Solutions
Multiple Choice
Example 1 2009 Question 5, 86%
Use F = Bqv
$\therefore$ $F = 2.4 \times 10^{-4} \times 1.6 \text{ x } 10^{-19} \times 8.4 \text{ x } 10^{7}$
$= 3.2 \times 10^{-15}$ N
$\therefore$ C (ANS)

Example 2 2009 Question 6, 79%
Use $Bq = \frac{mv}{r}$ to get $r = \frac{mv}{Bq}$
$\therefore$ $r = \frac{9.1 \times 10^{-31} \times 8.4 \text{ x } 10^{7}}{2.4 \times 10^{-4} \times 1.6 \times 10^{-19}}$ $\therefore$ r = 2.0 m.
$\therefore$ D (ANS)

Example 3 2009 Question 7, 51%
Use Hand rule: Force in direction B, Current: backwards as electrons are negative.
$\therefore$ D (ANS)

Example 4 2008 Question 1, 76%
First find the energy the electron gains as it passes through the potential difference of 5000 V.
E = Vq
$E = 5000 \times 1.6 \times 10^{-19}$
$E = 8.0 \times 10^{-18}$ J
The energy gained by the electron is in the form of kinetic energy.
To find the speed of the electrons use:
$E_k = \frac{1}{2} mv^2$
$\therefore$ $8.0 \times 10^{-18} = \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$
$\therefore$ $v = 4.2 \times 10^{7}$ m s^{-1}
$\therefore$ B (ANS)

Example 5 2008 Question 2, 88%
Use F = evB
$F = 1.6 \times 10^{-19} \times 4.00 \times 10^{7} \times 7.60 \times 10^{-4}$
$\therefore$ $F = 4.86 \times 10^{-15}$
$\therefore$ C (ANS)

Example 6 2008 Question 3, 82%

Use $r = \frac{mv}{eB}$

$$r = \frac{9.1\times10^{-31}\times4.00\times10^{7}}{1.6\times10^{-19}\times7.60\times10^{-4}}$$

∴ r = 0.30 m

∴ **A (ANS)**

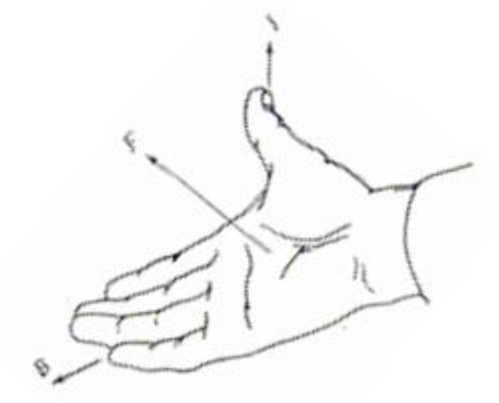
Example 7 2005 Question 8, 47%

You need to use the right hand slap rule for this. The electrons are moving to the right, so you thumb needs to point to the left (electrons are negative, thumb is positive current). The deflection is down so your palm must face down the page. Your fingers should now be pointing into the page, thus the magnetic field would be into the page, from Y to Z.

∴ **C (ANS)**

Example 8 2005 Question 1, 83%

Using the right hand rule, the hand is opened flat and the fingers are aligned with the magnetic field. The thumb is pointed in the direction of current flow and the palm is now facing the direction of the force.



In this case current (thumb) is up, the field from the magnet (going from N to S is into the page (at point P) so the force is in direction D.

∴ **D (ANS)**

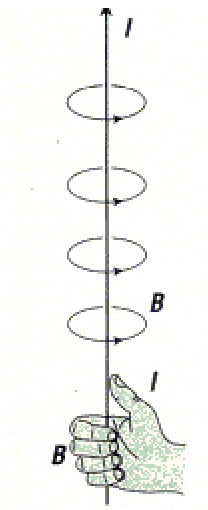
You need to be careful and make sure that you use your right hand and that you get all the directions correct.

Example 9 2004 Pilot Question 5, 40%

Use the right hand slap rule. The electrons are moving to the right, so your thumb points to the left (electrons are negative, thumb is positive current). The magnetic field is down the page (N to S) so your fingers should face down the page. Your palm should now be facing out of the page. Look at the diagram to the right of the picture and see that out of the page means the electrons are deflected to the right.

∴ **B (ANS)**

Example 10 2000 Question 2,



$\therefore$ **A** **(ANS)**

Example 11 1967 Question 103, 79%

Use WD = qV = $\frac{1}{2}mv^2$

$\therefore v^2 = \frac{2qV}{m}$

$\therefore v = \sqrt{\frac{2qV}{m}}$

$\therefore$ **A** **(ANS)**

Example 12 1967 Question 104, 72%

The distance that it will fall is given by

$y = u_{vertical}t + \frac{1}{2}gt^2$

where $u_{vertical} = 0$.

To find 't', consider the horizontal motion.

Use $u = \frac{x}{t}$

$\therefore t = \frac{x}{u}$

$\therefore y = 0 + \frac{1}{2} \times g \times \left(\frac{x}{u}\right)^2$

$\therefore y = \frac{gx^2}{2u^2}$

$\therefore$ **E** **(ANS)**

Example 13 1967 Question 105, 49%

If $y = \frac{gx^2}{2u^2}$ and $v = \sqrt{\frac{2qV}{m}}$ when we combine these two we get

$$y = \frac{gx^2}{2\left(\frac{2qV}{m}\right)}$$. Rearranging gives

$$x^2 = \frac{4qVy}{gm}$$.

On substitution of V = 10 V and y ~ 1 cm, we get

$$x^2 = \frac{4 \times 1.6 \times 10^{-19} \times 10 \times 1.0 \times 10^{-2}}{9.8 \times 9.1 \times 10^{-31}}$$

$\therefore$ $x^2 = 7.2 \times 10^9$

$\therefore$ x = 85 000 m

$\therefore$ 85 km

$\therefore$ **D (ANS)**

Example 14 1967 Question 106, 56%

The deflection is due to the acceleration, not the force.

$\therefore$ **D (ANS)**

Extended response

Example 15 2008 Question 2, 90%

Using the right hand rule, the hand is opened flat and the fingers are aligned with the magnetic field. The thumb is pointed in the direction of current flow and the palm is now facing the direction of the force.

Use the right – hand slap rule and you will see that the direction of the current is from A to B

$\therefore$ **AB (ANS)**

Example 16 2008 Question 3, 85%

It was important to see that the length of wire in the magnetic field was 40 cm or 0.4 m from the diagram.

F = BIL

$= 2.0\times10^{-3} \times 5.0 \times 0.4$

$= 4.0\times10^{-3}$ N (ANS)

Example 17 2007 Question 2, 65%

The amount of energy supplied to an electron as it passes through the potential difference can be found by using E = VQ. Since this energy is going to be the kinetic energy and the charge on an electron is e (1.60×10^{-19}) we can write: $eV = \frac{1}{2}mv^2$

$\therefore$ $1.6 \times 10^{-19} \times 2000 = \frac{1}{2} \times 9.11 \times 10^{-31} \times v^2$

$\therefore$ $v^2 = 7.025 \times 10^{14}$

$\therefore$ **$v = 2.65 \times 10^7$ m s^{-1} (ANS)**

Example 18 2007 Question 3, 65%

To find the radius you need to use the following equation:

$\therefore r = \frac{mv}{eB}$

$\therefore r = \frac{9.1\times10^{-31}\times5.0\times10^{6}}{1.6\times10^{-19}\times1.2\times10^{-4}}$

$\therefore$ **r = 0.24 m (ANS)**

Example 19 2007 Question 5, 67%

Use: F = evB

$\therefore F = 1.6 \times 10^{-31} \times 2500 \times 0.5$

$\therefore$ **F = 2.0 × 10^{-16} N down (ANS)**

To find the direction of the force you need to use the right hand slap rule. Be careful, the electrons are moving from left to right, so the conventional current flows from right to left (Thumb points to the left). The magnetic field is into the page (fingers point into the page). Therefore the force is downward (the palm is down).

Example 20 2007 Question 3, 80%

Use F = nBil,

Where n = 1, B = 4.0 × 10^{-5} T, I = 2000.0 A, and L = 20 m.

$\therefore F = 1 \times 4.0 \times 10^{-5} \times 2000 \times 20$

$\therefore$ **F = 1.6 N. (ANS)**

The field is in the N direction, the current is to the left, hence the force is **UP. (ANS)**

Example 21 2006 Question 2, 60%

cd is parallel to the field, B.

∴experiences no magnetic force.

∴ **0 N (ANS)**

Example 22 2006 Question 3, 60%

bc is perpendicular to the field, B

Therefore force is given by

F = BIL

$= 2.0\times10^{-2} \times 5.0 \times 0.020$

= 2.0×10^{-3} N, direction Q. (ANS)

Example 23 2006 Question 7, 58%

The electrons have 5 keV of energy.

Convert the eV's into joules, by multiplying by 1.6 × 10^{-19}

$\therefore E = 5000 \times 1.6 \times 10^{-19}$

$\therefore E = 8 \times 10^{-16}$ J

Use $E_k = \frac{1}{2}mv^2$ to find the velocity.

$8 \times 10^{-16} = \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$

$\therefore$ $v^2 = 1.76 \times 10^{15}$
$\therefore$ $v = 4.2 \times 10^{7}$ m s^{-1} (ANS)

Example 24 2006 Question 8, 58%
From the stem of the question you get
B = 1.7 T, r = 7 m, q = 1.6×10^{-19} C
Use

$$B = \frac{mv}{rq}$$

$\therefore$ mv = Brq
$\therefore$ mv = $1.7 \times 7 \times 1.6 \times 10^{-19}$
$\therefore$ $p = 1.9 \times 10^{-18}$ kg m s^{-1} (ANS)

Example 25 2005 Question 2, 62%

The magnetic field can be calculated by using $B = \frac{mv}{rq}$
Where mv = 1.2 × 10^{-18} kg m s^{-1}, r = 7.7 m,
q = 1.6 10^{-31} C

$$\therefore B = \frac{1.2\times10^{-18}}{7.7\times1.6\times10^{-19}}$$

$\therefore$ **B = 0.97 T (ANS)**

Example 26 2005 Question 7, 49%

Energy given to the electrons = 8.0 × 10^{-16} J the charge on an electron is 1.6 × 10^{-19} C. Using E = Vq, we get $V = \frac{E}{q}$

$$\therefore V = \frac{8.0\times10^{-16}}{1.6\times10^{-19}}$$

$\therefore$ **V = 5000 V (ANS)**

Example 27 2004 Pilot Question 6, 55%

Convert 10 keV to Joules by multiplying by 1.6 × 10^{-19}.
The electrons have 1.6 × 10^{-15} J of kinetic energy.

Using $E_k = \frac{1}{2}mv^2$

$$\therefore 1.6\times10^{-15} = \frac{1}{2}\times9.1\times10^{-31}\times v^2$$

$\therefore$ v^2 = 3.516 × 10^{15}

$\therefore$ **v = 5.93 × 10^7 m s^{-1} (ANS)**

Example 28 2004 Pilot Question 7, 55%

Use v = 5.93 × 10^7 m s^{-1}, m = 9.1 × 10^{-31} kg,
q = 1.6 × 10^{-19} C, B = 2.0 T

Rearranging $B = \frac{mv}{rq}$

$$\therefore r = \frac{mv}{Bq}$$

$$\therefore r = \frac{9.1\times10^{-31}\times5.93\times10^{7}}{2.0\times1.6\times10^{-19}}$$

$\therefore$ **r = 1.7 × 10^{-4} (ANS)**

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

$$F = BIL$$
$$B = \frac{F}{IL} = \frac{1}{2000 \times 10} = 5 \times 10^{-5}\ T$$

Question 2

Data

mass of Mercury	3.34×10^{23} kg
radius of Mercury	2.44×10^{6} m
universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}

The gravitational field strength at the surface of Mercury is close to

A. 9.00×10^{6} N kg^{-1}

B. 9.81 N kg^{-1}

C. 3.74 N kg^{-1}

D. 3.74×10^{-2} N kg^{-1}

✓ **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

As velocity is at right angle to the field, the force is at right angle to the velocity. Magnitude of the force remains constant. Constant force at right angle to the velocity results in circular motion.

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

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

$F = qvB$

$F = 0.5 \times 1.6 \times 10^{-19} \times 5 \times 10^7$

4.0×10^{-12} 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

RHS rule

✓ **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

$F = BIL$

$= 5 \times 10^{-5} \times 1000 \times 1$

$= 5 \times 10^{-2}$

Question 4

The gravitational field strength at the surface of Mars is 3.7 N kg^{-1}.

Which one of the following is closest to the change in gravitational potential energy when a 10 kg mass falls from 2.0 m above Mars's surface to Mars's surface?

A. 3.7 J

B. 7.4 J

C. 37 J

D. 74 J

Use the following information to answer Questions 5 and 6.

A light globe operates at 12 V_{RMS} AC that is supplied by a 240 V to 12 V transformer connected to a 240 V_{RMS} mains supply.

Question 5

In the transformer, the ratio of turns in the primary (input) to turns in the secondary (output) is

A. 20:1

B. 1:20

C. 28:1

D. 1:28

Question 6

If the light globe is to be operated using a battery instead of the mains supply, what voltage should the battery have for the light globe to operate correctly?

A. 12 V

B. 17 V

C. 8.5 V

D. 6.0 V

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

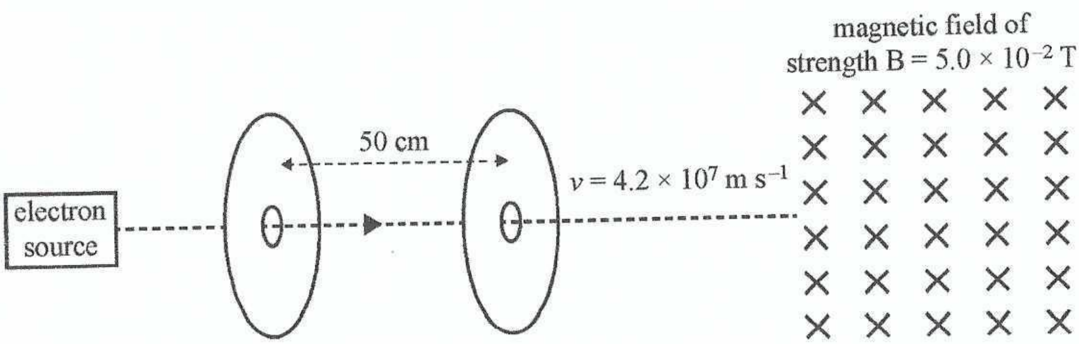


Figure 1

a. Calculate the voltage between the two plates. Show your working. 3 marks

____

____

____

____

V

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

$F = qvB$

$= 1.6 \times 10^{-19} \times 5 \times 10^{-2} \times 4.2 \times 10^{7}$

$= 3.4 \times 10^{-13}$

3.4×10^{-13} 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

Path will be part of a circle. As force remains constant and at the right angle to the velocity it will be circular motion.

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.

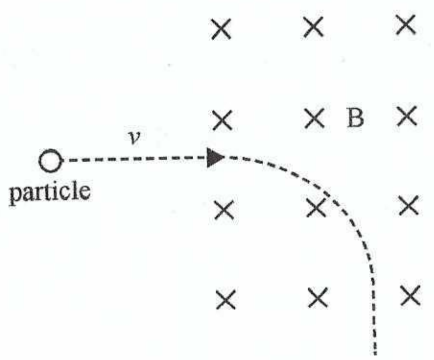


Figure 1

a. Is the charge q positive or negative? Give a reason for your answer. 44 % 1 mark

Negative

RHS rule B × v → ↓F

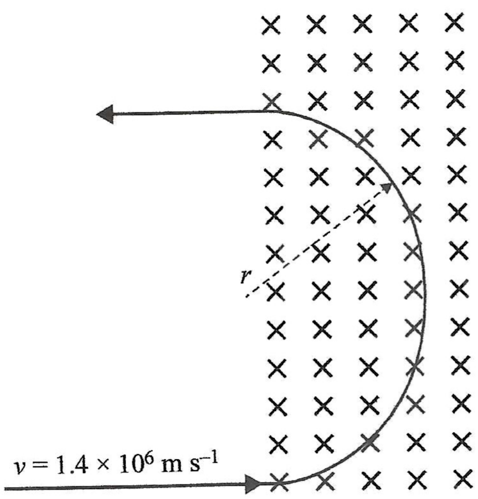
10 %

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

Magnitude of the force is constant and it will be always at the right angle to the velocity which results in a circular motion.

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 63%

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}

Force is always at right angle to the velocity so magnitude of the velocity stay constant

Question 4 58%

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. $2r$

$r = \frac{mv}{Bq}$ v↓ twice r↓ twice

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.

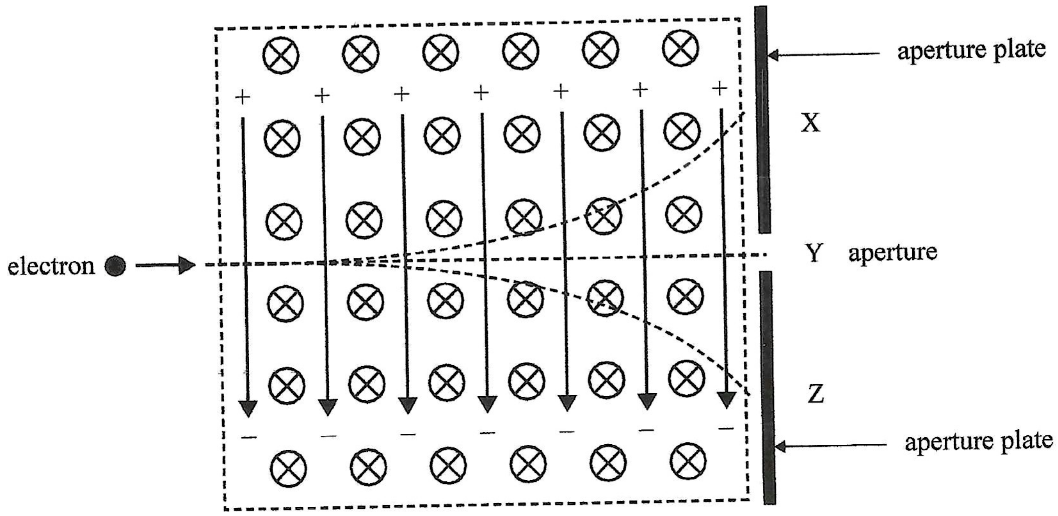


Figure 2

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

46 %

$F_{magnetic} = F_{electric}$ $\quad qv_0B = qE$

$v_0 = \frac{E}{B}$

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

75%

$v_0 = \frac{500 \times 10^3}{0.25}$

2×10^6 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

42%

Z

$v\uparrow \rightarrow F_{magnetic}\uparrow \rightarrow F_{down}\uparrow$

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

$F_e = const \quad F_m > F_e$

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.

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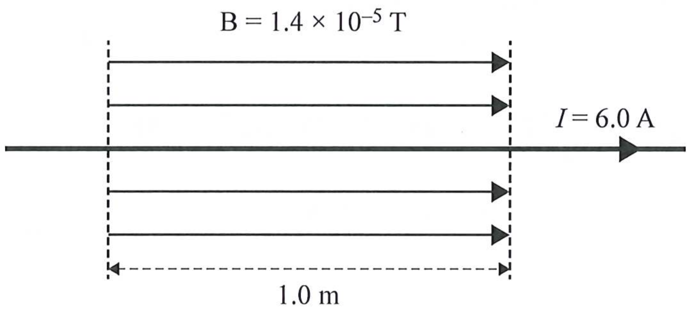
No marks will be given if more than one answer is completed for any question.

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

$\theta = 0°$ $F = BIL\sin\theta = 0$

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.

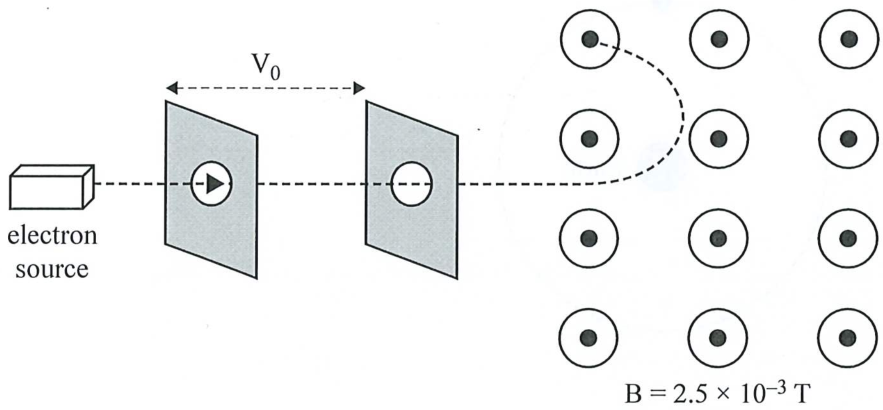


Figure 2

a. Calculate the value of the accelerating voltage, V_0. Show your working. 3 marks

$qV = \frac{1}{2} m v^2$

$V = \frac{9.1 \times 10^{-31} \times (2 \times 10^7)^2}{2 \times 1.6 \times 10^{-19}}$

1.1 kV

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

Magnetic force on the electron is always at the right angle to their velocity and constant in magnitude.

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

$qvB = \frac{mv^2}{r}$ $r = \frac{mv}{qB}$

$r = \frac{9.1 \times 10^{-31} \times 2 \times 10^7}{1.6 \times 10^{-19} \times 2.5 \times 10^{-3}}$

0.046 m

SECTION B

Instructions for Section B

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

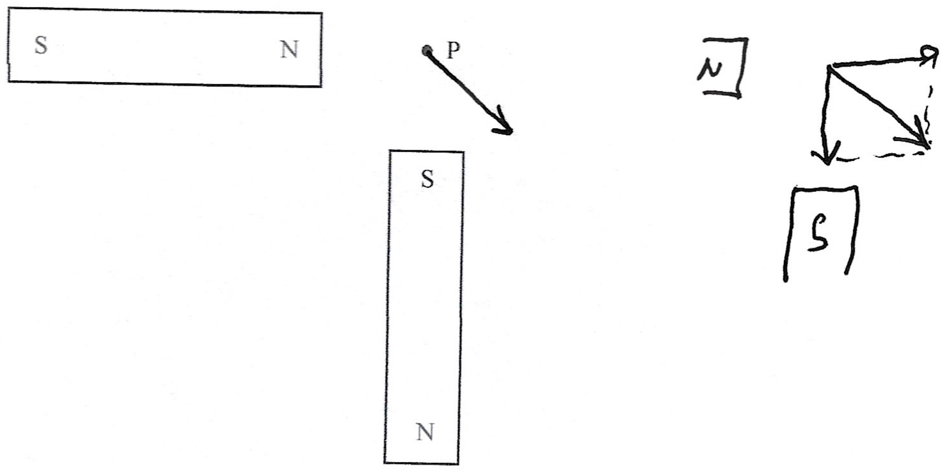


Figure 1

a. At point P on Figure 1, draw an arrow indicating the direction of the combined magnetic field of the two bar magnets. 39%

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

$B = \sqrt{0.01^2 + 0.01^2} = 0.0141$ 32%

14.1 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.

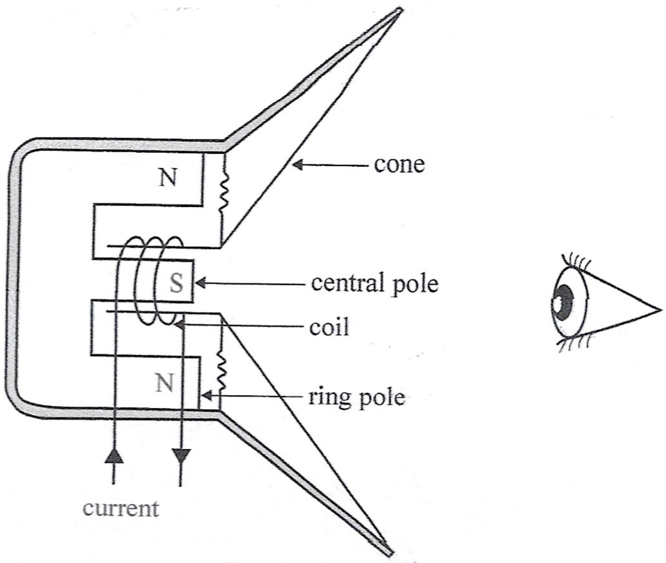


Figure 2

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.

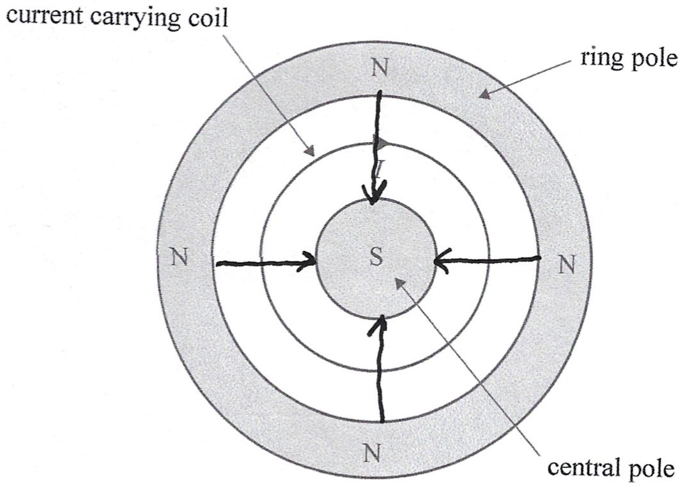


Figure 3

73%

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

61%

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

E

Use RHSR

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

23%

$F = nBIL = 20 \times 0.2 \times 2 \times 2\pi \times 0.05$

$= 2.5\ N$

2.5 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.

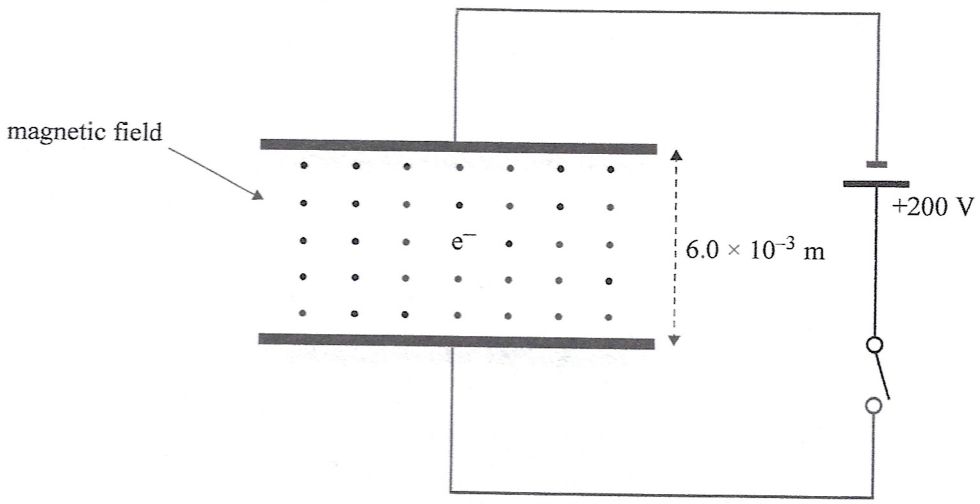


Figure 5

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

2 marks

$F = qvB$

$v = 0$ so $F = 0$

33%

The switch is now closed.

b. Determine the magnitude and the direction of any electric force now acting on the electron. Show your working. 3 marks

$F = qE \quad E = \frac{V}{d}$ 30%

$F = \frac{qV}{d} = \frac{200 \times 1.6 \times 10^{-19}}{6 \times 10^{-3}} = 5.3 \times 10^{-15}$

5.3×10^{-15} N	Direction Down

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

Ravi is correct about change in direction but wrong about constant magnitude. 7%
Mia is correct about increasing magnitude and wrong about not changing direction.
Due to electric field speed of electron will increase. $F = qvB$ so F will be increasing.
Force is perpendicular to velocity, as electron deflects direction of force changing.

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}.

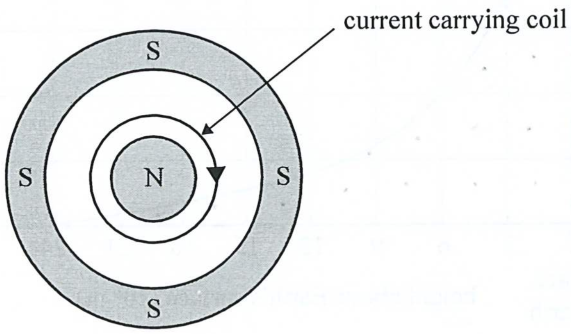
Question 1

Two parallel plates that are 10 mm apart have a potential difference of 5.0 kV between them.
Which one of the following best gives the strength of the electric field between the plates?

A. 5.0×10^{-1} V m^{-1}
B. 5.0×10^{1} V m^{-1}
C. 5.0×10^{2} V m^{-1}
D. 5.0×10^{5} V m^{-1}

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.

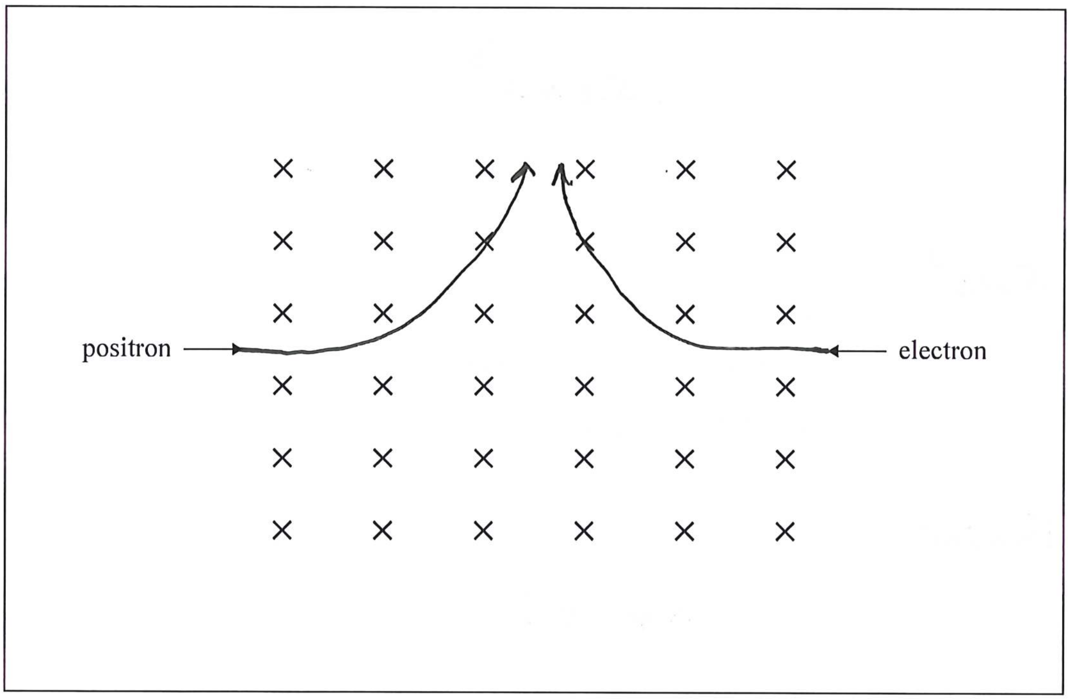


Figure 1

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.
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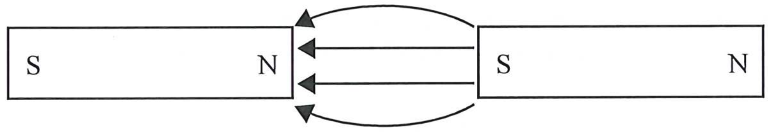
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
Take the value of g to be 9.8 m s^{-2}.

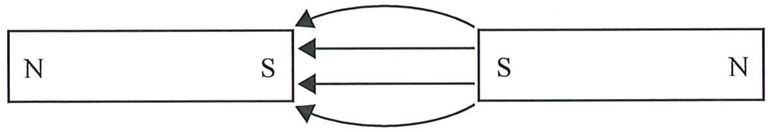
Question 1

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

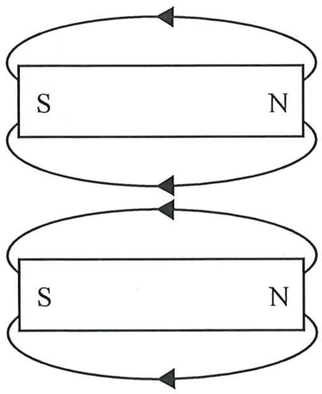
A.



B.

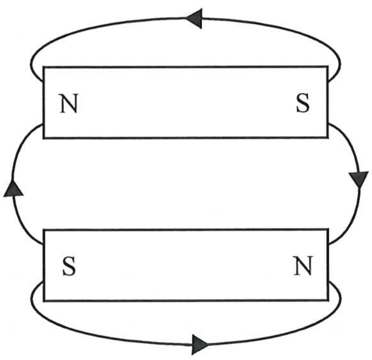


C.



All other options have wrong direction

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.

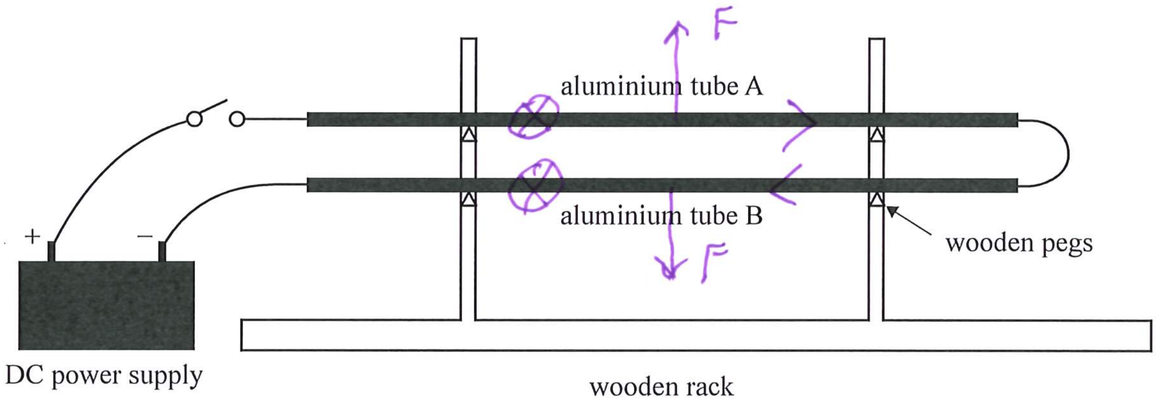


Figure 3

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 | A | (1)

As current in tubes is in the opposite directions, they will repel (1) as magnetic fields are directed into the page so force on A is ↑, on B is ↓ as shown on the picture. (1)

DO NOT WRITE IN THIS AREA

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.

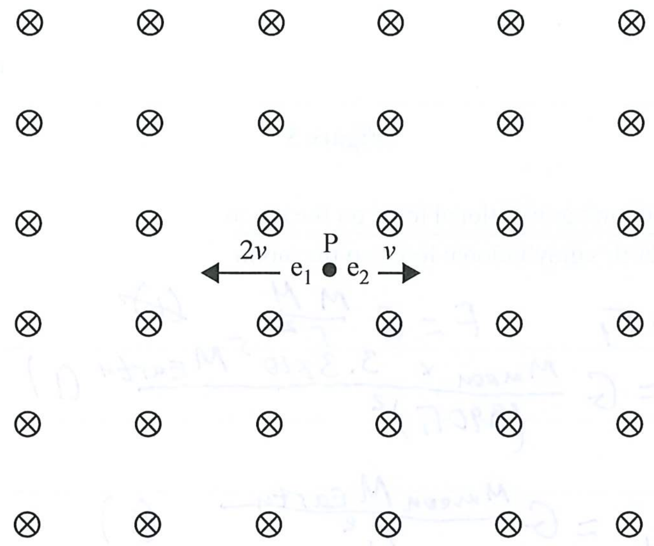


Figure 4

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 | 3 | (1)

Explain your answer.

$F = \frac{mv^2}{r} = qvB \qquad v = \frac{2\pi r}{T}$ (1)

$\frac{mv}{r} = qB \qquad \frac{v}{r} = \frac{2\pi}{T}$

$\frac{2\pi m}{T} = qB$

$T = \frac{2\pi m}{qB}$ (1) T is independent of v, so Outcome 3.

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.

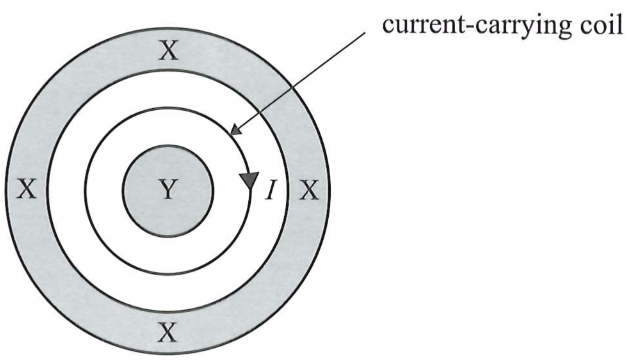
No marks will be given if more than one answer is completed for any question.

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.

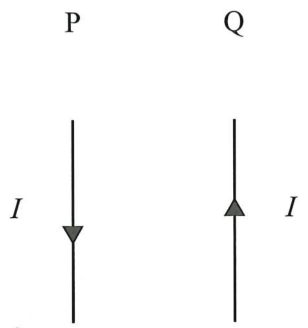


Figure 2a – Front view

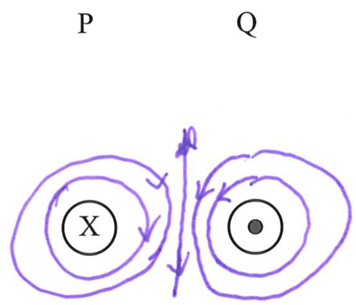


Figure 2b – Top view

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

Repel

Using RHSR