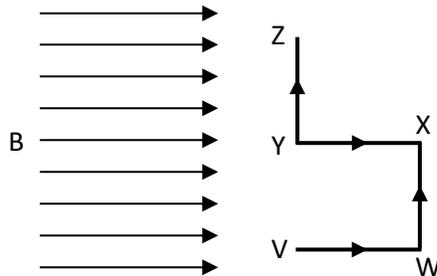
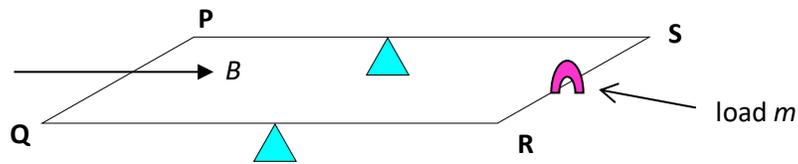


Additional Questions Magnetic Fields

- 1 The length of VW, WX, XY and YZ are 10.0 cm each. Find the net force on the segment of wire, VWXYZ, in the figure below if the strength of the magnetic field B is 0.40 T and the current I flowing through the wire is 5.0 A.



- A 0.40 N into the plane of the page
 B 0.40 N out of the plane of the page
 C 0.80 N into the plane of the page
 D 0.80 N out of the plane of the page
- 2 A current balance is used to measure the strength of the magnetic field B of an electromagnet. The side PQ of a current balance is inserted inside a large electromagnet. The direction of magnetic field is as shown in the figure below.

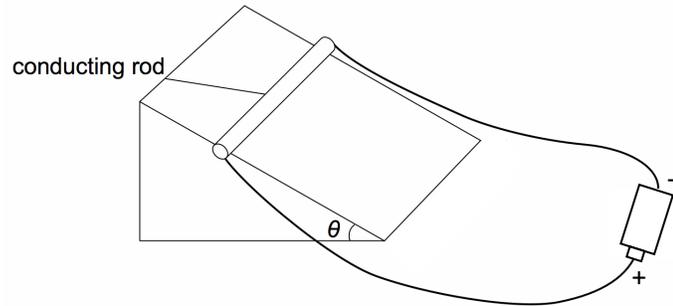


Length of PQ is L . PQ and RS are d_1 and d_2 respectively from the pivot. A load of mass m is placed along side RS. Take acceleration due to gravity to be g .

What is the direction and magnitude of the current along PQ?

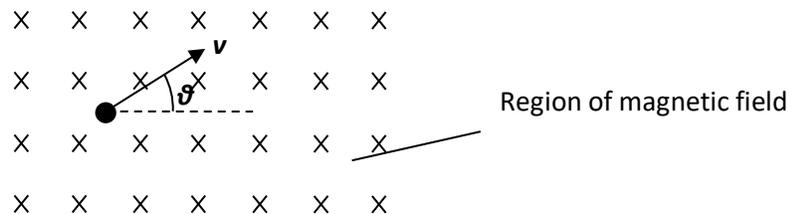
	<i>direction</i>	<i>magnitude</i>
A	from P to Q	$\frac{md_2}{BLd_1}$
B	from P to Q	$\frac{mgd_2}{BLd_1}$
C	from Q to P	$\frac{md_2}{BLd_1}$
D	from Q to P	$\frac{mgd_2}{BLd_1}$

- 3 A metal rod, length L and mass m , is placed on a very long and smooth plane, which makes an angle of ϑ to the horizontal. The rod is connected to a battery of e.m.f. E through light and flexible wires. The rod is released from rest at the top of the plane and moves in a uniform magnetic field B that is vertically downwards everywhere.



What is the magnitude of B required to keep the rod moving at constant velocity?

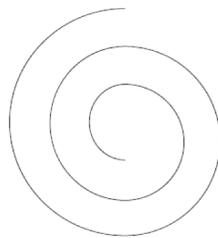
- A $\frac{mg}{IL}$ B $\frac{mg \tan \vartheta}{IL}$ C $\frac{mg \sin \vartheta}{IL}$ D $\frac{mg \cos \vartheta}{IL}$
- 4 When a charged particle is in a region of magnetic field, which of the following is not a necessary condition for the particle to experience a magnetic force?
- A Particle must be charged.
 B Particle must be moving.
 C Particle must be directed at an angle to magnetic field.
 D Particle must be accelerating.
- 5 A charge Q is travelling with speed v in a magnetic field B . At one instant in time, its velocity is at an angle ϑ to the horizontal as shown.



What is the magnetic force acting on it at this instant in time?

- A zero B BQv C $BQv \cos \vartheta$ D $BQv \sin \vartheta$

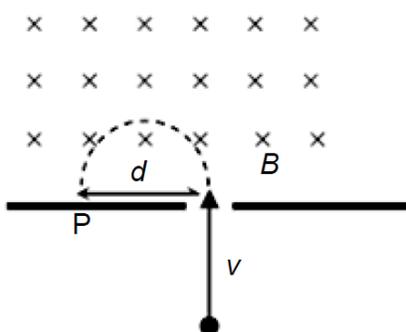
- 6 An electron moves in a circular orbit in a uniform magnetic field. Which of the following statements is correct?
- A The period of the orbit is independent of the speed of the electron.
 - B The momentum of the electron is dependent on its charge.
 - C The radius of the orbit is directly proportional to its charge.
 - D The magnetic force on the electron is dependent on the mass of the electron.
- 7 An electron is moving in air at right angles to a uniform magnetic field. The diagram below shows the path of the electron. The electron is slowing down.



Which one of the following correctly gives the direction of motion of the electron and the direction of the magnetic field?

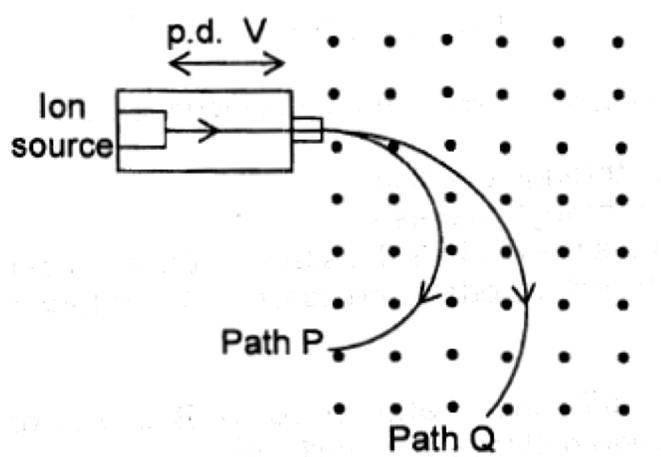
	<i>direction of motion</i>	<i>direction of magnetic field</i>
A	clockwise	into plane of paper
B	clockwise	out of plane of paper
C	anticlockwise	into plane of paper
D	anticlockwise	out of plane of paper

- 8 A particle of mass m and charge $+q$ enters with speed v at right angles to a magnetic field B . The particle arrives at point P, a distance d from the slit as shown in the diagram below.



Which of the following is a correct expression for d ?

- A $\frac{4\pi^2 m}{Bq}$ B $\frac{2mv}{Bq}$ C $\frac{\sqrt{2mv}}{Bq}$ D $\frac{\sqrt{8mv}}{Bq}$
- 9 P and Q are two ions with masses m_P and m_Q respectively. They have the same charge q and the work done on both charges after passing through an applied p.d. of V is qV . Subsequently, P and Q enter a magnetic field B .



The radius of the path of ions P and Q is r_P and r_Q respectively. What is the ratio of r_Q / r_P ?

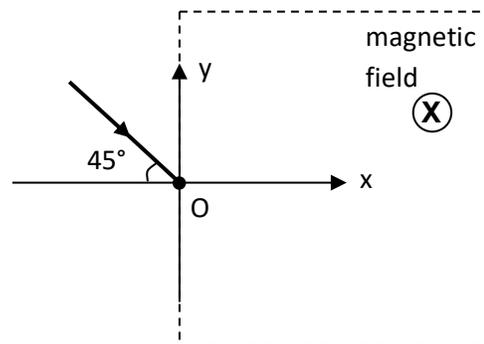
- A $\sqrt{\frac{m_Q}{4m_P}}$ B $\sqrt{\frac{m_Q}{2m_P}}$ C $\sqrt{\frac{m_Q}{m_P}}$ D $\sqrt{\frac{2m_Q}{m_P}}$

- 10 An electron moves in a circular orbit perpendicular to a uniform magnetic field. A second electron is also moving in a circular orbit in the same magnetic field with twice the radius.

How do the period of revolution and the speed of the second electron compare with those of the first?

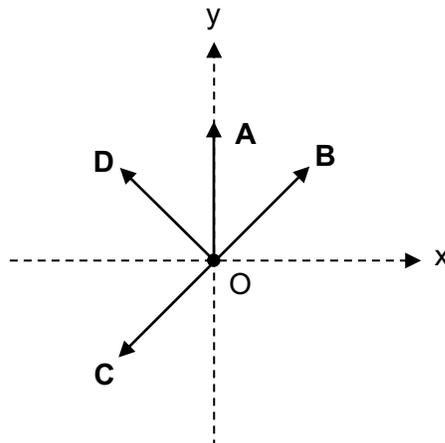
	<i>period of revolution</i>	<i>speed</i>
A	doubled	remains the same
B	halved	remains the same
C	remains the same	doubled
D	remains the same	halved

- 11 An electron enters a region at point O at an angle of 45° to the x-axis as shown. The region contains a magnetic field which is directed into the plane of the page.



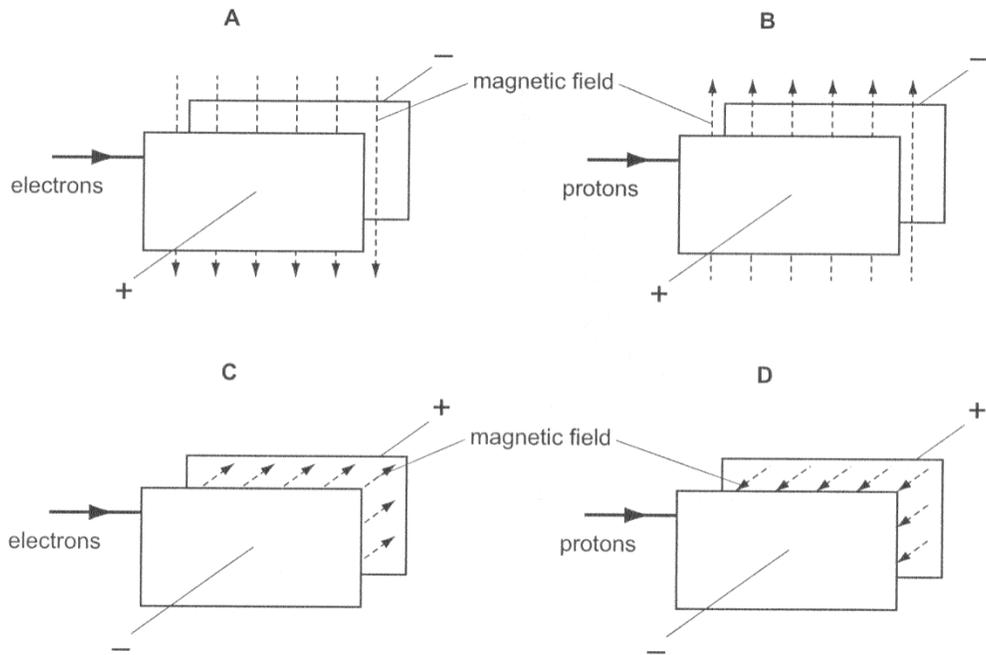
An electric field can be applied such that the electron is able to pass through the region undeflected.

Which of the following correctly shows the direction of the electric field from O?

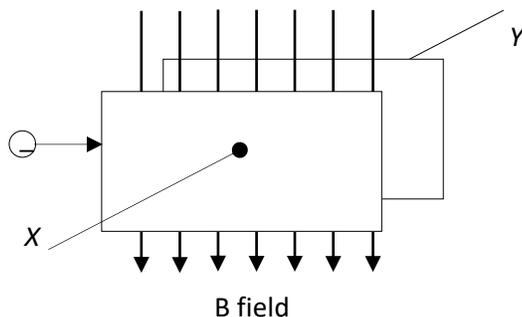


12 The diagrams show different particle beams entering a region between two metal plates in which there are uniform electric and magnetic fields.

In which arrangement would it be possible for the beam to pass through undeflected?



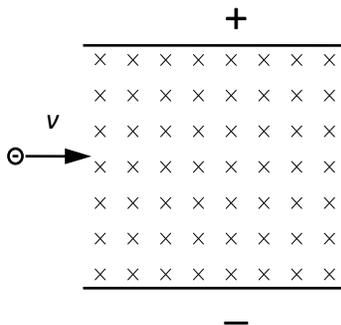
- 13 The diagram shows an electron beam entering the region between two metal plates in which there are uniform electric and magnetic fields.



If the speed of the electrons in the beam is $6.00 \times 10^5 \text{ m s}^{-1}$, and the strength of the magnetic field is 0.238 mT , what is the magnitude and direction of the electric field that will allow the beam to pass through undeflected?

	<i>magnitude / N C^{-1}</i>	<i>direction</i>
A	143	X to Y
B	143	Y to X
C	143000	X to Y
D	143000	Y to X

- 14 An electron enters a region where there are uniform electric field and magnetic field of 0.50 T acting at right angles to its horizontal velocity v , as shown in the figure below.



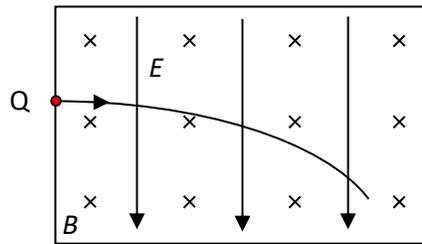
The electron remained undeflected when it enters the region. When the magnetic field is switched off, the electron immediately moved a vertical displacement of 0.15 mm in 1.0 ns .

Calculate the speed of the electron v .

Take the mass of the electron to be $9.11 \times 10^{-31} \text{ kg}$ and the magnitude of its charge to be $1.60 \times 10^{-19} \text{ C}$.

- A** $0.85 \times 10^3 \text{ m s}^{-1}$ **B** $3.4 \times 10^3 \text{ m s}^{-1}$ **C** $150 \times 10^3 \text{ m s}^{-1}$ **D** None of the above

- 15 In a region of cross electric field E and magnetic field B , a charge Q enters from the left and travelled a curved path as shown in the figure below.

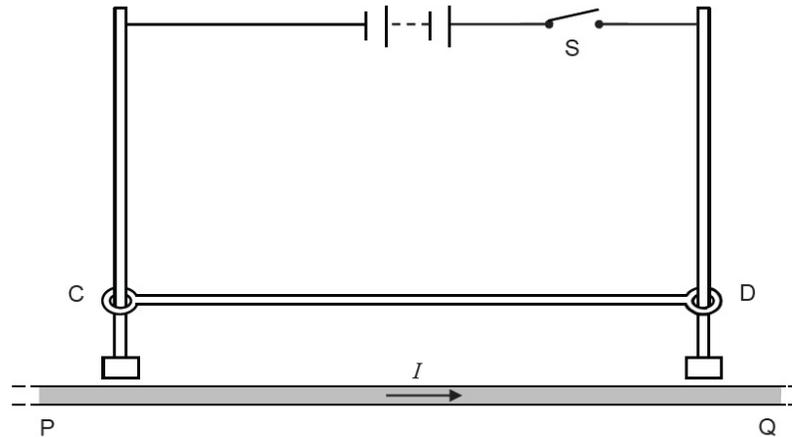


Which statement must be correct?

- A The charge has speed $> E/B$.
- B The charge has speed $< E/B$.
- C The charge is positive and has speed $> E/B$.
- D The charge is negative and has speed $> E/B$.

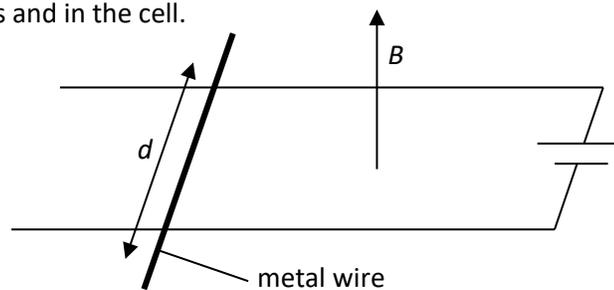
Structured Questions

- 16 Conductor PQ is now placed horizontally as shown in the figure below. Above PQ is another conductor CD that can slide up and down on two vertical metal rods while making electrical contact with them.



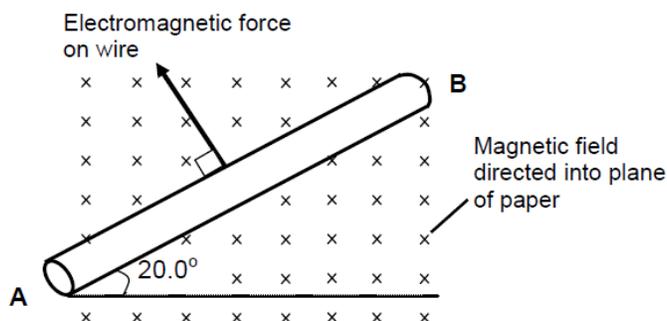
When switch S is closed such that current flows in CD, CD moves upwards and eventually comes to rest at a certain height above PQ.

- (a) Explain why CD initially starts to move upwards.
- (b) Explain why CD eventually comes to rest at a certain height above PQ.
- 17 In the figure below, a metal wire of mass $m = 80 \text{ g}$ can slide with negligible friction on two horizontal parallel rails separated by distance $d = 3.2 \text{ cm}$. The track lies in a vertical uniform magnetic field B of magnitude 5.0 T . At time $t = 0 \text{ s}$, a cell is connected to the rails, producing a constant current $I = 1.2 \text{ A}$ in the wire and rails (even as the wire moves). Assume negligible resistance in the rails and in the cell.

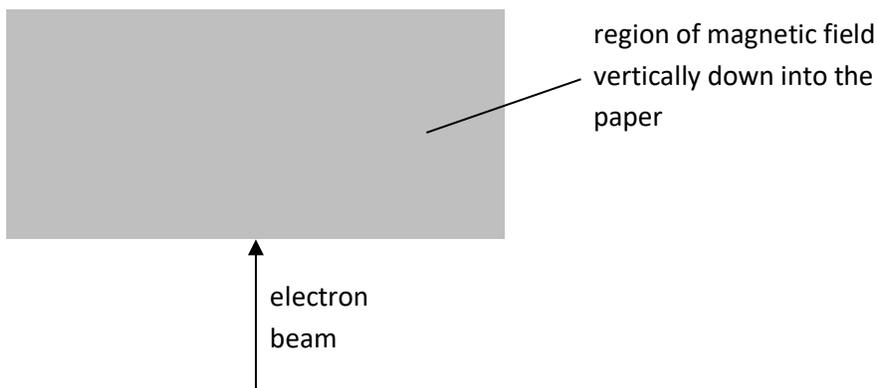


- (a) Determine the speed of the wire at $t = 2.0 \text{ s}$.
- (b) What is the direction of motion of the wire?
- (c) If the diameter of the metal wire is increased to twice the original value, explain how the wire's speed at $t = 2.0 \text{ s}$ will be affected.

- 18** A potential difference is applied across the ends of a uniform wire AB, so that there is an electromagnetic force acting at the centre of the wire as shown in the figure below. The wire is hinged at A and tilted such that it remains at equilibrium when held at an angle of 20.0° to the horizontal. The mass of AB is 8.0 g.



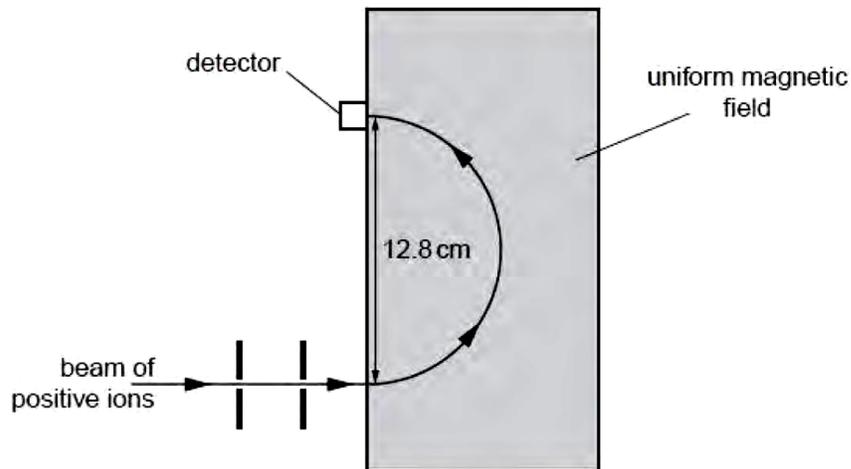
- (a) On the figure above, mark the direction of the current on the wire.
- (b) Taking moments about hinge A, calculate the magnitude of the electromagnetic force when the wire is held stationary, given that the length of AB is 2.0 cm.
- (c) Hence, calculate the current flowing in the wire when the strength of the magnetic field is 0.12 T.
- 19** A beam of electrons enter a magnetic field of 8.4 mT as shown in the figure below. The electrons are travelling with velocity $3.4 \times 10^7 \text{ m s}^{-1}$ perpendicularly to the field.



Take the mass of the electron to be $9.11 \times 10^{-31} \text{ kg}$ and the magnitude of its charge to be $1.60 \times 10^{-19} \text{ C}$.

- (a) Calculate, for electrons in the field, the magnitude of
- force on an individual electron,
 - acceleration of the electron.
- (b) Calculate the radius of the path taken by the electrons within the magnetic field.
- (c) Sketch the path travelled by the electrons within and beyond the field.

20 Positive ions are travelling through a vacuum in a narrow beam. The ions enter a region of uniform magnetic field B and are deflected in a semi-circular arc as shown below.

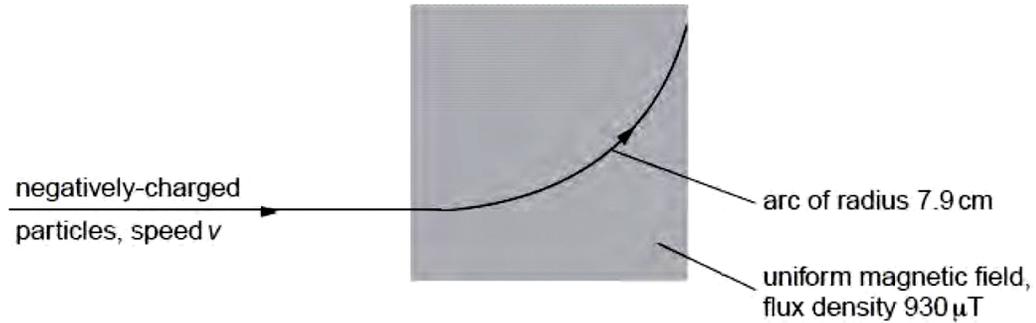


The ions, travelling with speed $1.40 \times 10^5 \text{ m s}^{-1}$, are detected at a fixed detector when the diameter of the arc in the magnetic field is 12.8 cm.

- (a) State the direction of the magnetic field.
- (b) The ions have mass $20u$ and charge $+1.6 \times 10^{-19} \text{ C}$. Determine the strength of the magnetic field. (u is the atomic mass unit and equals to $1.67 \times 10^{-27} \text{ kg}$)
- (c) Ions of mass $22u$ with the same charge and speed as those in (b) are also present in the beam.
- On the figure above, sketch the path of these ions in the same magnetic field.
 - In order to detect these ions at the fixed detector, the strength of the magnetic field is changed. Calculate the strength of this new magnetic field.

- 21** Negatively-charged particles are moving through a vacuum in a parallel beam. The particles have speed v .

The particles enter a region of uniform magnetic field of $930 \mu\text{T}$. Initially, the particles are travelling at right-angles to the magnetic field. The path of a single particle is shown in the figure below.



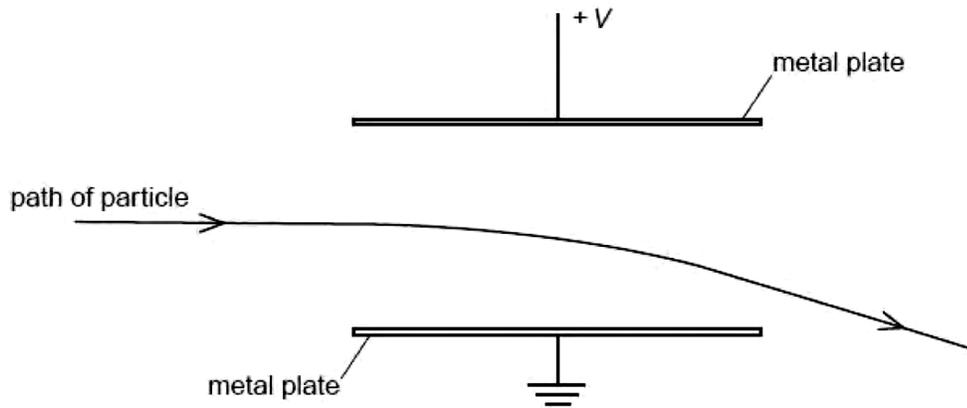
The negatively-charged particles follow a curved path of radius 7.9 cm in the magnetic field.

A uniform electric field is then applied in the same region as the magnetic field. For an electric field strength 12 kN C^{-1} , the particles are undeviated as they pass through the region of the fields.

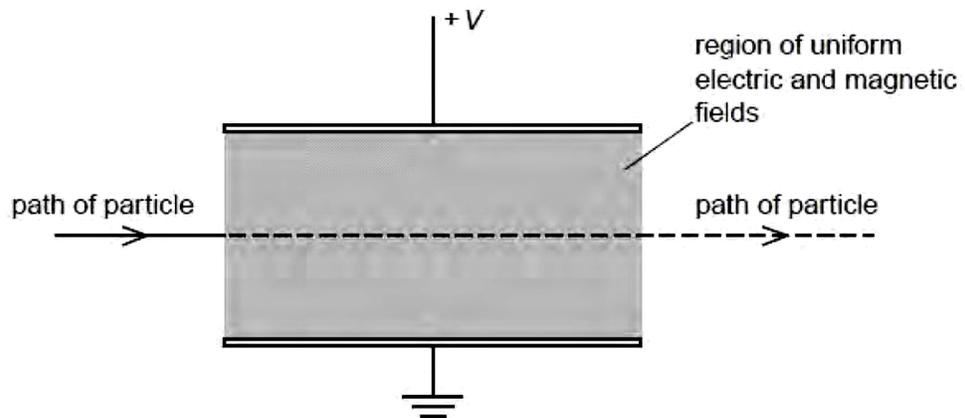
- (a)** On the figure above, mark with an arrow the direction of the electric field.
- (b)** Calculate, for the negatively-charged particles,
- the speed v ,
 - the ratio of charge to mass.

- 22** A particle has mass m and charge $+q$, and is travelling with speed v through a vacuum. The initial direction of travel is parallel to the plane of two charged horizontal metal plates, as shown in the figure below.

The uniform electric field between the plates has magnitude $2.8 \times 10^4 \text{ N C}^{-1}$ and is zero outside the plates. The particle passes through the plates and emerges beyond them.



A uniform magnetic field is now formed in the region between the metal plates. The magnetic field is adjusted so that the positively charged particle passes undeflected between the plates as shown in the figure below.



- (a) State and explain the direction of the magnetic field.
- (b) The particle has speed $4.7 \times 10^5 \text{ m s}^{-1}$. Calculate the strength of the magnetic field.
- (c) The particle in (b) has mass m , charge $+q$ and speed v . Without any further calculations, state the effect, if any, on the path of a particle that has
- mass m , charge $-q$ and speed v ,
 - mass m , charge $+q$ and speed $2v$,
 - mass $2m$, charge $+q$ and speed v .