**Q1.**A satellite orbiting the Earth moves to an orbit which is closer to the Earth.

Which line, **A** to **D**, in the table shows correctly what happens to the speed of the satellite and to the time it takes for one orbit of the Earth?

| | **Speed of satellite** | **Time For One Orbit Of Earth** |
|---|---|---|
| **A** | decreases | decreases |
| **B** | decreases | increases |
| **C** | increases | decreases |
| **D** | increases | increases |

**(Total 1 mark)**

**Q2.**A positive ion has a charge−to−mass ratio of $2.40 \times 10^{7}$ C $kg^{-1}$. It is held stationary in a vertical electric field.
Which line, **A** to **D**, in the table shows correctly both the strength and the direction of the electric field?

| | **Electric field strength / V $m^{-1}$** | **Direction** |
|---|---|---|
| **A** | $4.09 \times 10^{-7}$ | upwards |
| **B** | $4.09 \times 10^{-7}$ | downwards |
| **C** | $2.45 \times 10^{6}$ | upwards |
| **D** | $2.45 \times 10^{6}$ | downwards |

**(Total 1 mark)**

**Q3.**In the equation $X = \frac{ab}{r^n}$, $X$ represents a physical variable in an electric or a gravitational field, $a$ is a constant, $b$ is either mass or charge and $n$ is a number.

Which line, **A** to **D**, in the table provides a consistent representation of $X$, $a$ and $b$

according to the value of $n$?

The symbols $E$, $g$, $V$ and $r$ have their usual meanings.

| | ***n*** | ***X*** | ***a*** | ***b*** |
|---|---|---|---|---|
| **A** | 1 | $E$ | $\frac{1}{4\pi\varepsilon_0}$ | charge |
| **B** | 1 | $V$ | $\frac{1}{4\pi\varepsilon_0}$ | mass |
| **C** | 2 | $g$ | $G$ | mass |
| **D** | 2 | $V$ | $G$ | charge |

**(Total 1 mark)**

**Q4.** Which one of the following statements is correct?

An electron follows a circular path when it is moving at right angles to

**A** a uniform magnetic field.

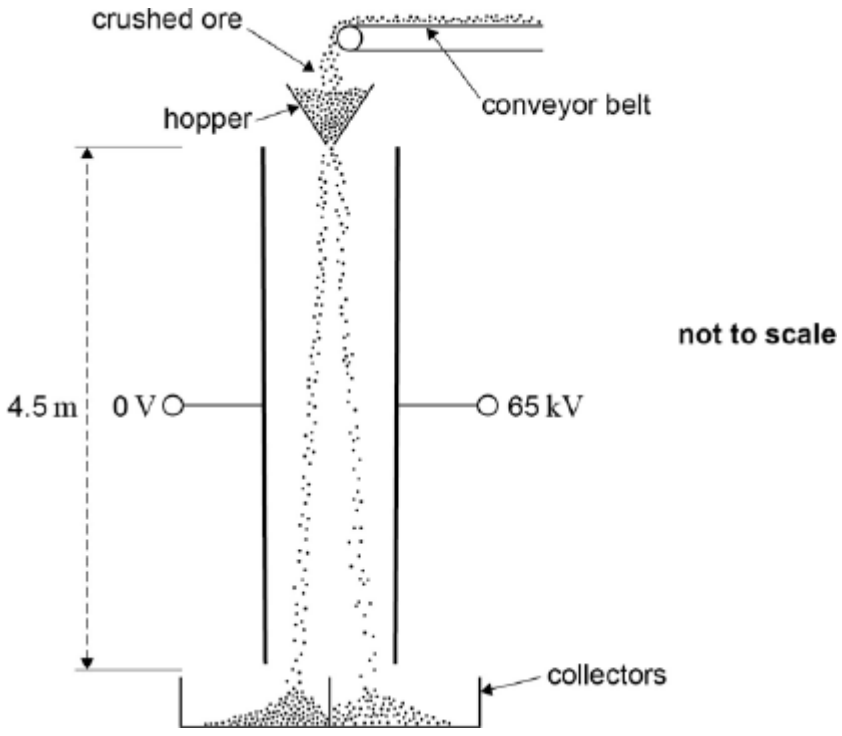
**B** a uniform electric field.

**C** uniform electric and magnetic fields which are perpendicular.

**D** uniform electric and magnetic fields which are in opposite directions.

**(Total 1 mark)**

**Q5.** The figure below shows a system that separates two minerals from the ore containing them using an electric field.




The crushed particles of the two different minerals gain opposite charges due to friction as they travel along the conveyor belt and through the hopper. When they leave the hopper they fall 4.5 metres between two parallel plates that are separated by 0.35 m.

(a) Assume that a particle has zero velocity when it leaves the hopper and enters the region between the plates.

Calculate the time taken for this particle to fall between the plates.

time taken = _____s

**(2)**

(b) A potential difference (pd) of 65 kV is applied between the plates.

Show that when a particle of specific charge $1.2 \times 10^{-6}$ C $kg^{-1}$ is between the plates its horizontal acceleration is about 0.2 m $s^{-2}$.

**(3)**

(c) Calculate the total horizontal deflection of the particle that occurs when falling between the plates.

horizontal deflection = _____m

**(1)**

(d) Explain why the time to fall vertically between the plates is independent of the mass of a particle.

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**(2)**

(e) State and explain **two** reasons, why the horizontal acceleration of a particle is different for each particle.

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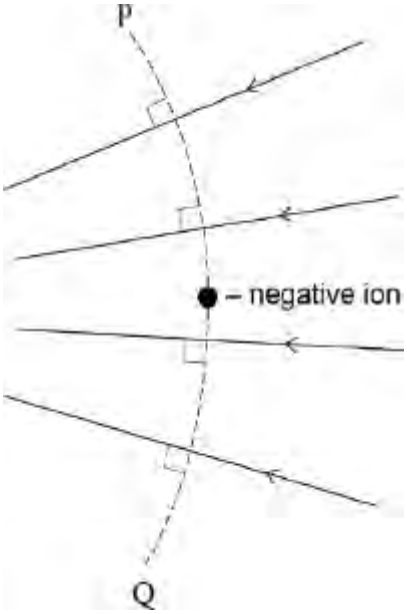
**(4)**
**(Total 12 marks)**

**Q6.** The diagram shows a small negative charge at a point in an electric field, which is represented by the arrowed field lines.




Which of the following statements, about what happens when the charge is displaced, is correct?

When the negative charge is displaced

**A** to the left the magnitude of the electric force on it decreases. ⬭

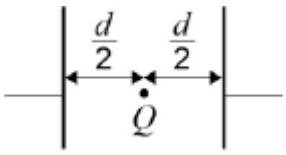
**B** to the right its potential energy increases. ⬭

**C** along the line PQ towards Q its potential energy decreases. ⬭

**D** along the line PQ towards P the magnitude of the electric force on it is unchanged. ⬭

**(Total 1 mark)**

**Q7.** Two parallel metal plates are separated by a distance $d$ and have a potential difference $V$ across them. Which expression gives the magnitude of the electrostatic force acting on a charge $Q$ placed midway between the plates?



**A** $\frac{2VQ}{d}$ ⬭

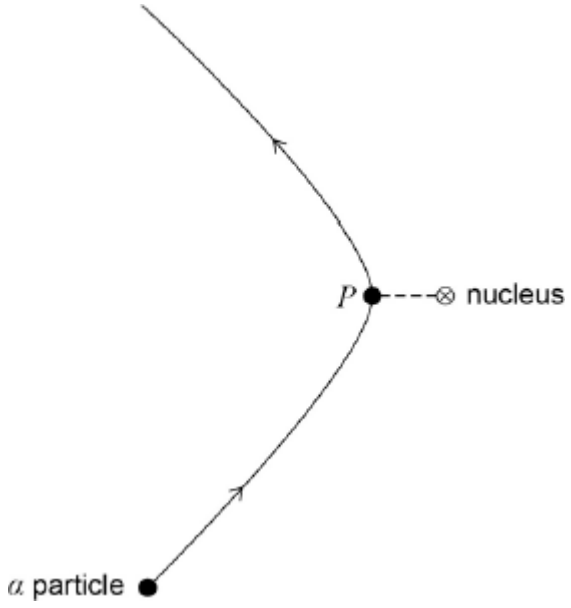
**B** $\frac{VQ}{d}$ ⬭

**C** $\frac{VQ}{2d}$ ⬭

**D** $\frac{Qd}{v}$ ⬭

**(Total 1 mark)**

**Q8.** The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.




Which of the following statements about the α particle on this path is correct?

**A** Its acceleration is zero at P. ⬭

**B** Its kinetic energy is greatest at P. ⬭

**C** Its potential energy is least at P. ⬭

**D** Its speed is least at P. ⬭

**(Total 1 mark)**

**Q9.** The electric potential at a distance $r$ from a positive point charge is 45 V. The potential increases to 50 V when the distance from the point charge decreases by 1.5 m. What is the value of $r$?

**A** 1.3 m ⬭

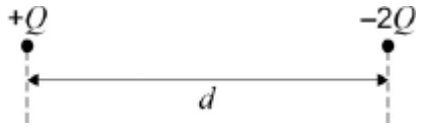
**B** 1.5 m ⬭

**C** 7.9 m ⬭

**D** 15m ⬭

**(Total 1 mark)**

**Q10.** The diagram shows two particles at distance $d$ apart. One particle has charge $+Q$ and the other $-2Q$. The two particles exert an electrostatic force of attraction, $F$, on each other. Each particle is then given an additional charge $+Q$ and their separation is increased to distance $2d$.




Which of the following gives the force that now acts between the two particles?

**A** an attractive force of $\frac{F}{4}$ ⬭

**B** a repulsive force of $\frac{F}{4}$ ⬭

**C** an attractive force of $\frac{F}{2}$ ⬭

**D** a repulsive force of $\frac{F}{2}$ ⬭

**(Total 1 mark)**

**Q11.** Which of the following statements about a parallel plate capacitor is **incorrect**?

**A** The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1 V. ⬭

**B** A uniform electric field exists between the plates of the capacitor. ⬭

**C** The charge stored on the capacitor is inversely proportional to the pd across the plates. ⬭

**D** The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates. ⬭

**(Total 1 mark)**

**Q12.** Which one of the following statements is correct?

The force between two charged particles

**A** is always attractive

**B** can be measured in $C^2\ F^{-1}\ m^{-1}$

**C** is directly proportional to the distance between them

**D** is independent of the magnitude of the charges

**(Total 1 mark)**

**Q13.** Which one of the following statements is correct?

When a negative ion is projected into an electric field

**A** the field can change the magnitude of the velocity but not its direction

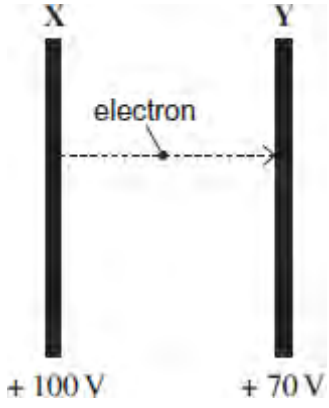
**B** the field can change the direction of the velocity but not its magnitude

**C** the field can change both the magnitude and the direction of the velocity

**D** the ion will accelerate in the direction of the field

**(Total 1 mark)**

**Q14.** Two fixed parallel metal plates $\mathbf{X}$ and $\mathbf{Y}$ are at constant potentials of + 100 V and + 70 V respectively. An electron travelling from $\mathbf{X}$ to $\mathbf{Y}$ experiences a change of potential energy $\Delta E_p$.



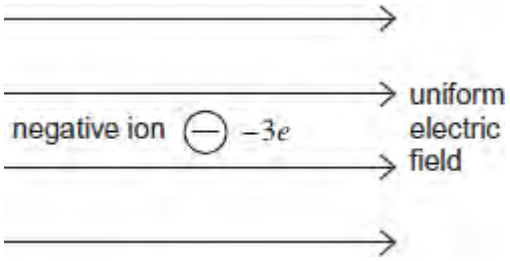

Which line, **A** to **D**, in the table shows correctly the direction of the electrostatic force $F$ on the electron and the value of $\Delta E_p$?

| | **Direction of $F$** | $\Delta E_p$ |
|---|---|---|
| **A** | towards $\mathbf{X}$ | + 30 eV |
| **B** | towards $\mathbf{Y}$ | – 30 eV |
| **C** | away from $\mathbf{X}$ | + 30 eV |
| **D** | away from $\mathbf{Y}$ | – 30 eV |

**(Total 1 mark)**

**Q15.**(a) **Figure 1** shows a negative ion which has a charge of $-3e$ and is free to move in a uniform electric field. When the ion is accelerated by the field through a distance of 63 mm parallel to the field lines its kinetic energy increases by 4.0 × 10sup class="xsmall">–16 J.

**Figure 1**




(i) State and explain the direction of the electrostatic force on the ion.

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**(2)**

(ii) Calculate the magnitude of the electrostatic force acting on the ion.

magnitude of electrostatic force ..... N

**(2)**

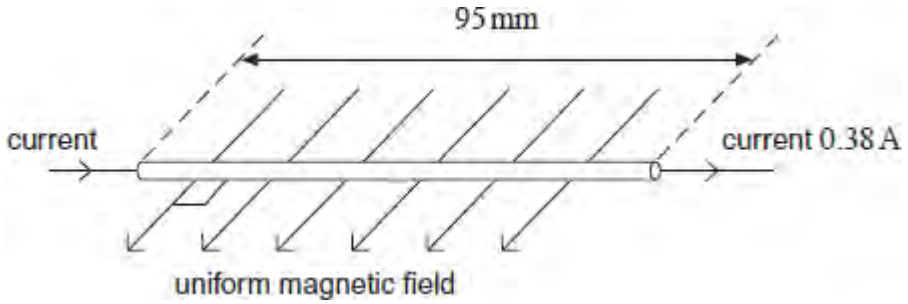
(iii) Calculate the electric field strength.

electric field strength ..... $NC^{-1}$

**(1)**

(b) **Figure 2** shows a section of a horizontal copper wire carrying a current of 0.38 A. A horizontal uniform magnetic field of flux density $B$ is applied at right angles to the wire in the direction shown in the figure.

**Figure 2**




(i) State the direction of the magnetic force that acts on the moving electrons in the wire as a consequence of the current and explain how you arrive at your answer.

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**(2)**

(ii) Copper contains $8.4 \times 10^{28}$ free electrons per cubic metre. The section of wire in **Figure 2** is 95 mm long and its cross-sectional area is $5.1 \times 10^{-6}$ m$^2$. Show that there are about $4 \times 10^{22}$ free electrons in this section of wire.

**(1)**

(iii) With a current of 0.38 A, the average velocity of an electron in the wire is$5.5 \times 10^{-6}$ m s$^{-1}$ and the average magnetic force on one electron is $1.4 \times 10^{-25}$ N. Calculate the flux density $B$ of the magnetic field.

flux density ..... T

**(2)**

**(Total 10 marks)**

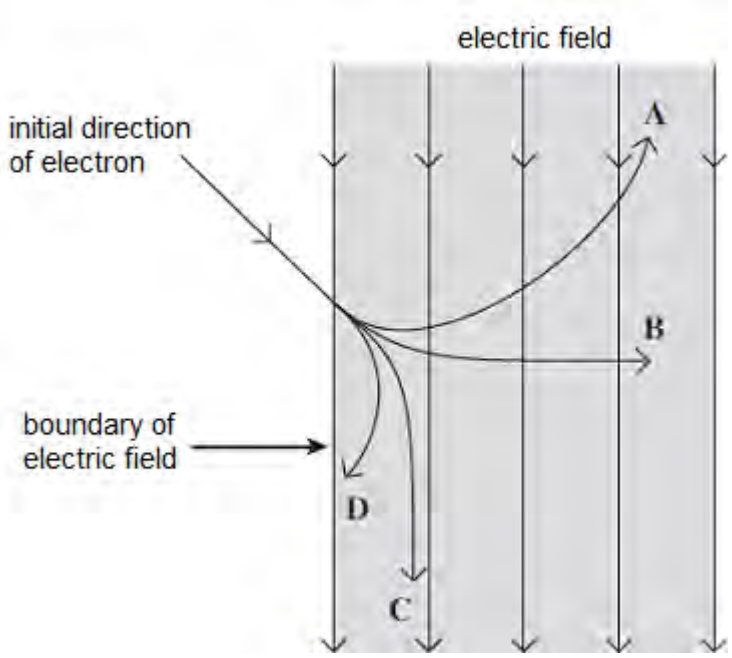
**Q16.** Two horizontal parallel plate conductors are separated by a distance of 5.0 mm in air. The lower plate is earthed and the potential of the upper plate is +50 V.

Which line, **A** to **D**, in the table gives correctly the electric field strength, *E*, and the potential, *V*, at a point midway between the plates?

| | **electric field strength *E* / Vm$^{-1}$** | **potential *V* / V** |
|---|---|---|
| **A** | $1.0 \times 10^4$ upwards | 25 |
| **B** | $1.0 \times 10^4$ downwards | 25 |
| **C** | $1.0 \times 10^4$ upwards | 50 |
| **D** | $1.0 \times 10^4$ downwards | 50 |

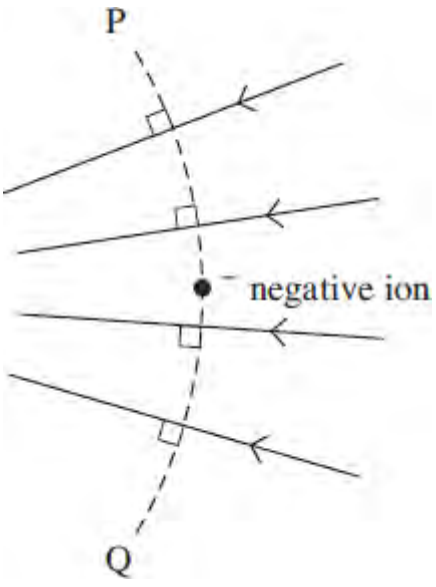
**(Total 1 mark)**

**Q17.** Which path, **A** to **D**, shows how an electron moves in the uniform electric field represented in the diagram?




**(Total 1 mark)**

**Q18.** The diagram shows a negative ion at a point in an electric field, which is represented by the arrowed field lines.




Which one of the following statements correctly describes what happens when the ion is displaced?

When the negative ion is displaced

**A** to the left the magnitude of the electric force on it decreases.

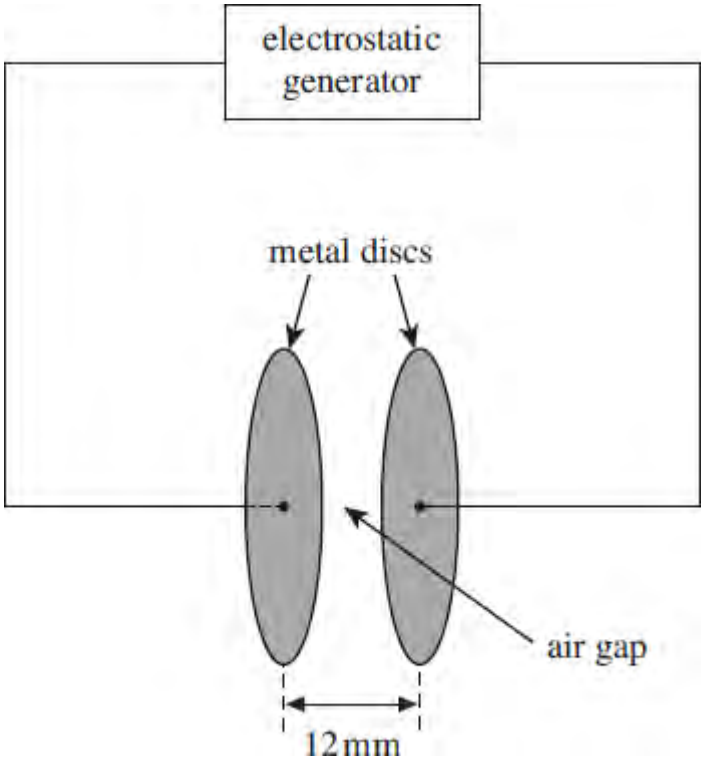
**B** to the right its potential energy increases.

**C** along the line PQ towards Q its potential energy decreases.

**D** along the line PQ towards P the magnitude of the electric force on it is unchanged.

**(Total 1 mark)**

**Q19.** The diagram below shows an arrangement to demonstrate sparks passing across an air gap between two parallel metal discs. Sparks occur when the electric field in the gap becomes large enough to equal the breakdown field strength of the air. The discs form a capacitor, which is charged at a constant rate by an electrostatic generator until the potential difference (pd) across the discs is large enough for a spark to pass. Sparks are then produced at regular time intervals whilst the generator is switched on.




(a) The electrostatic generator charges the discs at a constant rate of $3.2 \times 10^{-8}$ A on a day when the minimum breakdown field strength of the air is $2.5 \times 10^{6}$ V m$^{-1}$. The discs have a capacitance of $3.7 \times 10^{-12}$ F.

(i) The air gap is 12 mm wide. Calculate the minimum pd required across the discs for a spark to occur. Assume that the electric field in the air gap is uniform.

pd ..... V

**(1)**

(ii) Calculate the time taken, from when the electrostatic generator is first switched on, for the pd across the discs to reach the value calculated in part (a)(i).

time ..... s

**(2)**

(b) The discs are replaced by ones of larger area placed at the same separation, to give a larger capacitance.

State and explain what effect this increased capacitance will have on:

(i) the time between consecutive discharges,

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**(2)**

(ii) the brightness of each spark.

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**(2)**
**(Total 7 marks)**