Multiple choice questions

The first stage of the electrons' path through the synchrotron is the electron-gun injector, in which stationary electrons are initially accelerated by an electric field, E. The electric field in the injector is 200 kV m^{-1}. As they leave the injector, the electrons (travelling at 8.4×10^{7} m s^{-1}) are deflected by a magnetic field of 2.4×10^{-4} T through a curved path of constant radius. Ignore any relativistic effects.

Example 1 (2009 Question 5, 2 marks) 86%

Which one of the following best gives the force on an electron while in this magnetic field?

A. 3.2×10^{-7} N

B. 1.3×10^{-11} N

C. 3.2×10^{-15} N

D. 1.8×10^{-26} N

Example 2 (2009 Question 6, 2 marks) 79%

Which one of the following best gives the radius of the path of an electron while in this magnetic field?

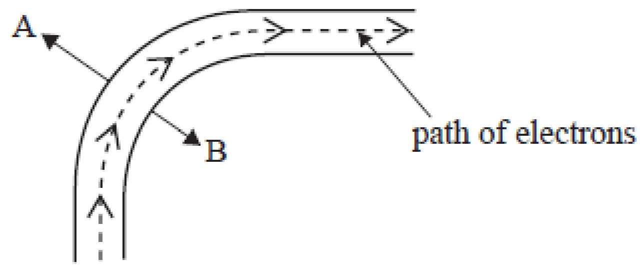
A. 0.20 m

B. 0.50 m

C. 1.0 m

D. 2.0 m

Electrons are travelling in the storage ring of a synchrotron at close to the speed of light. They are directed from a straight section into a curved section of the storage ring, as shown below.



Example 3 (2009 Question 7, 2 marks) 51%

Which one of the following best gives the direction that the magnetic field must have to keep the electrons in this curved path?

A. direction A on the diagram

B. direction B on the diagram

C. out of the page

D. into the page

Example 4 (2008 Question 1, 2 marks) 76%

In the electron gun of a synchrotron, electrons are accelerated by a voltage of 5000 V. Which one of the following best gives the speed of the electrons?

A. 1.8×10^{15} m s^{-1}

B. 4.2×10^{7} m s^{-1}

C. 3.0×10^{8} m s^{-1}

D. 5.0×10^{3} m s^{-1}

Example 5 (2008 Question 2, 2 marks) 88%

In a particular part of the synchrotron, electrons are maintained in a circular path by a magnetic field. The electrons are moving at 4.00×10^{7} m s^{-1}, perpendicular to a magnetic field of strength 7.60×10^{-4} T.
Which one of the following best gives the force on each electron?

A. 3.64×10^{-23} N

B. 4.86×10^{-17} N

C. 4.86×10^{-15} N

D. 1.26×10^{-12} N

Example 6 (2008 Question 3, 2 marks) 82%

Which one of the following best gives the radius of the electron's path?

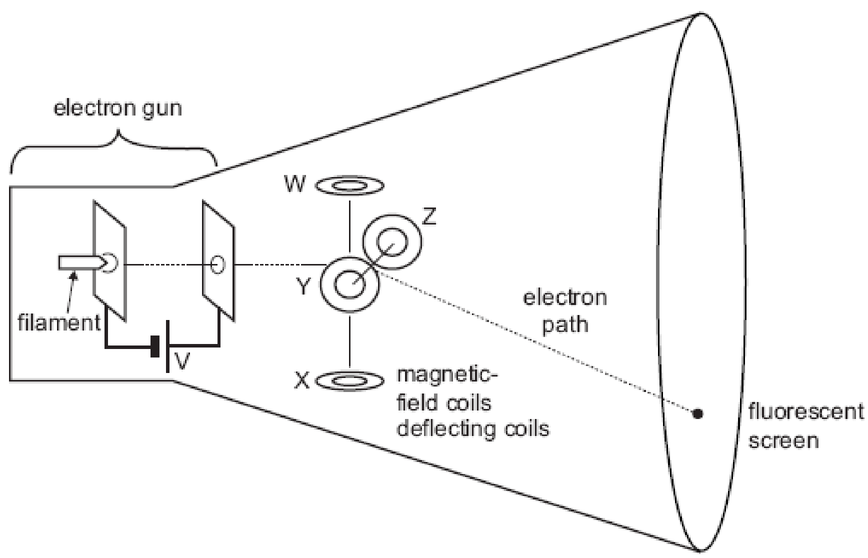
A. 0.30 m

B. 3.0 m

C. 4.6 m

D. 34 m

A typical cathode ray tube is shown below. It consists of an electron gun, a deflecting system and a fluorescent screen that emits light when struck by electrons.



The electron gun consists of a filament that emits electrons with very small kinetic energy into an electric field created by a high voltage, V, applied between a pair of parallel plates. In a particular case the electrons emerge from the gun with an energy of 8.0×10^{-16} J.
Charge on the electron: e = .1.6×10^{-19} C

Example 7 (2005 Question 8, 2 marks) 47%

After acceleration, the electrons enter the magnetic-deflecting system which consists of two pairs of mutually perpendicular magnetic-field coils (W and X), (Y and Z) aligned as shown above. The electrons are deflected **downwards**, as shown.
Choose one of the following options to complete the sentence.
The downward deflection can be achieved by the coils

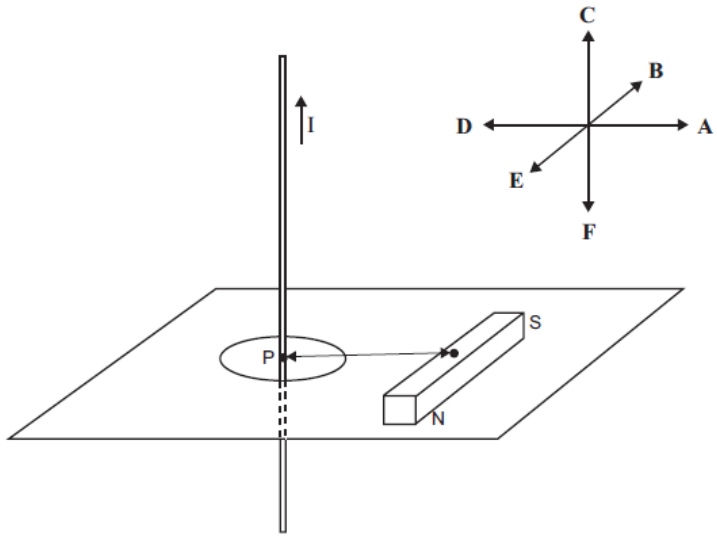
A. WX producing a magnetic field in direction W to X.

B. WX producing a magnetic field in direction X to W.

C. YZ producing a magnetic field in direction Y to Z.

D. YZ producing a magnetic field in direction Z to Y.

A vertical wire carrying a current I is placed opposite the centre of a permanent bar magnet as shown below.

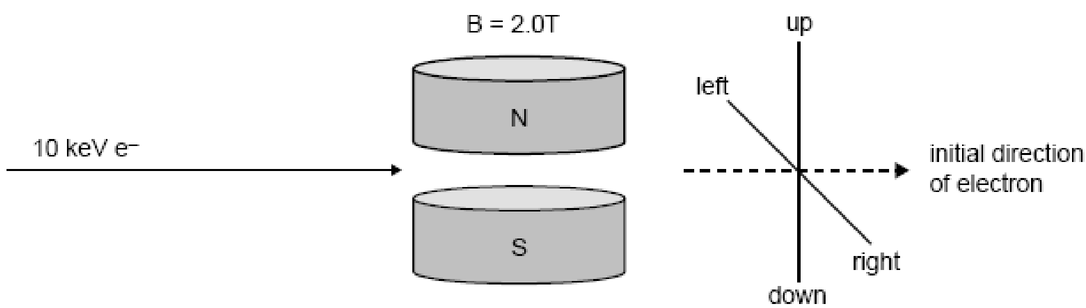


Example 8 (2005 Question 1, 2 marks) 83%

Which of the arrows **(A - F)** best shows the direction of the magnetic force on the wire at the point P?

Example 9 (2004 Pilot Question 5, 2 marks) 40%

A beam of 10 keV electrons enters a uniform magnetic field of strength 2.0T.



Which one of the following best describes the path of an electron as it passes through the magnetic field above?

A. the electron is deflected to the left

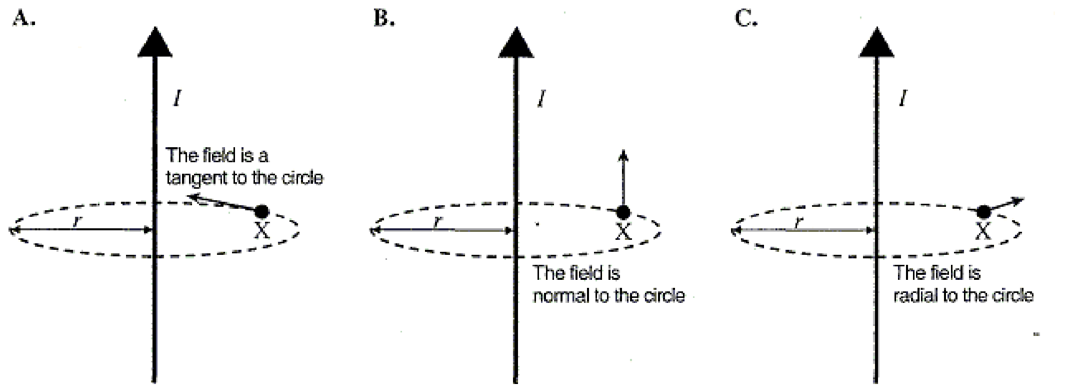
B. the electron is deflected to the right

C. the electron is deflected up

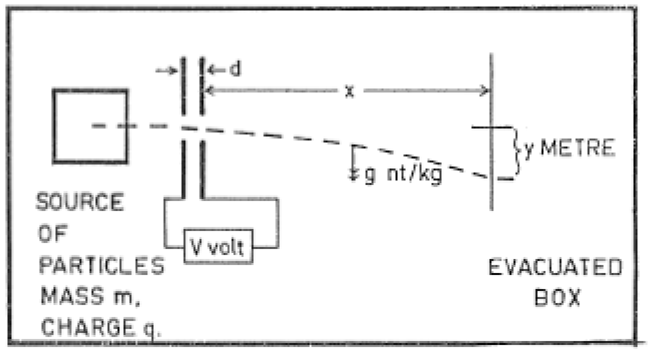
D. the electron is deflected down.

Example 10 (2000 Question 2, 2 marks)

Which **one** of the diagrams (A - C) best indicates the **direction** of the magnetic field at point X, a distance r from the lightning stroke? The direction of the current I is shown. The field at X is shown as an arrow.



A student knows that the masses of charged sub-atomic particles are generally determined from measurements based on their paths in electric and magnetic fields. He wonders whether the gravitational field of the earth could be used, and proposes the following apparatus.
The student proposes shielding the whole apparatus so that the effects due to the magnetic field of the earth are zero.



The particles, of mass *m* and charge *q,* travel between two plates *d* metre apart, across which a potential difference of *V* volt has been maintained. Each plate has a narrow hole, so that a well-defined beam of particles may pass to the right-hand end of the apparatus.

Example 11 (1967 Question 103, 1 mark) 79%

The velocity with which the particles emerge from the second parallel plate, *u* m/sec, is (neglecting the effect of gravity) equal to:

A. $\sqrt{\frac{2Vq}{m}}$

B. $\frac{Vq}{m}$

C. $\sqrt{\frac{Vqd}{m}}$

D. $\frac{V}{md}$

Example 12 (1967 Question 104, 1 mark) 72%

On leaving the system of plates, the particles travel a horizontal displacement of *x* metre. The gravitational field of the earth is *g* N / kg. This causes a vertical displacement of *y* metre, equal to

A. $\frac{u^2}{2g}$

B. $\frac{gx}{u}$

C. $\frac{gx^2}{u}$

D. $\frac{gx}{u^2}$

E. $\frac{gx^2}{2u^2}$

Example 13 (1967 Question 105, 1 mark) 49%

The student proposes to use a hot filament to emit electrons, and use a potential difference between the plates of 10 Volt. He wants to produce a vertical displacement, *y,* which is easily detectable (of the order 10^{-2} metre).
In order to achieve this, the length *x* would have to be about as long as

A. a classroom.

B. a. football field.

C. an aerodrome runway.

D. distance from Melbourne to Geelong.

Example 14 (1967 Question 106, 1 mark) 56%

The student admits the practical difficulty of his proposed apparatus, but still argues that it would be theoretically possible to determine the masses of charged sub-atomic particles by this method.
Four fellow students join in the discussion. Whose argument do you consider best?

A. Albert: "Yes, it would be theoretically possible. For a given potential difference across the plates, the velocity with which particles emerge is related to their mass, and for a given horizontal displacement their vertical displacement in the gravitational field is related to their velocity."

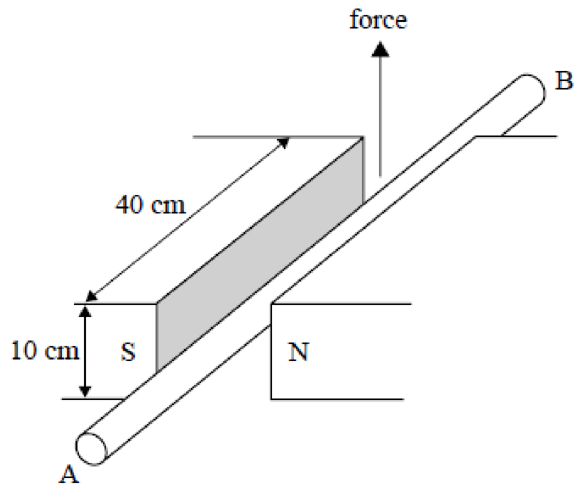
B. Brian: " I agree that it is theoretically possible. A given potential difference will cause all sub-atomic particles to emerge with the same speed; the particles then follow a parabolic path which is dependent on their mass."

C. Charles: "I don't think it would be possible. There would be no gravitational field inside the evacuated tube. On the other hand, if air were admitted, the particle beam would become diffuse due to collisions with air molecules."

D. David: "No, it would not be possible. In the absence of air resistance, all particles of a given speed follow the same parabolic path, regardless of mass, and therefore the amount of deflection would not allow determination of the mass."

Extended answer questions

The figure shows a magnet with pole pieces that are each 40 cm × 10 cm.
The uniform magnetic field strength between the poles is 2.0×10^{-3} T, and zero outside the poles.
A conducting wire, AB, carrying a current of 5.0 A, is placed between the poles as shown.
The force on the wire is upwards.



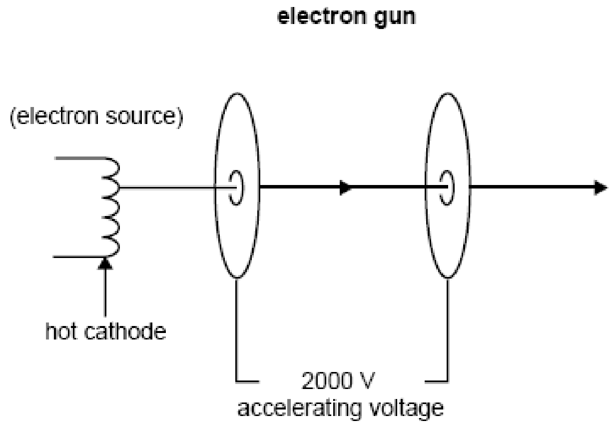
Example 15 (2008 Question 2, 2 marks) 90%

In which direction, AB or BA, is the current flowing in the wire?

Example 16 (2008 Question 3, 2 marks) 85%

What is the magnitude of the force on the wire?
Show working.

The figure below shows a simple electron gun used to inject electrons into the linac of a synchrotron. The accelerating voltage is 2000 V.
mass of electron = 9.11×10^{-31} kg, charge on electron = -1.60×10^{-19} C

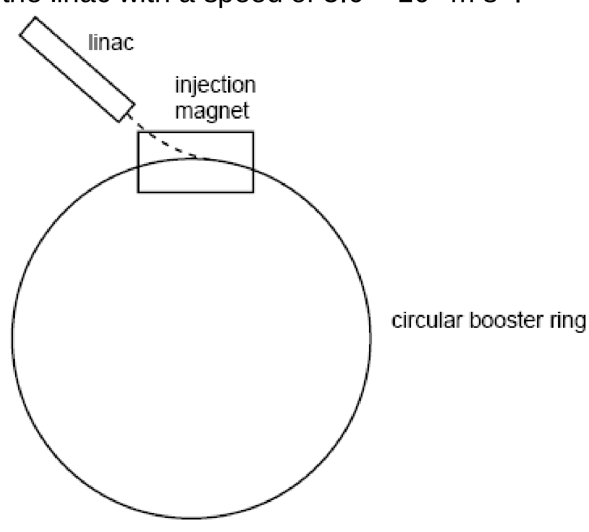


Example 17 (2007 Question 2, 2 marks) 65%

At what speed do the electrons emerge from the electron gun? (Ignore relativistic effects.)

Example 18 (2007 Question 3, 2 marks) 65%

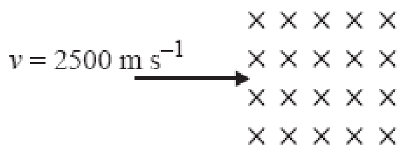
A magnet called an injection magnet of magnetic field strength 1.2×10^{-4} T bends a pulse of electrons emitted from the linac so that they enter the circular booster ring as shown below. The electrons emerge from the linac with a speed of 5.0×10^{6} m s^{-1}.



What is the magnitude of the radius of the trajectory of the electrons from the linac as they pass through the injection magnet?

Example 19 (2007 Question 5, 3 marks) 67%

In a synchrotron, an electron which is travelling at 2500 m s^{-1} moves from a linear region into a magnetic field of 0.50 T as shown below.



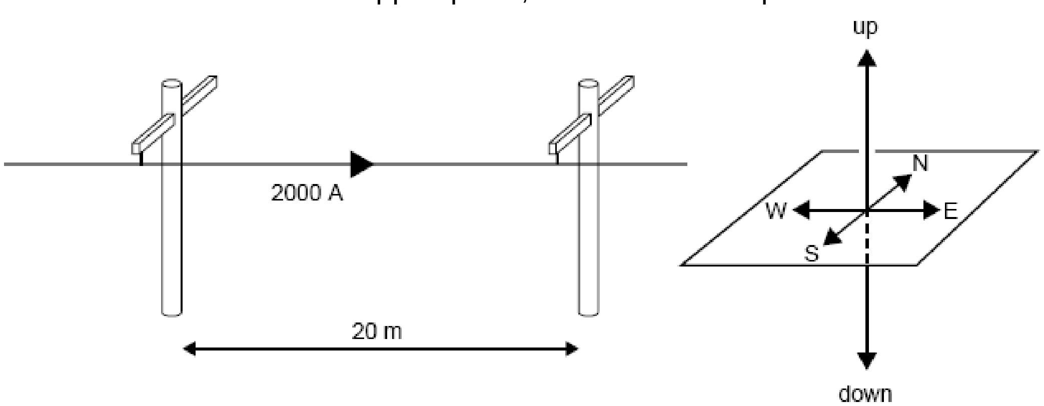
magnetic field into page

What will be the magnitude and direction (into page, out of page, up page, down page) of the force on the electron?

Example 20 (2007 Question 3, 2 marks) 80%

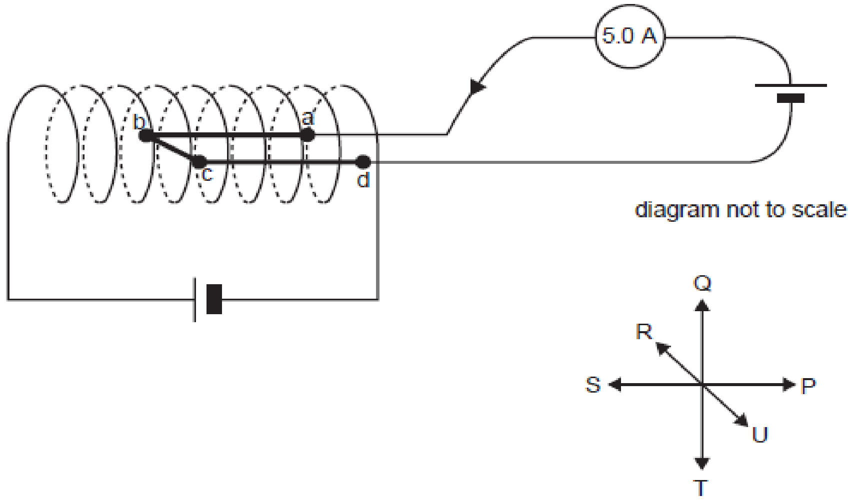
The figure below shows a power line at a mining site that carries a DC current of 2000 A running from west to east.

The earth's magnetic field at the mining site is 4.0×10^{-5}T, running horizontally from south to north. An engineer is concerned about the electromagnetic force due to the earth's magnetic field on the wire between the two support poles, which are 20 m apart.



Calculate the magnitude and direction (north, south, east, west, up, down) of the force due to the earth's magnetic field on the 20 m section of wire between the two poles.

The magnetic field strength in the solenoid is 2.0×10^{-2} T (Wb m^{-2}). A U-shaped conducting wire (a, b, c, d), carrying a current of 5.0 A in the direction a →d, is placed inside the solenoid as shown below.
The highlighted segment, **abcd**, of size 6.0 cm × 2.0 cm is completely immersed in the magnetic field as shown.



Use the key, PQRSTU, to indicate direction. If there is no direction, write **none**.

Example 21 (2006 Question 2, 2 marks) 60%

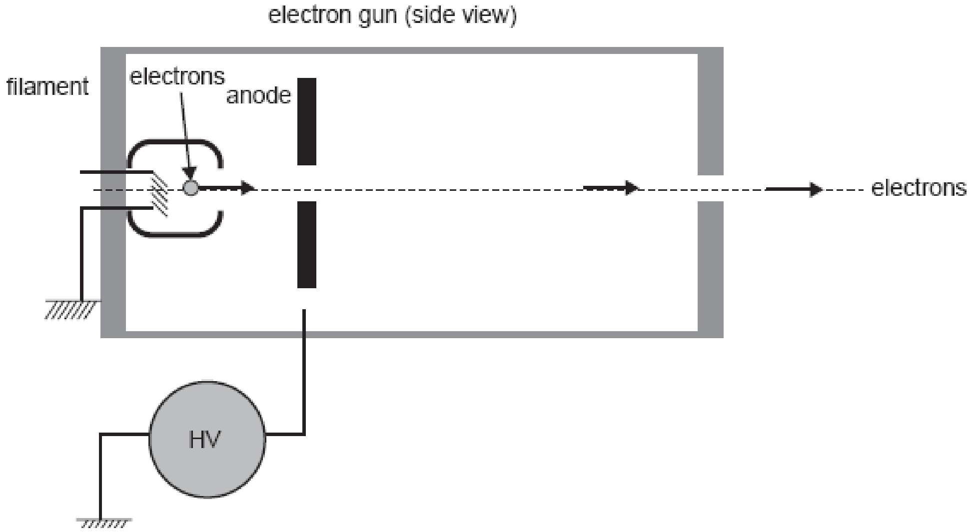
What is the force (magnitude and direction) on the 6.0 cm section of wire, **cd**?

Example 22 (2006 Question 3, 2 marks) 60%

What is the force (magnitude and direction) on the 2.0 cm section of wire, **bc**?

Example 23 (2006 Question 7, 3 marks) 58%

A simplified set-up for an electron gun is shown below. It contains a high-voltage source (HV). In normal operation, electrons emerge from the gun with energies of 5 keV.



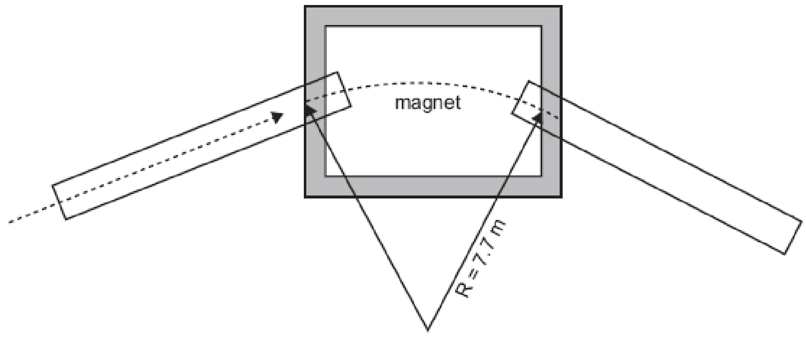
Calculate the velocity for electrons of energy 5 keV.
(m_e = 9.11 × 10^{-31} kg)

Example 24 (2006 Question 8, 3 marks) 58%

As high-energy electrons pass through one of the bending magnets in the Australian Synchrotron Facility, they are bent through an arc of radius 7 m. The magnetic field strength is 1.7 T (Wb m^{-2}).

Use the information above to determine the momentum of the electrons. Include a unit in your answer. (Ignore any relativistic effects in your calculation.)

One section of a storage ring is shown below. Electrons travelling through this section of the storage ring have a momentum of approximately 1.2 × 10^{-18} kg m s^{-1} and are bent through an arc of radius 7.7 m as shown. The charge on the electron is .1.6 × 10^{-19} C.

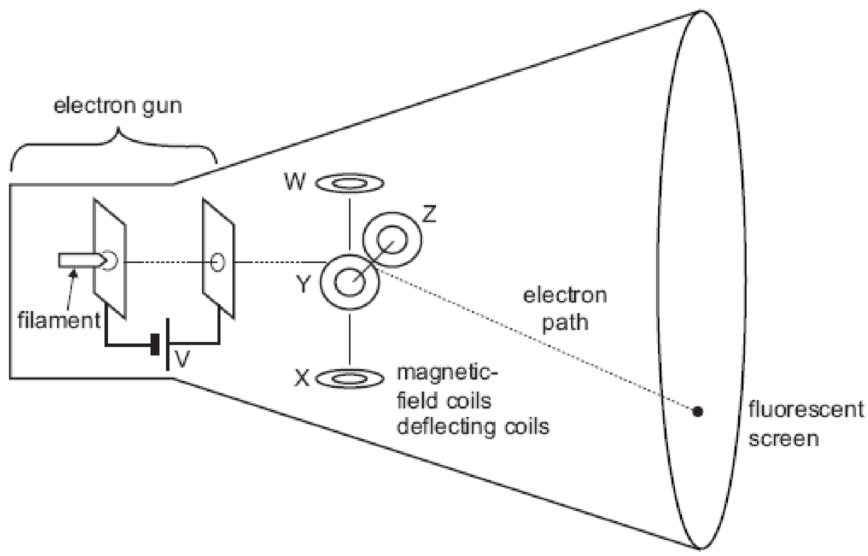


Example 25 (2005 Question 2, 2 marks) 62%

Calculate the strength of the magnetic field required to keep the electrons on this arc.

Example 26 (2005 Question 7, 2 marks) 49%

A typical cathode ray tube is shown below. It consists of an electron gun, a deflecting system and a fluorescent screen that emits light when struck by electrons.



The electron gun consists of a filament that emits electrons with very small kinetic energy into an electric field created by a high voltage, V, applied between a pair of parallel plates. In a particular case the electrons emerge from the gun with an energy of 8.0×10^{-16} J.
Charge on the electron: e = $.1.6 \times 10^{-19}$ C

Calculate the voltage, V, between the plates, used to accelerate the electrons.

Example 27 (2004 Pilot Question 6, 3 marks) 55%

Show that the velocity for 10 keV electrons is approximately 6×10^{7} m s^{-1}.
($m_e = 9.1 \times 10^{-31}$ kg)

Example 28 (2004 Pilot Question 7, 3 marks) 55%

Determine the radius of curvature of 10 keV electrons as they travel through a magnetic field of 2.0 T.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2}.

✓ **Question 1**

Engineers are measuring the force due to Earth's magnetic field on the supply wire of a railway line. The wire runs east–west and carries a current of 2000 A. Earth's magnetic field is horizontal and due north at the place where measurements are taken.

The engineers measure the force on a 10 m length of the wire to be 1.0 N.

Which one of the following best gives the strength of Earth's magnetic field at this point?

A. 2.0×10^{-8} T

B. 5.0×10^{-5} T

C. 5.0×10^{-4} T

D. 200 T

✓ **Question 3** (6 marks)

A uniform electric field accelerates protons from rest to a speed of 5.00×10^7 m s^{-1}.

Data

mass of proton	1.67×10^{-27} kg
charge on proton	$+1.60 \times 10^{-19}$ C

a. The protons then pass into a region of uniform magnetic field that is at right angles to their velocity. They are bent into a circular path.

Explain why the path is circular in shape. 3 marks

b. The strength of the uniform magnetic field is 500 mT.

Calculate the magnitude of the magnetic force on the protons. 3 marks

N

Use the following information to answer Questions 2 and 3.

A powerline carries a current of 1000 A DC in the direction east to west. At the point of measurement, Earth's magnetic field is horizontally north and its strength is 5.0×10^{-5} T.

✓ **Question 2**

Which one of the following best gives the direction of the electromagnetic force on the powerline?

A. horizontally west

B. horizontally north

C. vertically upwards

D. vertically downwards

✓ **Question 3**

The magnitude of the force on **each metre** of the powerline is best given by

A. 5.0×10^{3} N

B. 5.0×10^{2} N

C. 5.0×10^{-2} N

D. 5.0×10^{-5} N

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.
Where an answer box is provided, write your final answer in the box.
If an answer box has a unit printed in it, give your answer in that unit.
In questions where more than one mark is available, appropriate working **must** be shown.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

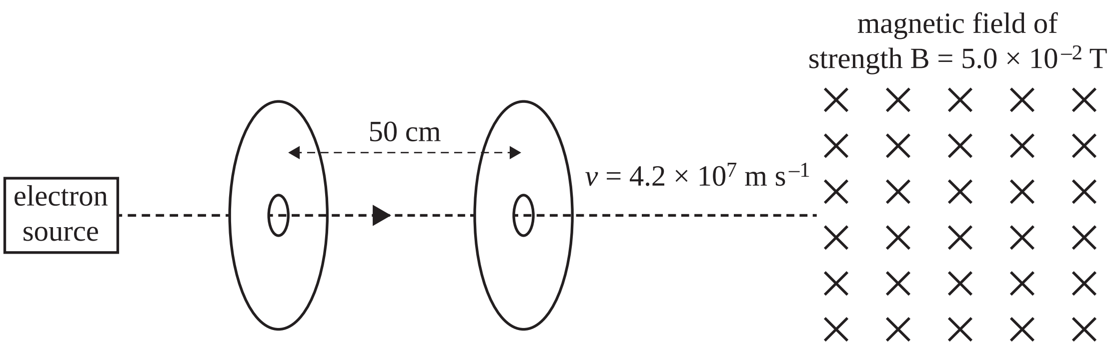
Question 1 (7 marks)

Electrons are accelerated from rest between two plates that are 50 cm apart, as shown in Figure 1.
The electrons emerge from the second plate at a speed, v, of 4.2×10^7 m s^{-1}.

Ignore relativistic effects.

Data

mass of electron	9.1×10^{-31} kg
charge on electron	-1.6×10^{-19} C



The electrons enter a region of uniform magnetic field of strength $B = 5.0 \times 10^{-2}$ T that is at right angles to their path.

✓ **b.** Calculate the magnitude of the force on each electron. Show your working. 2 marks

N

✓ **c.** Will the path of the electrons in this region of uniform magnetic field be a straight line, part of a parabola or part of a circle? Give a reason for your answer. 2 marks

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.
Where an answer box is provided, write your final answer in the box.
If an answer box has a unit printed in it, give your answer in that unit.
In questions where more than one mark is available, appropriate working **must** be shown.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

Question 1 (3 marks)

A particle of mass m and charge q travelling at velocity v enters a uniform magnetic field B, as shown in Figure 1.

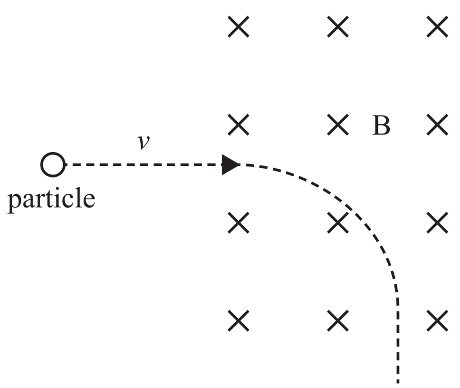


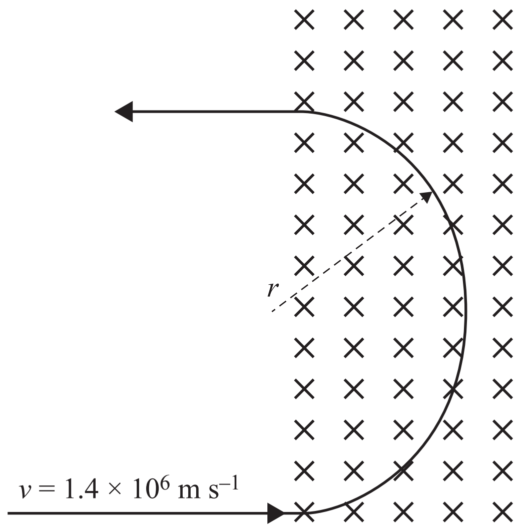
Figure 1

a. Is the charge q positive or negative? Give a reason for your answer. 1 mark

b. Explain why the path of the particle is an arc of a circle while the particle is in the magnetic field. 2 marks

Use the following information to answer Questions 3 and 4.

A positron with a velocity of 1.4×10^6 m s^{-1} is injected into a uniform magnetic field of 4.0×10^{-2} T, directed into the page, as shown in the diagram below. It moves in a vacuum in a semicircle of radius r. The mass of the positron is 9.1×10^{-31} kg and the charge on the positron is 1.6×10^{-19} C. Ignore relativistic effects.



Question 3

Which one of the following best gives the speed of the positron as it exits the magnetic field?

A. 0 m s^{-1}

B. much less than 1.4×10^6 m s^{-1}

C. 1.4×10^6 m s^{-1}

D. greater than 1.4×10^6 m s^{-1}

Question 4

The speed of the positron is changed to 7.0×10^5 m s^{-1}.

Which one of the following best gives the value of the radius r for this speed?

A. $\frac{r}{4}$

B. $\frac{r}{2}$

C. r

D. $2r$

Question 3 (6 marks)

Electron microscopes use a high-precision electron velocity selector consisting of an electric field, E, perpendicular to a magnetic field, B.

Electrons travelling at the required velocity, v_0, exit the aperture at point Y, while electrons travelling slower or faster than the required velocity, v_0, hit the aperture plate, as shown in Figure 2.

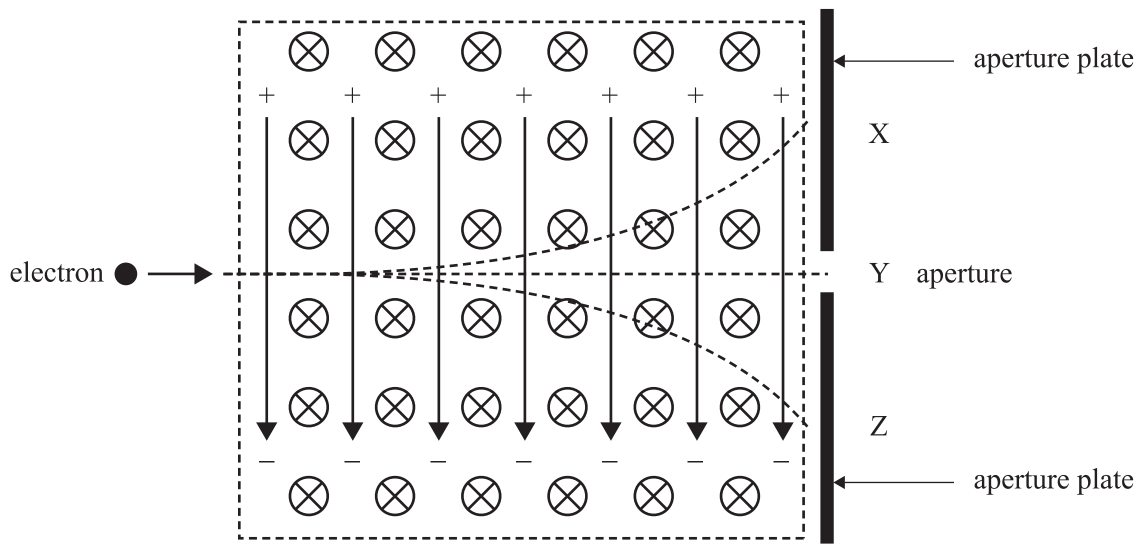


Figure 2

a. Show that the velocity of an electron that travels straight through the aperture to point Y is given by $v_0 = \frac{E}{B}$. 1 mark

b. Calculate the magnitude of the velocity, v_0, of an electron that travels straight through the aperture to point Y if $E = 500$ kV m^{-1} and $B = 0.25$ T. Show your working. 2 marks

m s^{-1}

c. **i.** At which of the points – X, Y or Z – in Figure 2 could electrons travelling faster than v_0 arrive? 1 mark

ii. Explain your answer to **part c.i.** 2 marks

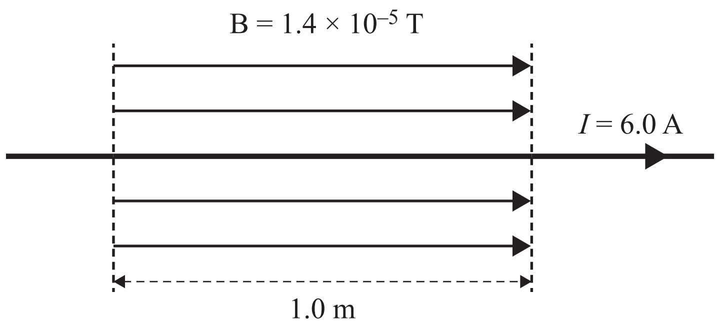
SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

Question 1

A wire carrying a current, I, of 6.0 A passes through a magnetic field, B, of strength 1.4×10^{-5} T, as shown below. The magnetic field is exactly 1.0 m wide.



The magnitude of the force on the wire is closest to

A. 0 N
B. 2.3×10^{-6} N
C. 8.4×10^{-5} N
D. 4.3×10^{5} N

Question 2 (8 marks)

An electron is accelerated from rest by a potential difference of V_0. It emerges at a speed of 2.0×10^7 m s^{-1} into a magnetic field, B, of strength 2.5×10^{-3} T and follows a circular arc, as shown in Figure 2.

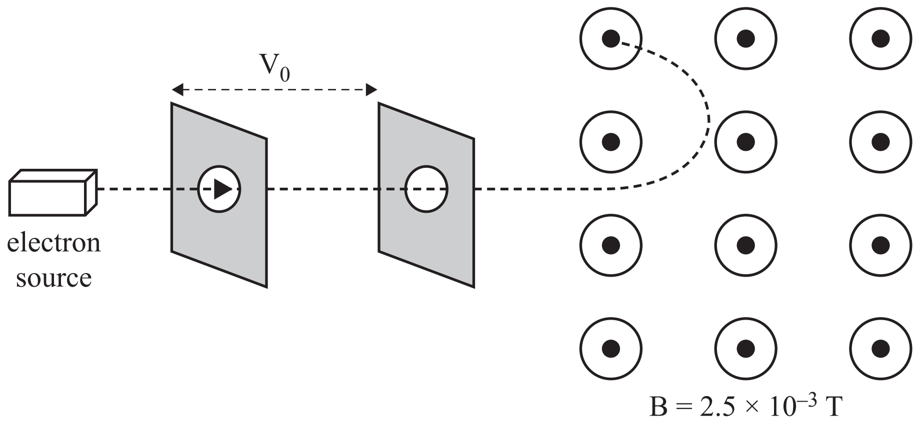


Figure 2

b. Explain why the path of the electron in the magnetic field follows a circular arc. 2 marks

c. Calculate the radius of the path travelled by the electron. Show your working. 3 marks

m

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.

Where an answer box is provided, write your final answer in the box.

If an answer box has a unit printed in it, give your answer in that unit.

In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the value of *g* to be 9.8 m s^{-2}.

Question 1 (3 marks)

Two identical bar magnets of the same magnetic field strength are arranged at right angles to each other and at the same distance from point P, as shown in Figure 1.

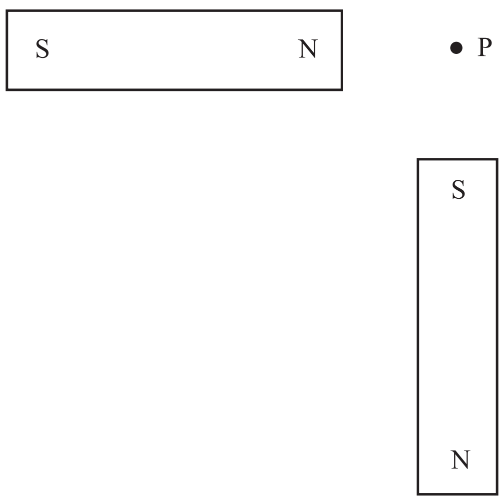


Figure 1

a. At point P on Figure 1, draw an arrow indicating the direction of the combined magnetic field of the two bar magnets. 1 mark

b. Calculate the magnitude of the combined magnetic field strength of the two bar magnets if each bar magnet has a magnetic field strength of 10.0 mT at point P. 2 marks

mT

Question 2 (4 marks)

A schematic side view of one design of an audio loudspeaker is shown in Figure 2. It uses a current carrying coil that interacts with permanent magnets to create sound by moving a cone in and out.

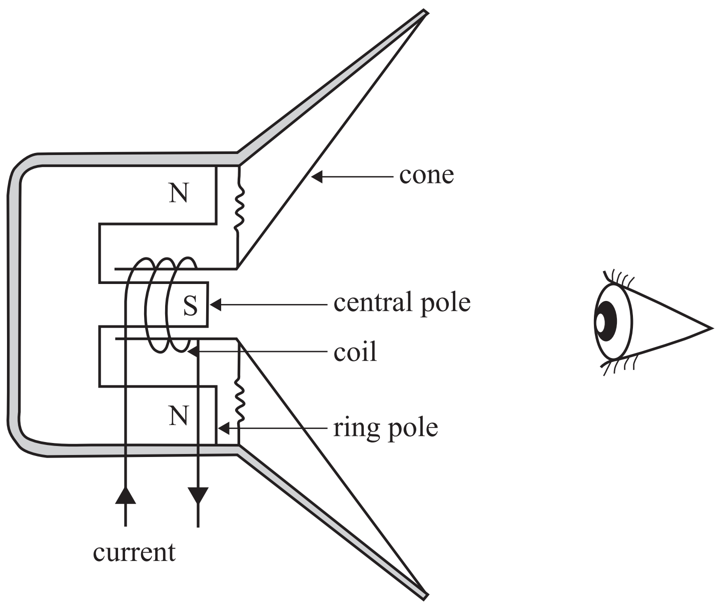


Figure 2

Figure 3 shows a schematic view of the loudspeaker from the position of the eye shown in Figure 2. The direction of the current is clockwise, as shown.

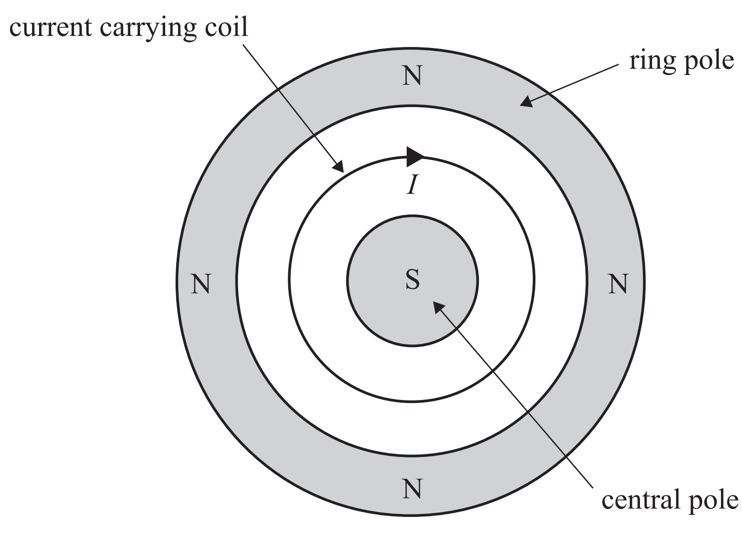


Figure 3

a. Draw **four** magnetic field lines on Figure 3, showing the direction of each field line using an arrow. 1 mark

b. Which one of the following gives the direction of the force acting on the current carrying coil shown in Figure 3? 1 mark

A. left **B.** right
C. up the page **D.** down the page
E. into the page **F.** out of the page

c. The current carrying coil has a radius of 5.0 cm and 20 turns of wire, and it carries a clockwise current (I) of 2.0 A. Its magnetic field strength (B) is 200 mT.

Calculate the magnitude of the force, F, acting on the current carrying coil. Show your working. 2 marks

N

Question 5 (9 marks)

Figure 5 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.

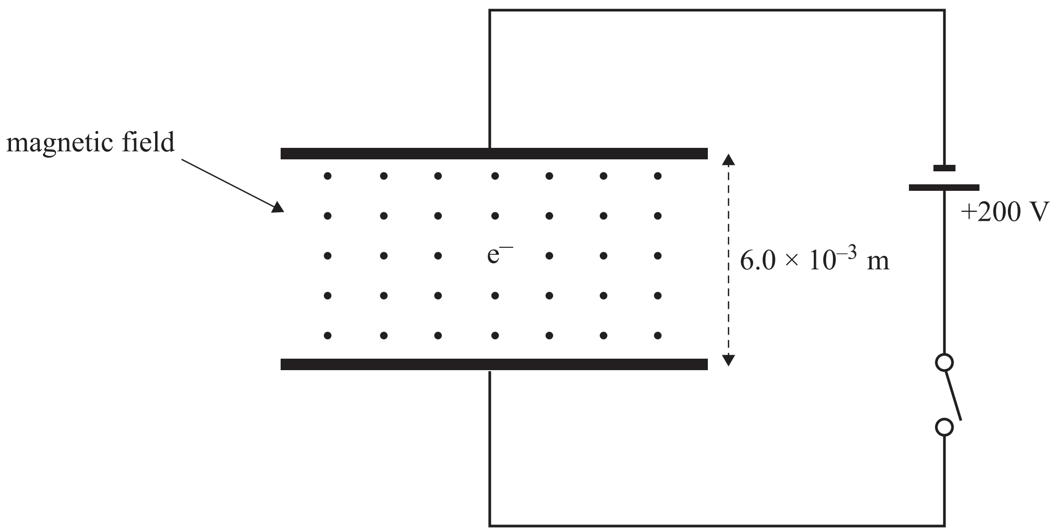


Figure 5

a. Explain why the magnetic field does not exert a force on the electron. Justify your answer with an appropriate formula. 2 marks

___

___

___

The switch is now closed.

c. 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. 4 marks

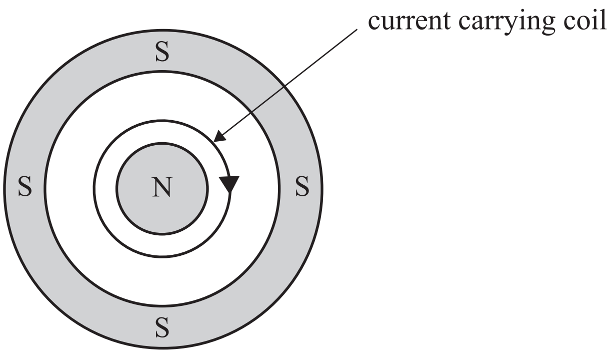
SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of *g* to be 9.8 m s^{-2}.

Question 2

A loudspeaker consists of a current carrying coil within a radial magnetic field, as shown in the diagram below. The direction of the current in the coil is also shown.



Which one of the following best describes the direction of the force on the coil?

A. out of the page
B. down the page
C. into the page
D. up the page

Question 3 (4 marks)

A positron and an electron are fired one at a time into a strong uniform magnetic field in an evacuated chamber. They are fired at the same speed but from opposite sides of the chamber.

Their initial velocities are initially perpendicular to the magnetic field and opposite in direction to each other, as shown in Figure 1.

A positron has the same mass as an electron (9.1×10^{-31} kg) and has the same magnitude of electric charge as an electron (-1.6×10^{-19} C) but is positively charged ($+1.6 \times 10^{-19}$ C).

On Figure 1, sketch and label the respective paths that the positron and the electron will take while in the uniform magnetic field.

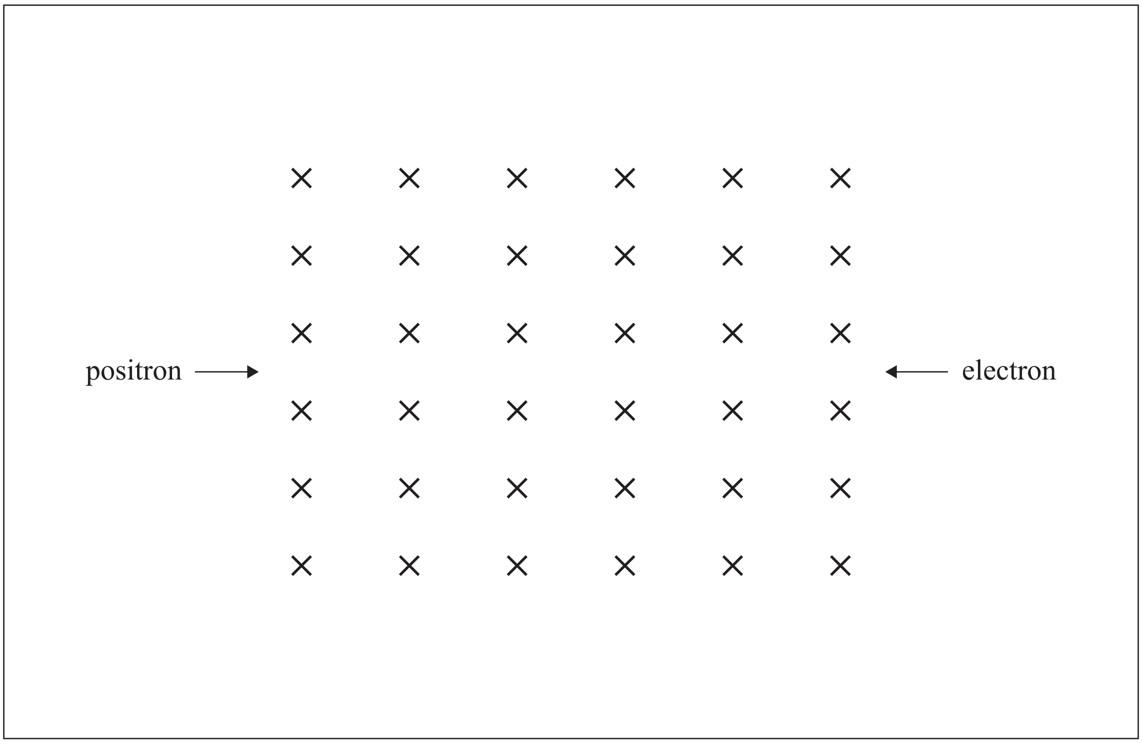


Figure 1

SECTION A – Multiple-choice questions

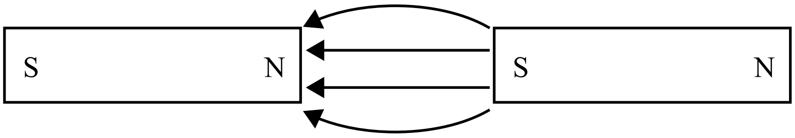
Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

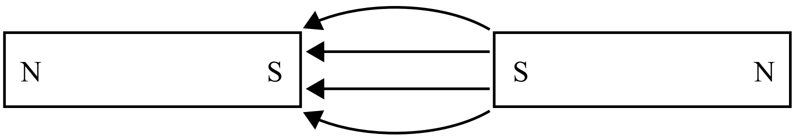
Question 1

Which one of the following diagrams best represents the magnetic field between two magnets?

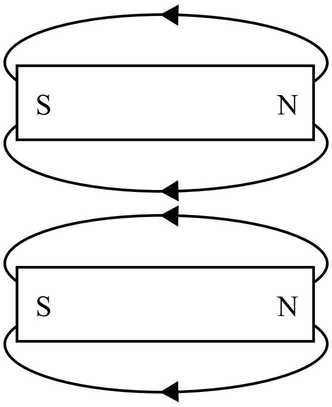
A.



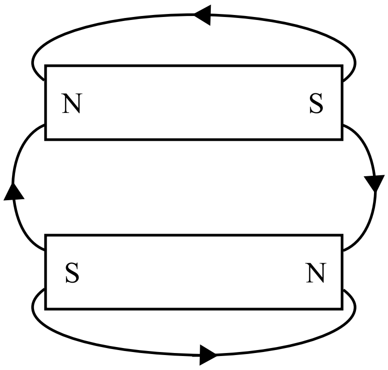
B.



C.



D.



Question 3 (3 marks)

Two thin, light aluminium tubes, A and B, are supported in a vertical wooden rack, as shown in Figure 3. Both of the aluminium tubes rest horizontally on wooden pegs.

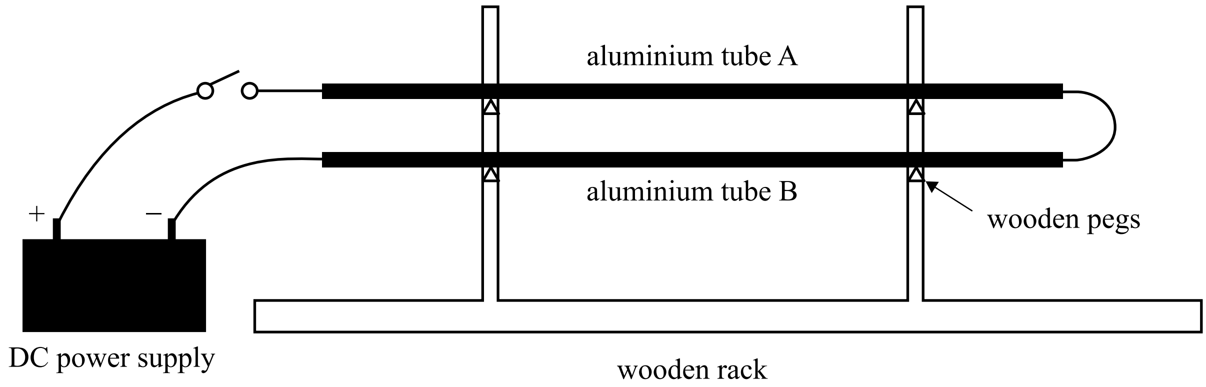


Figure 3

The two thin, light aluminium tubes form a series circuit with a DC power supply. It was observed that one of the tubes jumped upwards when the DC power supply was switched on.

Identify which tube jumped upwards and explain why this occurred.

Aluminium tube

Question 4 (4 marks)

Two electrons, e_1 and e_2, are emitted, one after the other, from point P in a uniform magnetic field, as shown in Figure 4.

Both electrons travel perpendicular to the magnetic field, but in opposite directions. Throughout their journey, both electrons remain within the magnetic field.

Electron e_1 travels at twice the speed of e_2. Relativistic effects can be ignored as both electrons are travelling at low speeds. Electrostatic effects at point P can be ignored as the two electrons are emitted at different times.

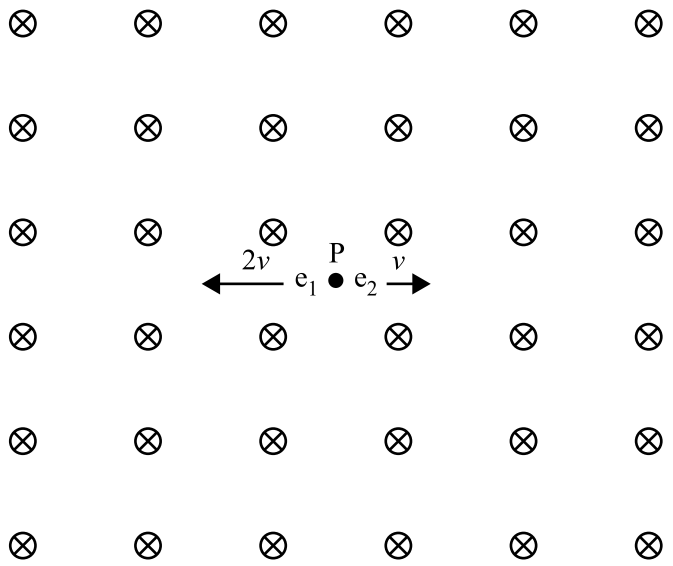


Figure 4

Which one of the following three outcomes occurs?

- Outcome 1 – Electron e_1 returns to point P in the shortest time.
- Outcome 2 – Electron e_2 returns to point P in the shortest time.
- Outcome 3 – Both electrons take the same time to return to point P.

Outcome

Explain your answer.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

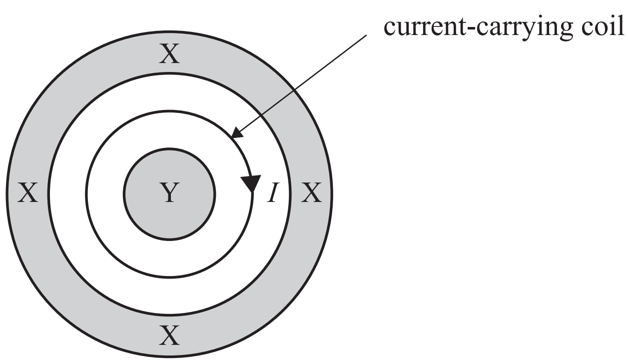
No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2}.

Question 1

One type of loudspeaker consists of a current-carrying coil within a radial magnetic field, as shown in the diagram below. X and Y are magnetic poles, and the direction of the current, I, in the coil is clockwise as shown.



The force, F, acting on the current-carrying coil is directed into the page.

Which one of the following statements correctly identifies the magnetic polarities of X and Y?

A. X is a north pole and Y is a south pole.

B. X is a south pole and Y is a north pole.

C. Both X and Y are north poles.

D. Both X and Y are south poles.

Question 3 (5 marks)

Two long, straight current-carrying wires, P and Q, are parallel, as shown in Figure 2a. The current in the wires is the same in magnitude and opposite in direction.

Figure 2b shows the wires as viewed from above.

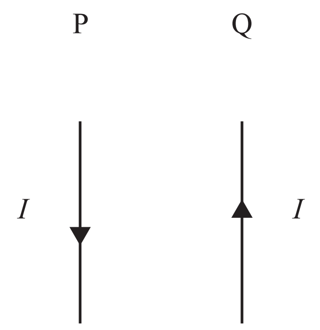


Figure 2a – Front view

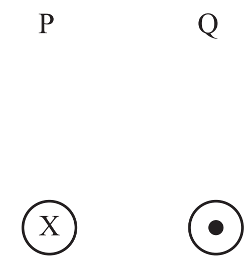


Figure 2b – Top view

a. On Figure 2b, sketch the magnetic field around the wires, showing the direction of the magnetic field. Use at least five field lines. 3 marks

b. Do the two wires, P and Q, attract or repel each other? Explain your reasoning. 2 marks