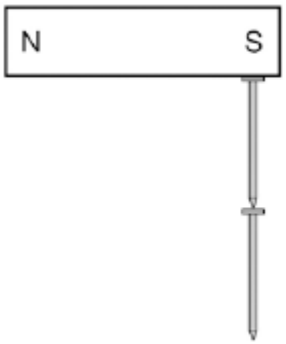
Q1.

Figure 1 shows two iron nails hanging from a bar magnet.

The iron nails which were unmagnetised are now magnetised.

Figure 1



(a) Complete the sentence.

Use a word from the box.

forced	**induced**	**permanent**

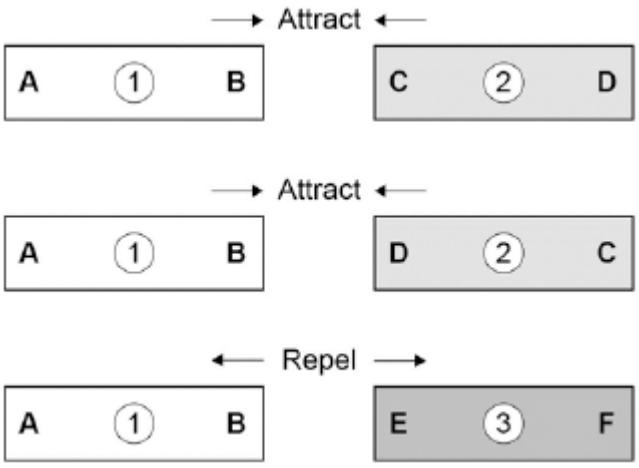
The iron nails have become _____ magnets.

(1)

(b) Each of the three metal bars in **Figure 2** is either a bar magnet or a piece of unmagnetised iron.

The forces that act between the bars when different ends are placed close together are shown by the arrows.

Figure 2



Which **one** of the metal bars is a piece of unmagnetised iron?

Tick **one** box.

Bar 1 ☐

Bar 2 ☐

Bar 3 ☐

Give the reason for your answer.

_____

_____

(2)

(c) A student investigated the strength of different fridge magnets by putting small sheets of paper between each magnet and the fridge door.

The student measured the maximum number of sheets of paper that each magnet was able to hold in place.

Why was it important that each small sheet of paper had the same thickness?

_____

_____

_____

(1)

(d) Before starting the investigation the student wrote the following hypothesis:

'The bigger the area of a fridge magnet the stronger the magnet will be.'

The student's results are given in the table below.

Fridge magnet	**Area of magnet in mm²**	**Number of sheets of paper held**
A	40	20
B	110	16
C	250	6
D	340	8
E	1350	4

Give **one** reason why the results from the investigation **do not** support the student's hypothesis.

_____

(1)

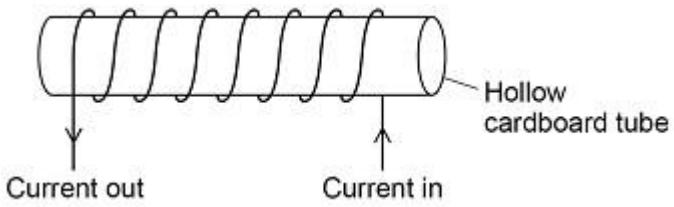
(Total 5 marks)

Q2.

(a) **Figure 1** shows a solenoid.

Draw the magnetic field of the solenoid on **Figure 1**.

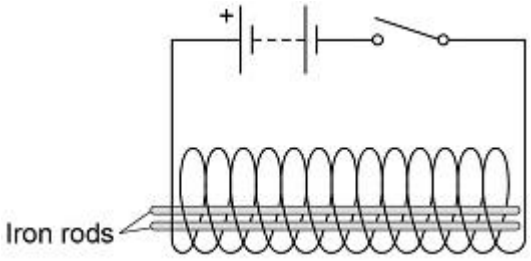
Figure 1



(2)

(b) **Figure 2** shows two iron rods placed inside a solenoid.

Figure 2



Explain why the iron rods move apart when the switch is closed.

(2)

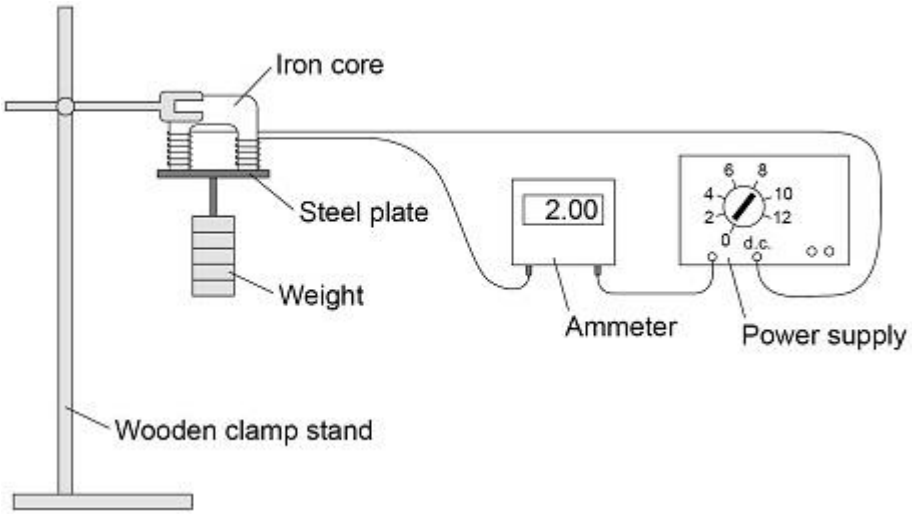
A student investigated the strength of an electromagnet.

The student investigated how the strength depended on:

- the current in the wire
- the number of turns of wire around the iron core.

Figure 3 shows the equipment used.

Figure 3



The student measured the strength of the electromagnet as the maximum weight the electromagnet could hold.

(c) The following table shows the results.

Current in amps	Number of turns of wire	Maximum weight in newtons
1.0	30	6.5
1.5	20	6.4
2.0	10	3.7

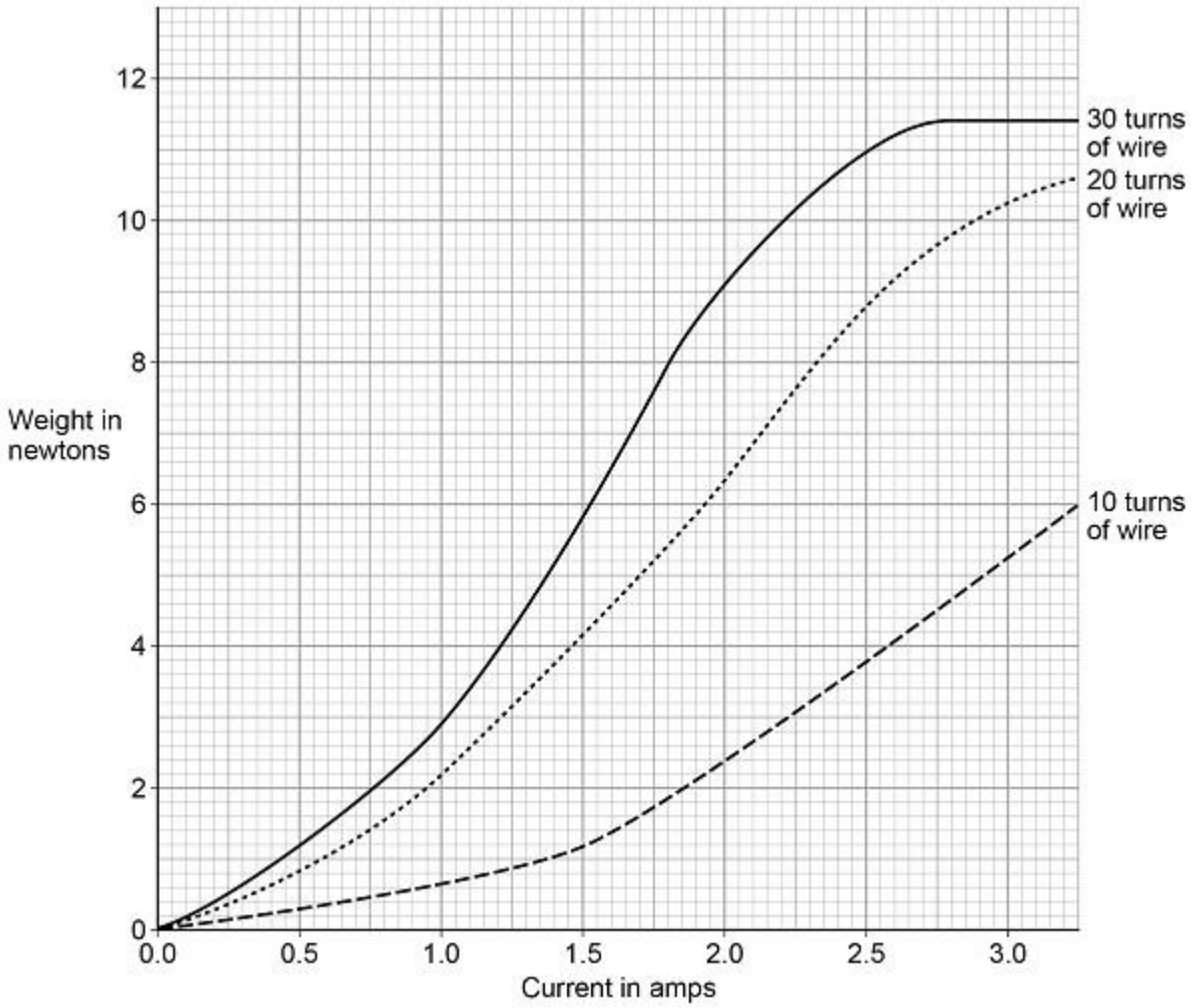
Explain why the method used by the student is **not** valid for this investigation.

(2)

A second student repeated the investigation using the same equipment.

Figure 4 shows the second student's results.

Figure 4



(d) How does increasing the current in the wire affect the strength of the electromagnet, when the electromagnet has 30 turns of wire?

_____

_____

_____

_____

(1)

(e) How does increasing the number of turns of wire from 10 to 20 affect the strength of the electromagnet, compared to increasing the number of turns of wire from 20 to 30?

_____

_____

_____

_____

(1)

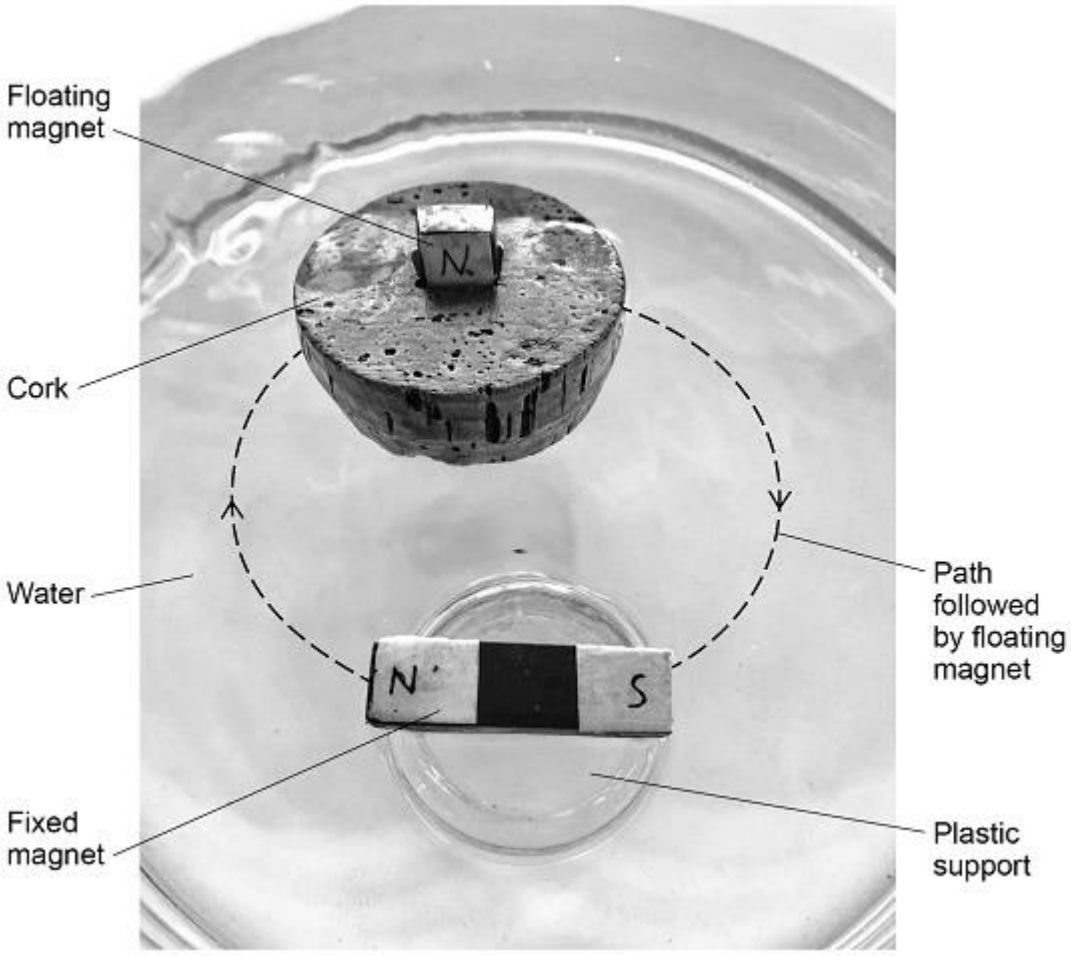
(Total 8 marks)

Q3.

A student placed a magnet on top of a plastic support in a bowl of water. This magnet was fixed in position and above the surface of the water.

The student put a second magnet into a piece of cork so that the magnet floated on the water. Only the north pole of the floating magnet was above the surface of the water.

The photograph below shows the arrangement of the magnets.



(a) The floating magnet was placed near to the north pole of the fixed magnet. The floating magnet then moved along the path shown in the photograph.

Explain why.

_____

_____

_____

_____

(2)

(b) The student replaced the floating magnet with a piece of iron.

What happened to the piece of iron?

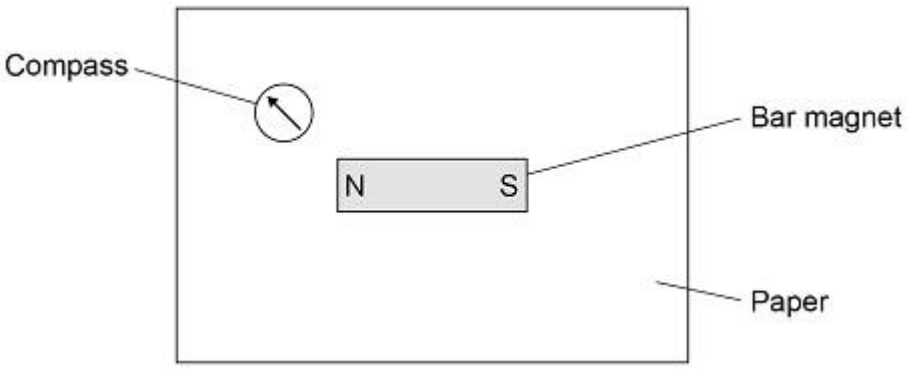
_____

(1)

(c) Describe how to use a compass to plot the magnetic field pattern around a bar magnet.

Use **Figure 1** to help you.

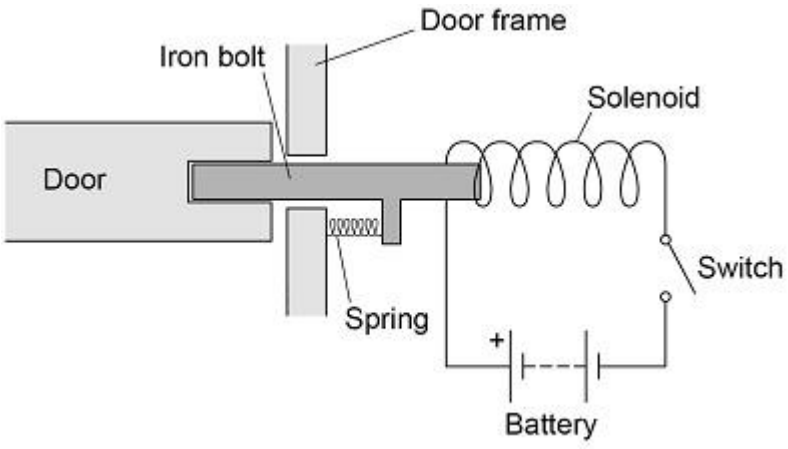
Figure 1



(4)

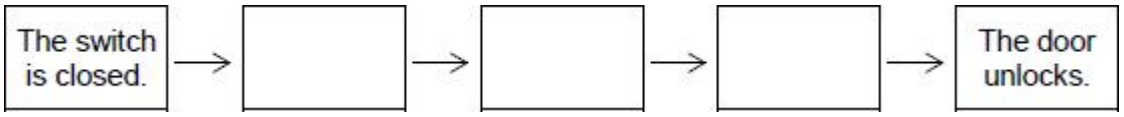
Figure 2 shows a diagram of an electromagnetic lock used to secure a door.

Figure 2



(d) **Figure 3** shows an incomplete sequence of how the door unlocks.

Figure 3



Write **one** letter in each box to show the correct sequence.

A The iron bolt moves.

B A magnetic field is created around the solenoid.

C There is a current in the circuit.

(2)

(e) The electromagnetic lock contains a spring.

When the door is unlocked the extension of the spring is 0.040 m.

spring constant = 200 N/m

Calculate the elastic potential energy of the spring when the door is unlocked.

Use the equation:

elastic potential energy = 0.5 × spring constant × (extension)^2

_____

_____

_____

_____

Elastic potential energy = _____ J

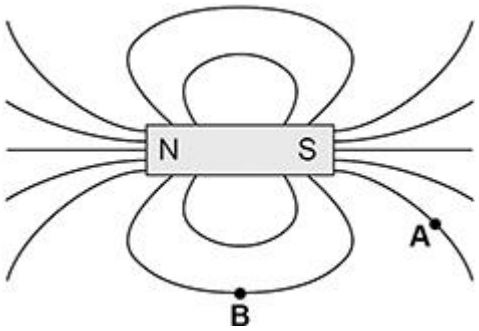
(2)

(Total 11 marks)

Q4.

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

Figure 1



(a) Draw an arrow at point **A** and point **B** to show the direction of the magnetic field at each point.

(1)

(b) A bar magnet produces its own magnetic field.

Complete the sentence.

Choose the answer from the box.

an electromagnet	**an induced magnet**	**a permanent magnet**

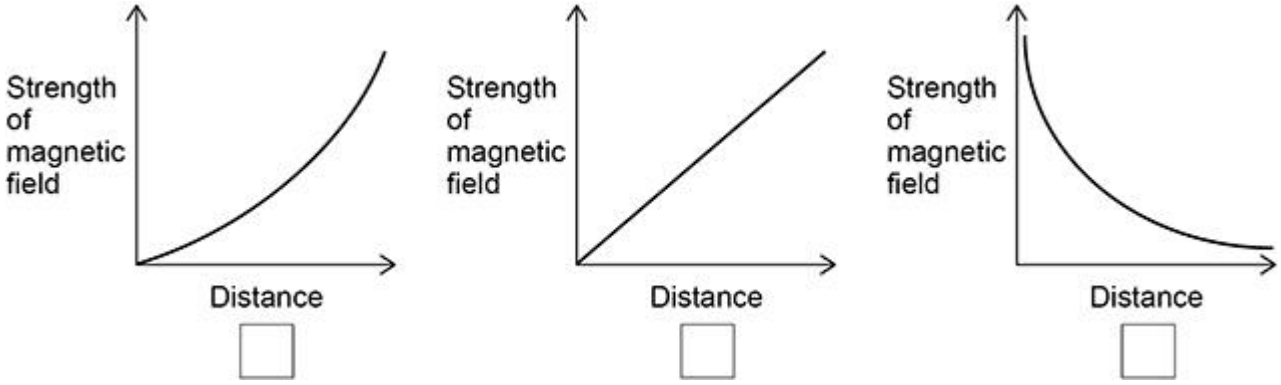
A bar magnet is an example of _____.

(1)

(c) Which graph shows how the strength of the magnetic field varies with distance from the bar magnet?

Give a reason for your answer.

Tick (✓) **one** box.



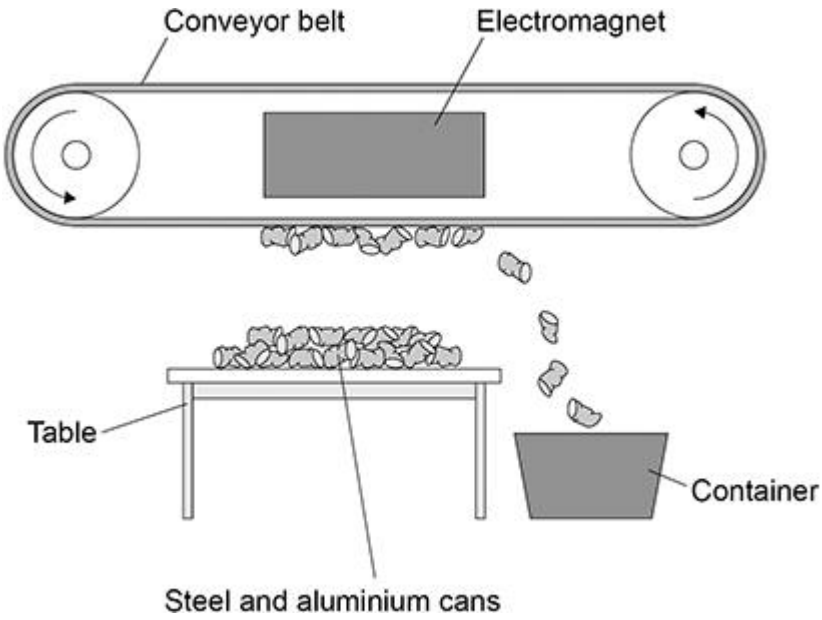
Reason _____

_____

(2)

Figure 2 shows an electromagnet being used to separate aluminium cans from steel cans.

Figure 2



(d) Explain how the electromagnet and conveyor belt are used to separate the steel cans from the aluminium cans.

_____

_____

_____

_____

(2)

(e) At the top of the table the strength of the magnetic field is only just enough to pick the cans up.

Describe **two** ways to increase the strength of magnetic field at the top of the table.

1 _____

_____

2 _____

_____

(2)

(f) Write down the equation which links distance travelled (*s*), speed (*v*) and time (*t*).

_____

(1)

(g) The conveyor belt moves a can at a speed of 1.7 m/s.

Calculate the time taken to move the can 3.3 m at this speed.

Give your answer to 2 significant figures.

_____

_____

_____

_____

_____

Time taken (2 significant figures) = _____ s

(4)

(Total 13 marks)

Q5.

(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)

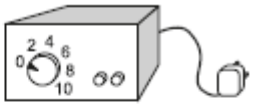
(b) **In this question you will gain marks for using good English, organising information clearly and using scientific words correctly.**

Some students want to build an electromagnet.

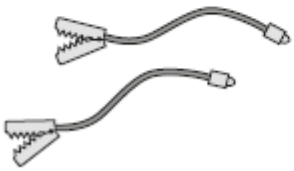
The students have the equipment shown below.

Insulated wire

Iron nail

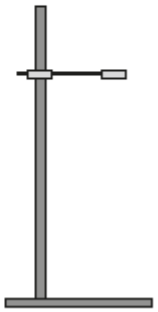


Power supply



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)

Q6.

(a) Name a material that could be used to make the outside case of the plug.

_____

Give a reason for your choice.

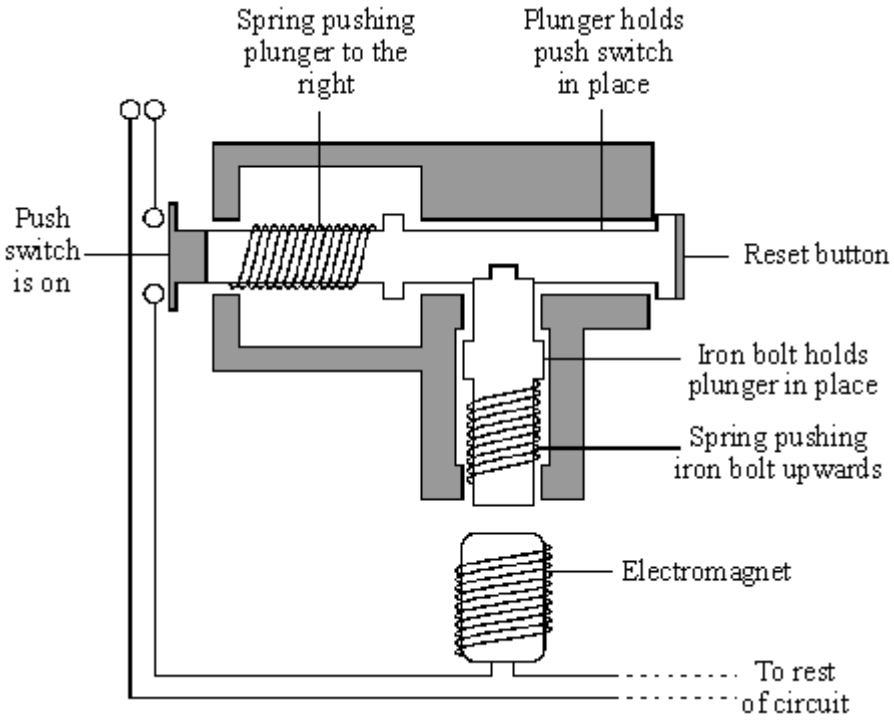
_____

_____

(2)

(b) *To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Some electrical circuits are protected by a circuit breaker. These switch the circuit off if a fault causes a larger than normal current to flow. The diagram shows one type of circuit breaker. A normal current (15 A) is flowing.



Source: adapted from V. PRUDEN and K. HIRST, AQA GCSE Sceince
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Explain what happens when a current larger than 15A flows. The answer has been started for you.

When the current goes above 15 A, the electromagnet becomes stronger and

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q1.

(a) induced

1

(b) bar 2

1

(the same end) of bar 1 attracts both ends of bar 2

or

only two magnets can repel so cannot be bar 1 or bar 3

1

(c) so the results for each magnet can be compared

or

so there is only one independent variable

fair test is insufficient

allow different thickness of paper would affect number of sheets each magnet could hold

accept it is a control variable

1

(d) because the magnet with the biggest area was not the strongest

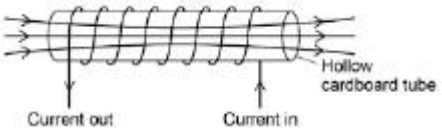
accept any correct reason that confirms the hypothesis is wrong eg smallest magnet holds more sheets than the largest

1

[5]

Q2.

(a) field lines going in, (through) and out of the solenoid



allow field lines only visible outside the cardboard tube

allow a bar magnet shaped field with lines above and below the solenoid

1

arrow(s) in correct direction

1

(b) the rods become (induced) magnets

allow the rods are (temporarily) magnetised
ignore rods repel

*do **not** accept rods become charged*

1

with the same polarity (at each end)

1

(c) changed two (independent) variables (at the same time)

allow need to keep current or number of turns constant

allow should only change one variable (at a time)

allow current and number of turns both changed
ignore fair test

1

so it is not possible to know the effect of one (independent) variable or the other

1

(d) (increasing the current) increases the strength until the strength reaches a maximum value

allow weight (held) for strength of electromagnet
ignore a given current value for when maximum strength happens

1

(e) increasing the number of turns from 10 to 20 increases the strength more than increasing from 20 to 30

a general trend is required

1

[8]

Q3.

(a) (the north pole of the floating magnet is) repelled from the north pole (of the fixed magnet)

1

and attracted to the south pole (of the fixed magnet)

*allow following a magnetic field line for **1 mark** if no other marks scored*

1

(b) it was attracted (to the fixed magnet)

allow it sticks / joins to the (fixed) magnet

allow it becomes an induced magnet

allow it becomes magnetised

1

(c) **Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

3–4

Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content:

- mark where the compass points on the paper
- move the compass to the marked point
- repeat until you go back to the magnet
- join up the points
- add an arrow pointing from the north pole to the south pole
- repeat for positions (above and below the bar magnet)

(d) C B A

*allow **1** mark for one letter in the correct box*

2

(e) $E_e = 0.5 \times 200 \times 0.040^2$

1

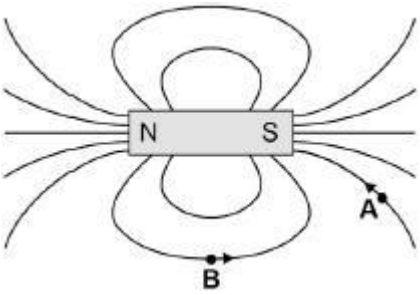
$E_e = 0.16$ (J)

1

[11]

Q4.

(a) both arrows correct

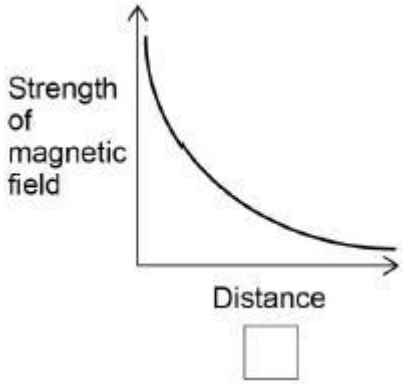


1

(b) a permanent magnet

1

(c) third box ticked



1

any **one** from

- (the only graph) that shows the magnetic field getting weaker (as distance increases)
- both other graphs show the magnetic field getting stronger (as the distance increases)

only scores if correct box is chosen

1

(d) steel cans are attracted to the electromagnet and are transferred to the container (by the conveyor belt)

1

aluminium cans are not attracted to the electromagnet and are left behind on the table

If no other mark scored: Steel cans are attracted (to the electromagnet) but aluminium cans are not – scores one mark

1

(e) raise the height of the table

allow longer legs on the table

allow put a (non-magnetic) box on top of the table

allow lower the electromagnet

1

use a larger potential difference / current
or
use a stronger electromagnet

allow more turns on the coil (of the electromagnet)

*do **not** accept insert a (soft) iron core*

1

(f) distance travelled = speed × time
or
$s = v\,t$

1

(g) $3.3 = 1.7 \times t$

1

$t = \frac{3.3}{1.7}$

1

$t = 1.941$ (s)

1

$t = 1.9$ (s)

allow a calculation using the given data incorrectly but correctly rounded to 2 sig figs

1

[13]

Q5.

(a) an electromagnet can be switched off

accept a permanent magnet cannot be switched off

or
an electromagnet is stronger

accept control the strength

(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]

Q6.

(a) plastic or rubber

accept any named plastic
*do **not** accept wood*

1

it is a (good) insulator **or** it is a poor conductor

ignore mention of heat if in conjunction with electricity

1

(b) *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*

Maximum of 2 marks if ideas not well expressed.

pulls iron bolt down **or** attracts the iron bolt **or** moves bolt out of plunger

answers in terms of charges attracting
or repelling gain no credit

1

plunger pushed / moved to the right (by spring) **or** plunger released

1

push switch opens / goes to off / goes to right

accept circuit is broken
for maximum credit the points must follow a logical sequence
*3 correct points but incorrect sequence scores **2** marks only*
ignore reset action

1

[5]