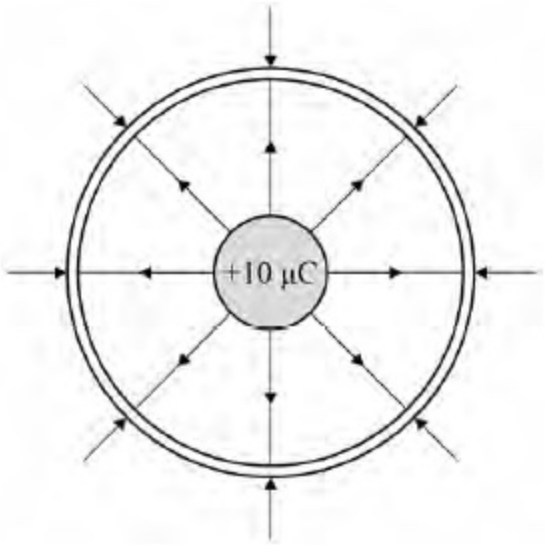
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

10. The ionisation potential for the atoms of a gas is V. Electrons of mass m and charge e travelling at a speed v can just cause ionisation of atoms in the gas.

What is V? → speed v

$E_k = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2E_k}{m}}$

A $\frac{eV}{2m}$ ⬭

$V = \frac{E}{Q} \rightarrow E = VQ = Ve$

B $\frac{2eV}{m}$ ⬭

$v = \sqrt{\frac{2Ve}{m}}$ ✓

C $\sqrt{\frac{eV}{2m}}$ ⬭

D $\sqrt{\frac{2eV}{m}}$ ⬭

(Total 1 mark)

11. An electric field acts into the plane of the paper. An electron enters the field at 90° to the field lines.

The force on the electron is

A zero. ⬭

B along the direction of the field. ⬭

C at 90° to the field. ⬭

D opposite to the direction of the field. ⬭

(Total 1 mark)

12. A positive charge of 2.0×10^{-4} C is placed in an electric field at a point where the potential is +500 V.

What is the potential energy of the system?

A 1.0×10^{-1} J ⬭

B 1.0×10^{-1} J C^{-1} ⬭

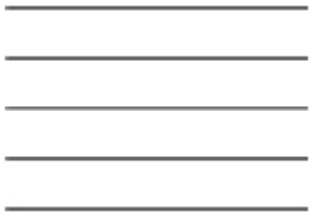
C 4.0×10^{-7} J ⬭

D 4.0×10^{-7} J C^{-1} ⬭

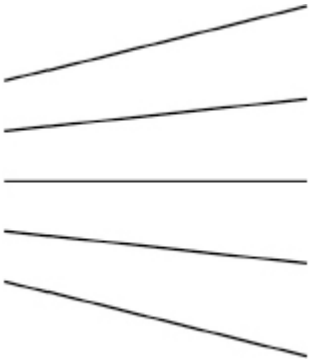
(Total 1 mark)

13. Which diagram shows lines of equipotential in steps of equal potential difference near an isolated point charge?

A



B



C

D

A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

14. Two fixed charges of magnitude $+Q$ and $+3Q$ repel each other with a force F. An additional charge of $-2Q$ is given to each charge.

What are the magnitude and the direction of the force between the charges?

	Magnitude of force	Direction of force	
A	$\frac{F}{3}$	repulsive	○
B	$5F$	attractive	○
C	$5F$	repulsive	○
D	$\frac{F}{3}$	attractive	○

(Total 1 mark)

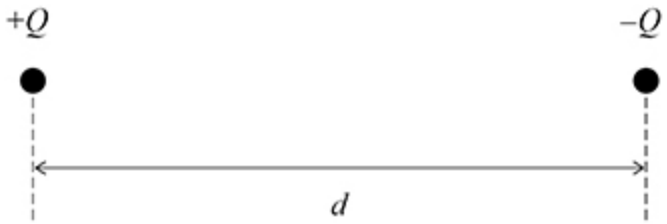
15. At a distance L from a fixed point charge, the electric field strength is E and the electric potential is V.

What are the electric field strength and the electric potential at a distance $3L$ from the charge?

	Electric field strength	Electric potential	
A	$\frac{E}{3}$	$\frac{V}{9}$	○
B	$\frac{E}{3}$	$\frac{V}{3}$	○
C	$\frac{E}{9}$	$\frac{V}{3}$	○
D	$\frac{E}{9}$	$\frac{V}{9}$	○

(Total 1 mark)

16. The diagram shows a particle with charge $+Q$ and a particle with charge $-Q$ separated by a distance d.
The particles exert a force F on each other.



An additional charge of $+2Q$ is then given to each particle and their separation is increased to $2d$.

What is the force that now acts between the particles?

A an attractive force of $\frac{9}{2}F$ ⬭

B an attractive force of $\frac{9}{4}F$ ⬭

C a repulsive force of $\frac{3}{2}F$ ⬭

D a repulsive force of $\frac{3}{4}F$ ⬭

(Total 1 mark)

17. Two protons are separated by distance r.
The electrostatic force between the two protons is **X** times the gravitational force between them.

What is the best estimate for **X**?

A 10^{20} ⬭

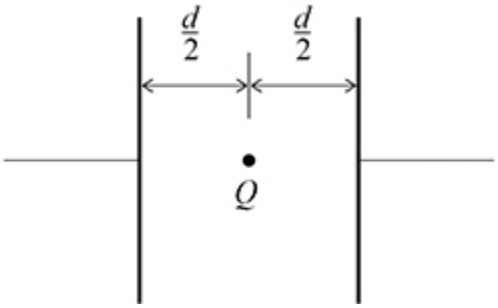
B 10^{28} ⬭

C 10^{36} ⬭

D 10^{42} ⬭

(Total 1 mark)

18. Two parallel metal plates separated by a distance *d* have a potential difference V across them. A particle with charge Q is placed midway between the plates.



What is the magnitude of the electrostatic force acting on the particle?

A zero ⬭

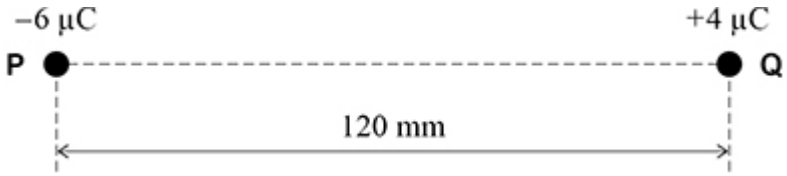
B $\frac{QV}{2d}$ ⬭

C $\frac{QV}{d}$ ⬭

D $\frac{2QV}{d}$ ⬭

(Total 1 mark)

19. Two charged particles **P** and **Q** are separated by a distance of 120 mm.
X is a point on the line between **P** and **Q** where the electric potential is zero.



What is the distance from **P** to **X**?

A 40 mm ⬭

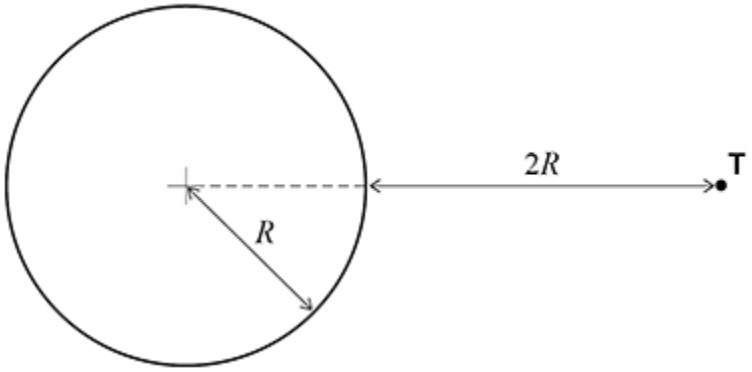
B 48 mm ⬭

C 60 mm ⬭

D 72 mm ⬭

(Total 1 mark)

20. An isolated spherical conductor is charged.
The conductor has a radius R and an electric potential V. The electric field strength at its surface is E.



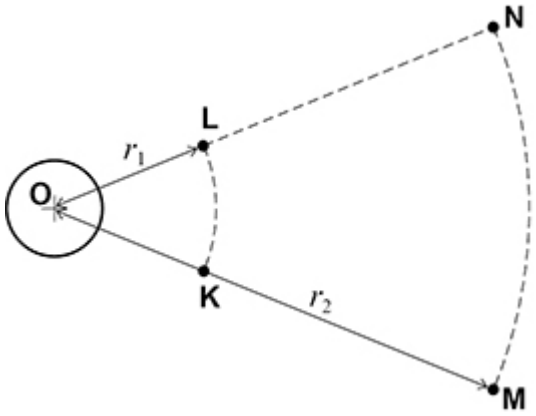
Point **T** is a distance $2R$ from the surface.

What are the electric field strength and electric potential at **T**?

	Electric field strength	Electric potential	
A	$\frac{E}{2}$	$\frac{V}{4}$	⬭
B	$\frac{E}{3}$	$\frac{V}{9}$	⬭
C	$\frac{E}{4}$	$\frac{V}{2}$	⬭
D	$\frac{E}{9}$	$\frac{V}{3}$	⬭

(Total 1 mark)

21. **O** is the centre of a negatively charged sphere.



K and **L** are two points at a distance r_1 from **O**.
M and **N** are two points at a distance r_2 from **O**.

Which statement is true?

A The work done moving an electron from **M** to **K** is the same as that done moving an electron from **K** to **L**. ⬭

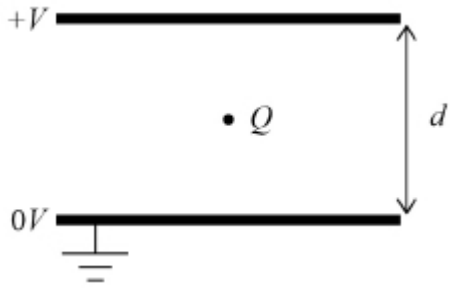
B The work done moving a positron from **K** to **M** is the same as that done moving an electron from **K** to **M**. ⬭

C No work is done moving an electron from **M** to **N**. ⬭

D No work is done moving a positron from **L** to **N**. ⬭

(Total 1 mark)

22. A small object of mass m has a charge Q. The object remains stationary in an evacuated space between two horizontal plates. The plates are separated by a distance d and the potential difference between the plates is V.



What is V?

A $\frac{mQg}{d}$ ⬭

B $\frac{mdg}{Q}$ ⬭

C $\frac{mQ}{d}$ ⬭

D $\frac{md}{Q}$ ⬭

(Total 1 mark)

23. 1.5 mJ of work is done when a charge of 30 μC is moved between two points, **M** and **N**, in an electric field.

What is the potential difference between **M** and **N**?

A 20 mV ⬭

B 20 V ⬭

C 45 V ⬭

D 50 V ⬭

(Total 1 mark)

24. A parallel-plate capacitor is fully charged and then disconnected from the power supply.
A dielectric is then inserted between the plates.

Which row correctly identifies the charge on the plates and the electric field strength between the plates?

	Charge	Electric field strength	
A	Stays the same	Increases	⬭
B	Increases	Decreases	⬭
C	Increases	Increases	⬭
D	Stays the same	Decreases	⬭

(Total 1 mark)