

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.7.2 THE MOTOR EFFECT (PACK 2)

SCORE

/72

PERCENTAGE

%

STEMUP

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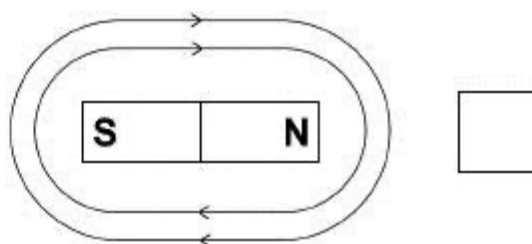
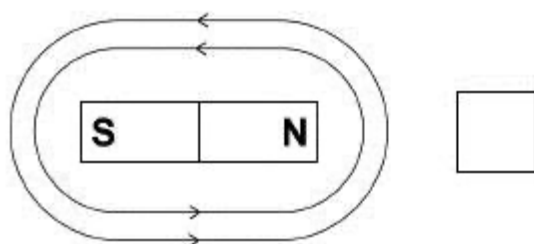
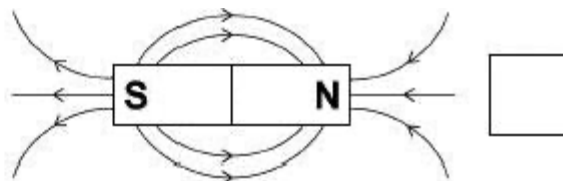
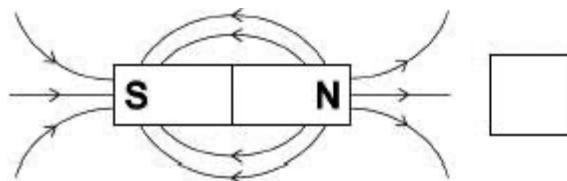
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Q1.

A magnet produces a magnetic field.

(a) Which diagram shows the magnetic field pattern around a bar magnet?

Tick **one** box.



(1)

(b) **Figure 1** shows three metal blocks.

The blocks are not labelled.

One block is a permanent magnet, one is iron and one is aluminium.

Figure 1

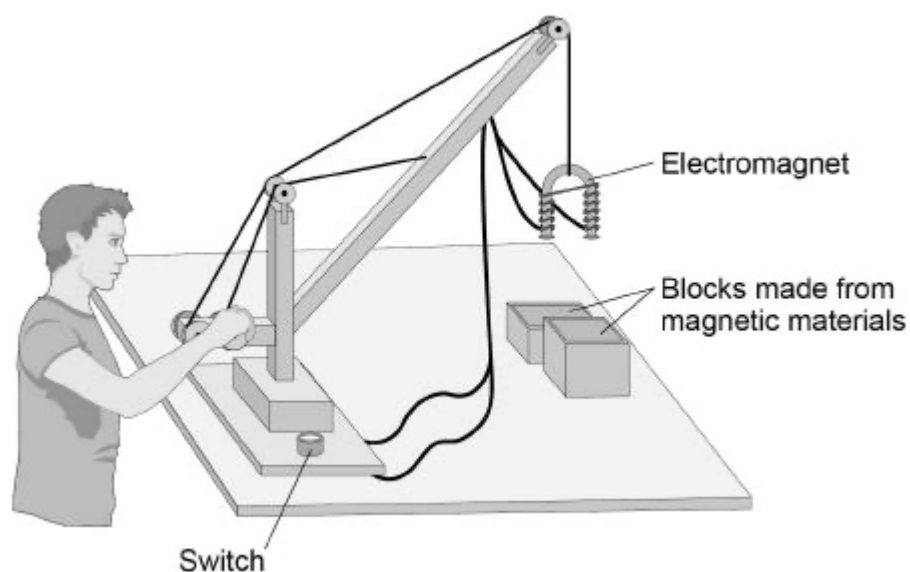


Describe how another permanent magnet can be used to identify the blocks.

(3)

(c) **Figure 2** shows a toy crane.

Figure 2



The toy crane uses an electromagnet to pick up and move the blocks.

Explain how this electromagnet is able to pick up and move the blocks.

(6)

(Total 10 marks)

Q2.

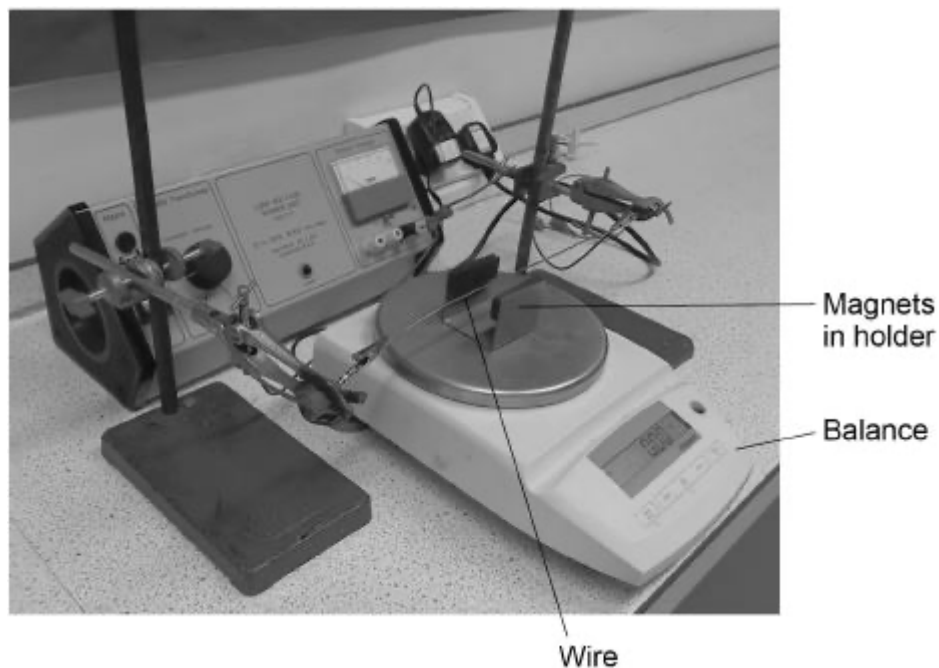
When a conductor carrying a current is placed in a magnetic field a force is exerted on the conductor.

This is called the motor effect.

- (a) Describe how the direction of the force can be determined using Fleming's Left Hand Rule.

(4)

The photograph below shows apparatus to demonstrate the motor effect.



The piece of wire is fixed so that it cannot move.

This is the method used.

1. Place the pair of magnets in their holder on the balance.
2. Set the reading on the balance to zero.
3. Pass a current through the wire.
4. Record the new reading on the balance.

- (b) When there is a current in the wire, the reading on the balance increases.

Explain in terms of forces why the reading increases.

(3)

(c) In one experiment, the teacher determined that the force on the wire was 2.14 mN

The current in the wire was 0.32 A

The length of wire within the magnetic field was 0.048 m

Calculate the magnetic flux density between the two magnets.

Use the Physics Equations Sheet.

Give your answer to 2 significant figures.

Magnetic flux density = _____ T

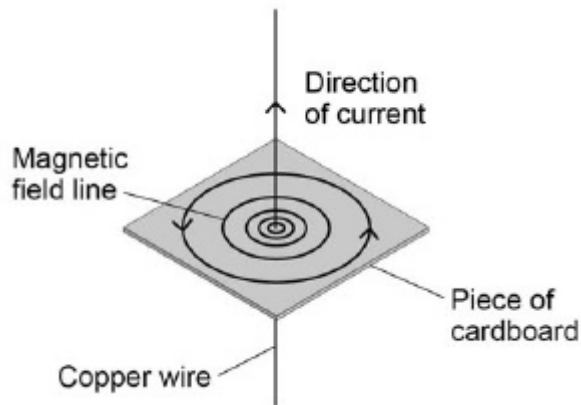
(4)

(Total 11 marks)

Q3.

Figure 1 shows the magnetic field around a copper wire carrying a current.

Figure 1



- (a) What do the arrows on the magnetic field line represent?

(1)

- (b) Complete the sentence.

Choose the answer from the box.

decreases	increases	stays the same
------------------	------------------	-----------------------

As the distance from the copper wire increases, the magnetic field strength _____.

(1)

- (c) Suggest how the field lines on **Figure 1** show the variation in field strength.

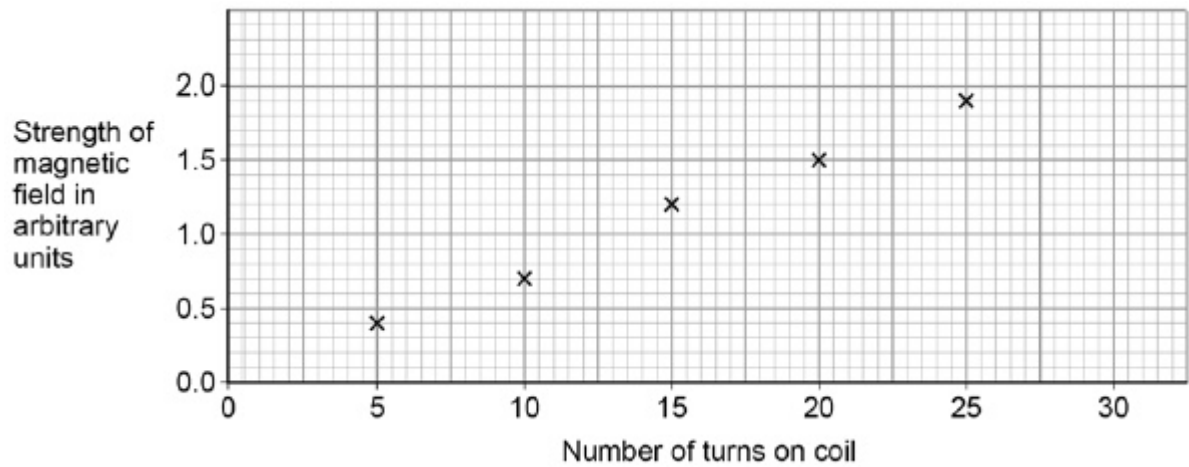
(2)

A student coiled the copper wire a different number of times to form a solenoid.

Each time the student measured the strength of the magnetic field inside the solenoid.

Figure 2 shows the results.

Figure 2



(d) Draw a line of best fit on **Figure 2**.

(1)

(e) Determine the increase in strength of magnetic field when the number of turns on the coil is changed from 12 to 18

Increase in strength of magnetic field = _____ arbitrary units

(2)

(f) How could the strength of the magnetic field be increased?

Tick **two** boxes.

Increase the current through the solenoid.

☐

Increase the potential difference across the solenoid.

☐

Increase the temperature of the solenoid.

☐

Spread the turns of wire on the solenoid further apart.

☐

Use wire with a higher resistance to make the solenoid.

☐

(2)

(g) **Figure 3** shows the north and south poles of a solenoid.

Figure 3



Draw field lines to show the magnetic field around the solenoid.

(2)

- (h) How can the solenoid be made into an electromagnet?

(1)

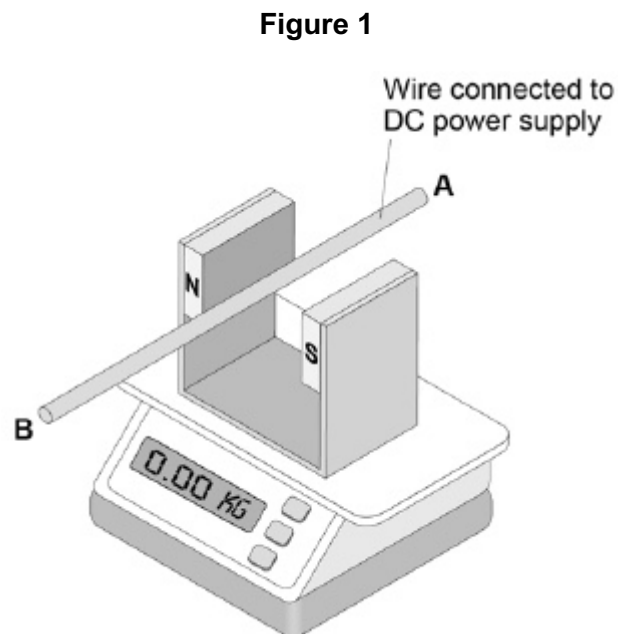
(Total 12 marks)

Q4.

A student placed a permanent magnet on a top-pan balance.

He clamped a straight piece of wire so that it was suspended in the magnetic field.

Figure 1 shows the apparatus.



- (a) When a current passed through the wire from **A** to **B**, the reading on the balance increased.

Explain why.

(4)

- (b) The student increased the current in the wire.

Sketch a graph on **Figure 2** to show the relationship between the current and magnetic force on the wire.

Label the axes, with the independent variable on the x-axis.

Figure 2



(2)

- (c) The length of the wire in the magnetic field in **Figure 1** is 4.8×10^{-2} m

The current in the wire is 0.80 A

The reading on the balance is 1.2×10^{-3} kg

Gravitational field strength = 9.8 N/kg

Calculate the magnetic flux density of the permanent magnet.

Magnetic flux density = _____ tesla

(5)

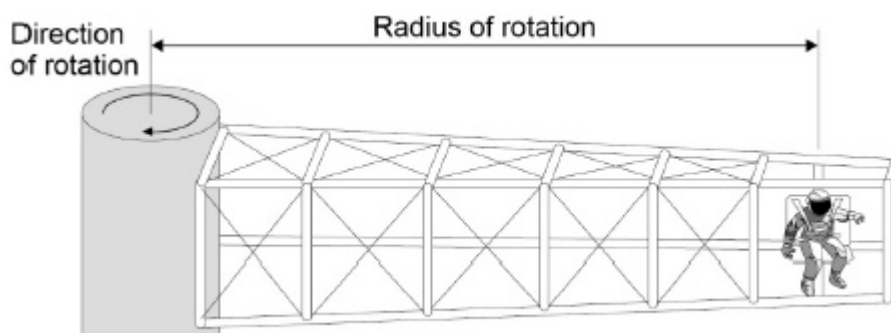
(Total 11 marks)

Q5.

Figure 1 shows a 'G-machine'.

The G-machine is used in astronaut training.

Figure 1



- (a) The astronaut travels at constant speed in a circle.

Explain why the astronaut is accelerating.

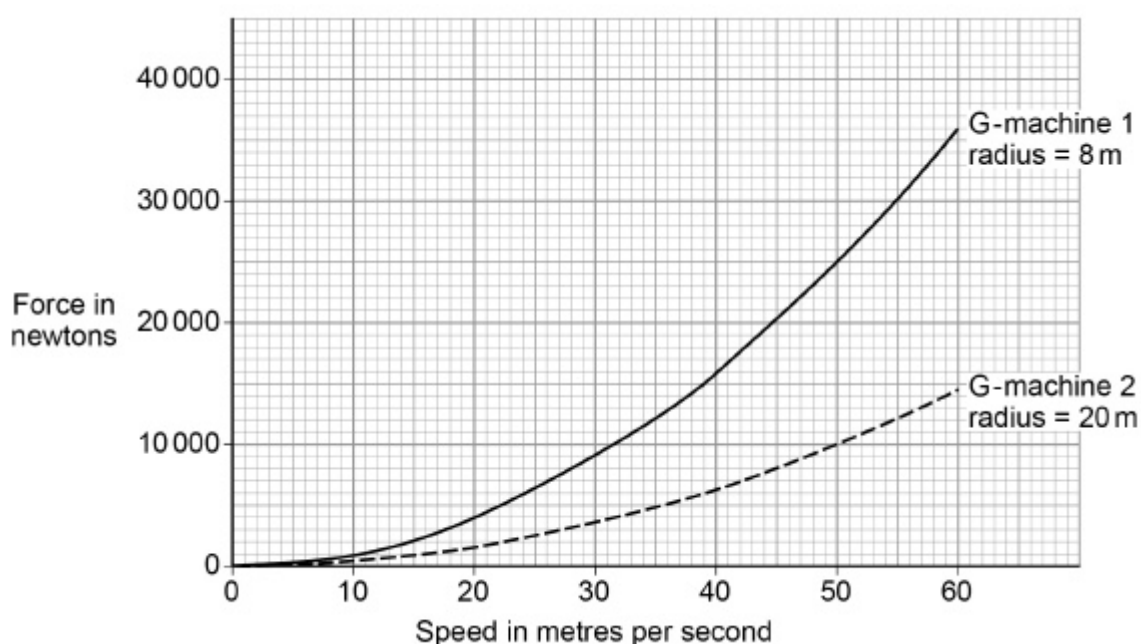
(3)

- (b) The force causing the astronaut to move in a circle is measured.

Figure 2 shows how the speed of the astronaut affects the force causing the astronaut to move in a circle.

The radius of rotation of the astronaut is different for each G-machine.

Figure 2



Give **three** conclusions about the factors affecting the size of the force required to move the astronaut in a circle.

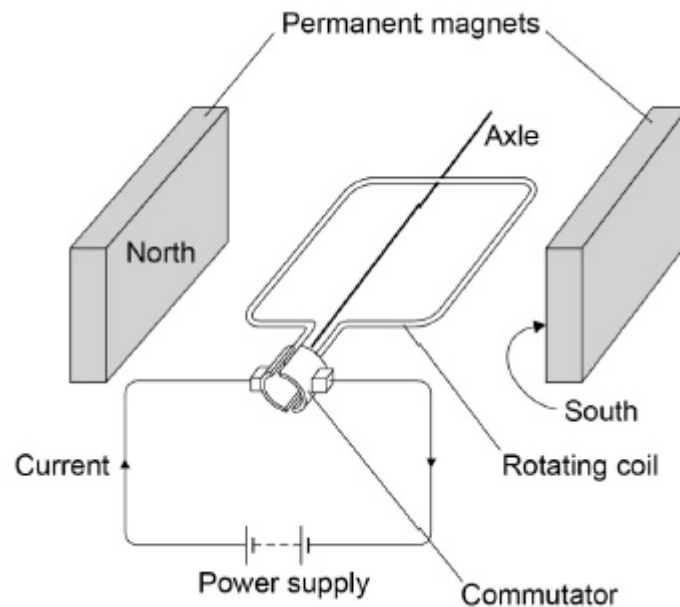
1. _____
- _____
2. _____
- _____
3. _____
- _____

(3)

- (c) Each G-machine is rotated by an electric motor.

Figure 3 shows a simple electric motor.

Figure 3



Explain why the coil rotates when there is a current in the circuit.

(3)
(Total 9 marks)

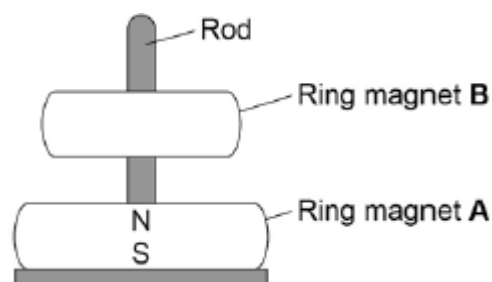
Q6.

A magnetic toy uses ring-shaped magnets.

Look at **Figure 1**.

The magnets can move up and down the rod. Ring magnet **B** appears to float.

Figure 1



- (a) The magnetic poles are labelled on ring magnet **A**.

Label the magnetic poles on ring magnet **B**.

(1)

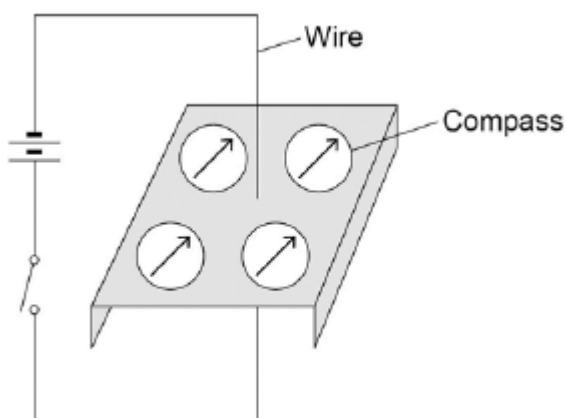
- (b) What would happen if ring magnet **B** was turned upside down?

(1)

- (c) **Figure 2** shows four plotting compasses arranged around a wire.

The needle of a compass is a magnet.

Figure 2



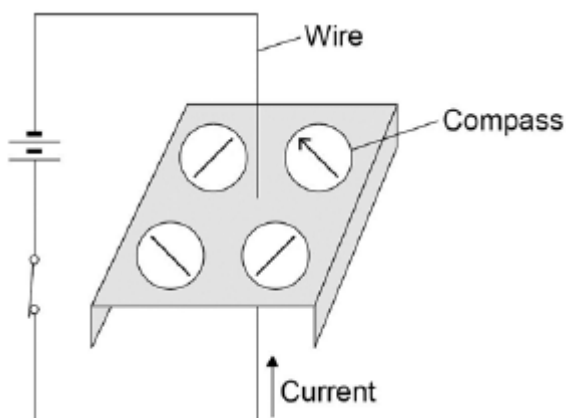
In **Figure 2** the switch is open and there is no current in the wire.

Explain why the compass needles all point in the same direction.

(2)

- (d) **Figure 3** shows the switch closed.

Figure 3



There is now a current in the wire.

The compass needles change direction.

On **Figure 3** draw arrowheads on the three incomplete compass needles to show their direction.

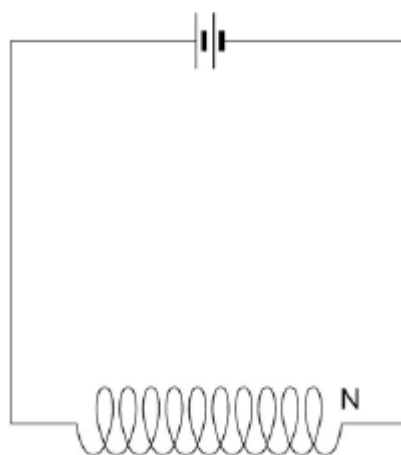
(1)

- (e) What would happen to the direction of the compass needles if the current was reversed?

(1)

- (f) **Figure 4** shows a coil of wire in a circuit.

Figure 4



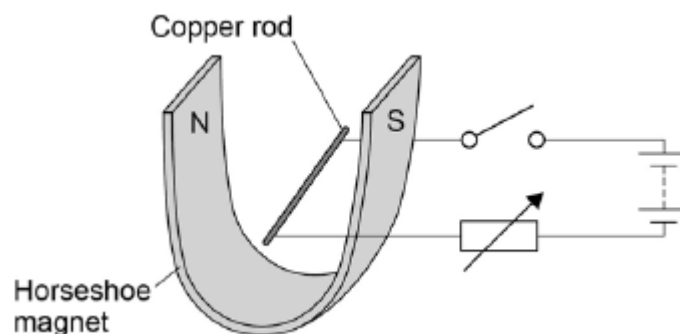
On **Figure 4** draw the magnetic field due to the current in the coil.

(3)

(Total 9 marks)

Q7.

A teacher used the equipment shown in the figure below to demonstrate the motor effect.



- (a) Describe how Fleming's left-hand rule can be used to determine the direction in which the rod will move when the switch is closed, and state the direction.

(4)

- (b) Increasing the current can increase the force acting on the copper rod.

Give **one** other way in which the size of the force acting on the copper rod could be increased.

(1)

- (c) The copper rod in the figure above has a length of 7 cm and a mass of 4×10^{-4} kg.

When there is a current of 1.12 A the resultant force on the copper rod is 0 N.

Calculate the magnetic flux density.

Gravitational field strength = 9.8 N / kg

Magnetic flux density = _____ T

(5)

(Total 10 marks)

Mark schemes

Q1.

- (a) 1st box ticked 1
- (b) (permanent magnet) has no effect on the aluminium 1
- iron is attracted (to the permanent magnet) 1
- (only) the (permanent) magnet can be repelled (by the permanent magnet) 1
- (c) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to give a clear account. 5–6
- Level 2:** Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear. 3–4
- Level 1:** Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking. 1–2
- No relevant content** 0

Indicative content

- completing the circuit
- turns the electromagnet on
- there is a current in the coil
- a magnetic field is produced around the coil
- the iron core becomes magnetised
- move electromagnet towards the blocks
- the block is attracted to the electromagnet
- moving the crane moves the block
- switching off the current switches off the electromagnet
- releasing the block

[10]

Q2.

- (a) place thumb and first two fingers (of left hand) at right angles to each other 1
- first / index finger indicates (direction of) magnetic field
allow forefinger for first/index finger
*do **not** accept electric field* 1

second / middle finger indicates (direction of) current

1

thumb (then) shows (direction of) force

allow motion / thrust

1

a clearly labelled diagram can score up to 4 marks

- (b) there is a downwards force on the magnets

1

(because when there is a current in the wire) there is a magnetic field around the wire

1

which interacts with the magnetic field of the (permanent) magnets

1

- (c) $0.00214 = B \times 0.32 \times 0.048$

this mark may be awarded if F is incorrectly / not converted

1

$$B = \frac{0.00214}{0.32 \times 0.048}$$

this mark may be awarded if F is incorrectly / not converted

1

0.1393 (T)

an answer that rounds to 0.14 (T) scores 3 marks

1

0.14 (T)

*allow answer consistent with their incorrectly / not converted F to 2 significant figures
allow an answer from an incorrect calculation to 2 significant figures*

1

an answer of 0.14 (T) scores 4 marks

an answer of 140 scores 3 marks

[11]

Q3.

- (a) the direction of the magnetic field

1

- (b) decreases

1

- (c) the distance between the field lines

allow the closer the lines the stronger the field for 2 marks

1

is smaller where the field is stronger where

allow where the lines are close the field is strong for **1** mark

1

- (d) straight line drawn within 1 mm of all points on the graph

1

- (e) 1.3 – 0.9

1

0.4 arbitrary units

1

- (f) increase the current through the solenoid

*if more than 2 boxes are ticked deduct **1** mark for each extra box ticked*

1

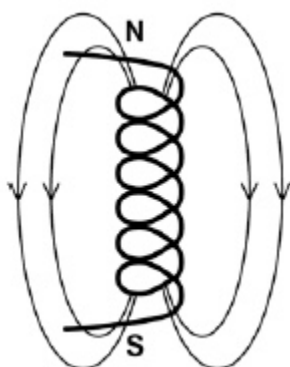
increase the potential difference across the solenoid

1

- (g) at least one field line on each side of the solenoid

1

an arrow to indicate the field going from North to South pole



1

- (h) add an iron core

allow a description of this, eg wrap the wire around an iron nail

adding a core is insufficient

1

[12]

Q4.

- (a) the current creates a magnetic field in the wire

1

which interacts with the magnetic field from the permanent magnet

1

Flemming's left hand rule says the force on the wire is upwards

1

so the force on the permanent magnets is downwards

1

- (b) x-axis labelled current **and**
y-axis labelled (magnetic) force
ignore units on labels 1
- straight line through the origin 1
- (c) $W = mg = 1.2 \times 10^{-3} \times 9.8$ 1
- $W = 0.01176$ 1
- $0.01176 = B \times 0.80 \times 4.8 \times 10^{-2}$ 1
- $B = \frac{1.2 \times 10^{-3} \times 9.8}{0.8 \times 4.8 \times 10^{-2}}$ 1
- $B = 0.31$
an answer of 0.031 scores 3 marks
an answer of 0.31 scores 5 marks 1
- [11]

Q5.

- (a) velocity is a vector (so has both magnitude and direction) 1
- direction is changing (and so velocity is changing) 1
- if velocity is changing, there is an acceleration 1
- (b) as radius increases, force required decreases
allow converse statements for all marking points 1
- as speed increases, force required increases 1
- at greater speeds, change in force for same change in speed is greater
allow force proportional to square of speed 1
- (c) a conductor carrying a current in magnetic field has a force exerted on it (by the motor effect) 1
- (so) force on opposite sides in opposite directions (so the coil turns)
allow current in opposite directions 1
- as coil turns, commutator reverses direction of current relative to coil (so rotation

can continue)

allow current / force directions in terms of arrows on the diagram (force directions do not have to be correct from Fleming's LHR to illustrate the point)

1

[9]

Q6.

- (a) S – top, N – bottom

1

- (b) touch / attracted to magnet **A**

1

- (c) the magnetic needles point to the north pole

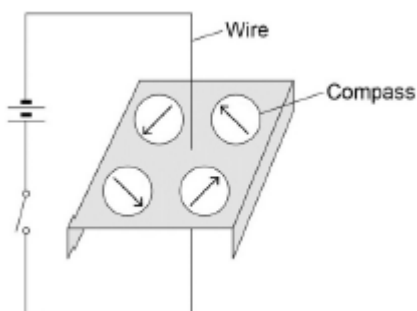
1

because The Earth has a magnetic field

1

accept the needles align to the Earth's magnetic field for 2 marks

- (d)



1

- (e) point in the opposite direction
change direction is insufficient

1

- (f) uniform field lines through the wire coil.

1

field lines curving round the top and bottom of the wire coil.

1

arrows indicating direction from N to S
*do **not** accept conflicting arrows*

1

[9]

Q7.

- (a) thumb, index finger and third finger are held mutually at right angles

1

index finger shows the direction of the magnetic field from North to South, third finger
shows the direction of the current from positive to negative terminal

	1
the thumb then shows the direction of the force acting on the copper rod	1
so the copper rod will move upwards	1
(b) any one from:	
use a stronger magnet	
increase the magnetic flux density	
increase the length of the copper rod in the magnetic field	
coil the copper rod	1
(c) $W = 9.8 \times 4 \times 10^{-4} = 3.92 \times 10^{-3}$	1
conversion of the length 7cm to 0.07m	1
$3.92 \times 10^{-3} = B \times 1.12 \times 0.07$	1
$B = 3.92 \times 10^{-3} / 0.0784$	1
$B = 0.05 \text{ (T)}$	1
<i>allow 0.05 (T) without working shown for the 5 calculation marks</i>	
	[10]

Examiner reports

Q1.

Foundation

- (a) Only 38% scored this mark. The most common incorrect response was where the direction of the magnetic field lines ran from south to north, although a number of students selected the third and fourth options.
- (b) This question was not well understood, because many students did not appreciate that they needed to identify all three blocks. Many identified iron and aluminium and not the second permanent magnet. There was widespread confusion as to which of iron and aluminium were magnetic and a significant minority simply said that a material was magnetic without indicating how they would identify it.

A significant number of students believed the attractive force varied in strength between the two blocks. Others referred to the colour / shade or weight of the block.

As a result, 60% scored zero for this question, and only 4% scored full marks. 16% did not attempt this question.

- (c) There were many very vague responses to this question, with few inclusions of the level of detail expected. Many students simply stated that the electromagnet could be switched on, moved to a different position and then switched off. There were few descriptions of how the electromagnet worked.

Many believed that the magnetic blocks were themselves magnets and talked about attraction and repulsion between the blocks and the electromagnet. As a result, only 2% gave answers worthy of level three and only a further 10% gave answers worthy of level two. 13% did not attempt this question with 28% scoring no marks.

Higher

- (a) 60% scored this mark. The most common incorrect response was where the direction of the magnetic field lines ran from south to north.
- (b) Many students did not appreciate that they needed to identify all three blocks. Many identified iron and aluminium and not the second permanent magnet.

There appeared to be widespread confusion as to which of iron and aluminium were magnetic and a significant minority simply said that a material was magnetic without indicating how they would identify it.

As a result, 40% scored zero for this question, and 17% scored all three marks.

- (c) There were many very vague responses to this question, with few inclusions of the level of detail expected. Many made reference to the ability to turn the electromagnet on and off but there were few descriptions of how the electromagnet worked with many incorrect references to 'electricity' passing through the core.

Many believed that the magnetic blocks were, in fact, magnets themselves and talked about the attraction and repulsion between the blocks and the electromagnet. As a result, only about 8% gave answers worthy of level three and a further 32% gave answers worthy of level two.

Q2.

- (a) Many students did not seem to be familiar with Fleming's Left Hand Rule. Just under half of students scored no marks. Many students re-phrased the question or wrote something irrelevant.

Those students who showed some knowledge of the rule were often unable to link the correct digit with the correct quantity.

Many either omitted the fact that the thumb, first finger and second fingers needed to be at right angles to each other, or attempted to describe the orientation of the digits in terms of up / down, out / in or left / right.

Nevertheless, about 10% of students achieved three or four marks.

- (b) Three quarters scored no marks. A very small percentage gained all three marks.

The majority did not think to link this question with the previous one relating to the motor effect and came up with some creative ideas as to why the balance reading should increase. Common answers were that the weight of the magnets would increase, or gravity would become stronger, or the current has mass.

- (c) Students seem to be more willing to tackle calculations than written answers, with around 94% of students attempting this question. Although only around 4% gained the full four marks, a further one third scored three marks, being able to select the correct equation and to manipulate it successfully.

The main error was in not converting the force from mN to N, or incorrectly converting it – many seem to think that $1\text{mN} = 1000\text{ N}$. A substantial number of students had taken note of the requirement to give their answer to two significant figures. Unfortunately, some did not do this correctly.