Magnetism part 3 AQA Triple Physics

Name:

Class:

Date:

Time: **87 minutes**

Marks: **83 marks**

Comments:

1. A door is fitted with a security lens and a lock.

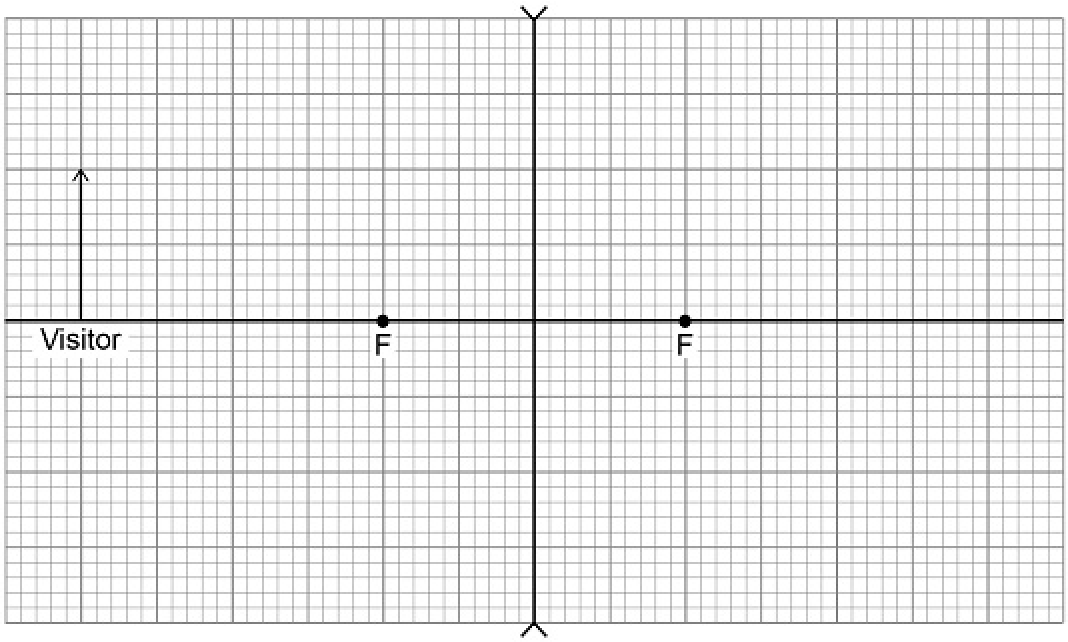
The security lens allows a person to see a visitor before opening the door.

The security lens is concave.

(a) The diagram below is an incomplete ray diagram representing a visitor standing near the security lens.

Complete the diagram to show how an image of the visitor is formed by the concave lens.

Draw an arrow to represent the image.



(3)

(b) The visitor moves further away from the security lens in the door.

How does the size of the image change?

Tick (✓) **one** box.

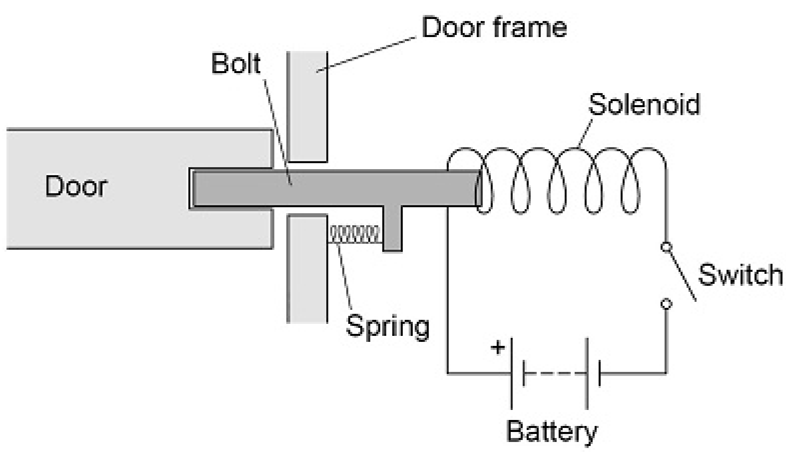
Decreases ☐

Increases ☐

Stays the same ☐

(1)

The diagram below shows a diagram of the lock. The door unlocks when the switch is closed.



(c) Which material should the bolt be made from?

Tick (✓) **one** box.

Aluminium ☐

Brass ☐

Copper ☐

Iron ☐

(1)

(d) Explain why the door unlocks when the switch is closed.

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(3)

(e) When the door unlocks, a force of 2.88 N is applied to the spring.

The spring extends by 1.50 cm.

Calculate the spring constant of the spring.

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____

____

Spring constant = ________________ N/m

(4)

(f) Give **two** ways the resultant force on the bolt could be increased.

1 ____

____

2 ____

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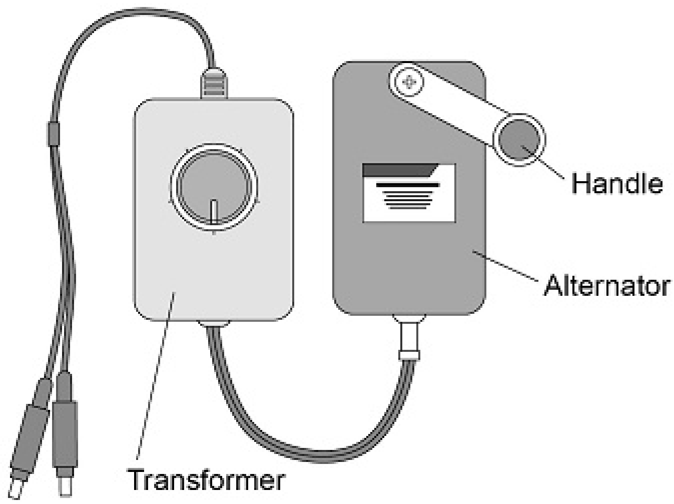
(2)

(Total 14 marks)

2. **Figure 1** shows a portable power supply.

Figure 1



(a) The portable power supply has an alternator connected to a transformer.

The transformer can be adjusted to have different numbers of turns on the secondary coil.

Suggest why.

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(2)

(b) A lamp is connected to the power supply.

The lamp requires an input potential difference of 5.0 V.

The alternator generates a potential difference of 1.5 V.

The primary coil of the transformer has 150 turns.

Calculate the number of turns needed on the secondary coil.

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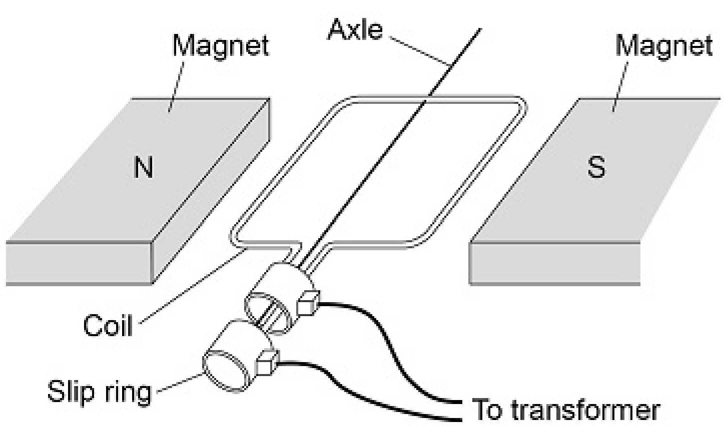
Number of turns on the secondary coil = ___

(3)

Figure 2 shows the inside parts of the alternator.

Figure 2



(c) The handle of the alternator is turned, causing the coil to rotate.

Explain why an alternating current is induced in the coil.

(5)

(d) Suggest the purpose of the slip rings.

(1)

(e) The alternator from the portable power supply is disconnected from the transformer and lamp.

Explain why the handle of the alternator becomes much easier to turn.

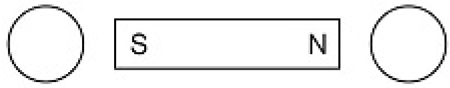
(3)

(Total 14 marks)

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

Each circle represents a compass.

Figure 1



Draw an arrow inside each circle to show the direction that each compass would point.

(1)

(b) **Figure 2** shows part of a coat.

The coat has two magnets hidden inside the material.

Figure 3 shows how the magnets are used to fasten the coat.

Figure 2

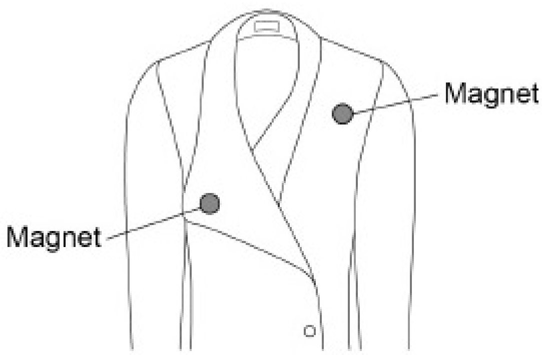


Figure 3

Explain why the magnets inside the coat must **not** have two south poles facing each other.

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(2)

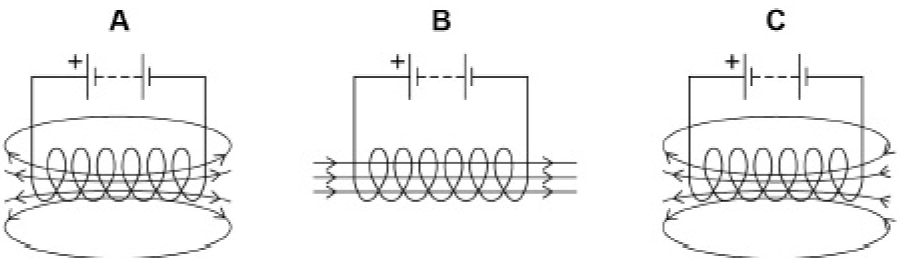
A coil of wire is connected to a battery.

The current in the coil produces a magnetic field.

(c) Which diagram in **Figure 4** shows the magnetic field produced by the current in the coil?

Tick (✓) **one** box.

Figure 4



A ☐ B ☐ C ☐

(1)

(d) A solid rod is placed inside the coil.

Which type of rod would make the magnetic field of the coil stronger?

Tick (✓) **one** box.

Glass rod ☐

Plastic rod ☐

Steel rod ☐

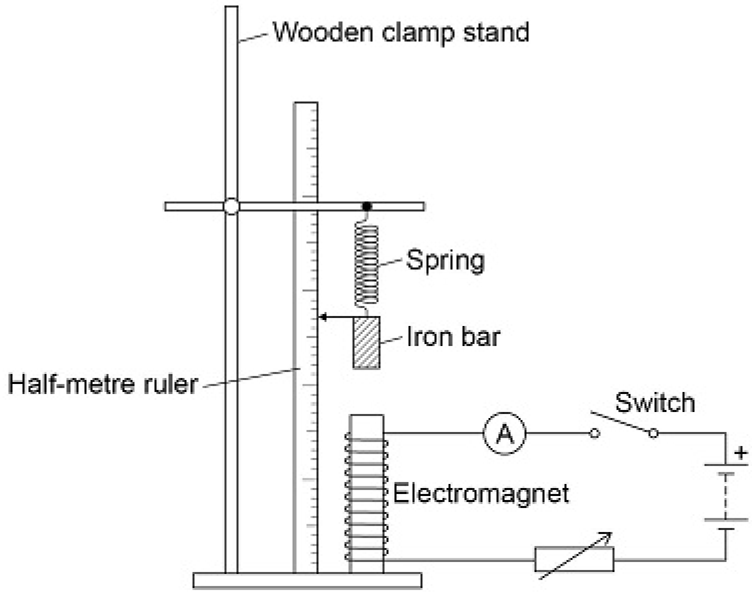
Wooden rod ☐

(1)

A student investigated how the strength of an electromagnet varies with the current in the coil of the electromagnet.

Figure 5 shows the equipment the student used.

Figure 5



(e) Why does the spring get longer when the electromagnet is switched on?

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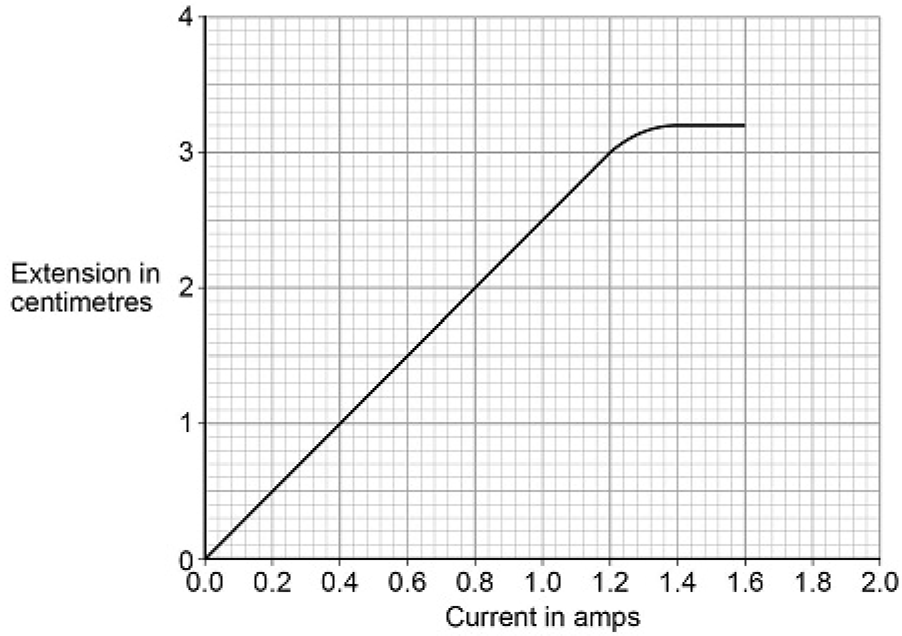
(1)

The student measured how much further the spring extended with different values of current in the coil.

Figure 6 shows the results.

Figure 6



(f) The current in the coil is increased from 0.6 A to 1.2 A

Determine the increase in the extension of the spring.

____

Increase in the extension = ________________________________ cm

(1)

(g) Calculate the increase in the force on the spring when the current in the coil increased from 0.6 A to 1.2 A

Spring constant = 0.18 N/cm

Use the equation:

force = spring constant × extension

____

____

Increase in the force = ____________________________ N

(2)

(h) Describe what happened to the strength of the electromagnet as the current in the coil increased from 1.2 A to 1.6 A

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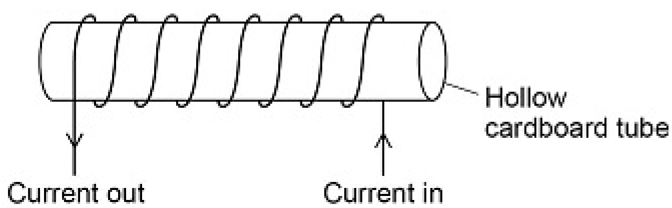
(2)

(Total 11 marks)

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

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

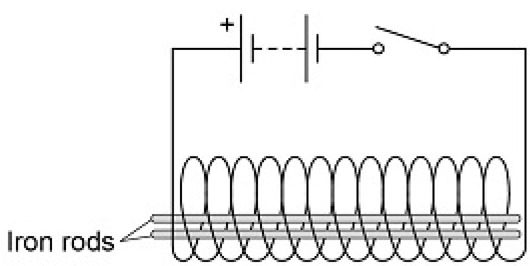
Figure 1



(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.

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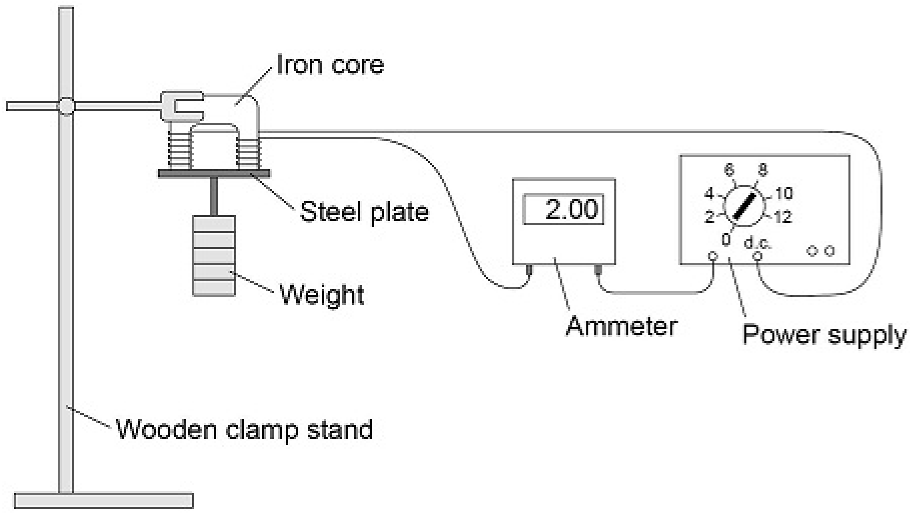
(2)

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.

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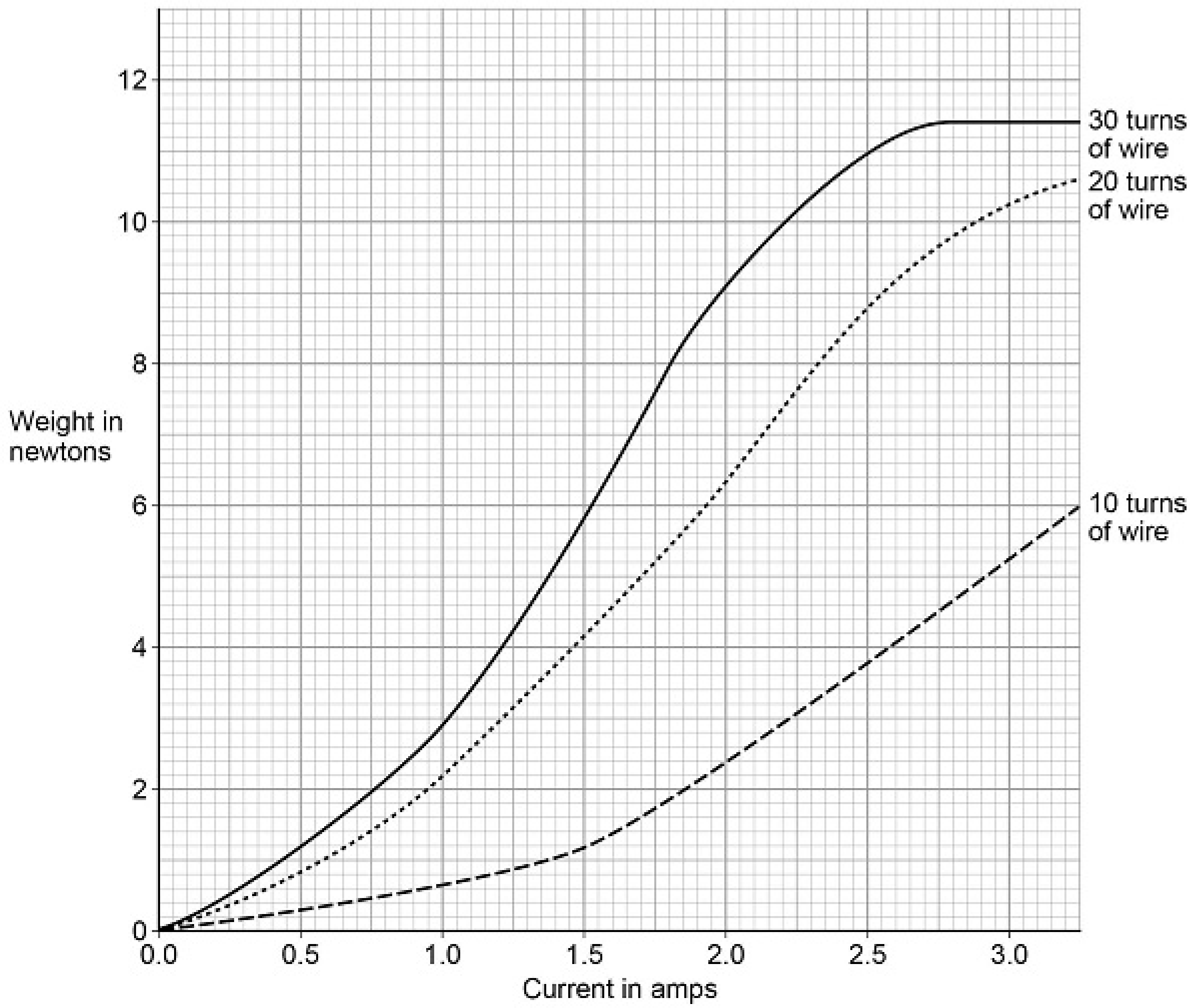
(2)

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?

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(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?

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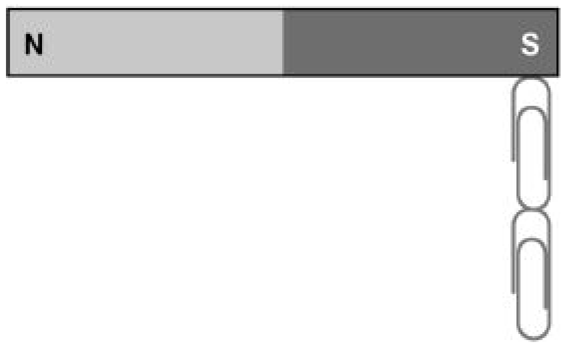
(1)

(Total 8 marks)

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

Figure 1



The paper clips have become magnetised.

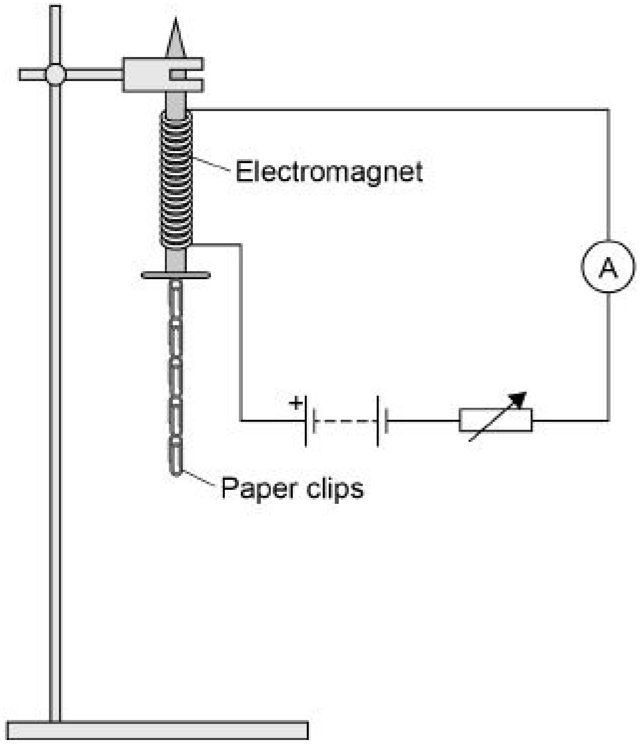
(a) Label the north and south poles of both paper clips.

(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.

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(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.

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(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.

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(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.

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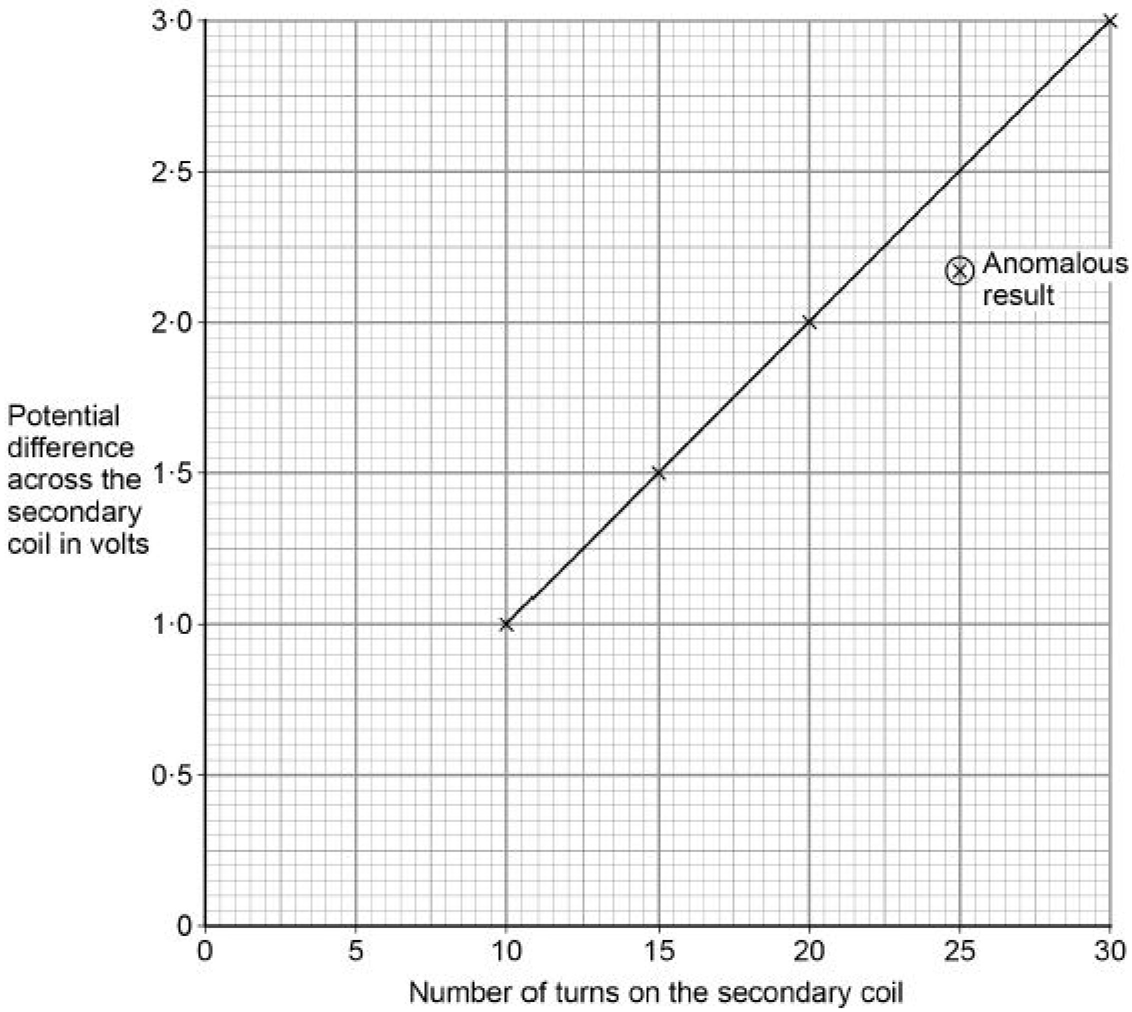
(3)
(Total 12 marks)

6. A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 1 shows the results collected by the student.

Figure 1



(a) **Figure 1** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

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(1)

(b) The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 1** that this happens?

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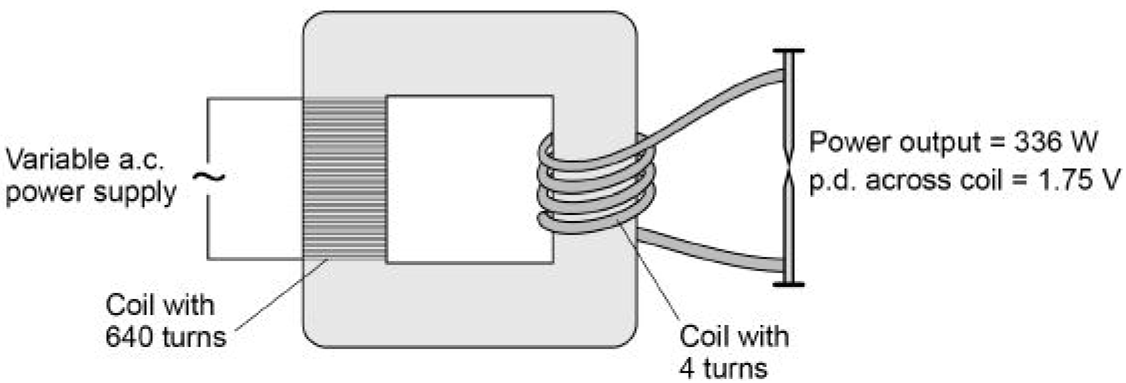
(1)

A spot-welder is a device that uses a transformer to produce a large current to join sheets of metal together.

Figure 2 shows a transformer demonstrating how a large current can heat and join two nails together.

Figure 2



(c) How does the amount of infrared radiation emitted by the nails change when the power supply is switched on?

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(1)

(d) Calculate the current from the power supply needed to provide a power output of 336 W.

Use the data in **Figure 2**.

The transformer is 100% efficient.

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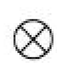
Current = ______________________ A

(5)

(Total 8 marks)

7. The circle in **Figure 1** represents a straight wire carrying a current. The cross shows that the current is into the plane of the paper.

Figure 1



(a) Complete **Figure 1** to show the magnetic field pattern around the wire.

(2)

(b) The magnetic flux density 10 cm from the wire is 4 microtesla.

Which of the following is the same as 4 microtesla?

Tick **one** box.

4×10^{-2} T ☐

4×10^{-3} T ☐

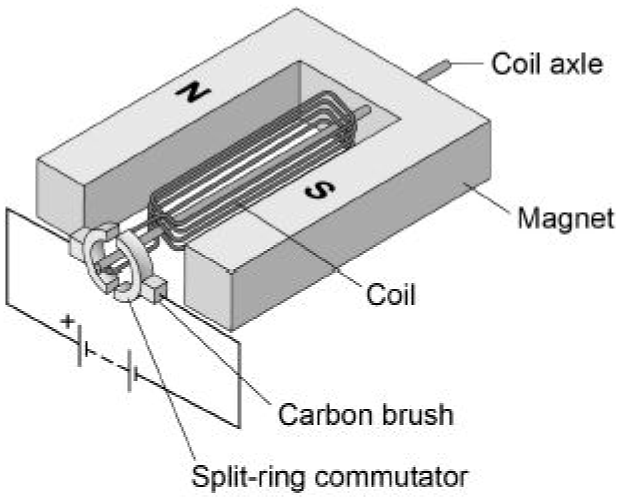
4×10^{-6} T ☐

4×10^{-9} T ☐

(1)

(c) **Figure 2** shows a simple electric motor.

Figure 2



When there is a current in the coil, the coil rotates continuously.

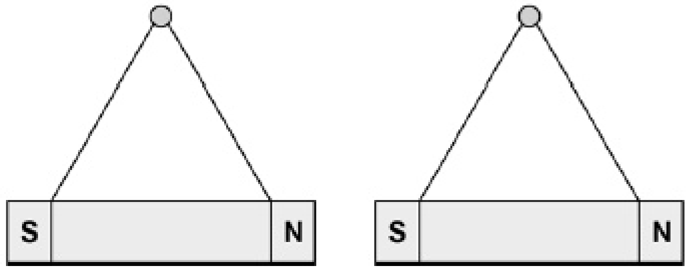
Explain why.

____

(4)
(Total 7 marks)

8. **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'.

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(2)

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

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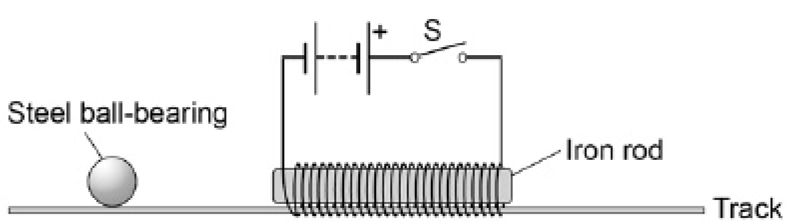
(3)

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.

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(4)

(Total 9 marks)

Mark schemes

1. (a) any **two** correct lines drawn from the top of the visitor and passing through the lens

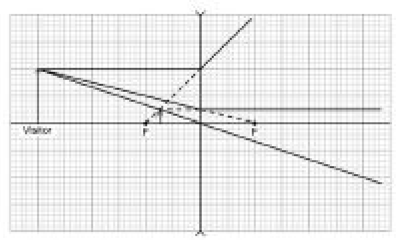
allow construction lines that are not dashed

2

image drawn at the correct position and with the correct orientation

mark only scores if first two marks scored.

*a convex lens diagram scores **0** marks*



1

(b) Decreases

1

(c) Iron

1

(d) there is a current in the solenoid / circuit

allow a charge flows through the solenoid / circuit

1

creating a magnetic field

allow the solenoid / coil is magnetised

1

attracting the bolt

1

(e) 1.50 cm = 0.015 m

1

2.88 = k × 0.015

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

1

k = 2.88 / 0.015

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

1

k = 192 (N/m)

allow a correctly calculated answer using an incorrectly/not converted distance

1

(f) Any **two** from:

- increase the current (in the solenoid / circuit)
  *allow any sensible suggestion for increasing the current such as increasing the p.d. / power of the battery **OR** using lower resistance wire in the solenoid*
- add more turns to the solenoid
  *do **not** allow increase the number of coils*
- use a spring with a lower spring constant
  allow use a weaker spring

2

[14]

2. (a) to vary the (output) potential difference
allow different devices require different potential differences

1

so that you don't need a different generator for each type of device
allow so that it is compatible with different devices
*do **not** allow answers in terms of power*

1

(b)

$$\frac{1.5}{5.0} = \frac{150}{N_s}$$

1

$$N_S = \frac{150}{0.3}$$

1

$N_S = 500$

1

(c) the coil moves through the magnetic field

or

the coil cuts magnetic field lines

1

a potential difference is <u>induced</u> (across the coil)

1

there is a complete circuit, so a current is induced (in the coil)

1

every half turn the potential difference reverses direction

1

so (every half turn) the current changes direction

1

(d) provides a continuous / moveable contact / connection (between the coil and the transformer / contacts / brushes)

or

stops the wires from twisting together

1

(e) (after disconnection) there is no induced current

1

so no magnetic field (produced around / by the coil)

1

to oppose the movement of the coil

1

[14]

3. (a) both arrows pointing horizontally and to the right

judged by eye

1

(b) (two south) poles would repel

allow magnets would repel

1

so the coat would not be held together

allow so the coat would not fasten

1

(c) C

1

(d) steel rod

1

(e) electromagnet exerts a downwards force on the iron bar

allow electromagnet pulls the iron (bar) down(wards)

allow electromagnet attracts the iron (bar)

1

(f) 1.5 (cm)

1

(g)

*an answer 0.27 (N) scores **2** marks*

F = 0.18 × 1.5
OR
F = 0.18 × their 3.6

1

F = 0.27 (N)

allow 0.18 × their 3.6 correctly calculated

1

(h) it increases

1

and reaches a maximum

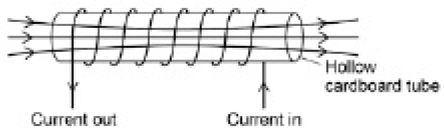
allow and then does not change

*any change other than current causing strength to increase scores **0***

1

[11]

4. (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]

5. (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 <u>fair test</u>
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]

6. (a) any **one** from:

- too few turns / coils on the secondary

  allow number of turns / coils on the primary was increased

- p.d. across the primary was reduced

  ignore human error

1

(b) the p.d. (across the secondary) goes above 2V

allow p.d. across secondary is higher than p.d. across primary after 20 turns

1

(c) it increases (until the nails reach a constant temperature)

1

(d) $\frac{640}{4} = \frac{V_p}{1.75}$

1

$V_p = \frac{640 \times 1.75}{4}$

1

V_p = 280 (V)

1

280 × I_p = 336

allow their calculated
$V_p \times I_p = 336$

1

I_p = 1.2 (A)

allow an answer that is consistent with their calculated value of V_p

1

or

336 = I_s × 1.75 (1)

$I_s = \frac{336}{1.75}$ (1)

I_s = 192 (A) (1)

$I_p = 192 \times \frac{4}{640}$ (1)

allow

$I_p = \text{their calculated } I_s \times \frac{4}{640}$

I_p = 1.2 (A) (1)

allow an answer that is consistent with their calculated value of I_s

*an answer of 1.2 (A) scores **5** marks*

[8]

7. (a) at least three circles drawn

1

clockwise arrows on circles

*allow **1** mark for one or two circles with clockwise arrows*

1

(b) 4 × 10^{-6}

1

(c) the sides of the coil (parallel to the magnet) experience a force (in opposite directions)

allow the current creates a magnetic field
ignore Fleming's Left Hand Rule

1

the forces cause moments that act in the same (clockwise / anticlockwise) direction
or
the moments cause the coil to rotate (clockwise / anticlockwise)

allow the magnetic fields interact to create a pair of forces (acting in opposite directions)
or
allow the magnetic fields interact causing the coil to rotate

1

(each half-revolution) the two halves of the (rotating) commutator swap from one (carbon) brush to the other

1

(each half-revolution) the commutator reverses the current (in the coil)
or
keeping the forces in the same direction (keeping the coil rotating)

allow keeps the current in the same direction relative to the (permanent) magnetic field

1

[7]

8. (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]