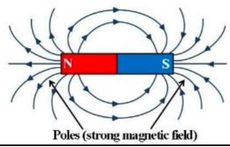
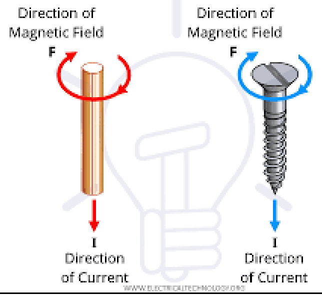
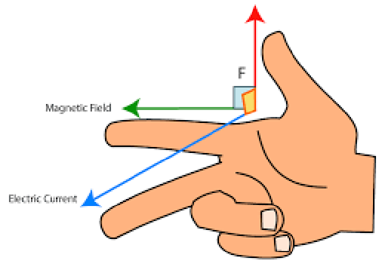
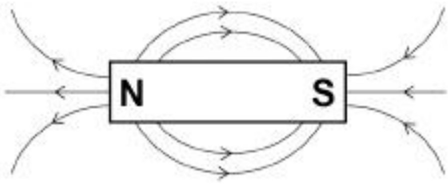
1	**Describe the force between like poles**	**Repels**
2	**Describe the force between unlike poles**	**Attracts**
3	**What is a permanent magnet?**	**A magnet that produces its own magnetic field**
4	**What is an induced magnet?**	**A material that becomes a magnet when it is placed in a magnetic field**
5	What direction does a magnetic field always act in?	From north to south
6	**Where is a magnetic field the strongest?**	**Next to the poles of the magnet** 
7	What happens to the strength of a magnetic field as you move further from the magnet?	It decreases
8	How do magnetic compasses provide evidence that the Earth's core must be magnetic?	A magnetic compass contains a small bar magnet. The Earth has a magnetic field. The compass needle points in the direction of the Earth's magnetic field
9	**What is the magnetic field like around a current-carrying wire?**	**Circular around the wire** 
10	**What factors affect the strength of a magnetic field due to a current-carrying wire?**	**Strength of the current, distance from the wire**
11	Describe three ways the strength of an electromagnet can be increased	Increasing the current in the wire, adding an iron core, adding more coils of wire
12	**How does an electric motor work?**	**The force on a current-carrying wire in a magnetic field pushes one side of a coil down and the other side up**
13	**(HT) Describe the motor effect**	**When a current carrying wire is placed in a magnetic field, the magnet producing the field and the conductor and the conductor exert a force on each other. This can be represented using**  **Fleming's left hand rule**

Q1.

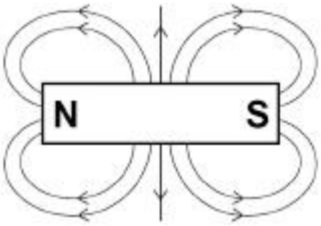
Magnets attract some metals.

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

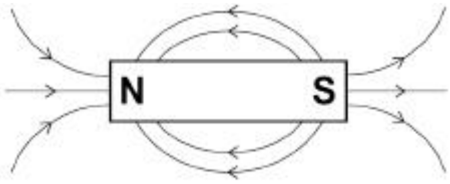
Tick (✓) **one** box.



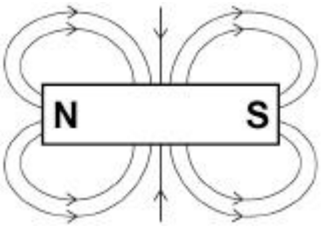
☐



☐



☐



☐

(1)

Figure 1 shows an iron bar near a permanent magnet.

Figure 1

The iron bar becomes an induced magnet.

(b) Label the poles on the iron bar.

(1)

(c) The magnet is turned around so that the north pole is closest to the iron bar.

Which statement about the iron bar is true?

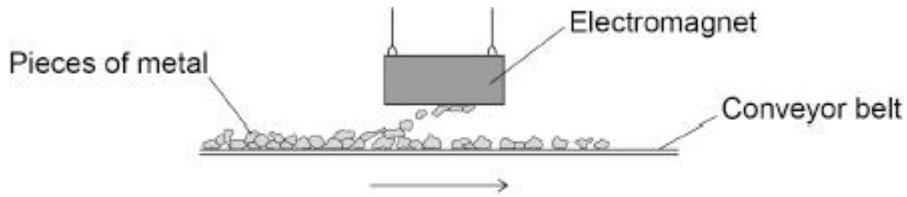
Tick (✓) **one** box.

The iron bar does not experience a magnetic force.	☐
The iron bar experiences a magnetic force of attraction.	☐
The iron bar experiences a magnetic force of repulsion.	☐

(1)

Figure 2 shows an electromagnet being used to separate pieces of different types of metal on a conveyor belt.

Figure 2



(d) Which **two** of the following types of metal would be attracted to the electromagnet?

Tick (✓) **two** boxes.

Aluminium	☐
Copper	☐
Magnesium	☐
Nickel	☐
Steel	☐

(2)

(e) What is an advantage of using an electromagnet instead of a permanent magnet to separate the types of metal?

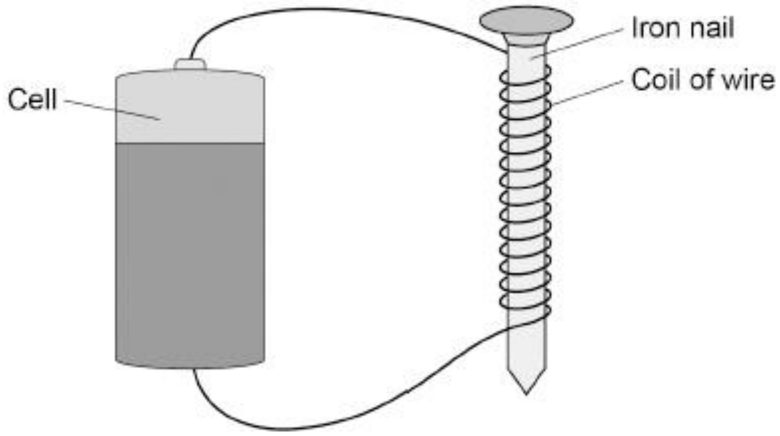
Tick (✓) **one** box.

An electromagnet attracts more types of metal than a permanent magnet.	☐
An electromagnet can be switched on and off.	☐
An electromagnet transfers less energy than a permanent magnet.	☐

(1)

Figure 3 shows a simple electromagnet.

Figure 3



(f) What is the purpose of the iron nail inside the coil of wire?

Tick (✓) **one** box.

The iron nail makes the magnetic field stronger.	☐
The iron nail reduces the magnetic field to zero.	☐
The iron nail reverses the magnetic field.	☐

(1)

(g) Which of the following would increase the strength of the electromagnet?

Tick (✓) **one** box.

Use a greater current. ☐

Use a shorter nail. ☐

Use a thinner wire. ☐

(1)
(Total 8 marks)

Q2.

Magnetic force is a non-contact force.

(a) Which **two** of these are also non-contact forces?

Tick (✓) **two** boxes.

Air resistance ☐

Electrostatic ☐

Friction ☐

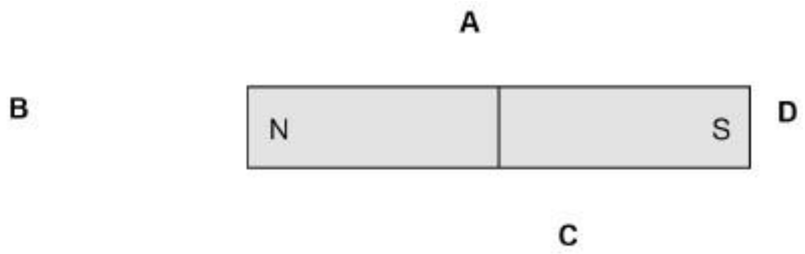
Gravitational ☐

Tension ☐

(2)

(b) **Figure 1** shows a bar magnet.

Figure 1



Which letter shows the position where the magnetic field around the bar magnet is strongest?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) When two magnets are brought close to each other they exert a force on each other.

Describe how two bar magnets can be used to demonstrate a force of attraction and a force of repulsion.

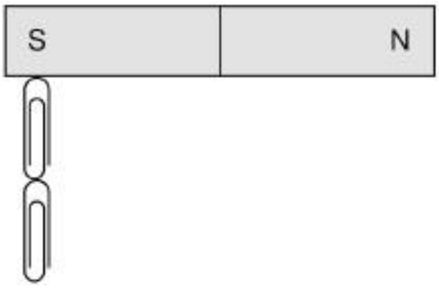
Force of attraction ____

Force of repulsion

(2)

Figure 2 shows some paper clips that are attracted to a permanent magnet.

Figure 2



(d) The paperclips become magnetised when they are close to the permanent magnet.

What is the name of this type of magnetism?

Tick (✓) **one** box.

Forced magnetism	☐
Induced magnetism	☐
Strong magnetism	☐

(1)

(e) Label the north and south poles of the two magnetised paper clips in **Figure 2**.

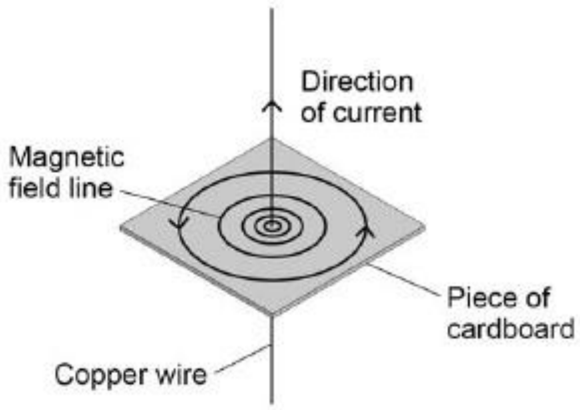
(2)

(Total 8 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.

____

____

____

____

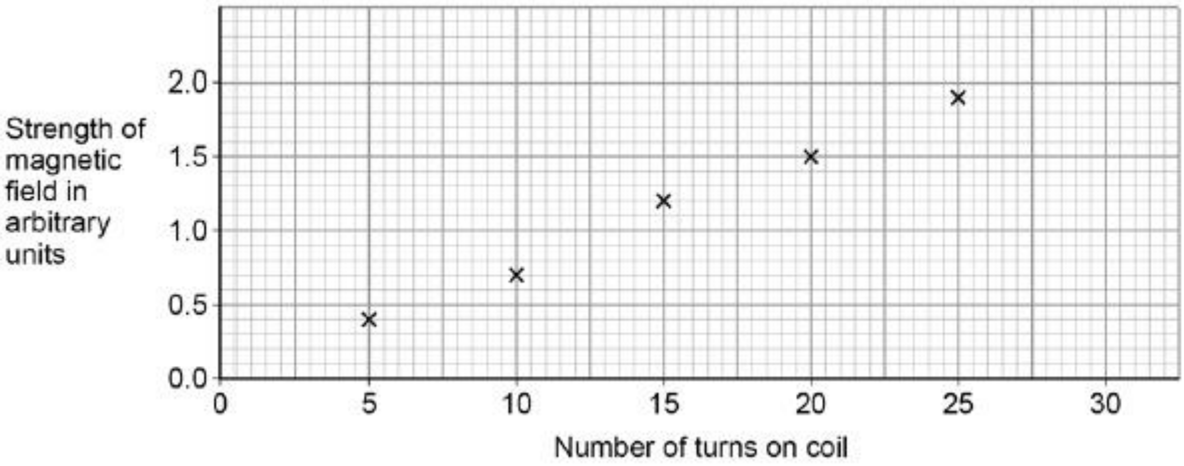
(2)

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?

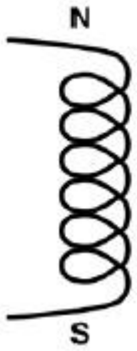
Tick **two** boxes.

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?

____

____

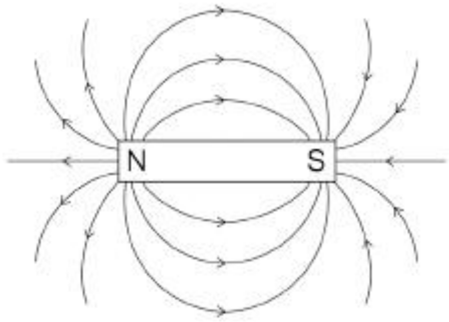
(1)
(Total 12 marks)

HIGHER QUESTIONS

Q1.

Figure 1 shows the magnetic field pattern around a permanent magnet.

Figure 1



(a) Where is the magnetic field of the magnet the strongest?

____

____

(1)

(b) How does **Figure 1** show that the strength of the magnetic field is not the same at all places?

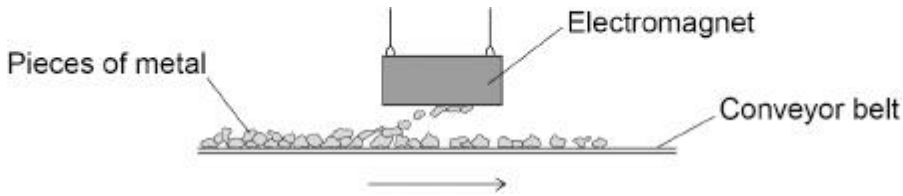
____

____

(1)

Figure 2 shows an electromagnet being used to separate iron and steel from non-magnetic metals.

Figure 2



(c) Explain **one** reason why an electromagnet is used instead of a permanent magnet.

____

____

____

____

(2)

(d) Pieces of iron and steel are attracted to the electromagnet.

Name **two** other metals that would be attracted to the electromagnet.

1 ___________________________

2 ___________________________

(2)

(e) The design of the electromagnet **cannot** be changed.

Give **two** ways the force exerted by the electromagnet on a piece of iron or steel could be increased.

1 ____

____

2 ____

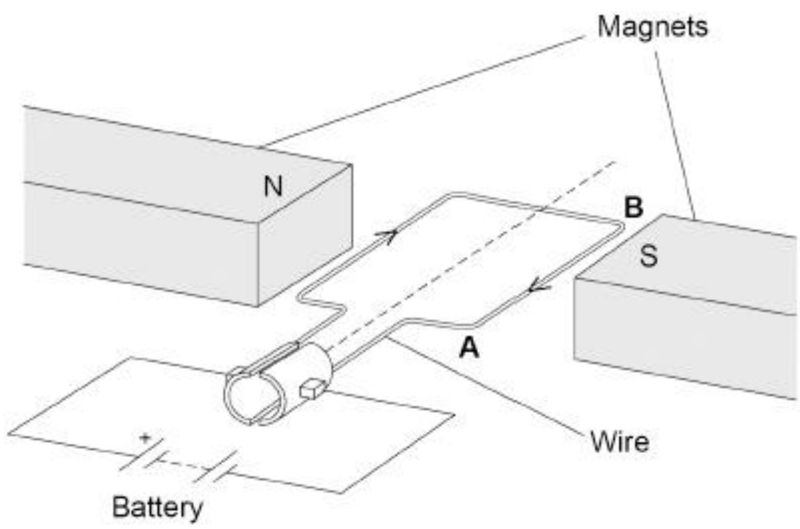
____

(2)

The conveyor belt that moves the pieces of metal is driven by an electric motor.

Figure 3 shows a simple electric motor.

Figure 3



(f) The length of the wire **AB** in the magnetic field is 120 mm.

There is a current of 4.0 A in the wire. The length of wire **AB** experiences a force of 0.36 N.

Calculate the magnetic flux density between the magnets.

Give the unit.

____

____

____

____

____

____

____

____

____

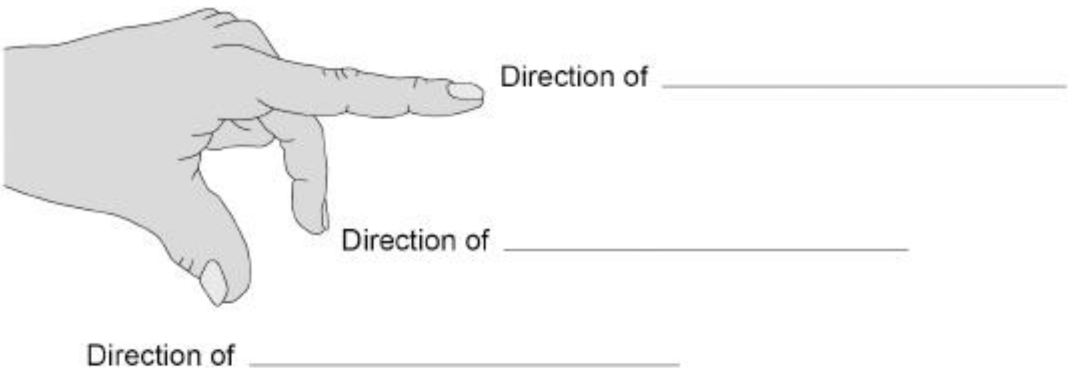
Magnetic flux density = ________________ Unit ___________

(5)

(g) Fleming's left-hand rule can be used to determine the direction of the force on wire **AB**.

Complete the labels on **Figure 4** to show Fleming's left-hand rule.

Figure 4



(2)

(Total 15 marks)

Q2.

(a) Electromagnets are often used at recycling centres to separate some types of metals from other materials.

Give **one** reason why an electromagnet would be used rather than a permanent magnet.

____

____

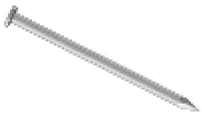
(1)

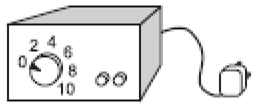
(b) **In this question you will gain marks for using good English, organising information clearly and using scientific words correctly.**

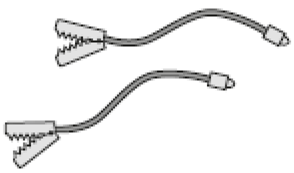
Some students want to build an electromagnet.

The students have the equipment shown below.

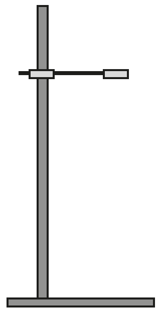

Insulated wire


Iron nail


Power supply


Connecting leads


Steel paperclips


Wooden clamp and stand

Describe how the students could build an electromagnet. Include in your answer how the students should vary and test the strength of their electromagnet.

(6)
(Total 7 marks)

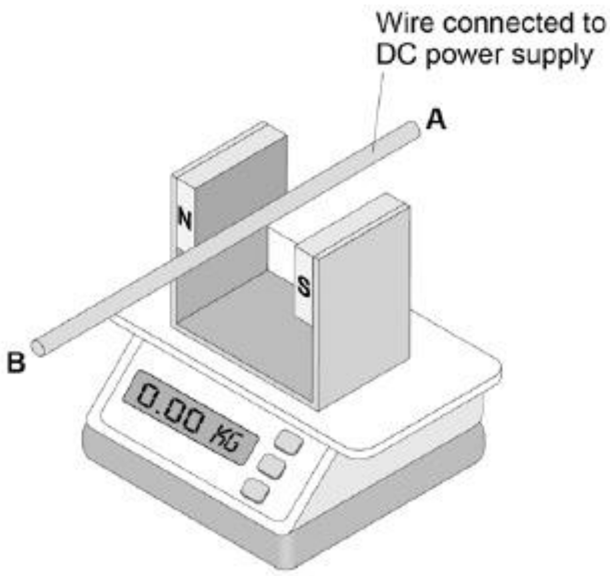
Q3.

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.

Figure 1



(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

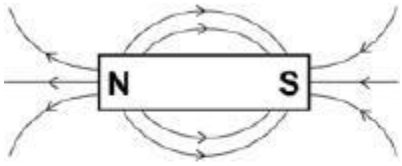
(5)

(Total 11 marks)

FOUNDATION Mark schemes

Q1.

(a) first box ticked



1

(b) 

1

(c) the iron bar experiences a magnetic force of attraction

1

(d) nickel

1

steel

1

(e) an electromagnet can be switched on and off

1

(f) the iron nail makes the magnetic field stronger

1

(g) use a greater current

1

[8]

Q2.

(a) electrostatic

1

gravitational

1

(b) D

1

(c) bring two unlike poles close together

allow north and south poles

allow opposite poles

1

bring two like poles close together

allow two north / south poles

allow N for north and S for south

1

(d) induced magnetism

1

(e) all 4 poles correctly labelled north and south

allow N for north and S for south
allow 1 mark for 2 or 3 correctly labelled poles

2

[8]

Q3.

(a) the direction of the magnetic field

1

(b) decreases

1

(c) the distance between the field lines

*allow the clos<u>er</u> the lines the strong<u>er</u> the field for **2** marks*

1

is small<u>er</u> where the field is strong<u>er</u>

*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

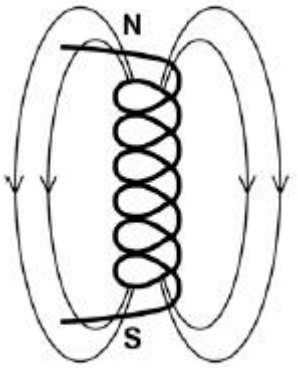
increase the potential difference across the solenoid

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 <u>iron</u> core

allow a description of this, eg wrap the wire around an <u>iron</u> nail

adding a core is insufficient

1

[12]

HIGHER Mark schemes

Q1.

(a) at the poles

1

(b) the distance between the field lines varies

1

(c) electromagnet is easy to demagnetise

allow electromagnet can be switched off

1

so easy to remove separated metal

allow electromagnet is (generally) stronger than a permanent magnet for ***1*** *mark if no other marks are awarded*

1

(d) cobalt

1

nickel

1

(e) increases the current in the coil of the electromagnet

allow increase potential difference across the coil

1

bring the electromagnet closer to the pieces of iron and steel

1

(f) L = 0.120 m

1

0.36 = B × 4.0 × 0.120

allow a correct substitution of an incorrectly / not converted value of L

1

$B = \frac{0.36}{(4.0 \times 0.120)}$

allow a correct rearrangement using an incorrectly / not converted value of L

1

B = 0.75

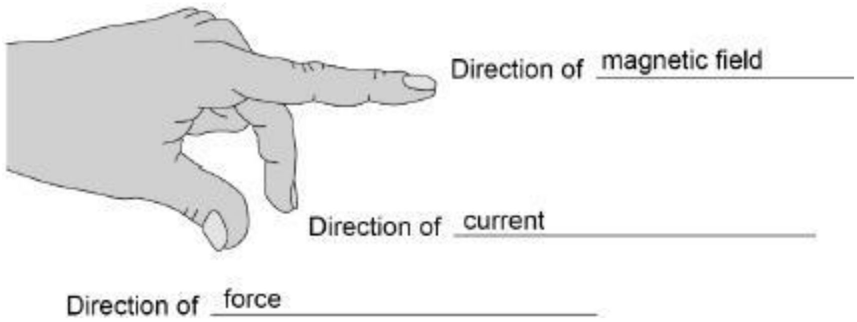
allow a correct calculation using an incorrectly / not converted value of L

1

T

1

(g)



allow **1** mark for 1 or 2 correct

2

[15]

Q2.

(a) an electromagnet can be switched off

accept a permanent magnet cannot be switched off

or

an electromagnet is stronger

accept control the strength

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
there is a description of how the electromagnet is made
and
there is a description of how the strength of the electromagnet can be varied
and
there is a description of how the strength of the electromagnet can be tested

Level 2 (3 – 4 marks):
there is a description of how the electromagnet is made
and either
there is a description of how the strength of the electromagnet can be varied
or
there is a description of how the electromagnet can be tested

Level 1 (1 – 2 marks):
there is a basic description of how to make an electromagnet
or
there is a basic description of how the strength of the electromagnet can be varied
or

there is a basic description of how the electromagnet can be tested

Level 0 (0 marks):
No relevant / correct content

examples of the points made in the response

Details of how to make an electromagnet
- wrap the wire around the nail
- connect the wire to the power supply (with connecting leads and croc clips)
- switch on the power supply

accept a current should be sent along the wire

Details of how to vary the strength of the electromagnet
- change the number of turns (on the coil)
- change the current (through the coil)
- change the separation of the turns

allow change the potential difference (across the coil)

accept wrap the coil more tightly

Details of how to test the electromagnet
- suspend paperclips from the electromagnet
- the more paperclips suspended, the stronger the electromagnet is
- clamp the electromagnet at different distances from the paperclip(s)
- the further the distance from which paperclips can be attracted the stronger the electromagnet is
- test before and after making alterations to change the strength
- compare the results from before and after making alterations
- use de-magnetised paper clips

accept count the number of paperclips
*with different current **or** p.d. **or** no. of turns*
***or** core and see if the number changes/increases*

6

[7]

Q3.

(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]