KS3 Science
Electromagnets 2

Rastrick
High School & Sixth Form

Name : _____
Class : _____
Teacher : _____

In this topic you will learn about:

- The interactions of magnets and how they can be used to evidence magnetic fields.
- How to make an electromagnet, why it works and how to demonstrate it's strength based on certain variables.

Practical Skills:

- Make predictions and decide variables
- Draw conclusions
- Create models

This topic has links to:

- Poles of magnets and magnetic fields – *GCSE*
- Electromagnets - *GCSE*

Maths in science:

- Graph drawing skills
- Converting units and interpreting data

Contents:

Week commencing 8th March - 29th March
4 lesson per week

Booklet expectations:

The booklet is your responsibility to look after and keep tidy.

You are expected to bring the booklet to every lesson with that class teacher.

Any corrections / self assessment to be completed in green pen, as indicated by your class teacher – Or when you see the 'feedback & assessment' logo

Any response to marking and literacy codes to be completed in green pen.

Any diagrams are to be drawn in pencil, graphs using a pencil and ruler etc.

All activities are to be completed, including homework, to the best of your ability, and corrected where needed.

When reading through the notes, you are expected to highlight any words you do not understand, then write their definitions on the glossary pages at the back of the booklet.

Rastrick
High School & Sixth Form

Glossary

Speaking & Listening – Ambitious Vocabulary, Formal Situations, Active Listening
Reading – Pre-complex Texts, DARTs, Comprehension
Writing – Modelling Genres, Scaffolds, Extended Pieces
Literacy & Numeracy

Key term	Definition
Poles	End of a magnet, either North or South
Attract	Pull towards, magents attract any magnetic material close by.
Repel	Push away, e.g. North of a magnet repels North.
Field	The area affected by a magnet
Compass	Tool used to show the direction of a magnetic field
Solenoid	A cylindrical coil of wire acting as a magnet when current flows through it.
Core	Piece of iron inside an electromagnet which makes the field stronger
electromagnet	Type of temporary magnet created when a current passes through it.
Armature	Pole in an electromagnet or moving part of a solenoid
Circuit breaker	Device that breaks a circuit when current is too high
Contact	Point at which a circuit is made e.g. a switch
Permanent	A magnet that cannot be turned off.
Temporary	A magnet that can be switched on or off
Alignment	When 2 separate entities point in the same direction.

Lesson 1: Permanent Magnets – Forces & Fields

In and On: Make a list of as many different things that use magnets.

Learning outcomes:

Know the laws of magnetic attraction.

Explain how a magnetic field can be represented by field lines.

Apply ideas about attraction to magnetic materials placed in a field.

Task 1: complete the table below to show which materials are magnetic and which are not.

Material	Magnetic	Non magnetic

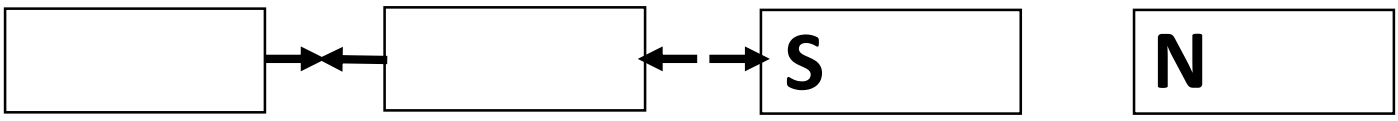
Task 2:

Complete the sentences:

Opposite poles of a magnet _____

Like poles _____

Add onto the magnets below the possible poles of each magnet and the missing arrows for the last part of the diagram.



_____

_____

1 Attract or repel?

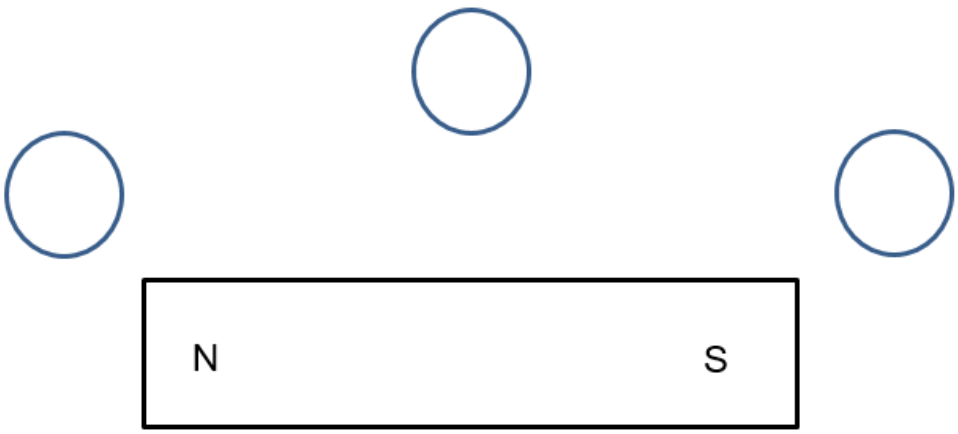
Imagine you are doing a set of simple experiments on magnetism. In each case you are bringing one object closer to another to see what happens.

Suggest what would happen if the objects were as follows:

Experiment	Object A	Object B	What happens?
A	Magnet – south pole on the right	Magnetic object	
B	Magnetic object	Magnet – north pole on the right	
C	Magnet – south pole on the right	Magnet – north pole on the right	
D	Magnet – north pole on the right	Magnet – south pole on the left	

2 Exploring the field >>

One of the ways of exploring a magnetic field is to use plotting compasses. Put a bar magnet on the rectangle here and move a plotting compass to each of the circles shown. Draw in the position of the compass needle, using an arrow to show north.



Now draw a smooth curved line using the direction of the compass needles to draw a magnetic field line from north to south poles. Do the same thing on the other side of the magnet.

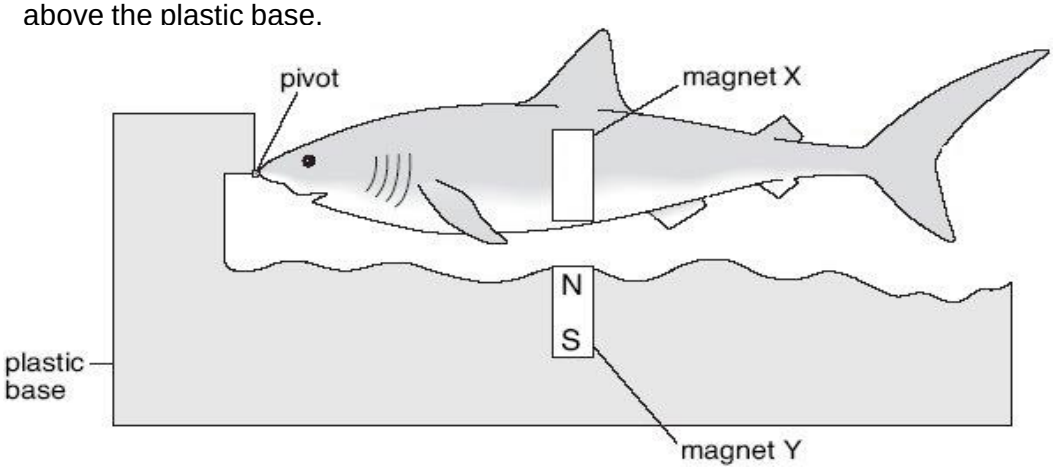
Now see if you can find some more field lines by moving the compass around and draw those in too.

3 Making a toy

>>>

You have been asked by a toy manufacturer to come up with a design for a child's game, using magnets. The idea is to have a small plastic car with a magnet inside it; the child has another magnet which they hold under the table. The car is placed on a piece of cardboard, printed to show the plan of a supermarket car park. The child has to guide the car around the car park and into the parking spaces. Sketch a design to show how the magnets need to be arranged in the car and in the controller.

Q1. The drawing shows a toy shark. Magnets X and Y make the shark 'float' above the plastic base.



Question & Enquiry
Feedback & Assessment
Literacy & Numeracy

(a) On magnet X, write the letters N and S to label the poles of the magnet.

1 mark

(b) (i) Choose a word from the list below to complete the sentence.

attract **cancel** **repel**

The toy shark 'floats' because the magnets ..... each other.

1 mark

(ii) Sophie pressed down on the tail of the shark with her finger. What happened to the shark when she removed her finger?

.....

1 mark

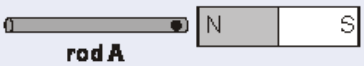
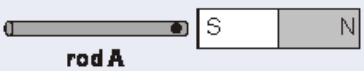
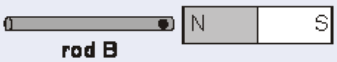
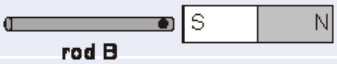
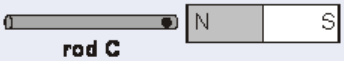
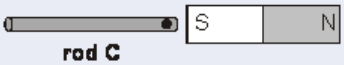
Question & Enquiry
Challenge

Q2. Hannah has three rods (A, B and C) made from different metals. One rod is a **magnet**; one is made of **copper**; and one is made of **iron**. She does not know which rod is which.

Each rod has a dot at one end.

(a) Hannah uses **only** a bar magnet to identify each rod. She puts each pole of the bar magnet next to the dotted end of each rod.

Complete Hannah's observations in the table below. Write if each rod is **copper**, **iron** or a **magnet**.

test	observations	type of rod
	attract	Rod A is ..... .
	attract	
	nothing happens	Rod B is ..... .
	.....	
	attract	Rod C is ..... .
	.....	

3 marks

Lesson 2 – Using Ideas About Magnetic Fields

Literacy & Numeracy

In and On: How could you use a compass to navigate yourself to the magnetic north pole?
.

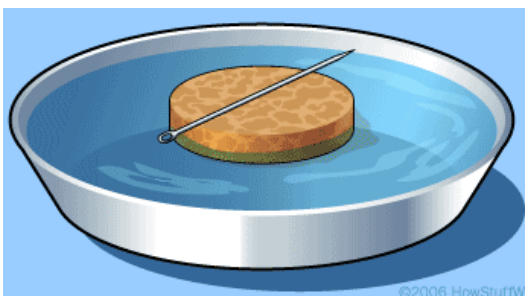
Learning Outcomes:
Describe key features of the Earth's magnetic field.
Explain why fields vary in strength.
Explore the fields around combinations of magnets.

What is domain theory?

How can you make an iron nail become magnetic in the classroom?

Why does this method make the nail temporarily magnetic?

You're stranded on a desert island and before you set sail, you need to know which direction to head in your boat. Explain how the experiment below could help you?



Additional Notes

Question & Enquiry

Relationships

Magnetic field lines demonstration.

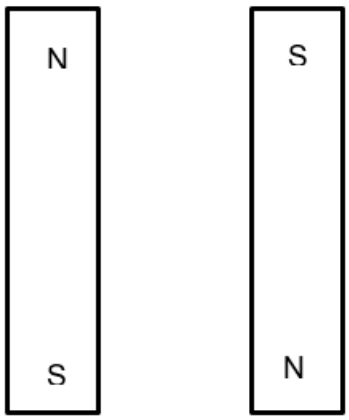
Using the textbook to help you, produce two diagrams to show the pattern created by iron filings around (i) attracting and (ii) repeling magnets.

Challenge: add direction arrows to the field lines.

2 The field produced by a pair of magnets

This task involves exploring field patterns between two magnets

Firstly, see if you can predict what the field lines will be like in the area where the magnets are close. Sketch them in lightly. Then check your answer by putting magnets on the sheet and using a plotting compass.



Based on what you have already learned, what would you PREDICT the field lines to look like. Sketch your ideas on the diagram.

3 Maglev trains

One kind of transport is called a Maglev train; Maglev stands for magnetic levitation. It uses magnetic fields to support the weight of the train, so it hovers above the ground.

a) What is the advantage of such a system compared with a wheeled train?

.....

b) What disadvantage can you see with this?

.....

Lesson 3 – Investigating Electromagnetism - Planning

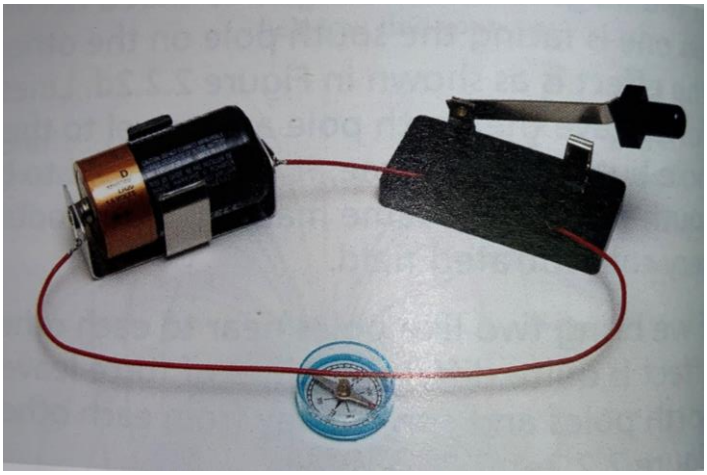
In and On: Complete the sentences using one of the following words to help explain your phrase.

and	because	but	however	
such as	therefore	which	so	to

1 Magnetism is a non-contact force …
2 Two pieces of iron attract each other …
3 An electromagnet needs electricity …
4 Bar magnets are permanent magnets …
5 Two pieces of metal repel each other …

Learning objectives
Describe what an electromagnet is.
Investigate the factors affecting the strength of electromagnets.

Teacher Demonstration: What will happen when an electric current flows through the wire?



Practical 2.2.3 Investigating the field of an electromagnet

In this practical investigation you will compare the magnetic effect of the current in an iron nail with that of the current in a coil of wire wrapped around an iron nail.

Apparatus

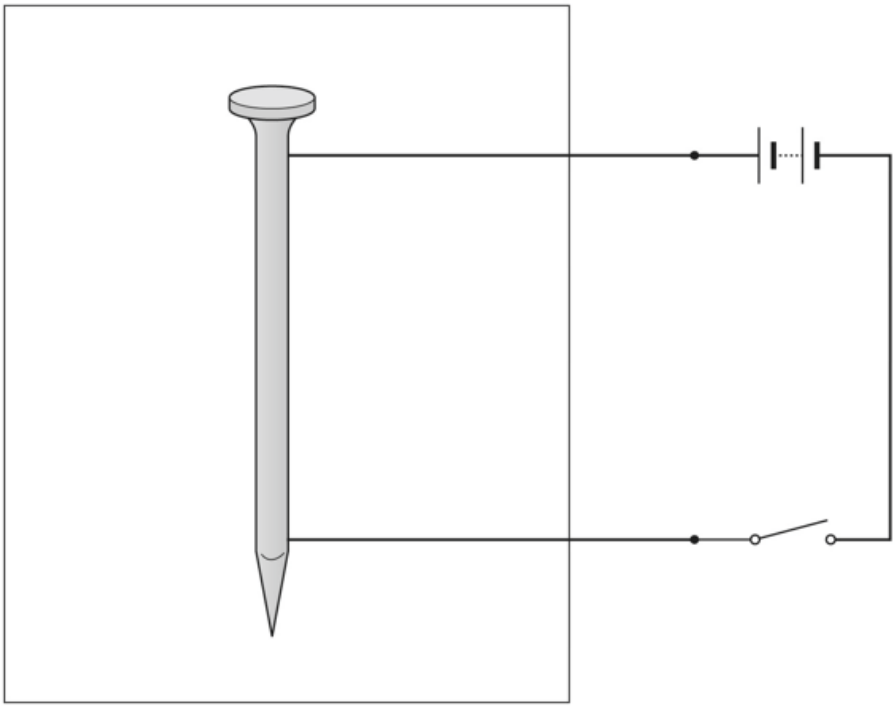
- iron nail (magnetically soft)
- D.C. battery, for example four 1.5 V cells and holders(s)
- 200 cm of insulated copper wire leads with bare ends
- crocodile clips
- connecting wires
- switch
- piece of plain white A4 card
- plotting compass
- safety goggles

SAFETY INFORMATION

Only have the current switched on for short periods to avoid overheating the wire.
Do not touch the wire until you are certain it is cool.

Method – Experiment 1

1. Set up the equipment as shown in the diagram.
2. Lay the iron nail on the white A4 card.
3. Switching the current on for only about 10 seconds at a time, use the plotting compass to investigate the field lines.

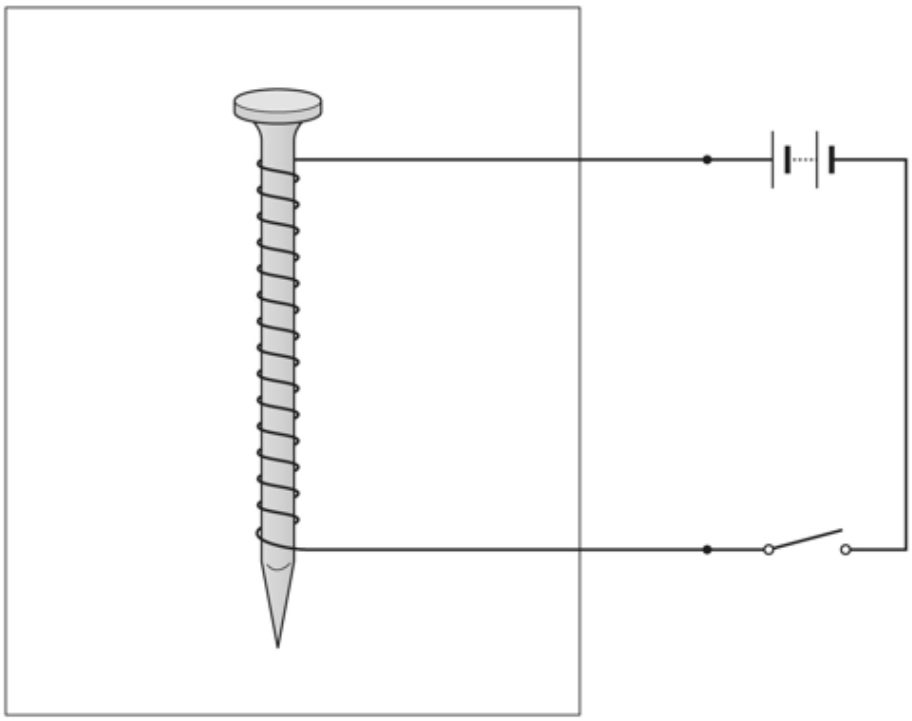


4. Draw a diagram of your observations on a large sheet of paper.

Sketch the field lines on this diagram!

Method – Experiment 2

1. Set up the equipment as shown in the diagram.
2. Coil the wire around the iron nail evenly, making sure that there are at least 10 coils around the nail.
3. Lay the iron nail on the A4 white card.
4. Switching the current on for only about 10 seconds at a time, use the plotting compass to investigate the field lines.



Sketch the field lines on this diagram!

5. Draw a diagram of your observations on a large sheet of paper.
6. Compare the field lines around the nail with no coils, with those around the nail with the coils around it.

Worksheet 2.2.3 Investigating electromagnetism

1 What are the variables? >

You are planning an investigation to find out how one factor affects the strength of an electromagnet. You could change **the number of coils**

a) What is the independent variable in your investigation?

.....

b) What values will you choose?

.....

c) What is the dependent variable?

.....

d) How will you measure it?

.....

e) Which variables will you control?

.....

f) What values will you choose for these?

.....

g) What are the hazards and risks of the investigation?

.....

h) What safety precautions will you take to address these risks and hazards?

.....

2 Accuracy and reliability >>

a) How will you make sure your results are accurate?

.....

.....

b) How will you make sure your results are reliable?

.....

.....

Worksheet 2.2.3 Investigating electromagnetism

3 Evaluate your investigation >>>

a) How will you know if your results are accurate and reliable?

.....

.....

b) How will you decide if your investigation is reproducible?

.....

.....

c) What could you do to improve your investigation further?

.....

.....

d) What conclusions can you draw from your investigation?

.....

.....

Lesson 4 – Investigating Electromagnetism - Practical

Hypothesis: _____

_____

_____

Variables:

Independent Variable: _____

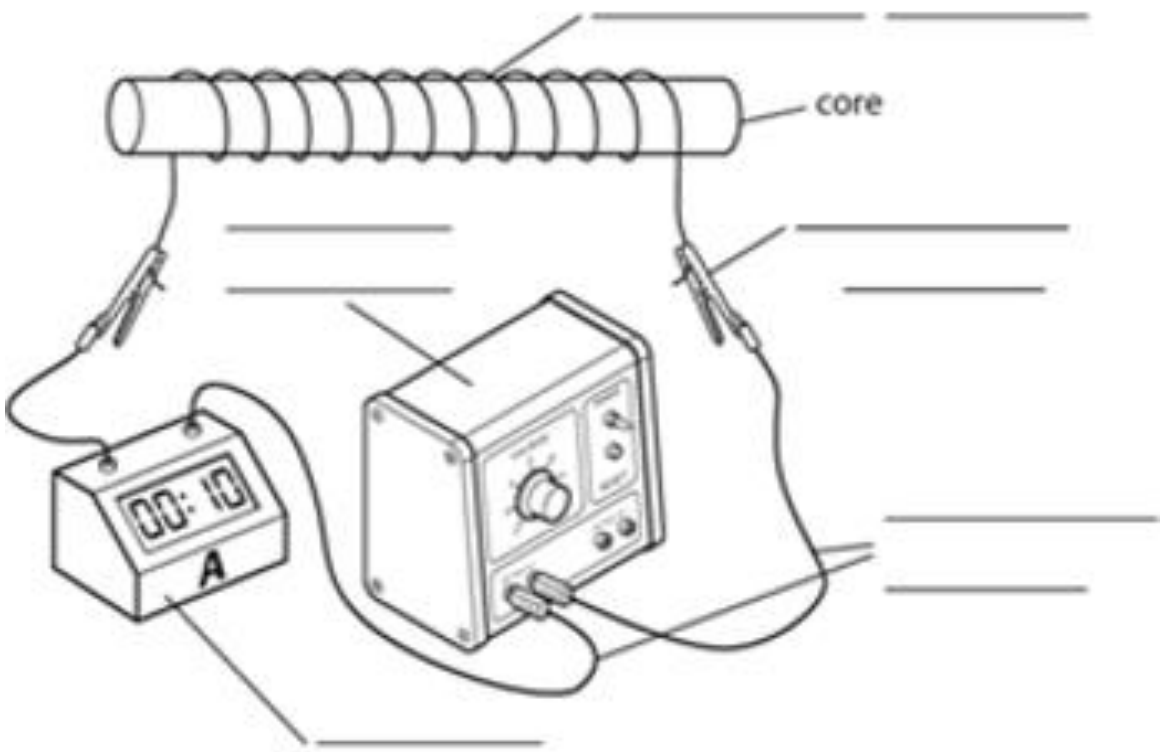
Dependent Variable: _____

Control Variable(s): _____

Equipment list

1	5
2	6
3	7
4	8

Label the diagram below



Method

This should be bullet points, short, to the point instructions that anyone with your equipment and this method could follow.

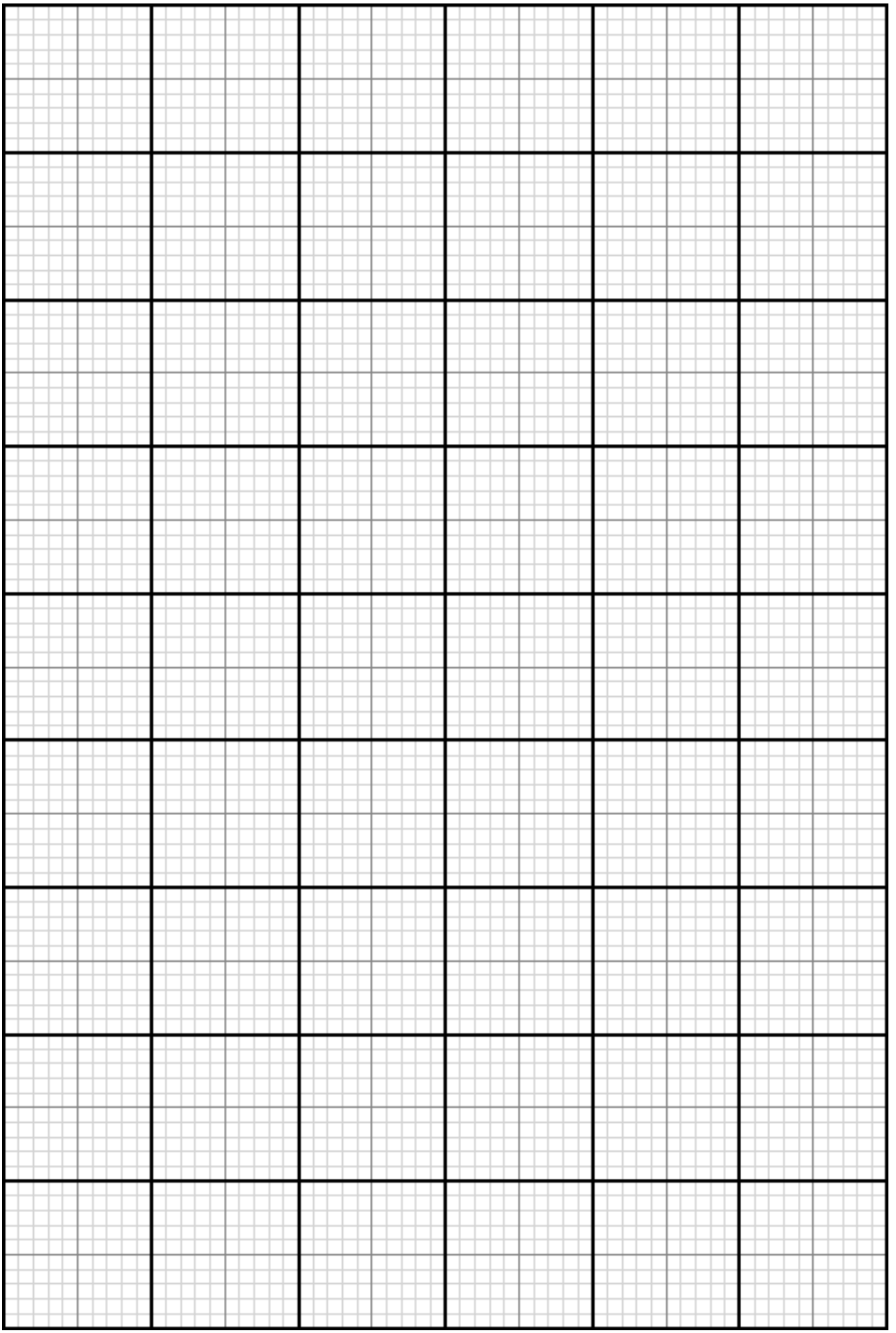
Risk assessment

Hazard – What could cause harm?
Risk – What harm could it cause?
Prevention – How will you stop the hazard from causing harm?

Hazard	Risk	Prevention
Overheating wire	Burning skin	

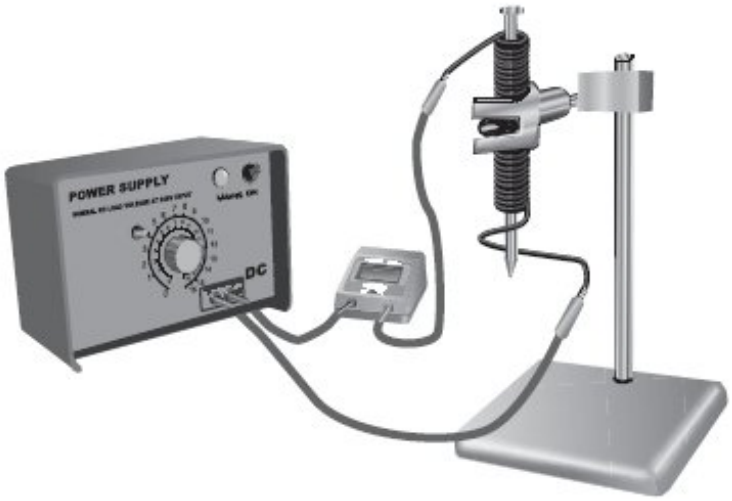
Results: Record your results in the table below.

Number of Coils	Number of Paperclips



Conclusion:_____

Q1. Alex makes an electromagnet.
She winds insulated wire around an iron nail.
She connects the wire to a power supply.
She uses the electromagnet to pick up some steel paper-clips.



This is her prediction.

The more turns of wire around the iron nail the stronger the electromagnet becomes.

(a) (i) Give the **one** factor she should change as she investigates her prediction.

.....

.....

1 mark

(ii) Give **one** factor she should keep the same.

.....

.....

1 mark

(iii) Describe how she could use the paper-clips to measure the strength of the electromagnet.

.....

.....

1 mark

(b) Alex wrote a report of her investigation.

> **My report.**
>
> My results are accurate because I can't see any odd results.

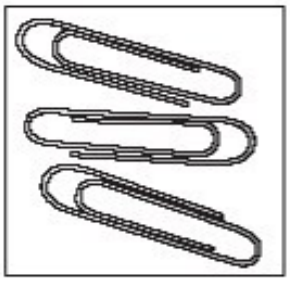
What would an odd result suggest?

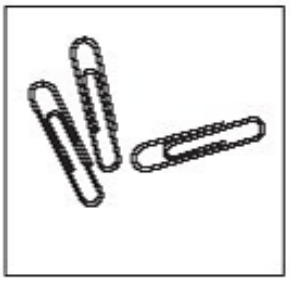
.....

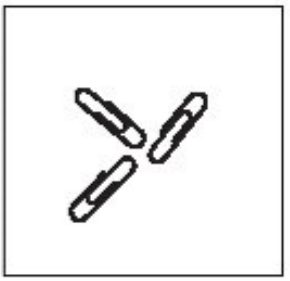
.....

1 mark

(c) (i) Which size paper-clips would Alex use to make her results more accurate?
Tick the correct box.







☐ ☐ ☐ ☐

1 mark

(ii) Give a reason for your choice.

.....

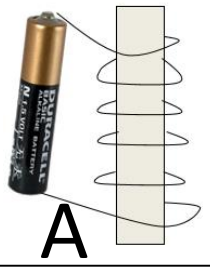
.....

.....

1 mark
maximum 6 marks

Lesson 5 – Using Electromagnets

In and On: Which of these electromagnets will be more powerful? How can you tell?



A

B

C

Learning Outcomes:

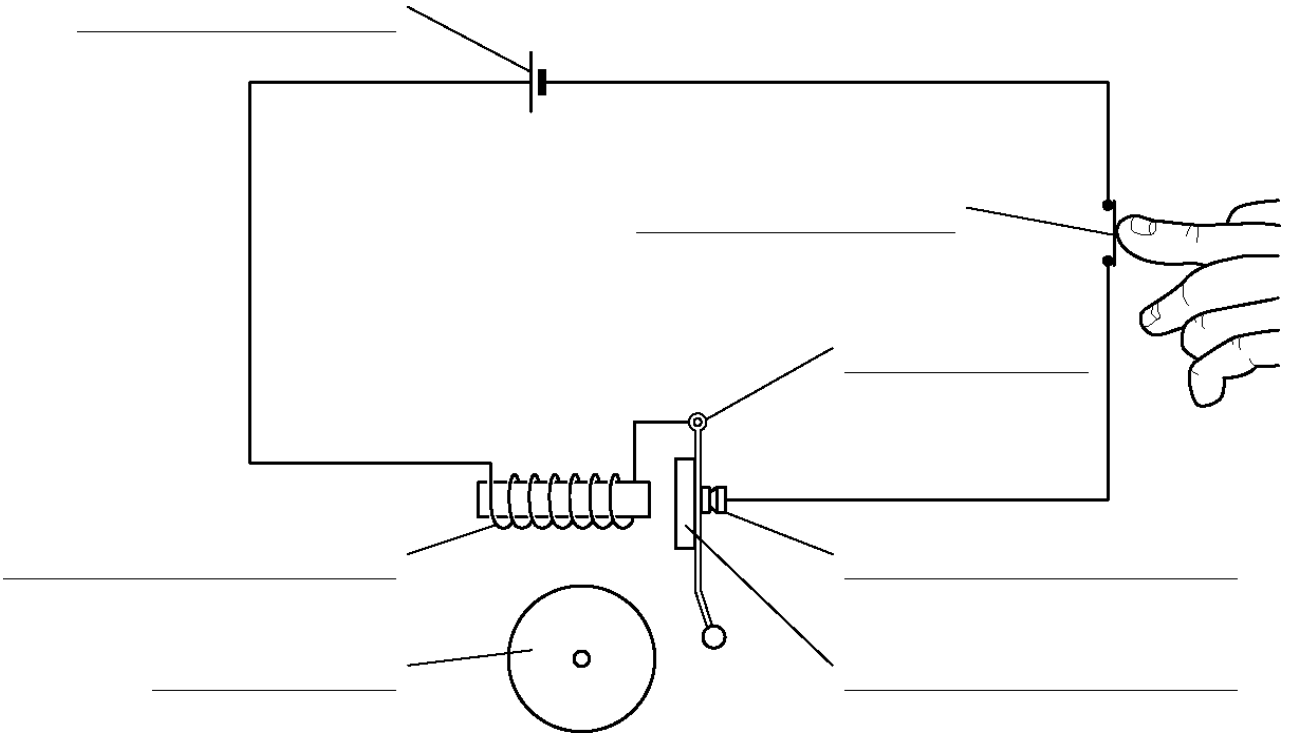
Describe different applications of magnets and electromagnets.

Compare and contrast the use of magnets and electromagnets in different applications.

Explain the advantages and disadvantages of using electromagnets.

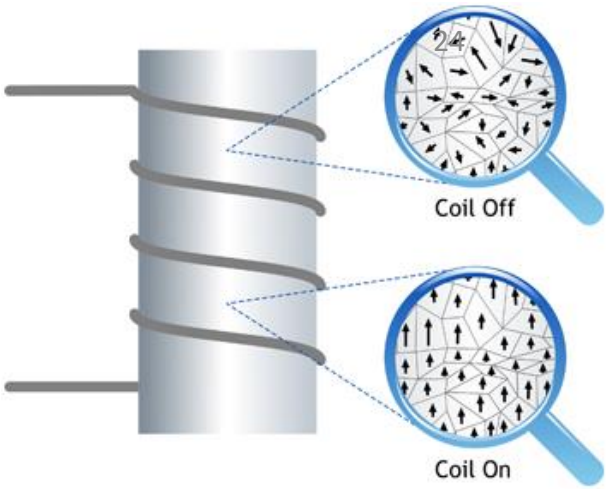
Missing words for diagram

- Armature
- Cell
- Contacts
- Electromagnet
- Bell
- Pivot switch



Electricity is the movement of _____ in a wire in _____ _____.

When the electricity is on, it makes _____ of a material line up.



Advantages of electromagnets

_____

_____

_____

Disadvantages of electromagnets

_____

_____

_____

home	**armature**	**backwards**	**circuit**	**coil of wire**	**current**		
electromagnet	**gap**	**gong**	**good**	**moved**	**sound**	**switch**	**touch**

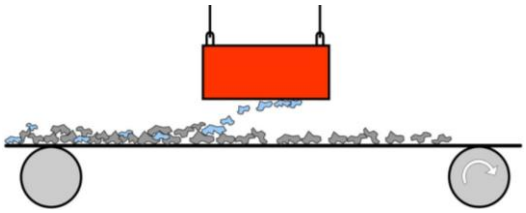
Use words from the box above to fill the gaps in these sentences. You can use some words more than once.

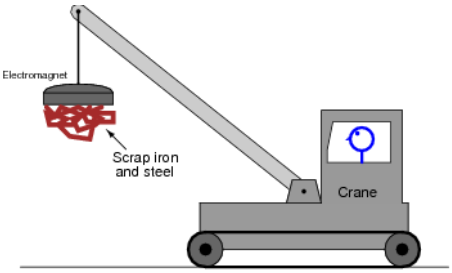
When someone presses the _____ , an electric current can flow around the _____. When the current flows in the _____ _____ _____ it becomes a magnet and attracts the _____ .

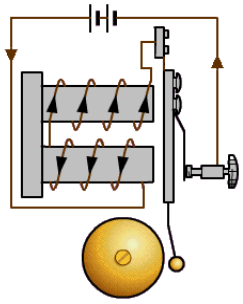
When the armature moves towards the _____ the end of it hits the _____ and makes a _____ . Now that the armature has _____, there is a _____ between the contacts. This means that the _____ cannot flow around the circuit. The _____ stops being magnetic, and the _____ springs back again.

When the armature has sprung back the contacts _____ . A current can flow again, so the electromagnet attracts the_____ again. The armature keeps springing _____and forwards as long as someone has their finger on the switch.

Give 3 uses of electromagnets and why they are useful in your example.

1. 

2. 

3. 

Give the three ways to make an electromagnet stronger.

1.

2.

3.

Additional Notes

Worksheet 2.2.4 Using electromagnets

1 Applications of magnets and electromagnets >

Look at the pictures. Decide which of the devices use permananet magnets and which use electromagnets in their operation. (You can use your Student Book to help you.)

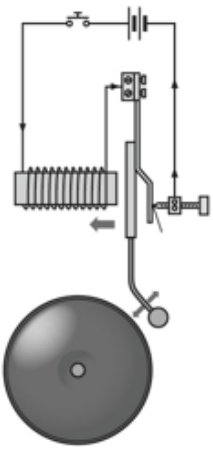
Magnet(s): .....

Electromagnet(s): .....

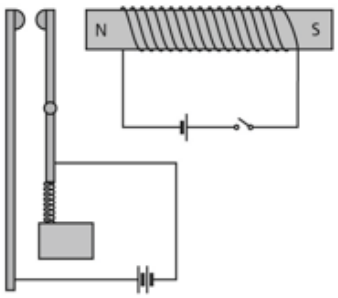
2 Electromagnet expert >>

Your task is to become an expert on one of the following:

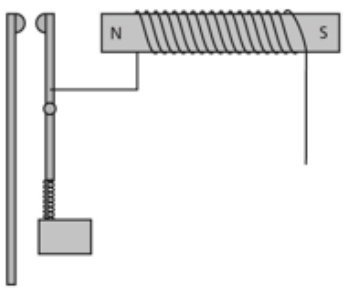
The electric bell



The relay



The circuit breaker



Your teacher may tell you which one to look at. Use the diagrams here and in your Student Book to help you.

Worksheet 2.2.4 Using electromagnets

Write a step-by-step account of how the device works.

.....

.....

.....

.....

.....

.....

Once you have had time to find out all you can, share your knowledge with two friends who researched the other devices, so that you learn about all three.

3 Advantages of using electromagnets >>>

Can you think of the main advantages and disadvantages of using electromagnets over ordinary permanent magnets in each of the applications in task 2?

.....

.....

.....

.....

.....

.....

.....

.....

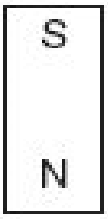
Revision Notes

Revision Diagrams

L1 Answers

Computers store data in magnetic disks and CDs.
Electromagnets are used to lift heavy objects
Doctors can see the inside of our bodies thanks to magnetic resonance imaging (MRI)
Maglev trains 'float' on top of tracks
The Earth has a magnetic field which we can use for navigation
Only **iron** (Fe), **nickel** (Ni) and **cobalt** (Co) are magnetic
Poles – part of the magnet with strongest magnetic force.
The poles are called North pole and South pole

Two like poles repel
Two Opposite poles attract

M1(a) 

b(i) repel

(ii) it moved upwards **or**
returned to its original position

accept 'it would move up and down'

2 iron nothing happens

*accept 'nothing' **or** 'no force' **or** 'it does not attract or repel'*

***both** answers are required for the mark*

Copper repel a magnet

accept 'move apart'

***both** answers are required for the mark*

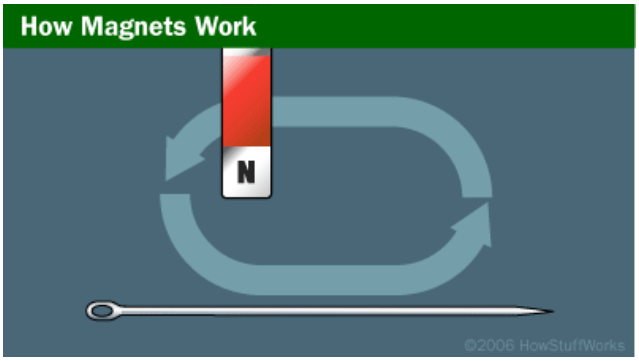
L2 Answers

Inside a magnet there are small regions called domains.

The direction of these domains is the same.

If a metal is not a magnet the domains have different directions.

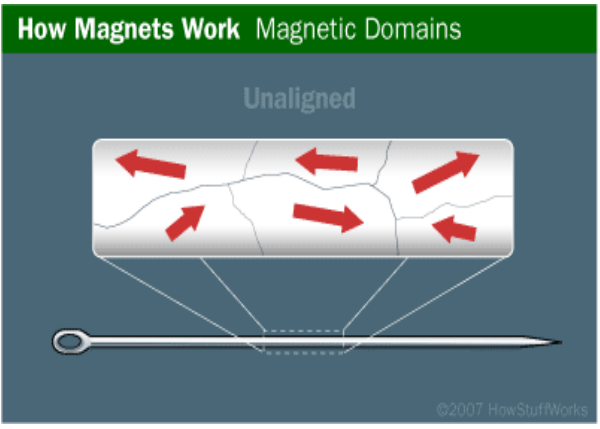
The arrows point towards the north pole in a magnet.

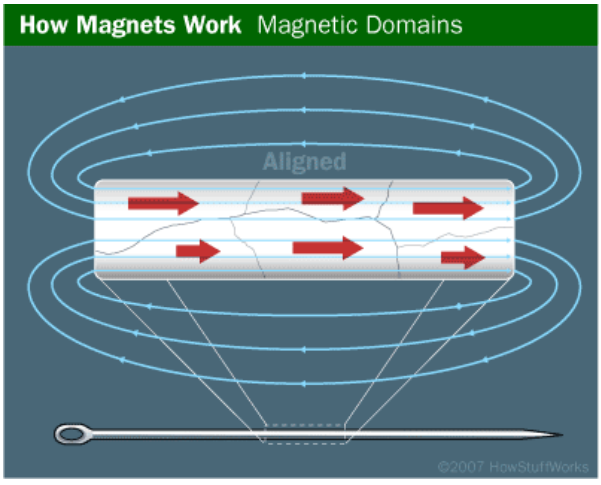


Stroke a piece of iron repeatedly with a magnet

1. always stroke with the same pole
2. always stroke in the same direction

Stroking the needle will make the domains line up in one direction, making the iron into a magnet.





How can you make an iron nail become magnetic in the classroom?

STROKE the nail with the same POLE of a magnet in the same DIRECTION.

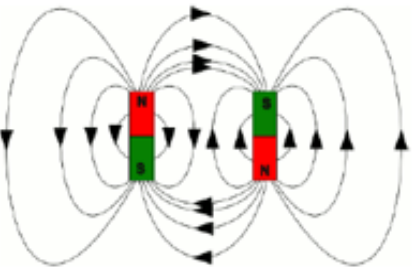
Why does this method make the nail temporarily magneti

The DOMAINS line up in the same direction.

You're stranded on a desert island and before you set sail, you need to know which direction to head in your boat. Explain how the experiment below could help you?

Turn the nail into a magnet and it will point towards the North pole.

1. It should become apparent that the field lines are parallel; different groups should get the same general alignment.
2.



3. a) with no wheels there will be less friction, less noise and less vibration
   b) the train will have to be supported and guided by other means; electromagnets need a supply of energy

L3 Answers

If you pass electricity through a coil of wire, the coil acts like a magnet – there is a magnetic field around it.

If you put a magnetic material such as an iron nail into the centre, the magnetic field gets even stronger.

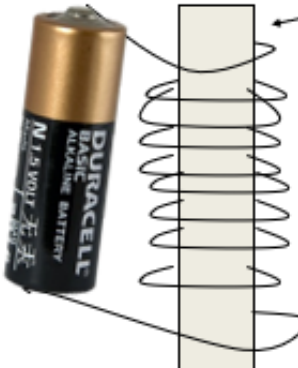
You have made a magnet using electricity – we call it an **electromagnet**.

Electromagnets are made of the three C's

Rastrick

Current - a flow of electrons in a wire (electricity).

Core usually made of soft iron.



Coils - usually copper wire covered in insulating material.

Answers to Worksheet 2.2.3

1.

	Method 1	Method 2
a)	Number of coils	Size of current
b)	1, 5, 10, 20	1, 2, 4, 6, 8 (A)
c)	Number of paper clips attracted	Number of paper clips attracted
d)	Count	Count
e)	Type of magnet, current (5 A), time (10 s)	Type of magnet, time (10 s), number of coils (10)
f)	Overheating the wire	Overheating the wire
g)	Have the current on for only a few seconds	Have the current on for only a few seconds

2. a) Count all the paper clips precisely; have someone check.

   b) Repeat each investigation at least three times; remove anomalous data and calculate the mean; if the results are not consistent, repeat until three consistent readings are achieved.

3. a) Repeat the experiment yourself and see if the same results are obtained.

   b) Ask someone else to repeat the procedure and see if they get the same results as you.

   c) Use something more lightweight than paper clips, such as small pins, so there is a greater degree of accuracy.

   d) You should find: the more coils there are, the stronger the electromagnet; the larger the current, the stronger the electromagnet.

Increasing or including any of the three C's will increase the strength of your electromagnet.
Electricity is the movement of electrons in a wire in one direction.
When the electricity is on, it makes domains of a material line up.
They are **non-permanent magnets** because magnetism can be turned on or off.
A bar magnet is a **permanent magnet** because the magnetism is always there.

The more / less coils around the nail, the stronger / weaker the electromagnet.

L4 Answers

Investigation: How will increasing the number of coils of an electromagnet affect the strength?

We are going to change the number of coils around the electromagnet and find out how it affects the strength.

Independent variable = Number of coils

Dependent variable = Number of paperclips it can pick up

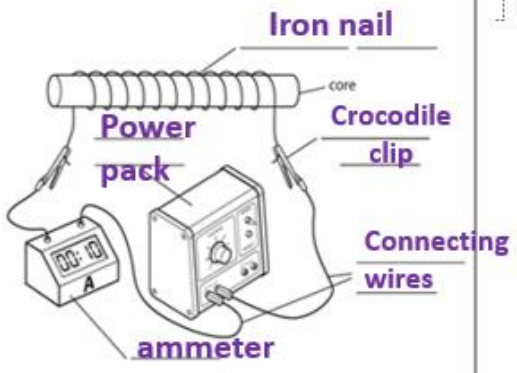
Prediction: The larger the number of coils, the stronger the magnet will be.

Apparatus

- insulated wire
- connecting wires
- power pack
- ammeter
- two crocodile clips
- paper clips
- iron rod or nail
- glass rod
- wooden rod or pencil

Method

Here is a diagram of the apparatus you will use. Label the diagram using words from the apparatus list.



To make this a fair test I must keep the current and the core the same.

Method: Wrap the wire around the iron nail.
Connect a crocodile clip to each end of the wire
Plug the other end of the wires into the Power pack.
Turn the Power Pack on.

M1.a(i) the number of turns **or** coils of wire

accept 'the coils'

accept 'the turns'

(ii) the current or the length **or** thickness **or** material of the wire **or** coil

*accept 'the voltage **or** power' accept 'the wire' or t*he circumference of the coil. The size of paper-clips

(iii) any **one** from, count the paper-clips picked up

accept 'number of paper-clips'; or measure their mass

accept 'weigh them'; 'the more clips the stronger the magnet'; 'measure the distance at which a magnet will just pick up a paper-clip'

(b) any **one** from

- an inaccuracy in results

accept a description of inaccuracies, such as 'she counted the number of clips wrongly'

- a problem with the data **or** results
- a problem with the method

(i)

if more than one box is ticked, award no mark

1 (L6)

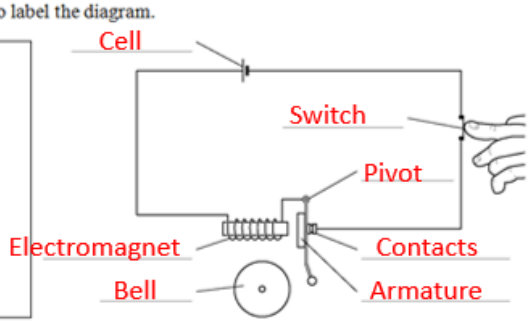
(ii) any **one** from

- with bigger paper-clips she might miss the precise point at
  which the electromagnet stopped picking up paper-clips
- the smaller paper-clips might help to identify the precise point
  at which the electromagnet stopped picking up paper-clips

Using Electromagnets: Electric Bell

1 Use words from the box to label the diagram.

armature cell
contacts electromagnet
bell pivot switch

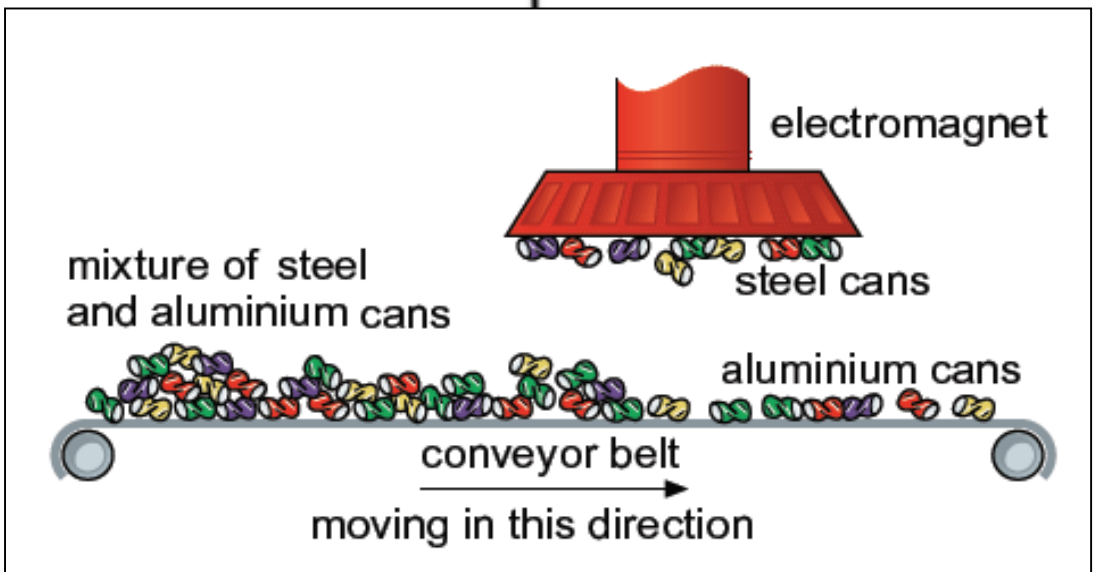


https://www.youtube.com/watch?v=qMB5nQmB82M

Electromagnets are very useful because unlike normal (permanent) magnets, they can easily be turned on and off.
The crane has a large electromagnet, which is turned on to lift scrap iron and steel, and turned off to drop it

In an electric bell, the electromagnet attracts the arm of the clanger, making it strike the bell.
In doing so, it breaks the circuit, which turns off the electromagnet.
The clanger goes back to its original position.
This completes the circuit again, turning the electromagnet back on, which attracts the clanger, which strikes the bell.
This goes on and on and so the bell rings and rings until you take your finger off the switch.

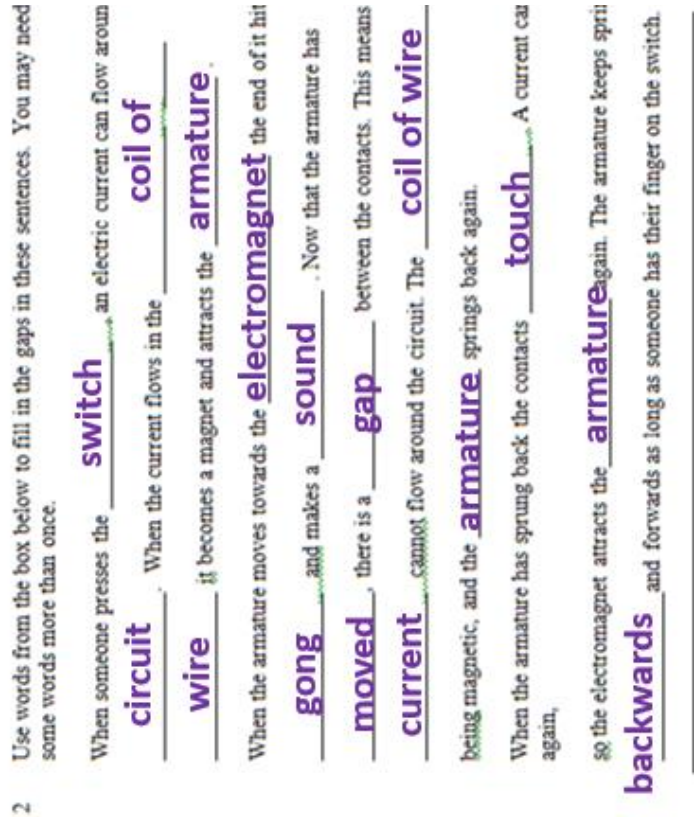
Advantages	Disadvantages
• Turned on and off • Regulate the strength	• Needs electricity – cost • Electromagnets heat up very fast



Answers to Worksheet 2.2.4

1. Magnets – fridge magnet/magnetic boards; magnetic knife holder. Electromagnets – motor in wheelchair; camera.
2. Correct step-by-step account of how the electric bell/circuit breaker works; as given in the Student Book. A relay consists of two circuits. The first contains a simple electromagnet and needs only a small current; this acts as a switch for a second circuit that uses a much larger current. The current flows in the first circuit and attracts the rocker arm to the electromagnet; this pivots and pushes the contacts together, completing the second circuit.
3. Advantages: better control of the circuits; the magnetic effect can be switched off when required; the electromagnet allows these appliances to work, which would not happen if they were replaced with ordinary magnets; if the electromagnet is dropped on the floor, it can be easily remagnetised; the strength of an electromagnet can be increased, whereas for permanent magnets this variability is limited.

   Disadvantages: always needs a current, so always uses energy; large electromagnets are expensive to run; the magnetic effect can be lost after a while and they shouldn't be run for very long periods of time; they need to be set up and maintained in order to operate.



2 Use words from the box below to fill in the gaps in these sentences. You may need some words more than once.

When someone presses the switch an electric current can flow aroun circuit. When the current flows in the coil of wire it becomes a magnet and attracts the armature.

When the armature moves towards the electromagnet the end of it hit gong and makes a sound. Now that the armature has moved, there is a gap between the contacts. This means current cannot flow around the circuit. The coil of wire being magnetic, and the armature springs back again.

When the armature has sprung back the contacts touch. A current ca again,

so the electromagnet attracts the armature again. The armature keeps spri backwards and forwards as long as someone has their finger on the switch.