Permanent and Induced Magnetism

These practice questions can be used by students and teachers and is

Suitable for GCSE AQA Physics Topic Question 8463

Level: GSCE AQA 8463

Subject: Physics

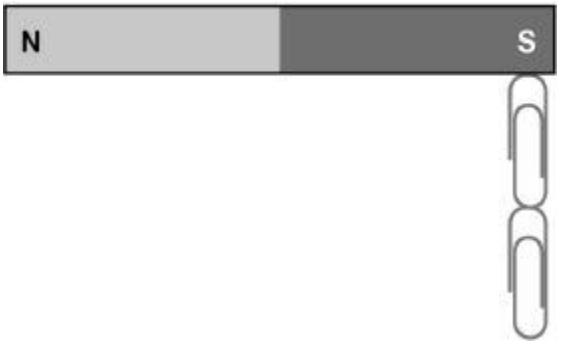
Exam Board: GCSE AQA

Topic: Permanent and Induced Magnetism

Q1.

Figure 1 shows two paper clips hanging from a bar magnet.

Figure 1



The paper clips have become magnetised.

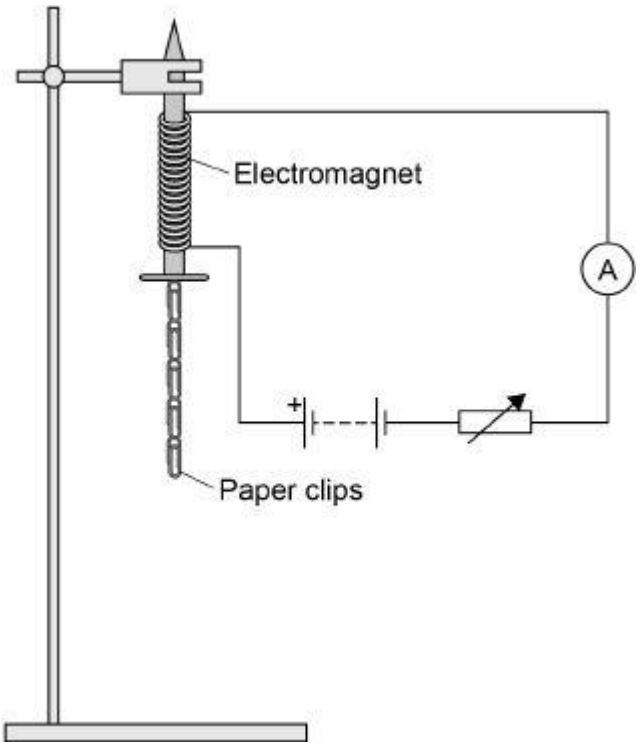
(a) Label the north and south poles of both paper clips.

(1)

A student investigated how the number of turns of wire on an electromagnet affects the strength of the electromagnet.

Figure 2 shows the equipment used by the student. Throughout the investigation the student kept the current through the wire constant.

Figure 2



(b) The student measured the strength of the electromagnet by counting the number of

paper clips the electromagnet could hold.

Explain why it was important that the paper clips were all the same size.

_____

_____

_____

_____

(2)

The table below shows the student's results.

Number of turns of wire on the electromagnet	Number of paper clips held
10	3
20	6
30	9
40	12

(c) Describe the pattern shown in the table.

_____

_____

_____

_____

(2)

(d) The student then used 50 turns of wire on the electromagnet.

The electromagnet picked up 18 paper clips. This was more paper clips than the student had expected.

Which **one** is the most likely cause of this result?

Tick **one** box.

The paper clips used with 50 turns were larger than the others. ☐

There were less than 50 turns of wire on the electromagnet. ☐

Some of the paper clips were already magnetised. ☐

(1)

(e) The student repeated the measurement for 50 turns of wire three more times.

This gave her the following set of results.

18 16 14 15

Explain what the student should now do with the **four** results for 50 turns of wire.

_____

_____

_____

_____

_____

_____

(3)

(f) The student wrote the hypothesis:

'Increasing the current through the wire will make the electromagnet stronger.'

Describe how the student should change the investigation to test this hypothesis.

_____

_____

_____

_____

_____

_____

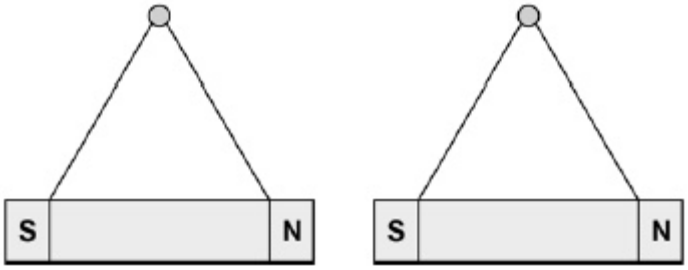
(3)

(Total 12 marks)

Q2.

Figure 1 shows two bar magnets suspended close to each other.

Figure 1



(a) Explain what is meant by the following statement.

'A non-contact force acts on each magnet'.

_____

_____

_____

_____

(2)

(b) Describe how to plot the magnetic field pattern of a bar magnet.

_____

_____

_____

_____

_____

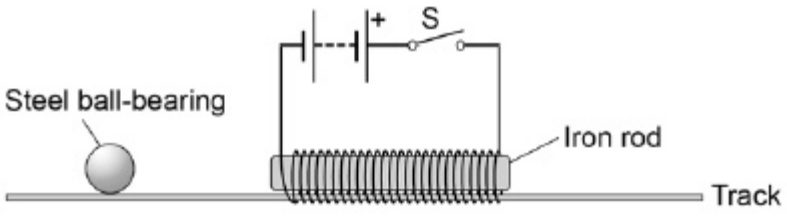
_____

(3)

A student has set up the apparatus shown in **Figure 2**.

The iron rod is fixed to the track and cannot move.

Figure 2



(c) The student gives the steel ball bearing a gentle push in the direction of the iron rod.

At the same time the student closes the switch **S**.

Explain the effect on the motion of the ball bearing when the switch **S** is closed.

(4)

(Total 9 marks)

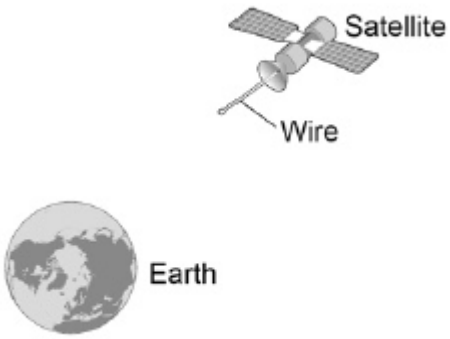
Q3.

Scientists have used a satellite system to investigate the idea of generating electricity in space.

As the system orbited the Earth a 20 km copper wire was reeled out.

Before the wire snapped a current of 1 amp was induced in the wire.

Figure 1



(a) What provides the force needed to keep a satellite in orbit around the Earth?

(1)

(b) Explain how a current is induced in the wire.

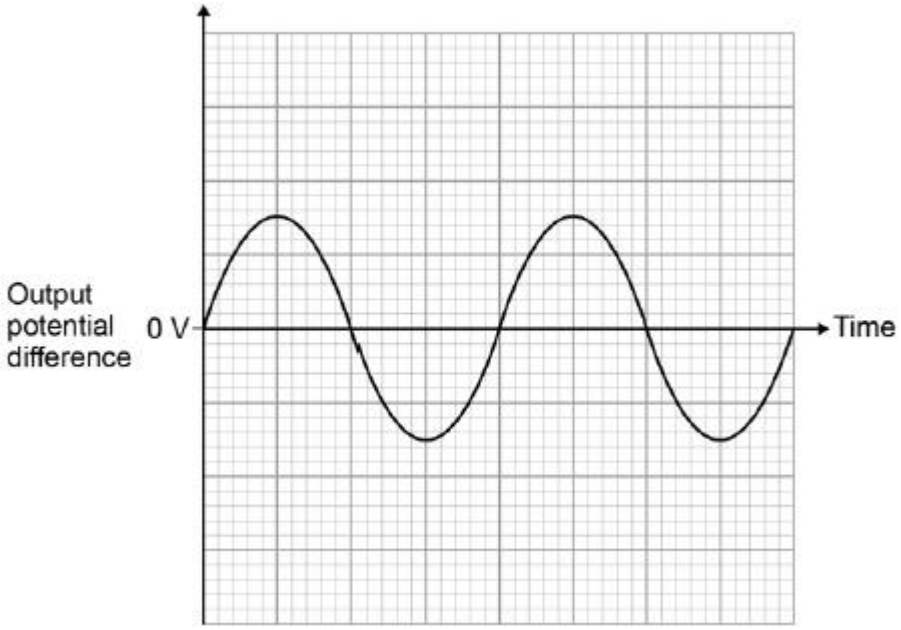
(3)

An alternator is connected to a data logger.

The data logger is connected to a computer.

Figure 2 shows how the output potential difference of the alternator varies with time.

Figure 2



(c) The coil inside the alternator now rotates at twice the frequency.

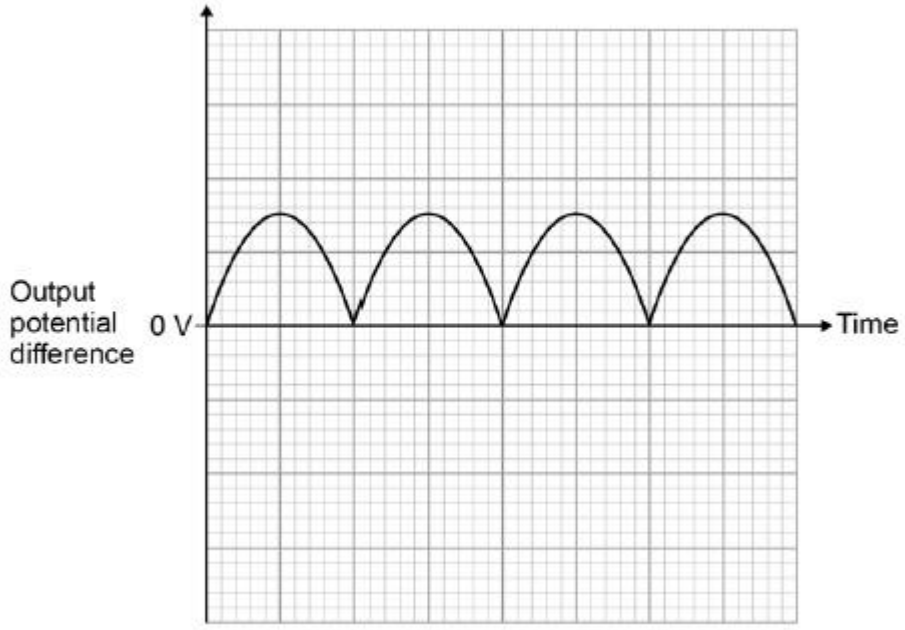
Draw on **Figure 2** to show how the output potential difference varies with time at this new frequency.

(2)

Another type of generator is now connected to the data logger and computer.

Figure 3 shows how the output potential difference varies with time for this generator.

Figure 3



(d) What name is given to this second type of generator?

_____

(1)

(e) Look at **Figure 2** and **Figure 3**.

Give one difference between the outputs from the two types of generator.

_____

_____

_____

(1)

(f) The charger used to charge the battery inside a laptop computer contains a small transformer.

The charger plugs into the mains electricity supply.

mains electricity supply = 230 V

number of turns on the primary coil of the transformer = 690

number of turns on the secondary coil of the transformer = 57

Calculate the potential difference applied by the charger across the battery inside the computer.

_____

_____

_____

_____

_____

_____

Potential difference = _____ V

(3)

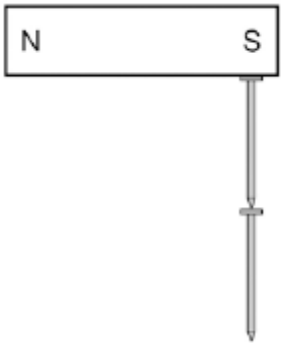
(Total 11 marks)

Q4.

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**

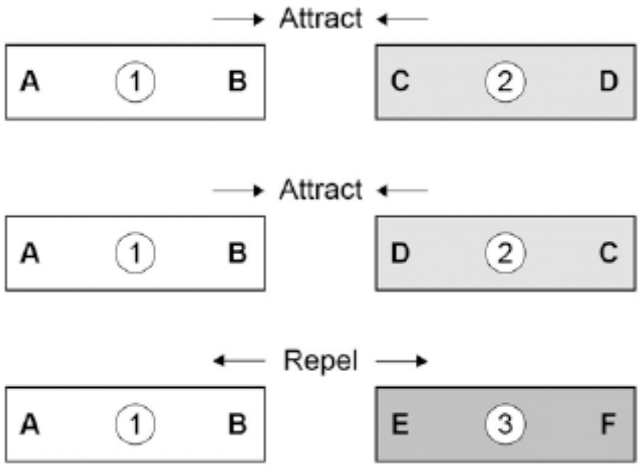
The iron nails have become _____ magnets.

(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 mm^2	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)

Q5.

Waves may be either longitudinal or transverse.

(a) Describe the difference between a longitudinal and a transverse wave.

_____

_____

_____

_____

(2)

(b) Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels.

_____

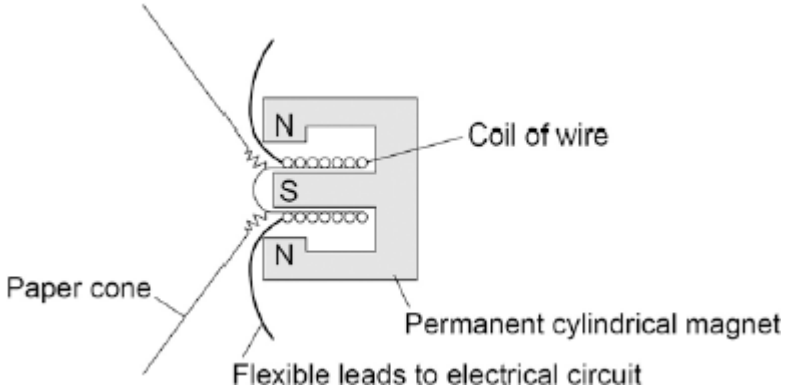
_____

_____

(1)

(c) The figure below shows the parts of a moving-coil loudspeaker.

A coil of wire is positioned in the gap between the north and south poles of the cylindrical magnet.



Explain how the loudspeaker converts current in an electrical circuit to a sound wave.

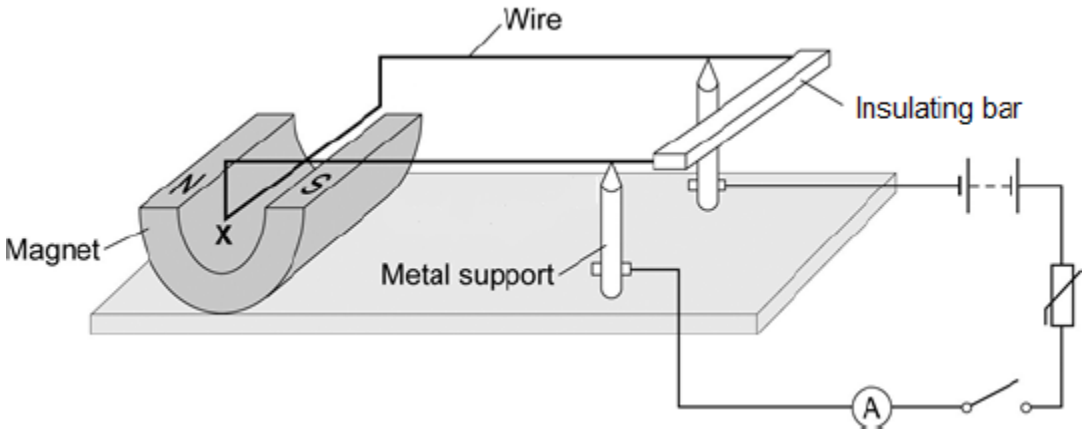
(6)

(Total 9 marks)

Q6.

Figure 1 shows a piece of apparatus called a current balance.

Figure 1



When the switch is closed, the part of the wire labelled **X** experiences a force and moves downwards.

(a) What is the name of the effect that causes the wire **X** to move downwards?

_____

(1)

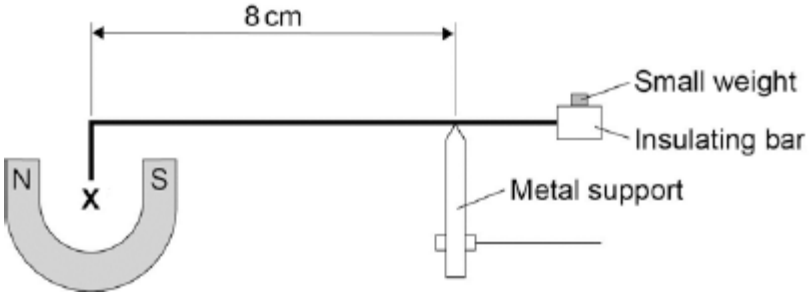
(b) Suggest one change you could make to the apparatus in **Figure 1** that would increase the size of the force that wire **X** experiences.

_____

(1)

(c) **Figure 2** shows how a small weight placed on the insulating bar makes the wire **X** go back and balance in its original position.

Figure 2



The wire **X** is 5 cm long and carries a current of 1.5 A.

The small weight causes a clockwise moment of 4.8×10^{-4} Nm.

Calculate the magnetic flux density where the wire **X** is positioned

Give the unit.

_____

_____

_____

_____

_____

_____

_____

Magnetic flux density = _____ Unit _____

(6)

(Total 8 marks)

Q7.

(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)

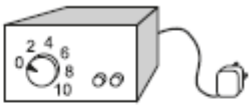
(b) **In this question you will gain marks for using good English, organising information clearly and using scientific words correctly.**

Some students want to build an electromagnet.

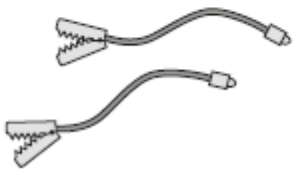
The students have the equipment shown below.

Insulated wire

Iron nail

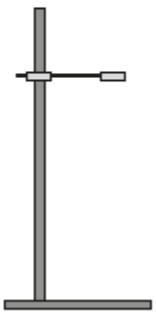


Power supply



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.

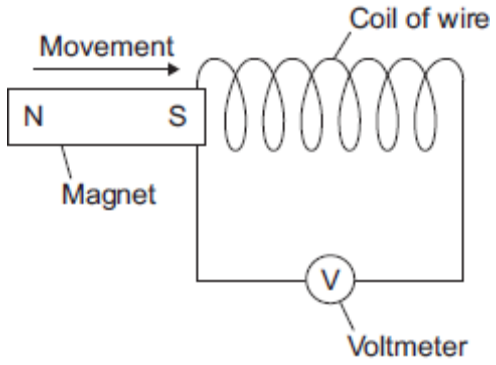
(6)

(Total 7 marks)

Q8.

Figure 1 shows a magnet moving into a coil of wire. This movement causes a reading on the voltmeter.

Figure 1



(a) Use the correct word from the box to complete the sentence.

generated	**induced**	**produced**

Moving the magnet into the coil of wire causes a reading on the voltmeter because a potential difference is _____ across the ends of the wire.

(1)

(b) A student investigated how the number of turns on the coil of wire affects the maximum voltmeter reading. The student changed the number of turns on the coil of wire, then moved the magnet into the coil. The student recorded the maximum voltmeter reading.

To obtain valid data, suggest **two** variables that the student should control in this investigation.

1. _____

_____

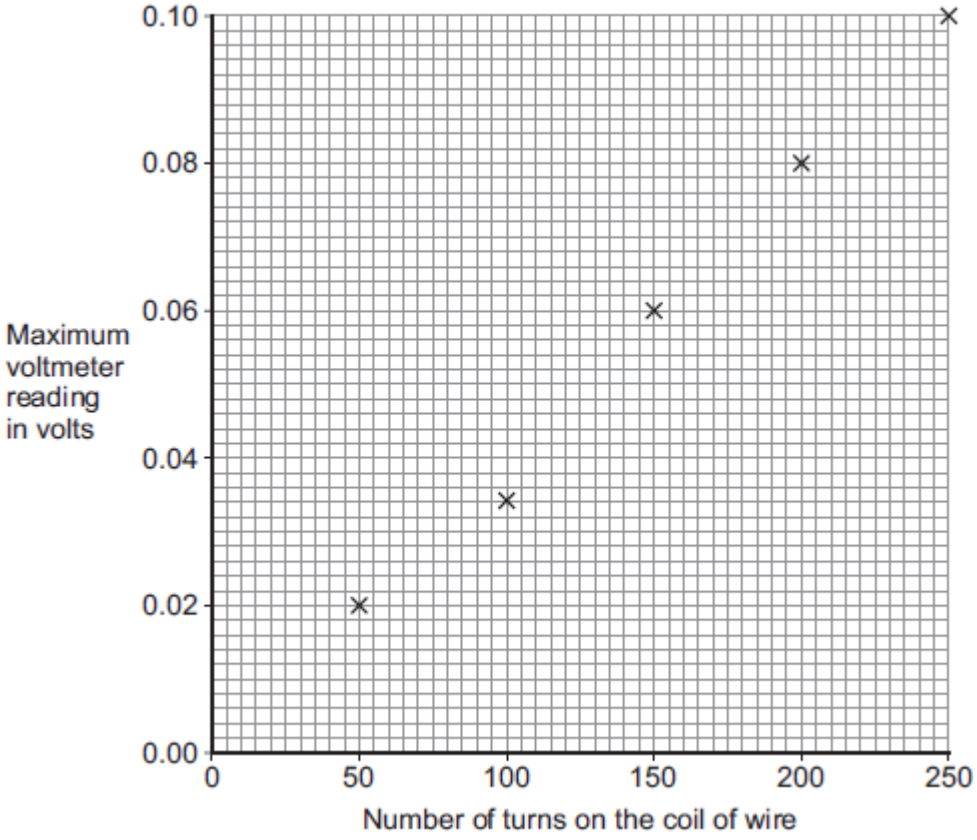
2. _____

_____

(2)

(c) The student's results are shown in **Figure 2**.

Figure 2



(i) One of the results is anomalous.
Suggest a reason for the anomalous result.

_____

(1)

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

(1)

(d) A data-logger can automatically record and store data.

It may have been better for the student to have used a data-logger in his investigation rather than a voltmeter.

Suggest **one** reason why.

_____

_____

(1)

(Total 6 marks)

Q9.

(a) **Diagram 1** shows a magnetic closure box when open and shut. It is a box that stays shut, when it is closed, due to the force between two small magnets.

These boxes are often used for jewellery.

Diagram 1

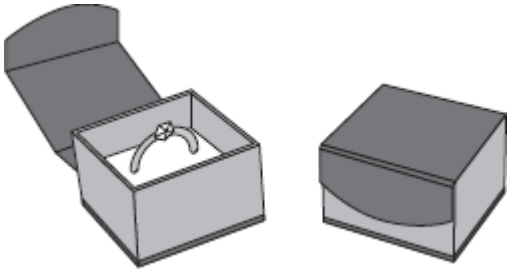
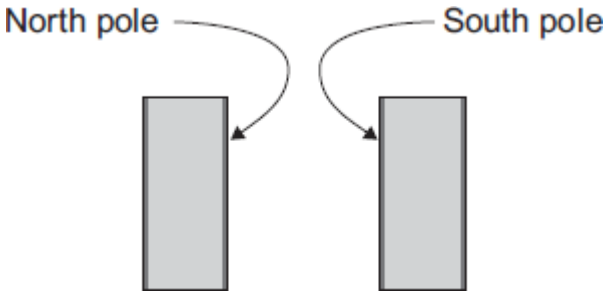


Diagram 2 shows the two magnets. The poles of the magnets are on the longer faces.

Diagram 2



(i) Draw, on **Diagram 2**, the magnetic field pattern between the two facing poles.

(2)

(ii) The magnets in the magnetic closure box must **not** have two North poles facing each other.

Explain why.

_____

_____

_____

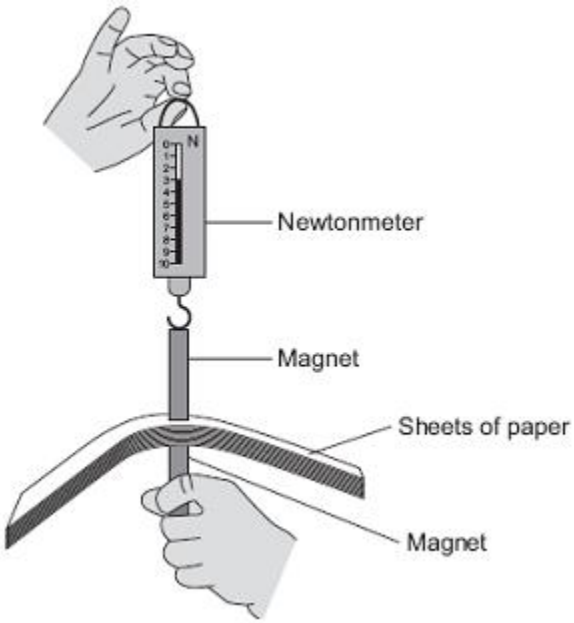
_____

(2)

(b) A student is investigating how the force of attraction between two bar magnets depends on their separation.

She uses the apparatus shown in **Diagram 3**.

Diagram 3



She uses the following procedure:

- ensures that the newtonmeter does not have a zero error
- holds one of the magnets
- puts sheets of paper on top of the magnet
- places the other magnet, with the newtonmeter magnetically attached, close to the first magnet
- pulls the magnets apart
- notes the reading on the newtonmeter as the magnets separate
- repeats with different numbers of sheets of paper between the magnets.

The results are shown in the table.

Number of sheets of paper between the magnets	10	20	30	40	50	60	70	80	120
Newtonmeter reading as the magnets separate	3.1	2.6	2.1	1.5	1.1	1.1	1.1	1.1	1.1

(i) Describe the pattern of her results.

_____

_____

_____

_____

(2)

(ii) No matter how many sheets of paper the student puts between the magnets, the force shown on the newtonmeter never reaches zero.

Why?

_____

_____

(1)

(iii) The student is unable to experiment with fewer than 10 sheets of paper without glueing the magnet to the newtonmeter.

Suggest why.

_____

_____

_____

_____

(2)

(iv) Suggest **three** improvements to the procedure that would allow the student to gain more accurate results.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(v) The thickness of one sheet of paper is 0.1 mm.

What is the separation of the magnets when the force required to separate them is 2.1 N?

_____

_____

Separation of magnets = _____ mm

(3)

(Total 15 marks)

Q10.

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

_____

Give a reason for your choice.

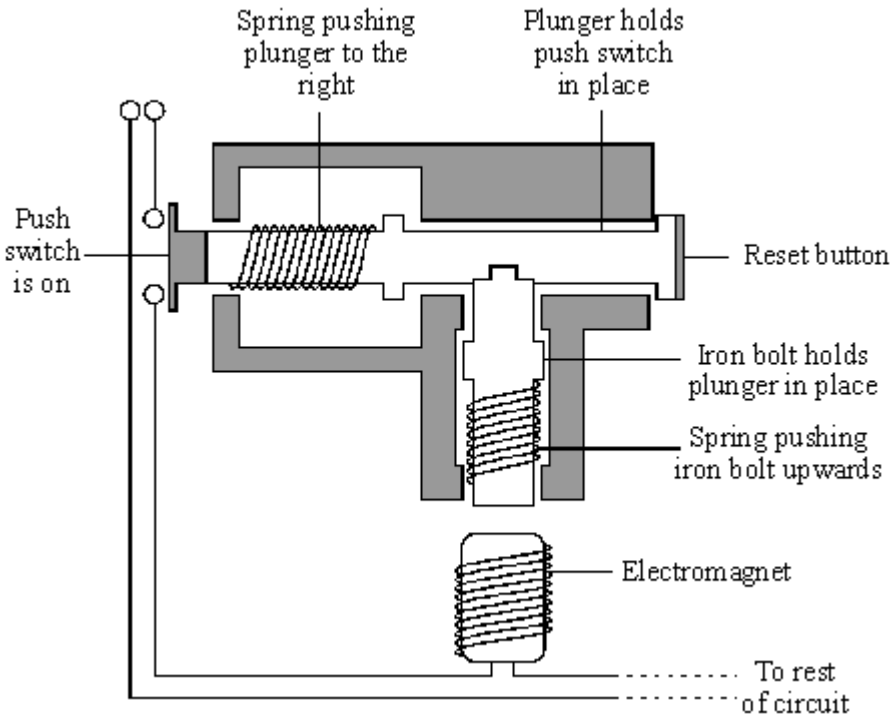
_____

_____

(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.



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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)

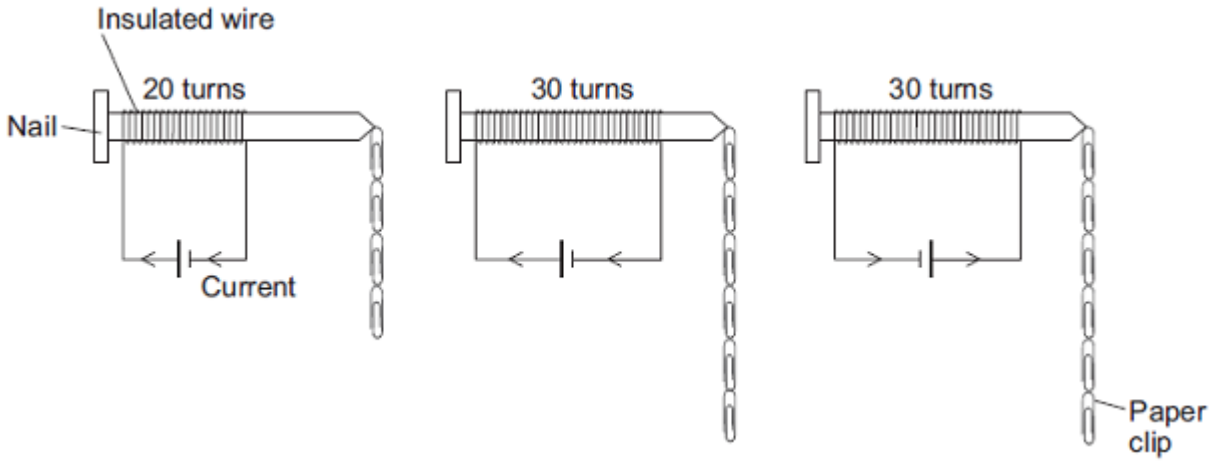
Q11.

A student is investigating the strength of electromagnets.

Figure 1 shows three electromagnets.

The student hung a line of paper clips from each electromagnet.

Figure 1



Electromagnet **A** Electromagnet **B** Electromagnet **C**

No more paper clips can be hung from the bottom of each line of paper clips.

(a) (i) Complete the conclusion that the student should make from this investigation.

Increasing the number of turns of wire wrapped around the nail will

_____ the strength of the electromagnet.

(1)

(ii) Which **two** pairs of electromagnets should be compared to make this conclusion?

Pair 1: Electromagnets _____ and _____

Pair 2: Electromagnets _____ and _____

(1)

(iii) Suggest **two** variables that the student should control in this investigation.

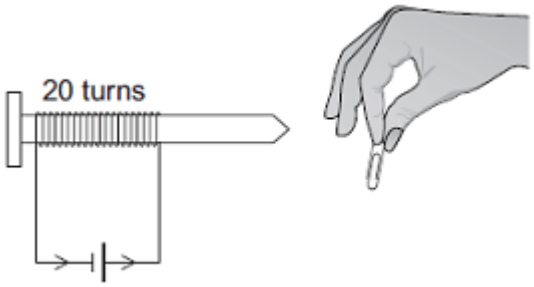
1. _____

2. _____

(2)

(b) The cell in electromagnet **A** is swapped around to make the current flow in the opposite direction. This is shown in **Figure 2**.

Figure 2



What is the maximum number of paper clips that can now be hung in a line from this electromagnet?

Draw a ring around the correct answer.

fewer than 4 **4** **more than 4**

Give **one** reason for your answer.

_____

_____

_____

(2)

(c) Electromagnet **A** is changed to have only 10 turns of wire wrapped around the nail.

Suggest the maximum number of paper clips that could be hung in a line from the end of this electromagnet.

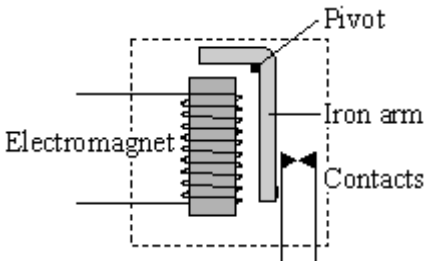
Maximum number of paper clips = _____

(1)

(Total 7 marks)

Q12.

The diagram shows a switch that is operated by an electromagnet.

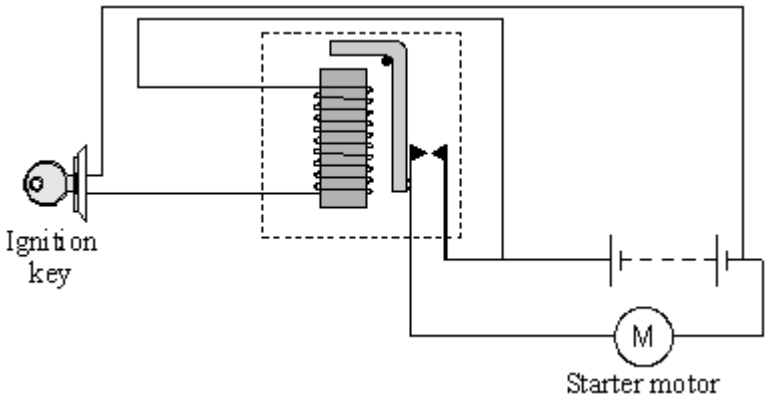


(i) What is this type of switch called?

_____

(1)

(ii) The switch is used in a car starter motor circuit.



Explain how turning the ignition key makes a current flow in the starter motor. The explanation has been started for you.

When the ignition key is turned _____

_____

_____

_____

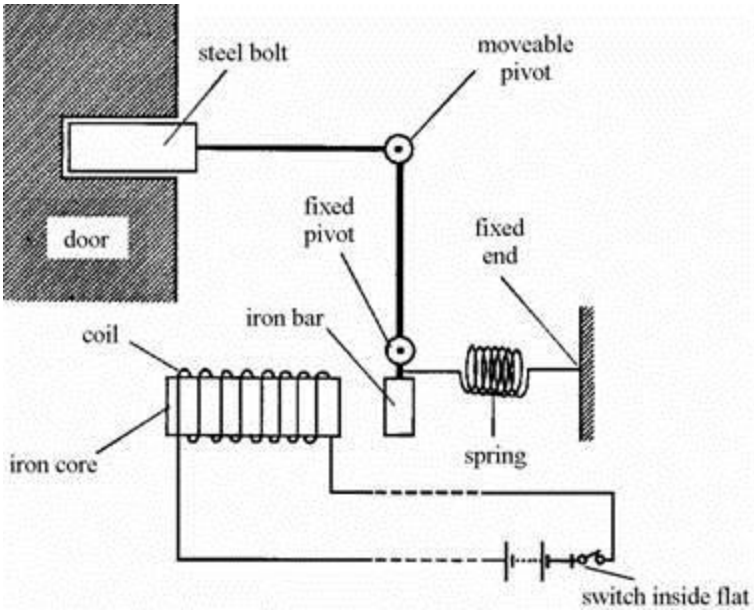
_____

(3)

(Total 4 marks)

Q13.

The diagram below shows a door lock which can be opened from a flat inside a building.



(a) Explain how the door is unlocked when the switch is closed.

_____

_____

_____

_____

(4)

(b) State **two** changes which would increase the strength of the electromagnet.

1. _____

2. _____

(2)

(c) Why is the spring needed in the lock?

_____

_____

(1)

(d) The connections to the coil were accidentally reversed. Would the lock still work?

_____

Explain your answer.

_____

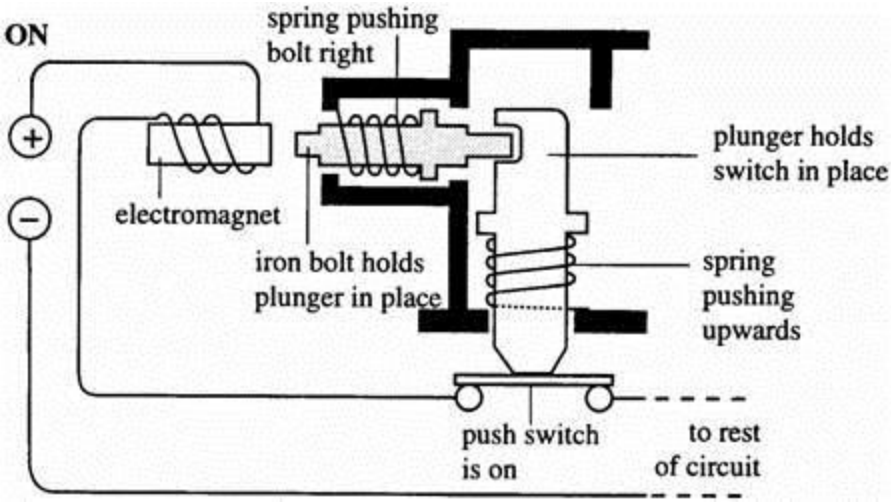
_____

(2)

(Total 9 marks)

Q14.

A fault in an electrical circuit can cause too great a current to flow.
Some circuits are switched off by a circuit breaker.

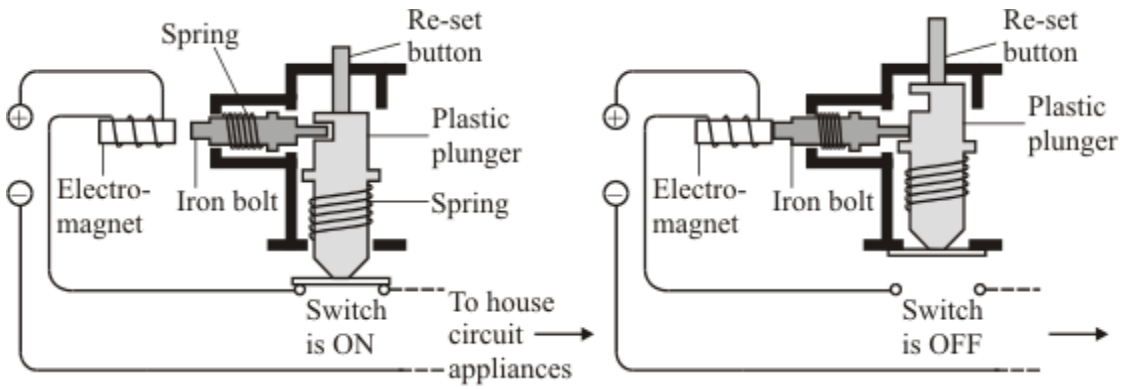


One type of circuit breaker is shown above. A normal current is flowing.
Explain, in full detail, what happens when a current which is bigger than normal flows.

(Total 4 marks)

Q15.

Circuit breakers help to make the electricity supply in homes safer.
A circuit breaker is an automatic safety switch. It cuts off the current if it gets too big.



Describe, in as much detail as you can, how this circuit breaker works.

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.

(Total 6 marks)

Mark schemes

Q1.

(a) top of each paper clip labelled N / north

both parts required

and

bottom of each paper clip labelled S / south

1

(b) so the paper clips have the same weight / mass

1

which allows the results for different numbers of turns to be compared (fairly)

allow fair test
allow the control variable (is the weight / mass of a paper clip)
allow to obtain valid results
ignore accurate results

1

(c) as the number of turns increases so does the number of paper clips (held)

allow positive correlation

1

in a linear pattern

*directly proportional scores **2** marks*
*allow a correct description of directly proportional for **2** marks*

1

(d) some of the paper clips were already magnetised

1

(e) discount the result of 18

ignore repeat experiment / measurements

1

as the three new results are similar (and not close to 18)

1

and use 15 (the mean of the new results)

allow find the mean of the remaining results (16,14 and 15)

if no other marks have been awarded: calculate the mean (of all four results) (1)

round down to 15 (1) − this mark only scores if the mean of 15.75 has been calculated

1

(f) keep number of turns constant

allow a specific number of turns

1

(use the variable resistor to) change the current (several times)

change the p.d. is insufficient

1

(for each current value) count how many paper clips the electromagnet will hold

1

[12]

Q2.

(a) the magnets are not touching

1

but (each) experiences a force

allow but there is a force of attraction between them

1

(b) place a (plotting) compass near the (north / south) pole of the magnet and mark the direction that the compass points

1

move the (plotting) compass around the bar magnet (to the other pole) marking at (regular) intervals the direction the compass points

1

join the points up and add an arrow pointing from the north pole to the south pole

1

(c) (closing switch S) causes a current in the coil

allow switches on the electromagnet

1

a magnetic field is created

1

a force of attraction acts on the ball bearing

1

so the ball bearing accelerates (towards the iron rod)

1

[9]

Q3.

(a) gravity

1

(b) as the wire moves through the Earth's magnetic field

1

a potential difference is induced between the ends of the wire

1

the wire must be part of a complete circuit

1

(c) new trace shows:

twice the frequency

1

twice the amplitude

1

(d) dynamo

dc generator is insufficient

1

(e) the alternator pd changes polarity, the 2nd type of generator does not

1

(f) $\frac{230}{V_s} = \frac{690}{57}$

1

$V_s = \frac{230 \times 57}{690}$

1

V_s = 19 (V)

*an answer of 19 (V) scores **3** marks*

1

[11]

Q4.

(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]

Q5.

(a) in a longitudinal wave the oscillations / vibrations are parallel to the direction of energy transfer.

accept wave travel for energy transfer throughout

1

in a transverse wave the oscillations / vibrations are perpendicular to the direction of energy transfer.

1

(b) accept any sensible suggestion eg a vibrating drum skin does not move the air away to create a vacuum (around the drum)

1

(c) **Level 3 (5–6 marks):**
A detailed explanation linking variations in current to the pressure variations of a sound wave, with a logical sequence.

Level 2 (3–4 marks):
A number of relevant points made, but not precisely. A link between the loudspeaker and
a sound wave is made.

Level 1 (1–2 marks):
Some relevant points but fragmented with no logical structure.

0 marks:
No relevant content.

Indicative content

the current in the electrical circuit is varying

the current passes through the coil

the coil experiences a force (inwards or outwards)

reversing the current reverses the force

the size of the current affects the size of the force

the varying current causes the coil to vibrate

the (vibrating) coil causes the cone to vibrate

the vibrating cone causes the air molecules to move

the movement of the air molecules produces the pressure variations in the air needed for
a sound wave

the air molecules bunch together forming compressions and spread apart forming rarefactions

6

[9]

Q6.

(a) motor effect

1

(b) increase the strength of the magnet

or

increase the current

1

(c) $4.8 \times 10^{-4} = F \times 8 \times 10^{-2}$

1

$F = 6 \times 10^{-3}$ (N)

1

$6 \times 10^{-3} = B \times 1.5 \times 5 \times 10^{-2}$

1

$$B = \frac{6 \times 10^{-3}}{7.5 \times 10^{-2}}$$

1

$B = 8 \times 10^{-2}$ or 0.08

1

*allow 8×10^{-2} **or** 0.08 with no working shown for **5** marks*

*a correct method with correct calculation using an incorrect value of F gains **3** marks*

Tesla

accept T

1

do not accept t

[8]

Q8.

(a) induced

1

(b) any **two** from:

- use the same (strength) magnet

  same size magnet is insufficient
- the speed that the magnet is moved

  accept movement of the magnet
- the area of the turns

  same type / length of wire is insufficient

- the magnetic pole being moved towards the coil (of wire).

use the same voltmeter is insufficient

2

(c) (i) voltmeter misread
or
number of turns miscounted

result misread is insufficient

human error is insufficient

allow the magnet was moved at a (slightly) different speed (into the coil) than for the other readings

allow spacing between the turns had changed

1

(ii) line of best fit passing through all points except (100, 0.034)

line does not need to go back to origin

1

(d) any **one** from:

- can re-check data / readings.

accept can go back to data

- can take more readings (in a given time)

can store data is insufficient

- easier to identify maximum value.

automatically records data is insufficient

accept is more accurate

accept eliminates human error

1

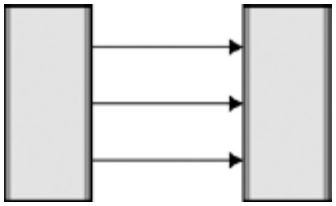
[6]

Q9.

(a) (i) field pattern shows:
some straight lines in the gap

1

direction N to S



1

(ii) north poles repel

1

(so) box will not close

1

(b) (i) as paper increases (rapid) decrease in force needed

1

force levels off (after 50 sheets)

1

(ii) the newtonmeter will show the weight of the top magnet

1

(iii) (top) magnet and newtonmeter separate before magnets separate

accept reverse argument

1

(because) force between magnets is greater than force between magnet and hook of newtonmeter

1

(iv) any **three** from:

- means of reading value of force at instant the magnets are pulled apart
- increase the pulling force gently
  or
  use a mechanical device to apply the pulling force
- clamp the bottom magnet
- use smaller sheets of paper
- fewer sheets of papers between readings (smaller intervals)
- ensure magnets remain vertical
- ensure ends of magnet completely overlap
- repeat the procedure several times for each number of sheets and take a mean
- make sure all sheets of paper are the same thickness

3

(v) 3 (mm)

*30 × 0.1 ecf gains **2** marks*

*2.1 N corresponds to 30 sheets gains **1** mark*

3

[15]

Q10.

(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]

Q11.

(a) (i) increase

1

(ii) A and B
and
B and C

both required for the mark

either order

1

(iii) any **two** from:

- size of nail
  or
  nail material
  allow (same) nail
- current
  allow (same) cell
  allow p.d.
  same amount of electricity is insufficient
- (size of) paper clip
- length of wire
  accept type / thickness of wire

2

(b) 4

1

B picks up the same number as C, so this electromagnet would pick up the same number as A
or
direction of current does not affect the strength of the electromagnet

allow it has got the same number of turns as A

1

(c) 2

allow 1 or 3

1

[7]

Q12.

(i) relay

accept solenoid

*do **not** accept magnetic switch*

1

(ii) a current flows through the coil (of the electromagnet)
or a current flows through the electromagnet
or a (magnetic) field is produced

accept 'electricity' for 'current'

*accept the electromagnet is activated **or** magnetised **or** turned on*

*do **not** accept answer in terms of magnetic charge*

1

the (iron) arm is attracted to the electromagnet

*accept the arm pivots **or** moves towards the electromagnet*

1

the contacts are pushed together

*do **not** accept contacts attract*

1

[4]

Q13.

(a) current flows
coil / core magnetised / electromagnet activated / energised / turned on
attracts iron bar causing bolt to be pulled out

each for 1 mark

4

(b) more turns
bigger current / e.m.f
softer iron core

any two for 1 mark each

2

(c) to relock door / return iron bar / to lock door

for 1 mark

1

(d) iron bar would still be attracted / coil still magnetised so still works
for 1 mark each

yes + wrong answer
0 marks

yes + current still flows
1 mark

yes + still magnetised / iron bar still attracted
2 marks

2

[9]

Q14.

electromagnet becomes <u>stronger</u> (*not* becomes magnetic) iron moves left – implied OK
plunger goes up push switch goes to off or circuit broken unless plunger moves down
for 1 mark each

[4]

Q15.

Quality of written communication: One mark for correct sequencing.
bolt out → plunger up → switch off / circuit broken

1

any **five** from

- high current flows
- electromagnet is stronger
- the iron bolt is pulled out
- the plastic plunger moves up
- the switch is lifted / open / off
accept circuit is broken
- no current flowing
- to re-set the plunger must be pushed down

5

[6]