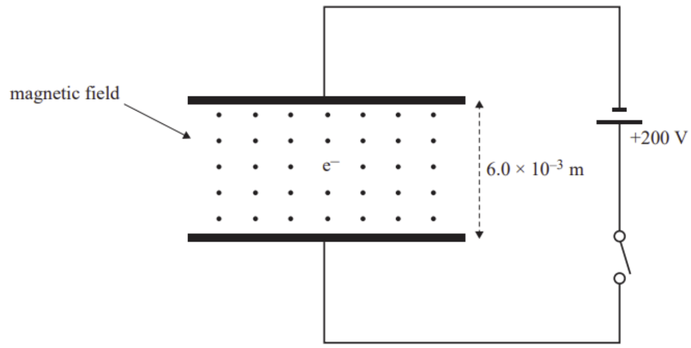
The figure below shows a stationary electron (e^-) in a uniform magnetic field between two parallel plates. The plates are separated by a distance of 6.0×10^{-3} m, and they are connected to a 200 V power supply and a switch. Initially, the plates are uncharged. Assume that gravitational effects on the electron are negligible.



The switch is now closed.

20 2021 Question 5a, 2 marks

Explain why the magnetic field does not exert a force on the electron. Justify your answer with an appropriate formula.

21 2021 Question 5c, 4 marks

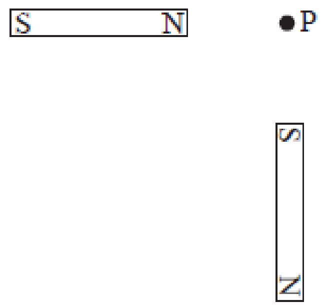
Ravi and Mia discuss what they think will happen regarding the size and the direction of the magnetic force on the electron after the switch is closed.

Ravi says that there will be a magnetic force of constant magnitude, but it will be continually changing direction.

Mia says that there will be a constantly increasing magnetic force, but it will always be acting in the same direction.

Evaluate these two statements, giving clear reasons for your answer.

Two identical bar magnets of the same strength are arranged at right angles and are equidistant from point P, as shown below.



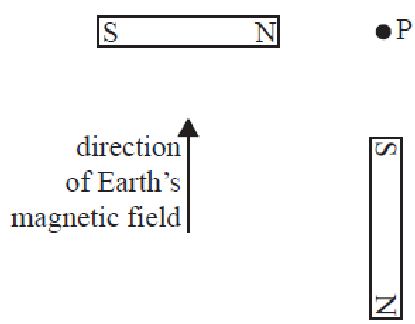
For Question 1 only, ignore the Earth's magnetic field.

58 2011 Question 1, 1 mark

At point P on the diagram, draw an arrow indicating the direction of the combined magnetic field of the bar magnets.

59 2011 Question 2, 2 marks

The bar magnets are replaced by two weaker magnets. The two new magnets are identical to each other. They are arranged at right angles and are equidistant from point P.
The magnitude of the magnetic field of a **single** bar magnet at point P is the same as the magnitude of the magnetic field of Earth at point P. The direction of Earth's magnetic field is shown below.



At point P on the diagram, draw an arrow indicating the direction of the combined magnetic field of the bar magnets and Earth.

Use the following information to answer Questions 3 and 4.

105 1980 Question 67, 1 mark

The electron would travel in a circle instead of a spiral

A. if a stronger magnetic field of appropriate intensity were used.

B. if the chamber were evacuated, so that the electron would no longer lose energy by colliding with the atoms in the bubble chamber.

C. if the direction of the magnetic field were made perpendicular to the present direction.

D. if the speed with which the electron enters were adjusted to a particular value.

A charged particle of mass *m* kg, charge *q* coulomb enters a region of uniform magnetic field B N A^{-1} m^{-1} with speed *v* m s^{-1}, and moves in a circle of radius *R* m.

106 1977 Question 62, 1 mark

Which of the following statements is true?

A. The directions of the field, the force on the particle and its velocity are all at right angles to one another.

B. The force is at right angles to the velocity of the particle, and is parallel to the direction of the field.

C. The force is at right angles to the velocity of the particle, and is opposite to the direction of the field.

D. The field is a circular one, and the direction of motion follows the field; the force is at right angles to the plane of the field.

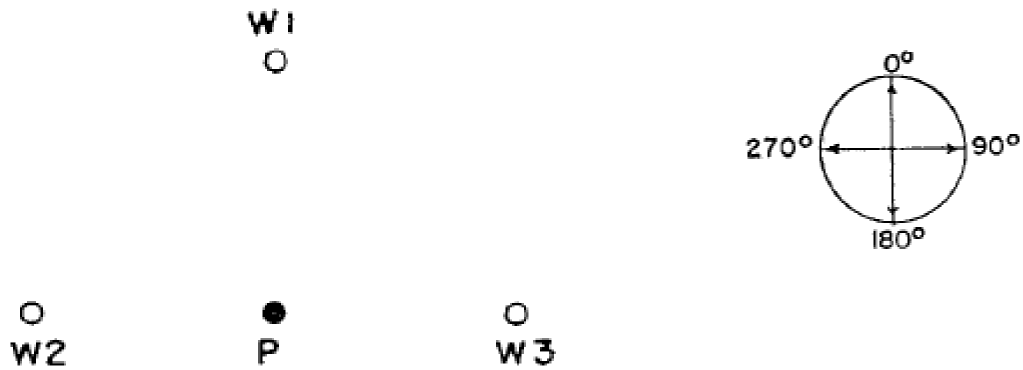
107 1977 Question 63, 1 mark

What is the time taken for the particle to make one complete revolution?

108 1977 Question 64, 1 mark

How much work has been done on the particle during this one revolution?

The figure below shows three long straight wires, W_1, W_2, and W_3, running perpendicular to the page, all at the same distance from P.



In questions 77 to 79, specify directions in degrees, using the axes shown.

When a current I flows through W_1 alone, up *out of the paper,* it produces at P a magnetic field of magnitude B.

114 1974 Question 77, 1 mark

What is the direction of this field at P?

(°)

115 1974 Question 78, 1 mark

When a current I flows through each of W_1, W_2, and W_3, up *out of the paper,* what is the direction of the magnetic field at P, due to these currents?

(°)

116 1974 Question 79, 1 mark

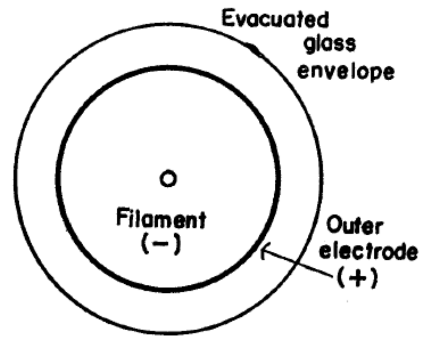
With currents in W_1 and W_3 as in question 78, but the current in W_2 reversed, what is now the direction of the field at P?

(°)

Electrons emitted from a central filament are accelerated towards an outer positively charged electrode.
The potential difference between the filament and the outer electrode is 200 volt.

Charge on electron, e =1.6 × 10^{-19} C

Mass of electron, m = 9.1 × 10^{-31} kg.

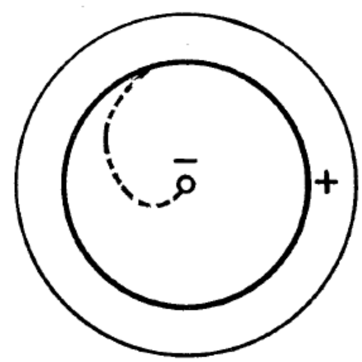


117 1974 Question 87, 1 mark

What is the kinetic energy, in Joule, of an electron as it reaches the outer electrode?

118 1974 Question 88, 1 mark

What is the momentum of an electron as it reaches the outer electrode?



The apparatus is now placed in a uniform magnetic field ,B. The resulting path of an electron is shown.

119 1974 Question 89, 1 mark

What is the direction of the magnetic field?

A. Into the page **B.** Out of the page

C. Up the page **D.** Down the page

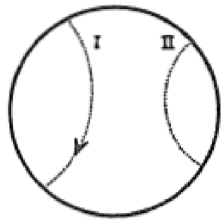
E. To the right **F.** To the left.

120 1974 Question 90, 1 mark

What is now the magnitude of the momentum (p) of an electron as it reaches the outer electrode?

The radius of curvature of the outer part of an electron path is found to be r metre.

The figure below shows tracks produced by two cosmic ray particles in a cloud chamber. A magnetic field was directed perpendicular to the plane of the picture.



128 1971 Question 93, 1 mark

Given that track I was produced by an electron moving downwards as shown, track II must be due to

A. another electron, of different energy, moving downwards.

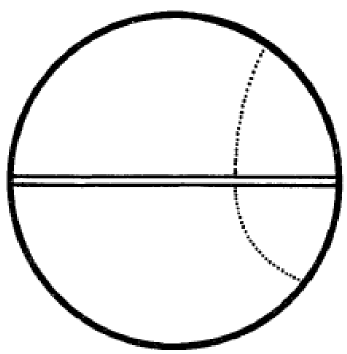
B. a positively charged particle moving either upwards or downwards.

C. either a negatively charged particle moving upwards or a positively charged particle moving downwards.

D. a positively charged particle moving downwards.

E. another electron, of different energy, moving either upwards or downwards.

A thin, horizontal lead foil was then inserted in the chamber, nothing else being changed.



129 1971 Question 94, 1 mark

The track shown in Fig. 2 could then be produced by

A. a negatively charged particle moving upwards.

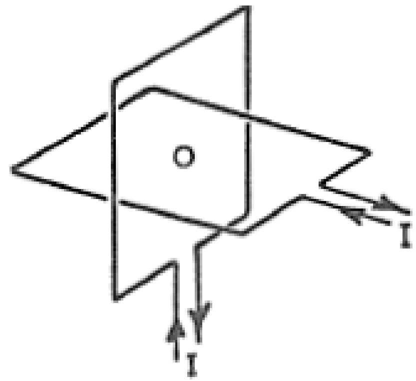
B. a positively charged particle moving downwards.

C. a positively charged particle moving either upwards or downwards.

D. either a negatively charged particle moving upwards, or a positively charged particle moving downwards.

E. either a positively charged particle moving upwards, or a negatively charged particle moving downwards.

Two identical square loops of wire are at right angles to each other and have a common centre O. The magnetic field produced at O, when a current *I* flows through the *vertical* loop, is *B.*



130 1971 Question 98, 1 mark

What is the magnitude of the magnetic field at O when both loops carry current *I?*

131 1971 Question 99, 1 mark

What is the magnitude of the magnetic field when the vertical loop carries current *I* and the horizontal loop carries current *2I?*

132 1971 Question 100, 1 mark

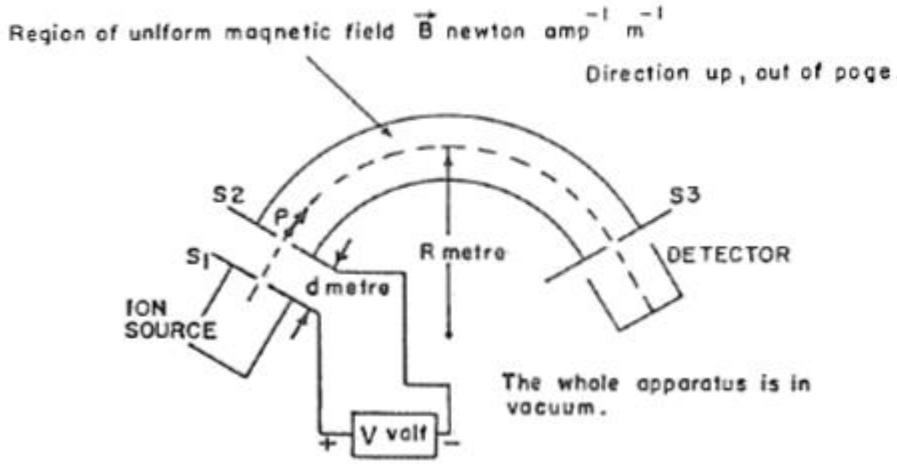
If the current in either loop can be made to be *+I, -I* or zero, how many different directions can the resultant magnetic field take at O? (Ignore the case of zero resultant field.)

133 1971 Question 101, 1 mark

The vertical loop is now replaced by a vertical coil which consists of 3 turns, each identical with the original loop.
If current *I* flows through this coil and through the horizontal loop, what is the magnitude of the magnetic field at O?

In questions 81 to 83 there are diagrams of current carrying wires.

Where two wires are shown, the magnitude of the current is the same in each.



142 1969 Question 97, 1 mark

The momentum p of each ion as it enters slit S_2 is given by :

A. Vqmd. **B.** $\sqrt{2Vqm}$ **C.** $\frac{mq}{Vd}$

D. Vdq. **E.** $\sqrt{2Vqmd}$

Between S_2 and S_3 the ions travel in a region of uniform magnetic field.

143 1969 Question 98, 1 mark

For the ions to pass through S_3, the field B must have a magnitude given by :

A. $\frac{p}{qR}$ **B.** $\frac{p}{qRm}$ **C.** $\sqrt{\frac{qR}{p}}$

D. $\sqrt{\frac{pq}{R}}$ **E.** $\frac{pm}{qR}$

The accelerating potential, V, and magnetic field, B, are adjusted so that deuterons which exit S_1 will pass through S_3.

		charge (relative to proton)	*mass* (relative to proton)
	deuteron	+1	2
	Helium ion	+2	4

Then no further adjustment is made and doubly charged helium ions are introduced at S_1.

144 1969 Question 99, 1 mark

What will happen to these helium ions ?

A. They go through S_2 with the same velocity as the deuterons and will pass through S_3.

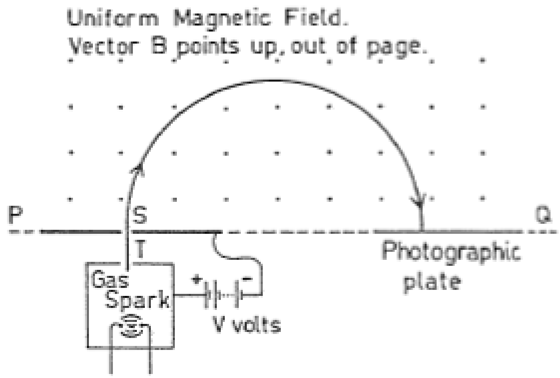
B. They go through S_2 with the same velocity as the deuterons but will *not* pass through S_3.

C. They go through S_2 with the same momentum as the deuterons and will pass through S_3.

D. They go through S_2 with the same momentum as the deuterons but will *not* pass through S_3.

E. They go through S_2 with the same kinetic energy as the deuterons and will pass through S_3.

F. They go through S_2 with the same kinetic energy as the deuterons but will *not* pass through S_3.



The diagram represents, schematically, a mass spectrograph. A spark discharge in a gas produces ions of negligible kinetic energy. These drift through a hole T and are accelerated by an electric field, produced by a battery of EMF *V* volts. The ions pass through a hole S, located in the plane PQ and enter a region in which there is a uniform magnetic field, the direction of which is shown in the diagram. The ions then follow a semi-circular path and are recorded on a photographic plate, also in the plane PQ. The whole apparatus is in a good vacuum.

154 1966 Question 99, 1 mark

Which of the following correctly describes ions following the path shown in the diagram?

A. They are positively charged.

B. They are negatively charged.

C. They may be either positively or negatively charged.

D. They must carry only one elementary charge

155 1966 Question 100, 1 mark

The apparatus is set to detect ions having a particular charge. Which of the following adjustments would be necessary to allow ions of the opposite charge to be detected with the photographic plate in the same position?

A. Reverse the magnetic field only.

B. Reverse polarity of the battery only.

C. Reverse both the magnetic field and the polarity of the battery.

D. Leave the direction of the magnetic field and the polarity of the battery unchanged, but alter the magnitudes of both.