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)
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.

___________________________________________________________________
___________________________________________________________________
(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.

<table>
<thead>
<tr>
<th>Fridge magnet</th>
<th>Area of magnet in mm²</th>
<th>Number of sheets of paper held</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>110</td>
<td>16</td>
</tr>
<tr>
<td>C</td>
<td>250</td>
<td>6</td>
</tr>
<tr>
<td>D</td>
<td>340</td>
<td>8</td>
</tr>
<tr>
<td>E</td>
<td>1350</td>
<td>4</td>
</tr>
</tbody>
</table>

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

___________________________________________________________________
___________________________________________________________________

(1)

(Total 5 marks)
A student investigates the electromagnetic force acting on a wire which carries an electric current. The wire is in a magnetic field.

The diagram shows the circuit which the student uses.

(a) Draw an X on the diagram, with the centre of the X in the most strongest part of the magnetic field.

(b) Give one change that she can make to the magnets to decrease the electromagnetic force on the wire.

___________________________________________________________________
___________________________________________________________________

(c) The student wants to change the electromagnetic force on the wire without changing the magnets or moving their position.

(i) Give one way in which she can increase the electromagnetic force.

___________________________________________________________________
___________________________________________________________________

(ii) Give one way in which she can reverse the direction of the electromagnetic force.

___________________________________________________________________
___________________________________________________________________

(Total 4 marks)
The diagram shows the design for a remotely controlled door bolt.

When the correct numbers are entered into the keypad the transformer switches on. Then the door can be opened.

(a) What kind of transformer is shown in the diagram?
___________________________________________________________________

(b) What does the abbreviation a.c. stand for?
___________________________________________________________________

(c) Complete the sentences using the correct words from the box.

<table>
<thead>
<tr>
<th>attracts</th>
<th>downwards</th>
<th>magnet</th>
<th>reflects</th>
<th>repels</th>
</tr>
</thead>
<tbody>
<tr>
<td>sideways</td>
<td>switch</td>
<td>transformer</td>
<td>upwards</td>
<td></td>
</tr>
</tbody>
</table>

(i) When a current flows in the coil, the coil becomes a ____________________ .

(ii) The coil _____________________ the iron bolt which moves ______________

(Total 5 marks)
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](image)

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)
(a) Some people wear magnetic bracelets to relieve pain. Figure 1 shows a magnetic bracelet.

There are magnetic poles at both A and B. Part of the magnetic field pattern between A and B is shown.

Figure 1

What is the pole at A? ______________________

What is the pole at B? ______________________

(b) Figure 2 shows two of the lines of the magnetic field pattern of a current-carrying wire.

Figure 2

The direction of the current is reversed.

What happens to the direction of the lines in the magnetic field pattern?

___________________________________________________________________

(1)
Fleming’s left-hand rule can be used to identify the direction of a force acting on a current-carrying wire in a magnetic field.

(i) Complete the labels in Figure 3.

![Figure 3](image)

(ii) Figure 4 shows:

- the direction of the magnetic field between a pair of magnets
- the direction of the current in a wire in the magnetic field.

![Figure 4](image)

In which direction does the force on the wire act?

__________________________________________________________________________

(iii) Suggest three changes that would decrease the force acting on the wire.

1. ____________________________________________________________

2. ____________________________________________________________

3. ____________________________________________________________
(d) **Figure 5** shows part of a moving-coil ammeter as drawn by a student.

The ammeter consists of a coil placed in a uniform magnetic field. When there is a current in the coil, the force acting on the coil causes the coil to rotate and the pointer moves across the scale.

**Figure 5**

(i) The equipment has **not** been set up correctly.

What change would make it work?

________________________________________________________________________________________

________________________________________________________________________________________

(1)

(ii) **Figure 6** shows the pointer in an ammeter when there is no current.

**Figure 6**

What type of error does the ammeter have?

________________________________________________________________________________________

(1)

(Total 10 marks)
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 2 shows the two magnets. The poles of the magnets are on the longer faces.

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

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

Explain why.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
(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.

<table>
<thead>
<tr>
<th>Number of sheets of paper between the magnets</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newtonmeter reading as the magnets separate</td>
<td>3.1</td>
<td>2.6</td>
<td>2.1</td>
<td>1.5</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>
(i) Describe the pattern of her results.

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

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

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