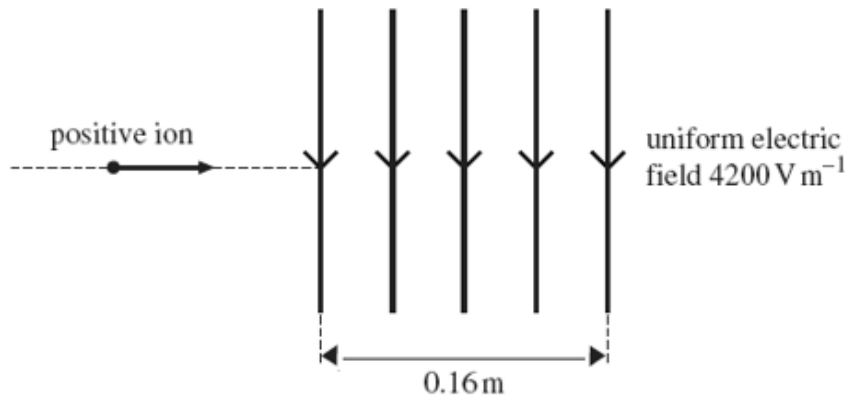


Q1. An electron and a proton are 1.0×10^{-10} m apart. In the absence of any other charges, what is the electric potential energy of the electron?

- A $+2.3 \times 10^{-18}$ J
- B -2.3×10^{-18} J
- C $+2.3 \times 10^{-18}$ J
- D -2.3×10^{-18} J

(Total 1 mark)

Q2.



An ion carrying a charge of $+4.8 \times 10^{-19}$ C travels horizontally at a speed of 8.0×10^5 ms⁻¹. It enters a uniform vertical electric field of strength 4200 V m⁻¹, which is directed downwards and acts over a horizontal distance of 0.16 m. Which one of the following statements is **not** correct?

- A The ion passes through the field in 2.0×10^{-7} s.
- B The force on the ion acts vertically downwards at all points in the field.
- C The magnitude of the force exerted on the ion by the field is 1.6×10^{-9} N.
- D The horizontal component of the velocity of the ion is unaffected by the electric field.

(Total 1 mark)

Q3. 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 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 15 m

(Total 1 mark)

Q4. (a) Complete the table of quantities related to fields. In the second column, write an SI unit for each quantity. In the third column indicate whether the quantity is a scalar or a vector.

quantity	SI unit	scalar or vector
gravitational potential		
electric field strength		
magnetic flux density		

(3)

(b) (i) A charged particle is held in equilibrium by the force resulting from a vertical electric field. The mass of the particle is 4.3×10^{-9} kg and it carries a charge of magnitude 3.2×10^{-12} C. Calculate the strength of the electric field.

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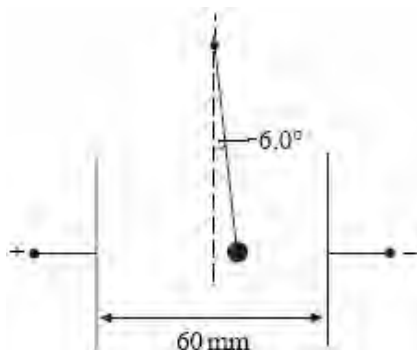
(ii) If the electric field acts upwards, state the sign of the charge carried by the particle

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(3)

(Total 6 marks)

Q5. A small charged sphere of mass 2.1×10^{-4} kg, suspended from a thread of insulating material, was placed between two vertical parallel plates 60 mm apart. When a potential difference of 4200 V was applied to the plates, the sphere moved until the thread made an angle of 6.0° to the vertical, as shown in the diagram below.



(a) Show that the electrostatic force F on the sphere is given by $F = mg \tan 6.0^\circ$, where m is the mass of the sphere.

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(3)

(b) Calculate the charge on the sphere.

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(3)

(Total 6 marks)

Q6. (a) (i) Define the *electric field strength*, E , at a point in an electric field.

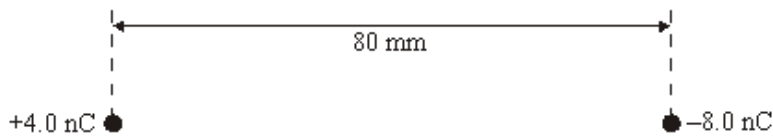
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(ii) State whether E is a scalar or a vector quantity.

- (b) Point charges of $+4.0 \text{ nC}$ and -8.0 nC are placed 80 mm apart, as shown in the figure below.



- (i) Calculate the magnitude of the force exerted on the $+4.0 \text{ nC}$ charge by the -8.0 nC charge.

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- (ii) Determine the distance from the $+4.0 \text{ nC}$ charge to the point, along the straight line between the charges, where the electric potential is zero.

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(4)

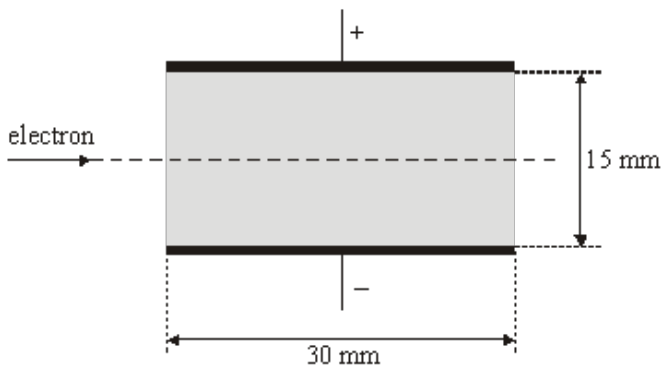
- (c) Point **P** in the figure above is equidistant from the two charges.

- (i) Draw two arrows on the figure above at **P** to represent the directions and relative magnitudes of the components of the electric field at **P** due to each of the charges.
- (ii) Hence draw an arrow, labelled **R**, on the figure above at **P** to represent the direction of the resultant electric field at **P**.

(3)

(Total 10 marks)

- Q7.** (a) An electron travels at a speed of $3.2 \times 10^7 \text{ ms}^{-1}$ in a horizontal path through a vacuum. The electron enters the uniform electric field between two parallel plates, 30 mm long and 15 mm apart, as shown in the figure below. A potential difference of 1400 V is maintained across the plates, with the top plate having positive polarity. Assume that there is no electric field outside the shaded area.



- (i) Show that the electric field strength between the plates is $9.3 \times 10^4 \text{ Vm}^{-1}$.
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- (ii) Calculate the time taken by the electron to pass through the electric field.
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- (iii) Show that the acceleration of the electron whilst in the field is $1.6 \times 10^{16} \text{ m s}^{-2}$ and state the direction of this acceleration.

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(b) Determine the magnitude and direction of the velocity of the electron at the point where it leaves the field.

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(3)
(Total 8 marks)