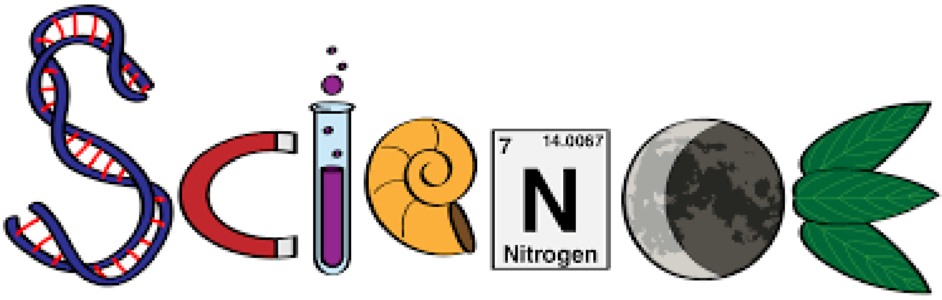
Meopham School



HOMEWORK BOOKLET

P7 Higher

Homework 1

Magnets and Magnetism **True or False?**

Decide whether each of the following statements about magnets and magnetism are true or false. Write a corrected version for each statement you believe to be false.

Statement	True or False?	Correction (If False)
Iron, cobalt, aluminium and copper are all examples of magnetic metals.		
Magnetic field lines are drawn pointing from the south to the north pole of a bar magnet.		
Magnetic forces are the strongest at the poles of a magnet.		
The north pole of one bar magnet would be repelled by the south pole of a second bar magnet.		
A compass contains a tiny bar magnet that aligns with the Earth's magnetic field.		
When an induced magnet is removed from a magnetic field, it remains magnetic.		

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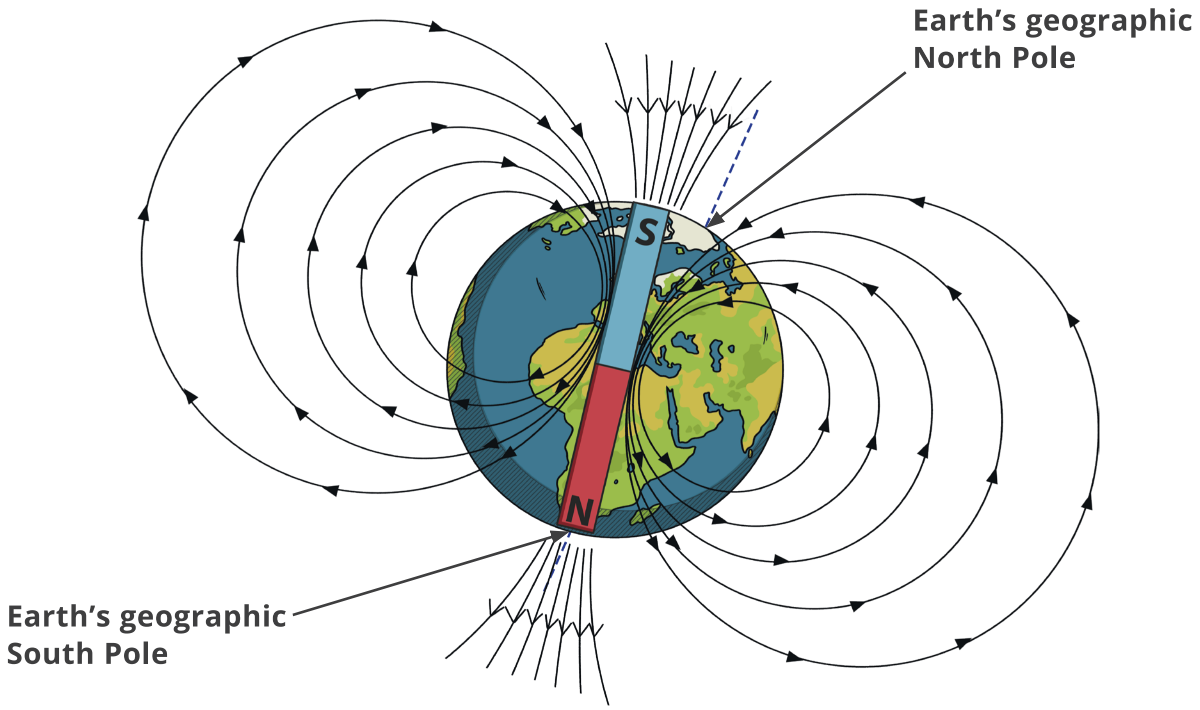
Magnetism **Extended Writing**

Homework 1

The Earth's core produces its own magnetic field.

Figure 1 shows how a bar magnet can be used to model the magnetic field produced by the Earth's core.

Figure 1



Evaluate **Figure 1** as a model of the Earth's magnetic field.

In your answer, you should explain how a magnetic compass can be used to provide evidence for this model.

[6 marks]

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Homework 1

Key Words

attract field lines like pole repel strength unlike

Planning

Use this box to briefly plan your answer. Which points do you need to remember to make?

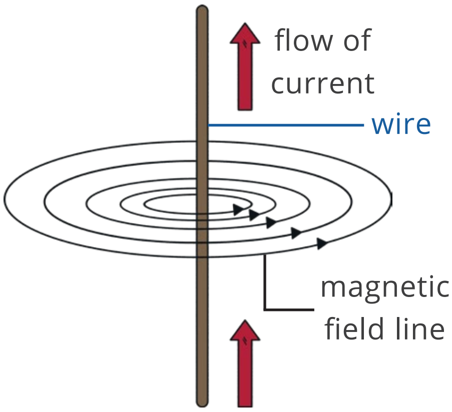
Answer

Remember to **explain** how a magnetic compass can be used to provide evidence for the model.

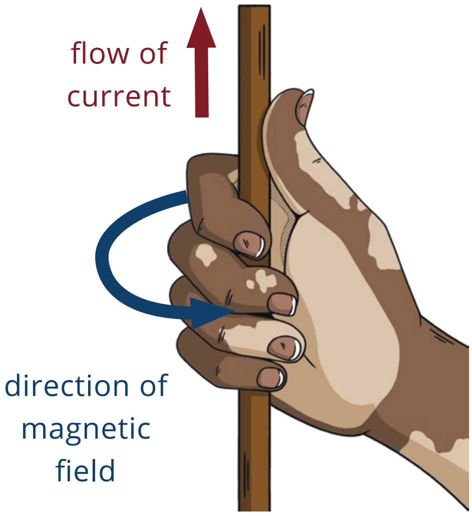
Electromagnetism and the Motor Effect

Homework 2

Current-Carrying Wires



When an electric current flows through a wire, a circular **magnetic field** is created around it. This is because charged particles experience magnetic forces when they move. This magnetic field is drawn as a series of concentric circles with the wire at their centre. The closer together the lines are, the stronger the field is. The field is strongest closest to the wire so as you move further away from it, the distance between the circles increases. The strength of the magnetic field increases if the current flowing through the wire is increased.



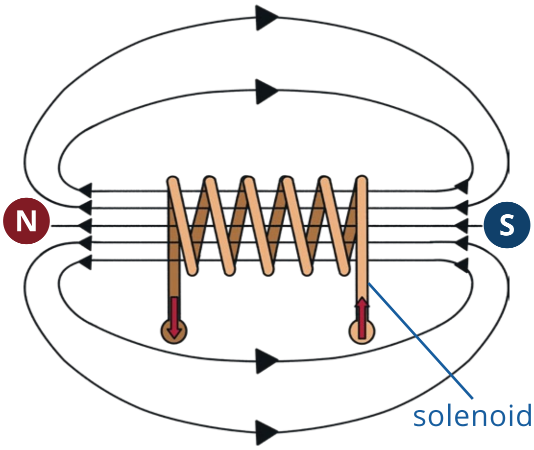
The direction of the magnetic field is shown by the arrows on the circles. The direction of the magnetic field can be determined using the **right-hand grip rule**. To do this, curl the fingers of your right hand into a fist. Then point your thumb to align with the flow of current in the wire.

The direction of your curled fingers will show whether the magnetic field is flowing clockwise or anticlockwise. In the example shown, the magnetic field is moving in an anticlockwise direction around the wire. Reversing the direction of the current flowing through the wire would reverse the direction of the magnetic field. See if you can show this using the right-hand grip rule.

Solenoids

Twisting a wire into a **coil** creates a **solenoid**. A solenoid is a coil of wire that produces a magnetic field when a current flows through it. Inside the solenoid, the field lines are parallel to one another. The individual magnetic fields around each loop of the coil combine to form a single, **uniform** magnetic field which is **stronger** than that of the same piece of wire when straightened.

Outside the solenoid, the field lines bend to form a complete loop that passes through the centre of the coil. As you move away from the coil, the weaker the magnetic field becomes. Therefore, the magnetic field lines around the solenoid are drawn further apart than those inside the solenoid. Like a straight wire, the strength and direction of the magnetic field around a solenoid is also affected by the current flowing through it. Increasing the current increases the strength of the magnetic field, while reversing the current reverses the direction of the magnetic field.



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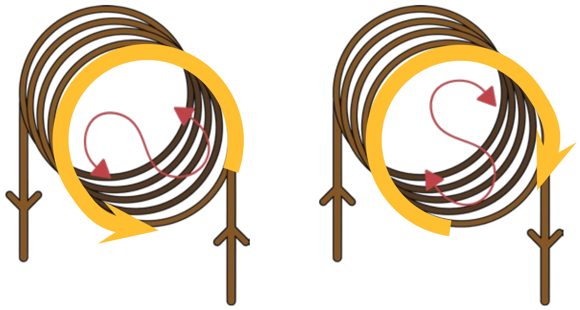
Homework 2

Magnetic field lines are drawn pointing in the direction that the magnetic force would act if the **north pole** of another magnet was placed at that point within the field. For this reason, the north pole of the solenoid pictured above is located at the end of the coil where the field lines exit: two magnetic north poles **repel** each other, so the force of the magnetic field is acting away from the left-hand side of the solenoid.

The direction of the flow of current through the solenoid can be used to determine the location of its magnetic poles. The north pole is always located at the end where the current flows through the coils in an **anticlockwise** direction.

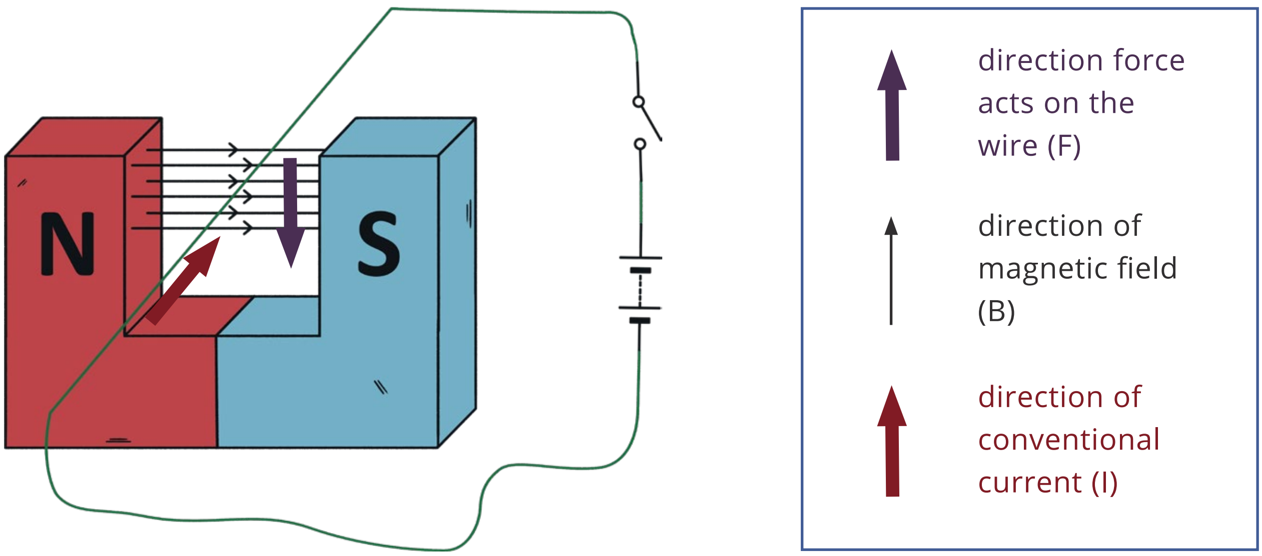


Electromagnets

When a solenoid is coiled around an **iron core** it creates an **electromagnet**. When current flows through the wire and creates a magnetic field, it also magnetises the iron core. The iron core remains magnetic while current flows through the wire. The magnetic field around an electromagnet is stronger than that of a solenoid. Like a wire and a solenoid, the strength of an electromagnet can be increased by increasing the current flowing through the wire.

The Motor Effect

When a wire carrying a current is placed in an external magnetic field it experiences a **force**. This is because the magnetic field around the wire interacts with the external magnetic field. The force experienced by the wire causes it to move in a direction which is **perpendicular** to the external magnetic field. This is called the **motor effect**. Reversing the direction of the current through the wire reverses direction in which the force acts.



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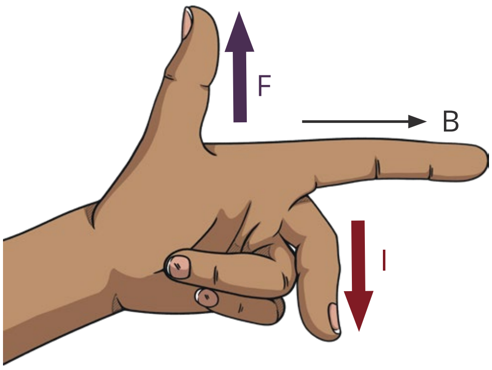
Homework 2

The direction of the force exerted on the wire can be determined using **Fleming's left-hand rule**. To do this, curl the fingers of your left hand into a fist and extend your thumb upwards as if giving someone a 'thumbs up'. Your extended thumb represents the direction of the **force (F)** acting on the wire. Next, extend your forefinger straight out at a right angle to your thumb. Your forefinger represents the direction of the magnetic **field (B)** from north to south. Finally, extend your middle finger to the right so it is perpendicular to both your thumb and your forefinger. Your middle finger represents the direction in which **current (I)** flows through the wire. Conventional current flows from the positive terminal of a cell or battery to its negative terminal.



To find the direction in which a wire moves due to the motor effect, align your middle finger with the given current and your forefinger with the magnetic field. Your thumb will then point in the direction that the wire moves in when the force acts upon it.

The Size of the Force

Increasing the current flowing through a wire increases the **magnitude** of the force it experiences due to the motor effect. This force is also increased when a stronger magnet is used to provide the external magnetic field and when the length of the wire inside the magnetic field is increased. The force is at its greatest when the wire carrying the current is **perpendicular** to the magnetic field. When the magnetic field lines run **parallel** to the flow of current no resultant force occurs.

When a current flows through a wire or other electrical conductor, and it is placed at right angles to an external magnetic field, the size of the force the wire experiences can be calculated using the equation:

force = magnetic flux density x current x length

$$F = B\,I\,l$$

Force is represented by the symbol F. Force is measured in newtons (N).

Current is represented by the symbol I. Current is measured in amps (A).

Length is represented by the symbol l. Length is measured in metres (m).

Magnetic flux density is a term given to describe the strength of the magnetic field. It is represented by the symbol B. Magnetic flux density is measured in tesla (T).

Electromagnetism and the Motor Effect

1. State the direction of current flow through the coils of a solenoid at its magnetic south pole.

____

2. Give **two** ways of increasing the size of the force experienced by a current-carrying wire placed in an external magnetic field.

   1. ____

   2. ____

3. An electric current flows upwards through a vertical wire. Use the right-hand grip rule to determine the direction of the magnetic field around the wire.

____

4. Describe how magnetic field lines can be drawn to show the strength of the magnetic field.

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5. Compare the magnetic field produced by a straight wire and a solenoid when the same current is passed through them.

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6. Suggest what happens to the magnetic field through an electromagnet when the current flowing through it is reversed.

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Homework 2

7. Calculate the current that would be required to flow through a 50cm length of wire suspended within the Earth's magnetic field for it to experience a force of 2N. The magnetic flux density of the Earth's magnetic field is 5.0 x 10^{-5} T.

   Give your answer in standard form.

   current = ________________ A

8. Explain why magnetic field lines point into a solenoid at its south pole.

9. Explain how Fleming's left-hand rule can be used to determine the direction of the magnetic field around a wire.

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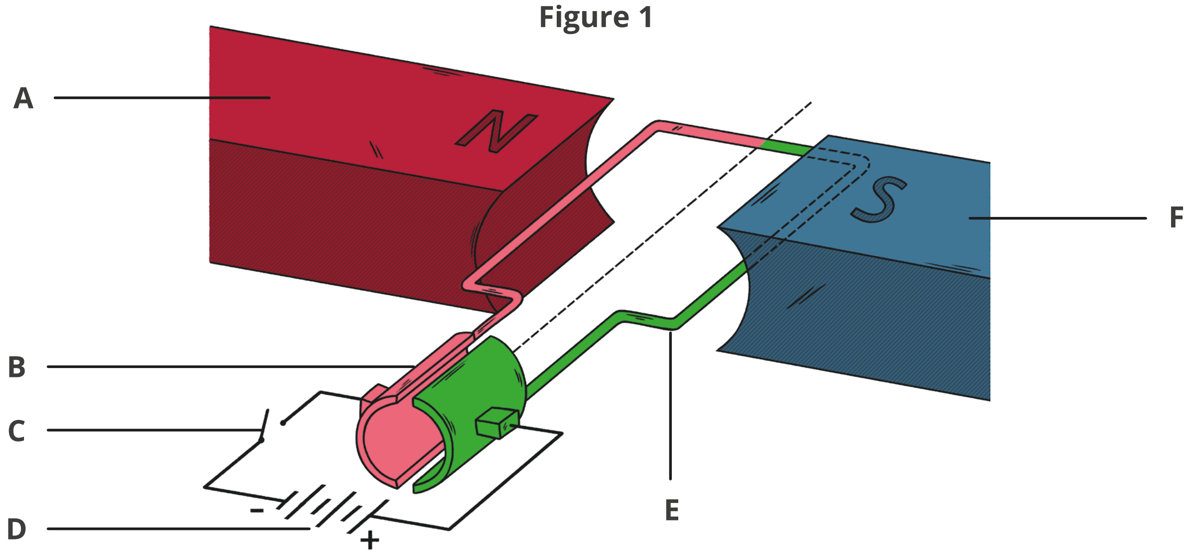
How an Electric Motor Works

Homework 2

Figure 1 represents a simple electric motor. Each of the parts is labelled A-F.

Figure 1



1. Parts A and F are both parts of a magnet.

   a) What is part A?
   Tick **one** box.

   a magnetic compass ☐
   a permanent magnetic field ☐
   the north pole of a permanent magnet ☐
   the south pole of a permanent magnet ☐

   b) What is part F?
   Tick **one** box.

   a magnetic compass ☐
   a permanent magnetic field ☐
   the north pole of a permanent magnet ☐
   the south pole of a permanent magnet ☐

   c) In which direction does the magnetic field between parts A and F act?
   Tick **one** box.

   from the north pole to the south pole of the permanent magnet ☐
   from the positive to the negative terminal of the battery ☐
   from the south pole to the north pole of the permanent magnet ☐
   in a circular direction around the permanent magnet ☐

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Homework 2

d) Parts A and F make up a permanent magnet. There is always a magnetic field acting between parts A and F.

What is a permanent magnet?

____

____

2. Parts C and D are both parts of an electric circuit.

a) What is part C?
Tick **one** box.

a battery ☐
a cell ☐
a switch ☐
a wire ☐

b) What is part C?
Tick **one** box.

a battery ☐
a cell ☐
a switch ☐
a wire ☐

c) In **Figure 1**, there is no electric current flowing around the circuit.
Explain the change that needs to be made to the circuit to cause an electric current to flow.

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d) In which direction will the current flow around this circuit?
Tick **one** box.

from the north pole to the south pole of the permanent magnet ☐
from the positive to the negative terminal of the battery ☐
from the south pole to the north pole of the permanent magnet ☐
in a circular direction around the permanent magnet ☐

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3. Part E represents a loop of wire suspended in the magnetic field. The loop of wire is connected to the electric circuit by part B. The loop of wire becomes magnetic when current flows through it.

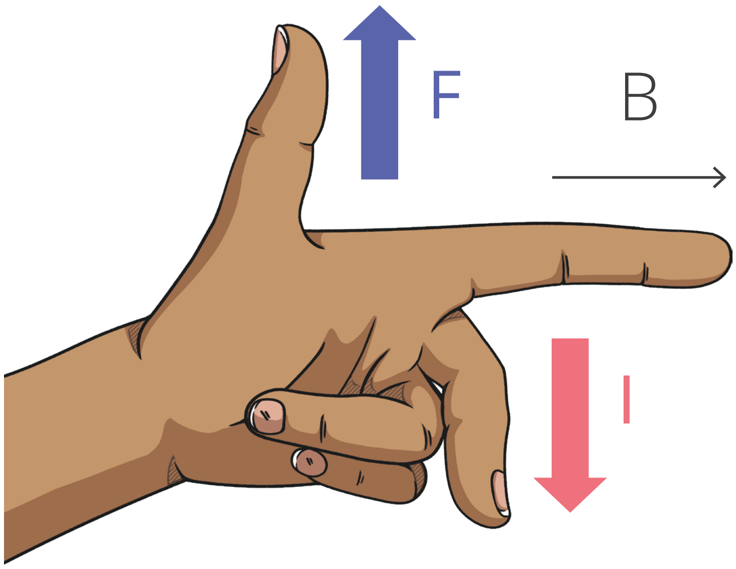
a) What type of magnet is the loop of wire?
Tick **one** box.

bar ☐
horseshoe ☐
induced ☐
permanent ☐

b) The magnetic field around the loop of wire interacts with the permanent magnetic field. This causes a force to act on each side of the loop of wire.

Fleming's left-hand rule can be used to determine the direction of the force acting on each side of the loop.

When held at right-angles to each other, the thumb of the left hand represents the direction of the force (F), the index finger represents the direction of the magnetic field (B) and the middle finger represents the direction of conventional current (I).



Use Fleming's left-hand rule to determine the direction of the force acting on the side of the loop of wire closest to part F.

Tick **one** box.

downwards ☐
left ☐
right ☐
upwards ☐

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c) Use Fleming's left-hand rule to determine the direction of the force acting on the side of the loop of wire closest to part A.

Tick **one** box.

downwards ☐

left ☐

right ☐

upwards ☐

d) The forces acting on the loop of wire, as current flows through it, cause it to rotate.

Use your answers from the questions (part b and c) to determine which direction the loop of wire will rotate.

Tick **one** box.

anticlockwise ☐

back and forth ☐

clockwise ☐

there will be no movement ☐

4. When the loop of wire is moving parallel to the direction of the magnetic field, the magnitude of the force acting on it is zero. In **Figure 1**, this first occurs when the coil has rotated by 90° from its starting position. With no force acting on it, the coil would be expected to stop moving.

However, the loop of wire has some momentum. This causes it to continue to rotate by a small amount. Past 90°, part B causes the loop of wire to continue to rotate.

Part B is called a **split-ring commutator**. It is made of two separate halves. Each half is connected to one end of the loop of wire. Rather than a permanent wired connection, brushes at each end of the loop of wire allow current to flow through the loop. This enables the loop of wire to freely rotate within the split-ring commutator.

Explain how the split-ring commutator allows the loop of wire to continue to rotate.

Your answer should refer to the direction of the current flowing through the loop of wire and the forces acting on each side of it.

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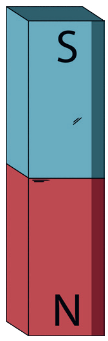
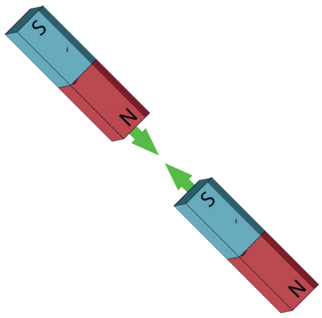
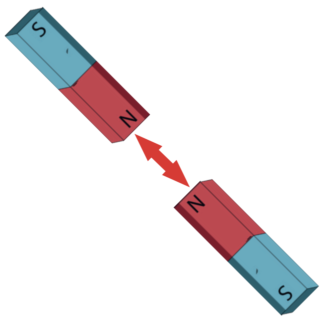
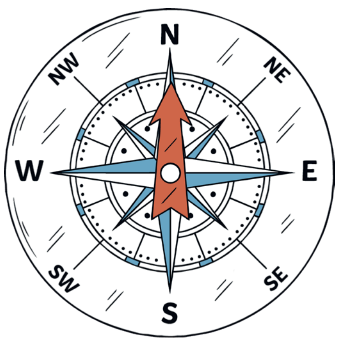
Homework 3

Magnetism and Electromagnetism

Each image in the table below represents a key term relating to magnetism or electromagnetism. Write the key term and a description for each image in the correct columns.

Key Word	Image	Description
		
		
		
		

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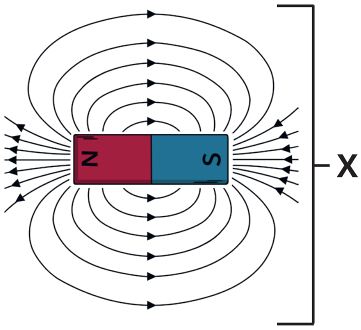
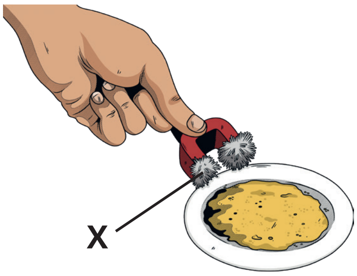
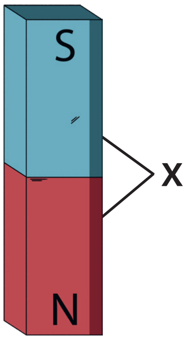
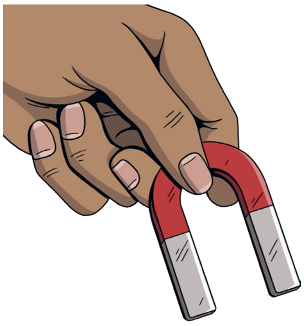
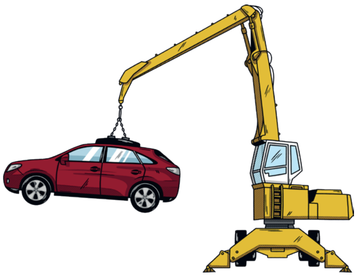
Homework 3

Key Word	Image	Description
		
		
		
		
		

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Homework 3

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	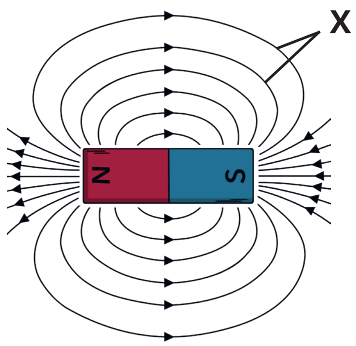	
	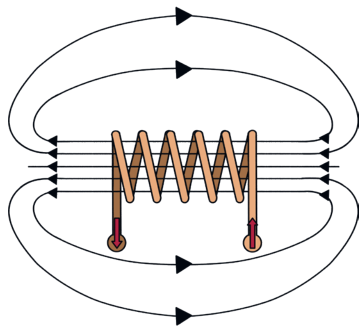	
	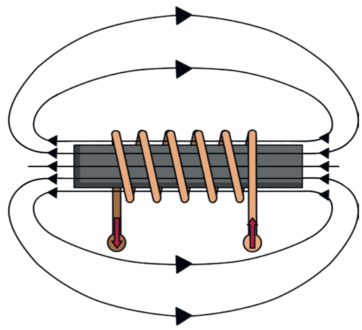	
	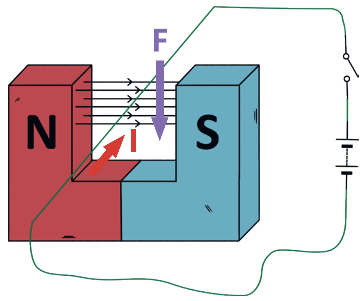	
	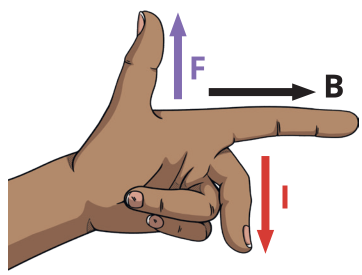	

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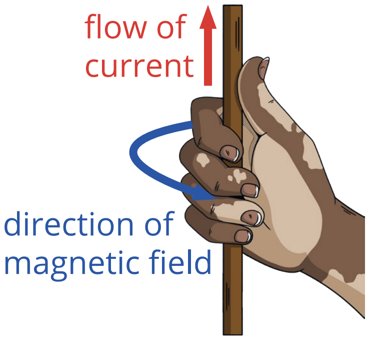
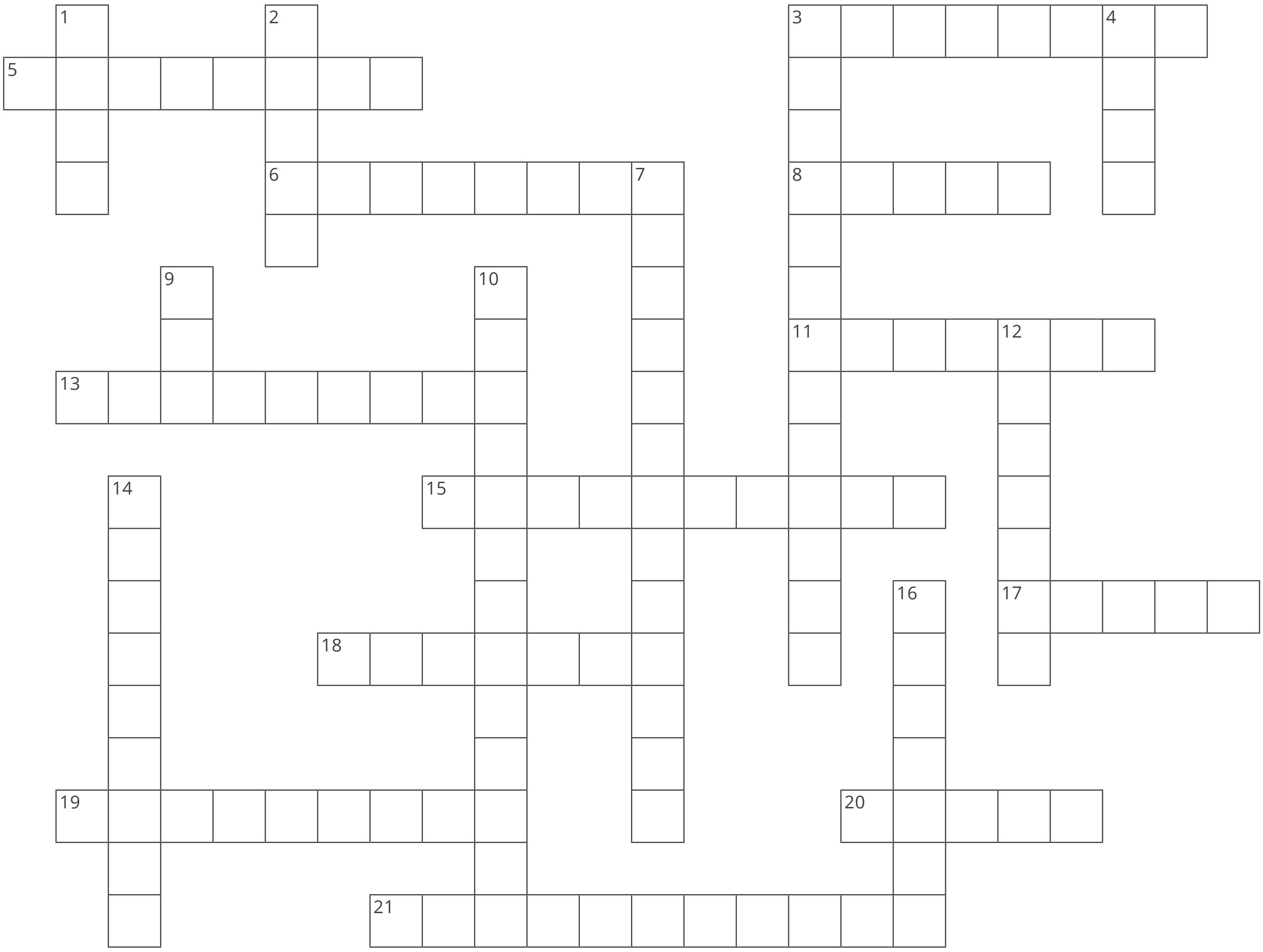
		

Homework 3

Magnetism and Electromagnetism **Crossword**

Solve the clues relating to magnetism and electromagnetism to complete the crossword. Choose the answers from the box below. The numbers at the end of each clue tell you how many letters there are in the answer.



attraction	Fleming	magnetic field	right-hand grip
attraction	force	motor effect	solenoid
bar	horseshoe	north	south
circular	induced	permanent	tesla
compass	iron	pole	
electromagnet	magnetic	repulsion	

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Homework 3

Across

3. This word describes a material that can be attracted by a magnet or made into one. Examples are iron, steel, nickel and cobalt. (8)
5. A coil of wire that produces a magnetic field when a current flows through it. (8)
6. This word describes the shape of the magnetic field around a current-carrying wire. (8)
8. Magnetic field lines are drawn acting away from this pole of a permanent magnet. (5)
11. A material only becomes this type of magnet when it is placed in a magnetic field. (7)
13. A U-shaped permanent magnet with a magnetic pole at each end. (9)
15. A force that causes two unlike magnetic poles to move towards each other. (10)
17. Magnetic field lines are drawn acting towards this pole of a permanent magnet. (5)
18. The left-hand rule, used to determine the relative orientation of the force, the current in the conductor and the magnetic field causing the motor effect, is named after this scientist. (7)
19. A force that causes two like magnetic poles to move away from each other. (9)
20. The unit of magnetic flux density. (5)
21. The effect produced when a conductor carrying a current creates a magnetic field and this interacts with another magnetic field to produce a force. (5,6)

Down

1. A point on a magnet where the magnetic field is the strongest. Permanent magnets have two of these: north and south. (4)
2. This acts on a conductor in the direction represented by the thumb when using Fleming's left-hand rule. (5)
3. The area around a magnet, electric current or moving charged particle where there is a magnetic force. (8,5)
4. A magnetic metal that can be used as the core of an electromagnet. (4)
7. The rule showing the direction of the magnetic field around a current-carrying wire when the fingers are curled into the palm and the outstretched thumb is aligned with the direction of the current. (5-4,4)
9. A rectangular permanent magnet with a magnetic pole at each end. (3)
10. A solenoid with an iron core. (13)
12. A device containing a small bar magnet that points in the direction of the Earth's magnetic field. (7)
14. This word describes a magnet that produces its own magnetic field. (9)
16. The direction in which this flows through a conductor is represented using the middle finger in Fleming's left-hand rule. (7)

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