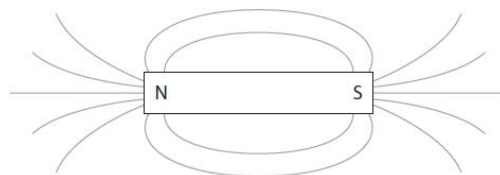


**Q1.**

Figure 4 shows the shape of the magnetic field near a bar magnet.



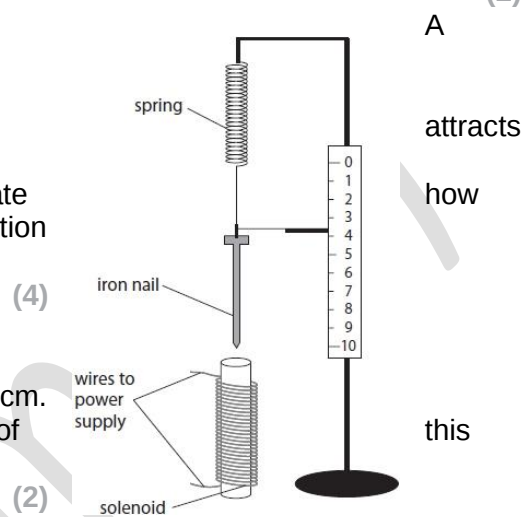
- (i) Draw arrows on the field lines in Figure 4 to show the direction of the magnetic field.
- (ii) Place a letter X on Figure 4 at a place where the magnetic field is strongest.
- (iii) Describe **two** differences between the magnetic field shown in Figure 4 and a uniform magnetic field.

Figure 4

**Q2.**

student sets up the apparatus shown in Figure 9.

- (i) When the current in the solenoid is switched on, the solenoid attracts the iron nail.  
Describe how the student could use this apparatus to investigate the size of the current in the solenoid affects the force of attraction between the solenoid and the iron nail.



- (ii) The spring constant of a different spring is 24 N/m.  
The spring is extended from its unstretched length by 12 cm.  
Calculate the energy transferred in extending the spring by 12 cm.  
Use an equation selected from the list of equations at the end of paper.

**Q3.**

Two long, thin magnets are held with their N-poles facing each other. The force,  $F$ , between the magnets can be calculated using the equation  
Where:  $K$  is a constant value  $d$  is the distance between the magnets.

$$F = \frac{K}{d^2}$$

- (i) The magnets are 4.0 cm apart. The force between the magnets is 1.2 N. Calculate the value of  $K$ .  
State the unit.
- (ii) The magnets are held the same distance apart but with the N-pole of one magnet now facing the S-pole of the other magnet.  
The value of  $K$  does not change. State how the force would compare with the force in part (i).

**Q4.**

Figure 8 shows two metal rods carrying a current. A metal roller touches both rods and completes the circuit. The roller is in the magnetic field produced by a magnet.

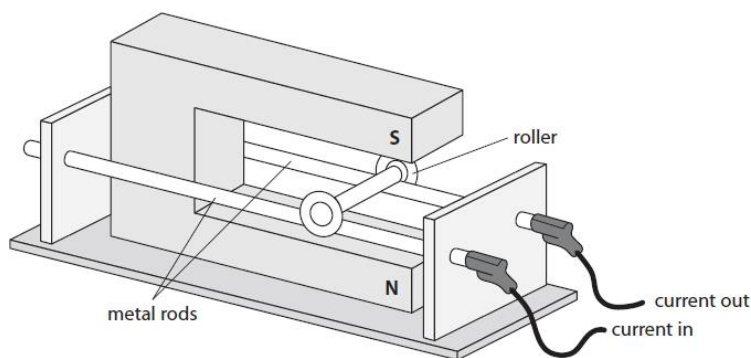


Figure 8

- (i) The magnetic flux density of the magnetic field at the roller is 1.2 T.  
The current in the roller is 2.5 A.  
The length of the roller carrying the current is 0.060 m. Calculate the force on the roller.  
Use the equation  $F = B \times I \times l$

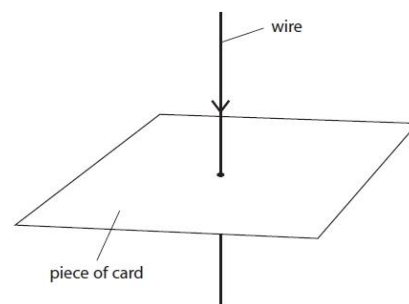
- (ii) Describe how Fleming's left-hand rule can be used to determine the direction of the force acting on the roller. You may draw a diagram to help your answer.

- (iii) Draw an arrow on Figure 8 to show the direction of the force acting on the roller.

**Q5.**

A wire is placed at right angles to the Earth's magnetic field.  
 The wire is 0.600 m long and carries a current of 93.1 mA.  
 The force on the wire is  $1.11 \times 10^{-5}$  N.  
 Calculate the magnetic flux density of the Earth's magnetic field.  
 Use the equation

$$F = B \times I \times l$$



(2)

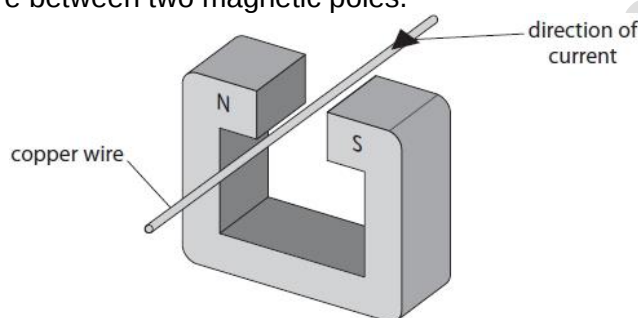
**Q6.**

Figure 7 shows a wire carrying a current.

Draw, on the card in Figure 7, the magnetic field that is produced by the current. **Figure 7**

**Q7.**

Figure 4 shows a copper wire between two magnetic poles.



**Figure 4**

The current in the wire is in the direction shown by the arrow.  
 The wire experiences a force due to the magnetic field.

(i) The direction of the force due to the magnetic field is

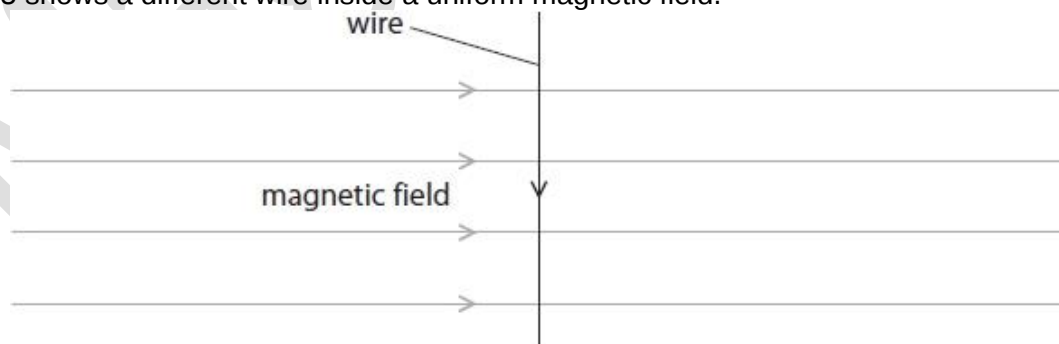
- ☐ **A** down
- ☐ **B** up
- ☐ **C** towards the north pole of the magnet
- ☐ **D** towards the south pole of the magnet

(1)

(ii) The interaction between the magnetic fields produced by the magnet and the current in the wire produces forces on the magnet and the wire.  
 Compare these two forces.

(1)

(iii) Figure 5 shows a different wire inside a uniform magnetic field.



**Figure 5**

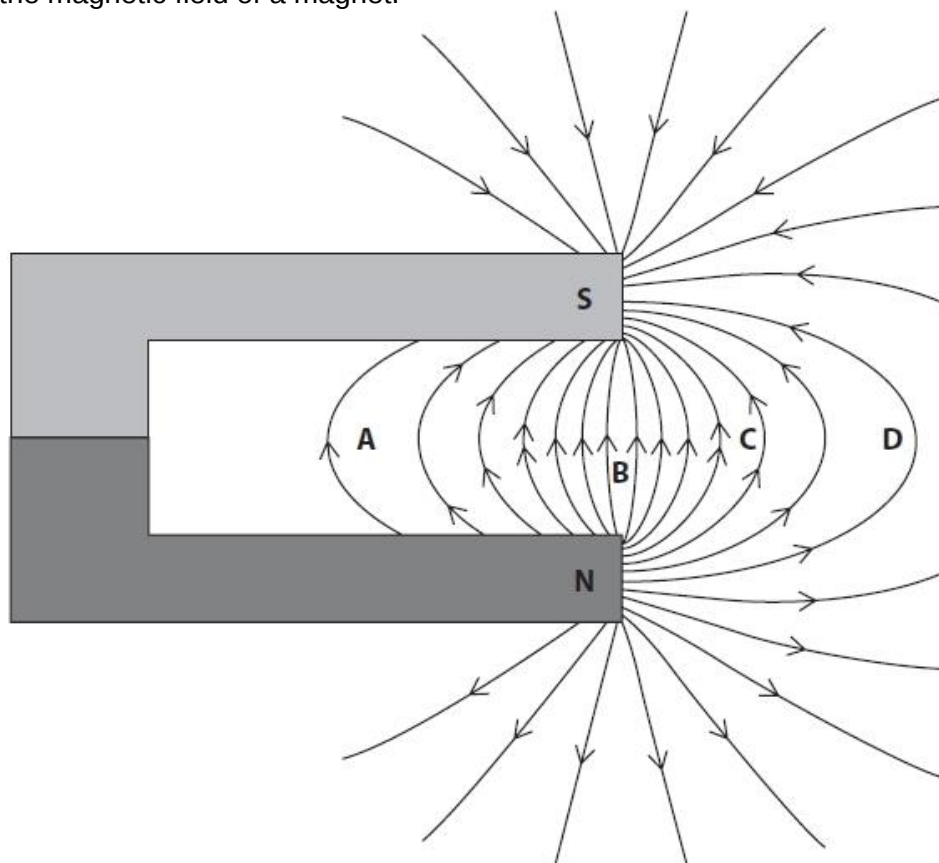
The magnetic flux density of the magnetic field is 0.72 N/A m.  
 The length of the wire inside the field is 30 mm.  
 The size of the force due to the magnetic field on the wire is 0.045 N.  
 Calculate the size of the current in the wire.

Use an equation selected from the list of equations from the relevant equation sheet.

(3)

**Q8.**

Figure 6 shows the magnetic field of a magnet.



**Figure 6**

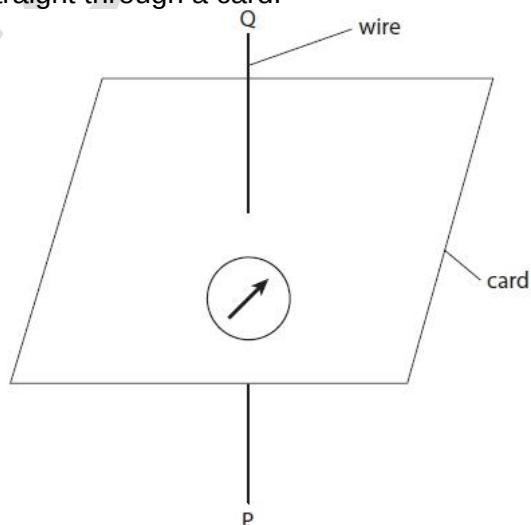
At which point is the magnetic field strongest?

- ☐ A
- ☐ B
- ☐ C
- ☐ D

(1)

**Q9.**

A student uses a plotting compass to investigate the magnetic field around a wire. Figure 3 shows the wire going straight through a card.

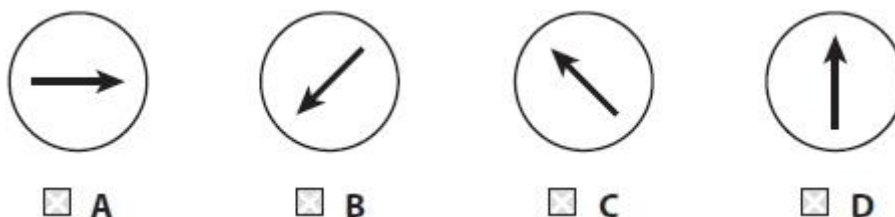


**Figure 3**

Figure 3 shows the compass needle when there is no current in the wire.

(i) Which of these shows a possible direction of the compass needle when there is a current in the wire going from P to Q?

(1)



(ii) Describe how the student could develop the investigation to find the shape of the magnetic field produced by the current.

(3)

**Q10.**

A student uses plotting compasses to investigate the magnetic field between the poles of two bar magnets.

Figure 5 shows **one** of the plotting compasses and **one** of the bar magnets.

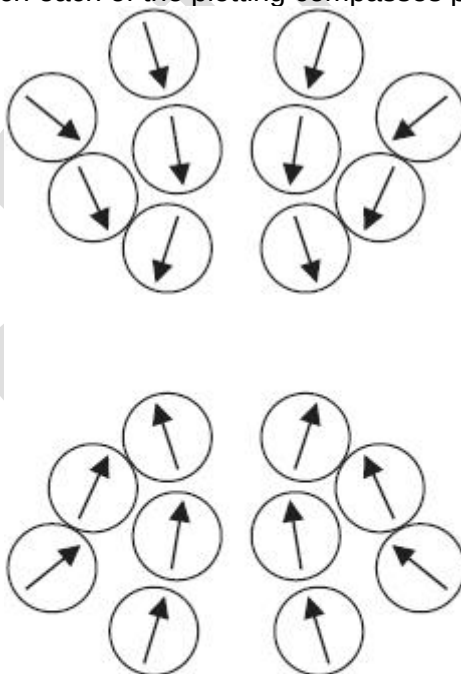


**Figure 5**

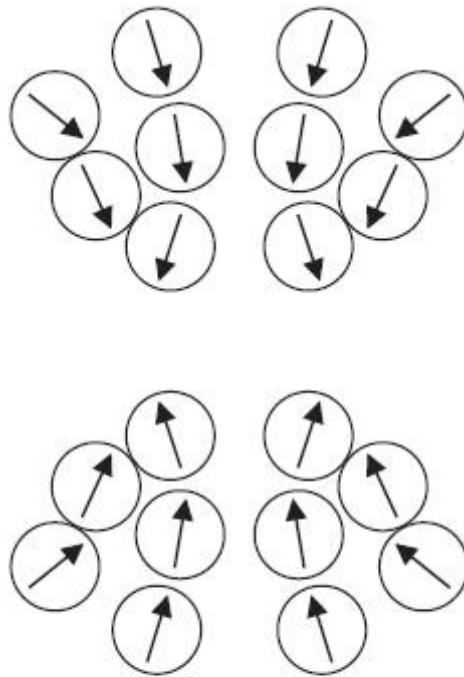
The student places the two magnets on a piece of paper with a pole of one magnet a few centimetres away from a pole of the other magnet.

The student places 20 plotting compasses on the paper near the magnets.

Figure 6 shows the direction in which each of the plotting compasses points.



**Figure 6**

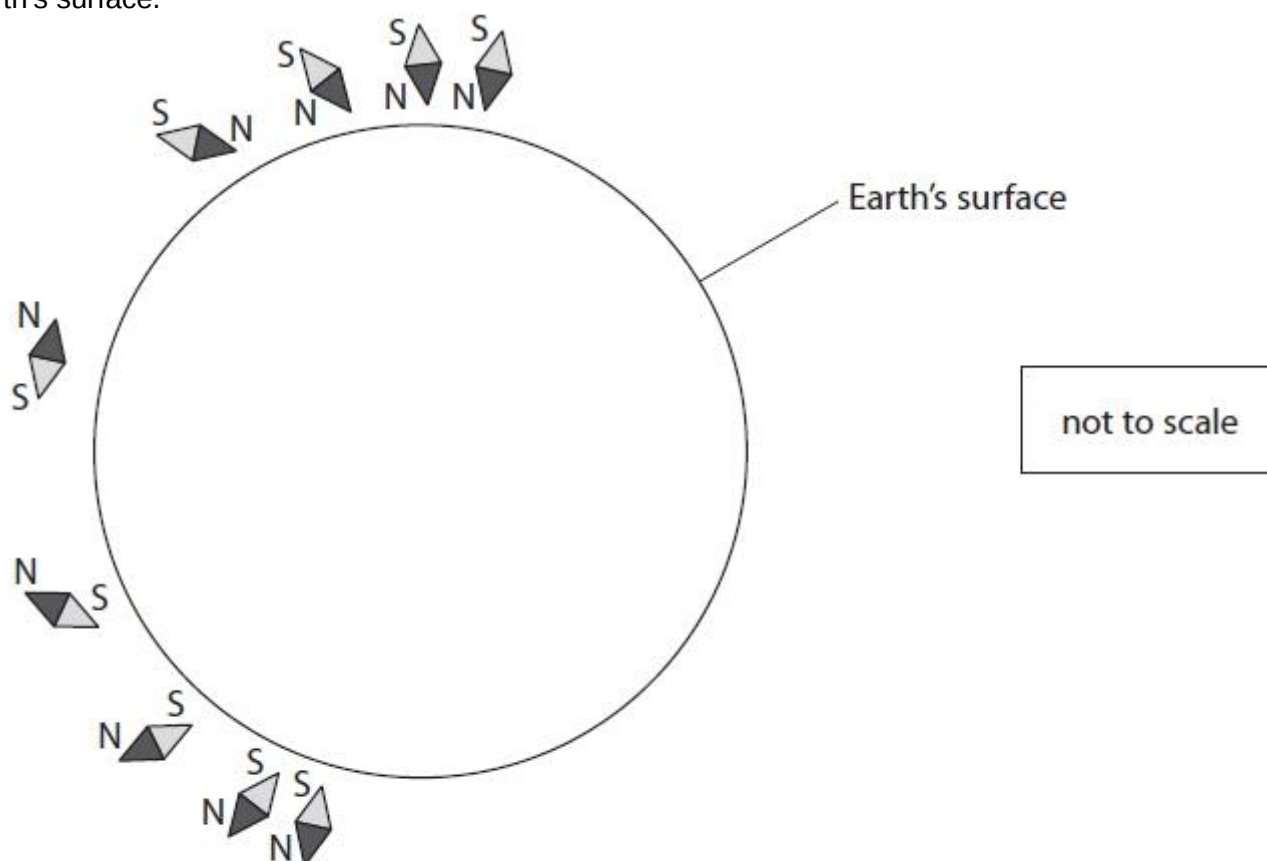


**Figure 6**

- (i) Draw two rectangles on Figure 6 to show the positions of the two bar magnets. Label the N-pole and the S-pole of each magnet. (2)
- (ii) The student wants to determine the shape of the magnetic field for a larger area around the magnets. Describe how the student should continue the investigation using just one plotting compass. (3)

**Q11.**

Figure 5 shows the directions of some plotting compass needles placed at different points near the Earth's surface.



**Figure 5**

(i) Sketch, on Figure 5, the Earth's magnetic field outside and inside the Earth.

(2)

(ii) State which part of the Earth generates its magnetic field.

(1)

**Q12.**

State how a uniform magnetic field may be obtained in a school laboratory.

(1)

**Q13.**

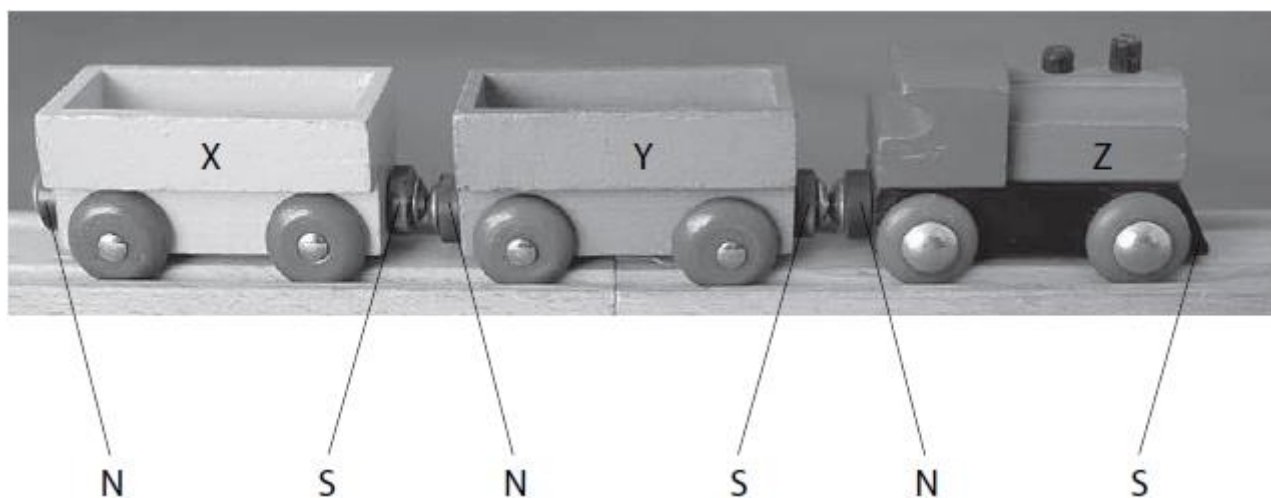
A student has a bar magnet, a piece of iron the same size as the magnet, and some paper clips. Describe how the student could use these items to demonstrate temporary induced magnetism.

(3)

**Q14.**

Wooden trucks on a toy railway have permanent magnets that hold the train together.

The magnets are arranged so that an N-pole touches an S-pole between each truck, as shown in Figure 15.



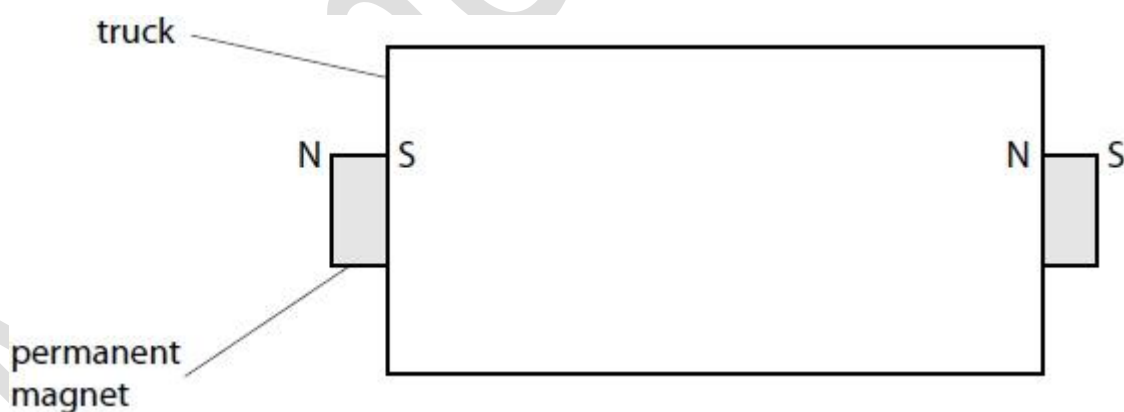
**Figure 15**

- (a) Truck Y is removed from the train, turned through  $180^\circ$  and is then replaced between truck X and Z. How does this affect the train?

(1)

- ☐ **A** Y attracts both X and Z as before
- ☐ **B** Y still attracts X but now repels Z
- ☐ **C** Y still attracts Z but now repels X
- ☐ **D** Y now repels both X and Z

- (b) The structure of a truck, seen from above, is shown in Figure 16. The permanent magnets cause a magnetic field both inside and outside the truck.



**Figure 16**

Which of these correctly shows the field inside the truck?

(1)

