Edexcel GCSE Physics

Your notes

Magnetism

Contents

Magnetism

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The Law of Magnetism

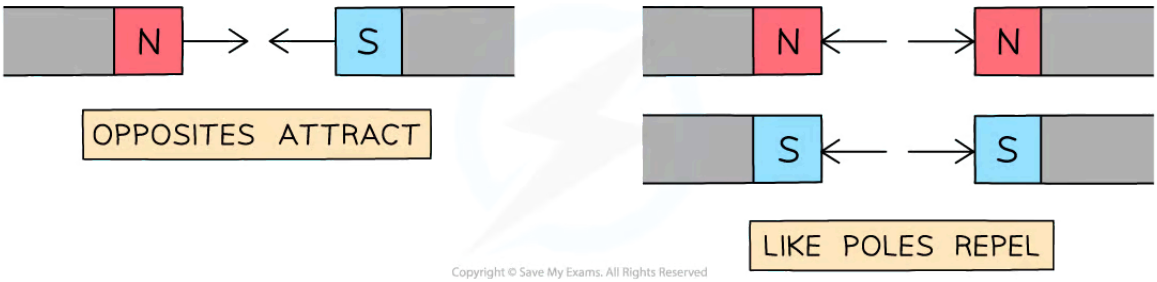
Poles of a Magnet

- The ends of a magnet are called **poles**
- Magnets have two poles: a **north** and a **south**

Poles of a Magnet

The Law of Magnetism

- When two magnets are held close together, there will be an attractive or repulsive force between the magnets depending on how they are arranged:



Opposite poles attract; like poles repel

- The Law of Magnetism states that:
  - Two **like** poles (S and S or N and N) **repel** each other
  - Two **unlike** poles (S and N) **attract** each other
- The attraction or repulsion between two magnetic poles is an example of a **non-contact force**

Permanent & Induced Magnets

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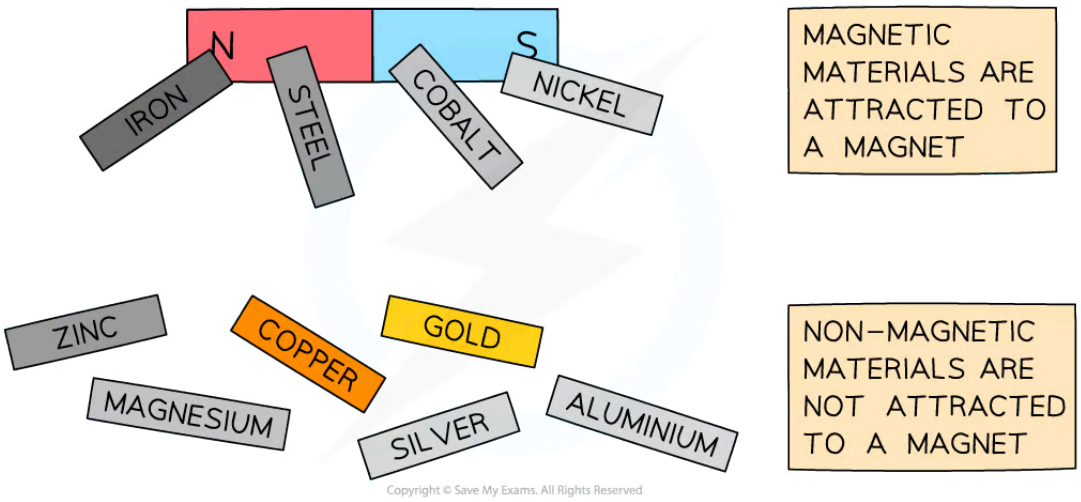
Magnetic Materials



Magnetic materials are attracted to a magnet; non-magnetic materials are not

- Very few metals in the Periodic Table are magnetic. These include:
  - Iron
  - Cobalt
  - Nickel
- Steel is an alloy which contains iron, so it is also magnetic
- Magnetic materials (which are not magnets) will always be **attracted** to the magnet, regardless of which pole is held close to it

Magnetic materials attracted to magnets

- To test whether a material is a magnet it should be brought close to a known magnet

- If it can be **repelled** by the known magnet then the material itself is a magnet
- If it can only be **attracted** and **not repelled** then it is a magnetic material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Induced Magnetism

- There are two types of magnets
  - Permanent magnets
  - Induced magnets

Permanent Magnets

- Permanent magnets are made out of permanent magnetic materials, for example steel
- A permanent magnet will **produce its own magnetic field**
  - It will not lose its magnetism

Induced Magnets

- When a magnetic material is placed in a magnetic field, the material can temporarily be turned into a magnet.
  - This is called **induced magnetism**
- When magnetism is induced on a material:
  - One end of the material will become a north pole
  - The other end will become a south pole
- Magnetic materials will always be **attracted** to a permanent magnet
  - This means that the end of the material closest to the magnet will have the **opposite** pole to magnets pole closest to the material

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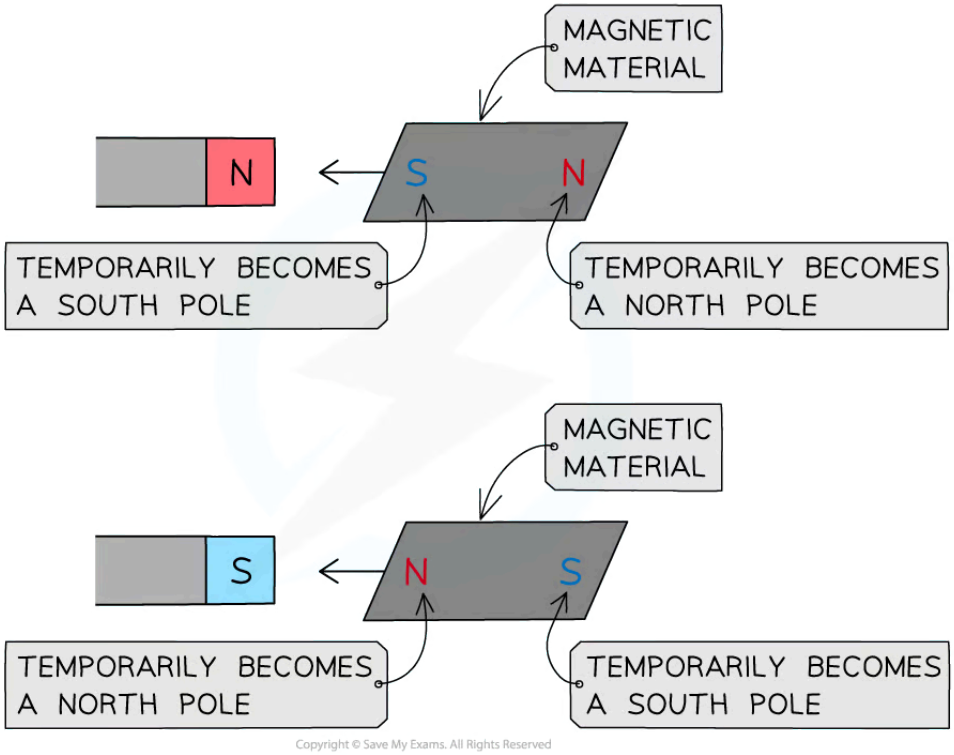

Inducing magnetism in a magnetic material

- When the magnetic material is removed from the magnetic field it will lose most/all of its magnetism quickly

Worked Example

The diagram below shows a magnet held close to a piece of metal that is suspended by a light cotton thread. The piece of metal is attracted towards the magnet.

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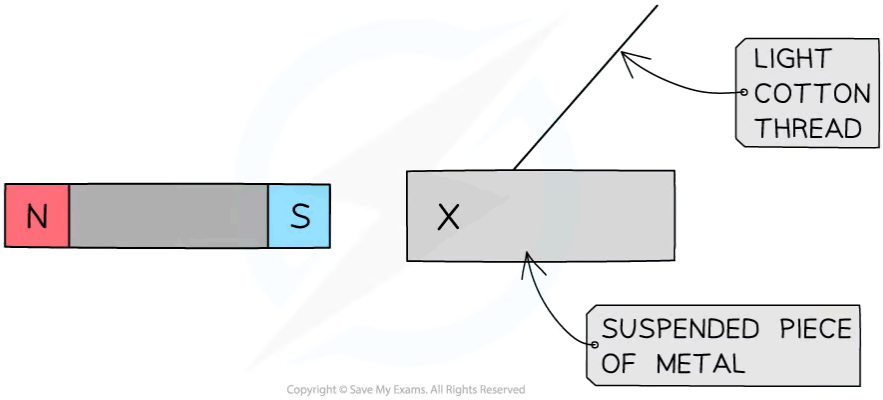

Which of the following rows in the table gives the correct type of pole at X and the correct material of the suspended piece of metal?

	Type of pole at X	Material of suspended piece of metal
A	North	Nickel
B	South	Nickel
C	North	Aluminium
D	South	Aluminium

Answer: A

- X must be a north pole
  - The piece of metal is being attracted towards the magnet
  - The law of magnetism states that opposite poles attract
- The material of the suspended piece of metal is nickel
  - Nickel is a magnetic material (It will experience a force when it is placed in a magnetic field, in this case it is attracted towards the magnet)
- **B** is incorrect because X cannot also be a south pole (and hence is a north pole)
  - If the pole at X was a south pole then the piece of metal would be repelled from the magnet because the law of magnetism states that like poles repel

- **C** and **D** are incorrect because aluminium is not a magnetic material
  - A non-magnetic material would be unaffected by the magnetic field produced by the magnet.


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Magnetic Fields

- All magnets are surrounded by a **magnetic field**
- A magnetic field is defined as:

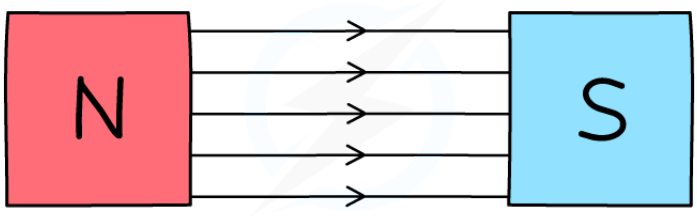
  The region around a magnet where a force acts on another magnet or on a magnetic material (such as iron, steel, cobalt and nickel)

Magnetic Field Lines

- Magnetic field lines are used to represent the **strength** and **direction** of a magnetic field
- The direction of the magnetic field is shown using **arrows**
- The **strength** of the magnetic field is shown by the **spacing** of the magnetic field lines
  - If the magnetic field lines are **close together** then the magnetic field will be **strong**
  - If the magnetic field lines are **far apart** then the magnetic field will be **weak**
- There are some rules which must be followed when drawing magnetic field lines. Magnetic field lines:
  - Always go **from north to south** (indicated by an arrow midway along the line)
  - Must **never touch or cross** other field lines

Uniform Magnetic Field

- A **uniform** magnetic field will be produced in the **gaps** between **opposite poles**
  - Note: Outside that gap the field will not be uniform



A uniform field is created when two opposite poles are held close together

- A uniform magnetic field is one that has the **same strength and direction at all points**

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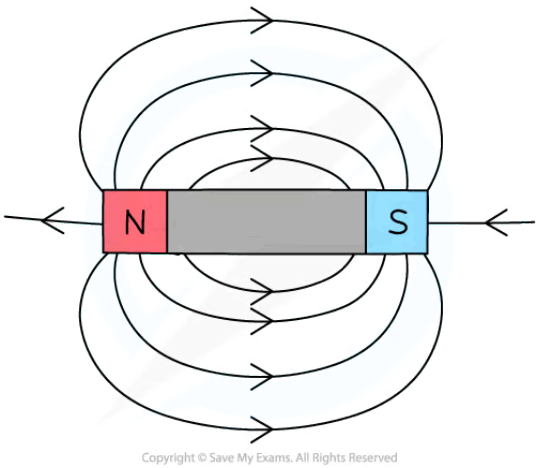
- To show that the magnetic field has the same strength at all points there must be **equal spacing** between all magnetic field lines
- To show that the magnetic field is acting in the same direction at all points there must be an arrow on each magnetic field line going from the north pole to the south pole

- The magnetic field lines are the **same distance apart** between the gaps of the poles to indicate that the field strength is the same at every point between the poles

Magnetic Field Around a Bar Magnet

- The magnetic field is **strongest at the poles**
  - This is where the magnetic field lines are **closest** together
- The magnetic field becomes **weaker as the distance from the magnet increases**
- This is because the magnetic field lines are getting **further apart**



The magnetic field around a bar magnet

- Two bar magnets can repel or attract, the field lines will look slightly different for each:

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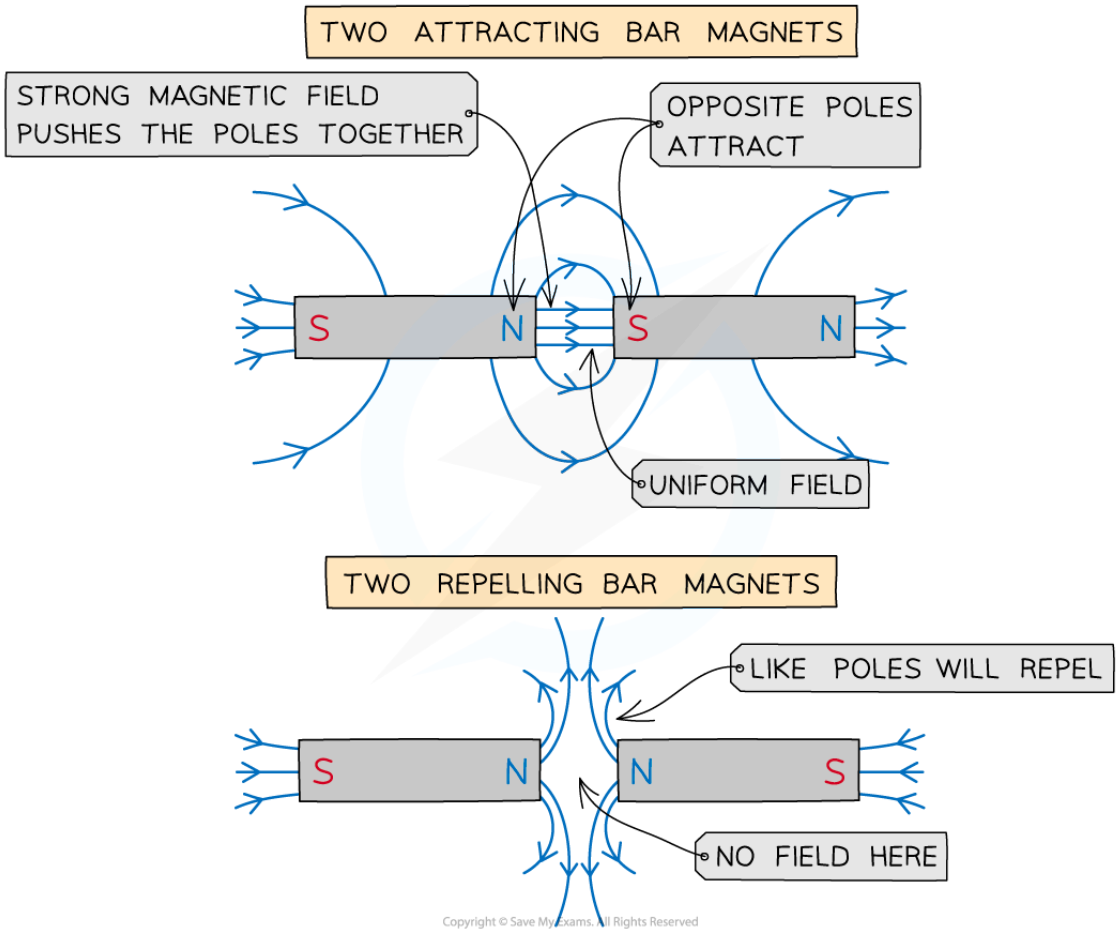

Magnetic field lines for attracting and repelling bar magnets

- Therefore, the magnetic field lines around different configurations of two bar magnets would look like:

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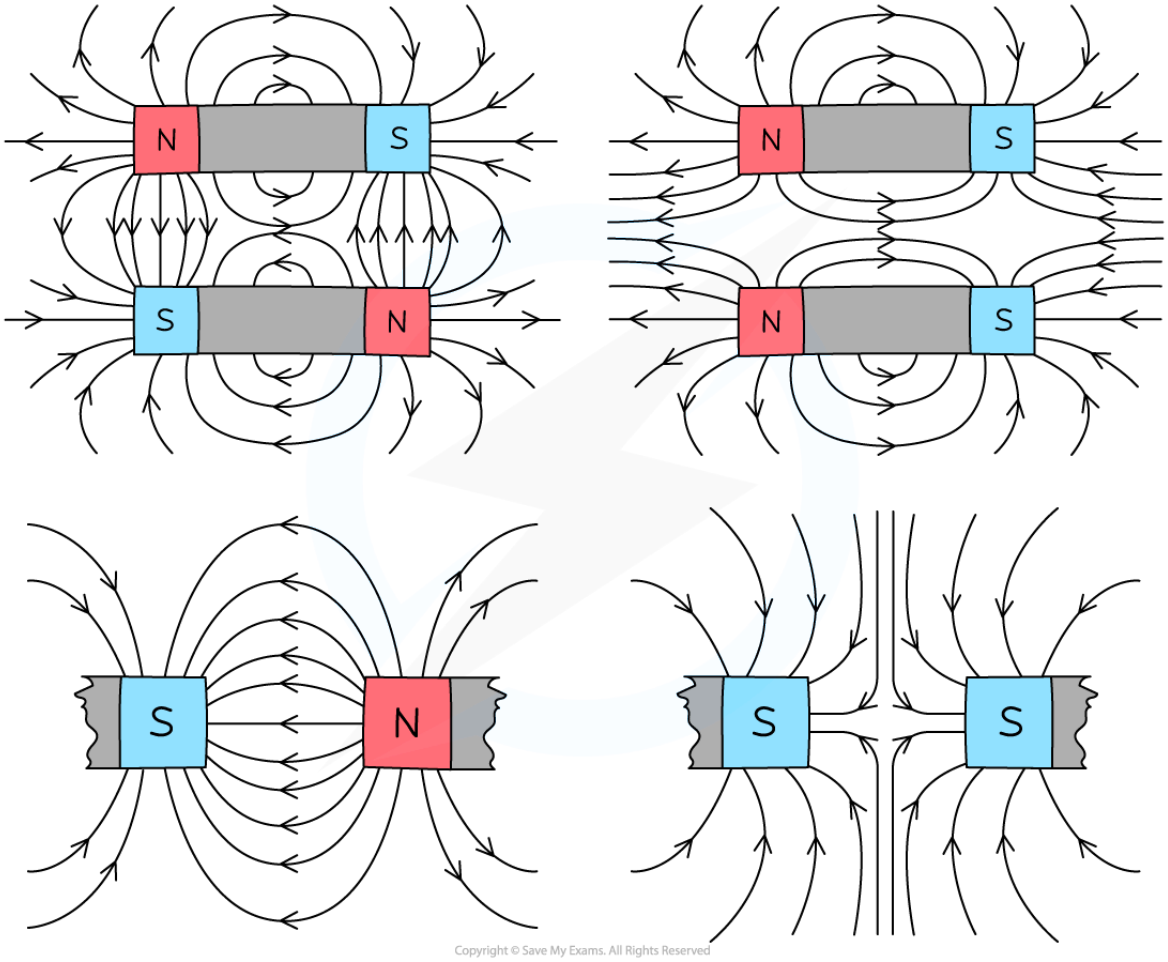

Magnetic field lines between two bar magnets

Examiner Tips and Tricks

If you are asked to draw the magnetic field around a bar magnet remember to indicate both the **direction** of the magnetic field and the **strength** of the magnetic field. You can do this by:

- Adding arrows pointing away from the north pole and towards the south pole
- Making sure the magnetic field lines are further apart as the distance from the magnet increases

Plotting Magnetic Fields

- The shape and direction of a magnetic field may be investigated using **plotting compasses**

- A plotting compass is like a small bar magnet, with a north and south pole
- The arrow of the plotting compass represents the **north pole**

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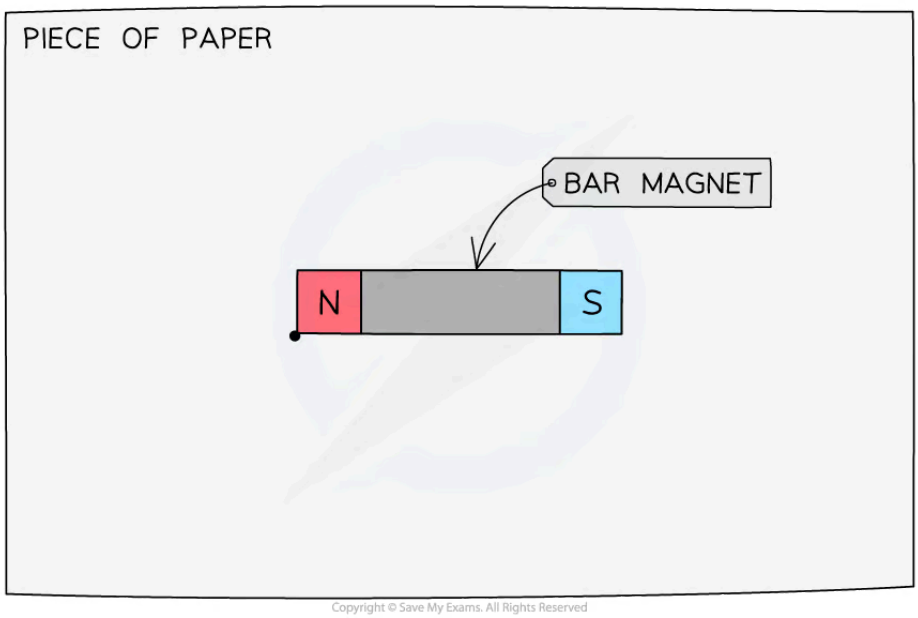
Investigating the Shape and Direction of a Magnetic Field

Step 1:

- Place the magnet on top of a piece of paper
- Draw a dot at one end of the magnet (near its corner)



Step 2:

- Place a plotting compass next to the dot, so that one end of the needle of the compass points away from the dot
- Use a pencil to draw a new dot at the other side of the compass needle

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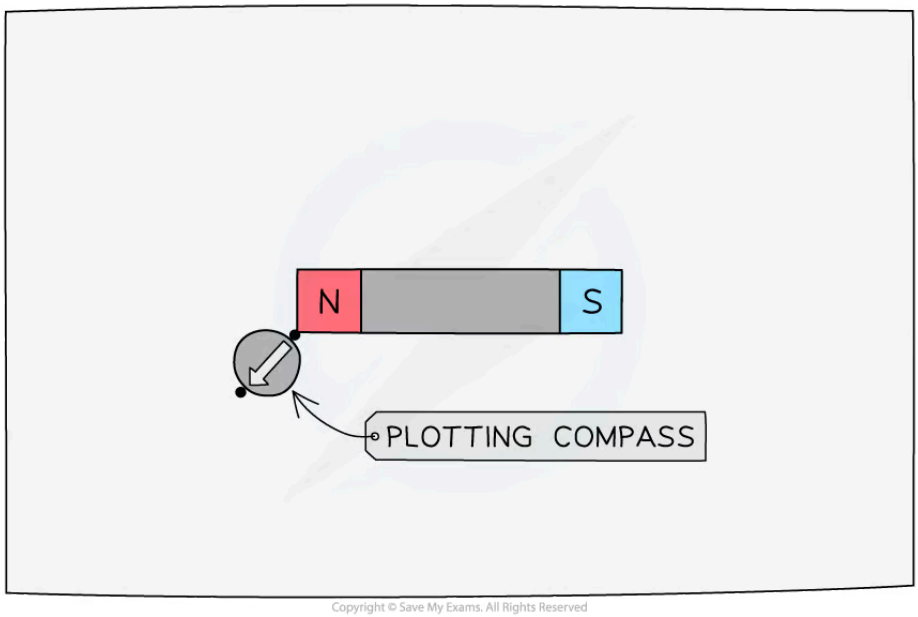
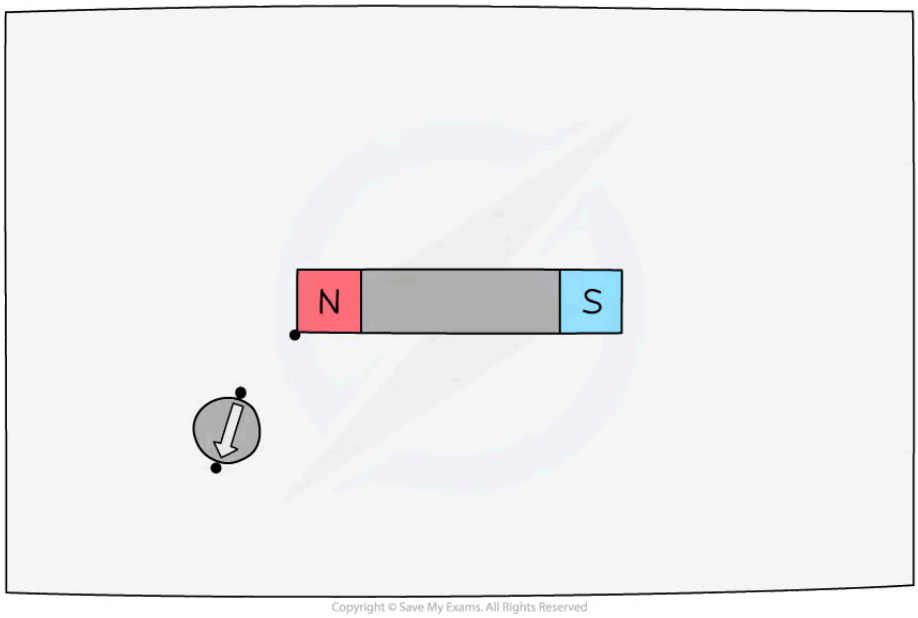


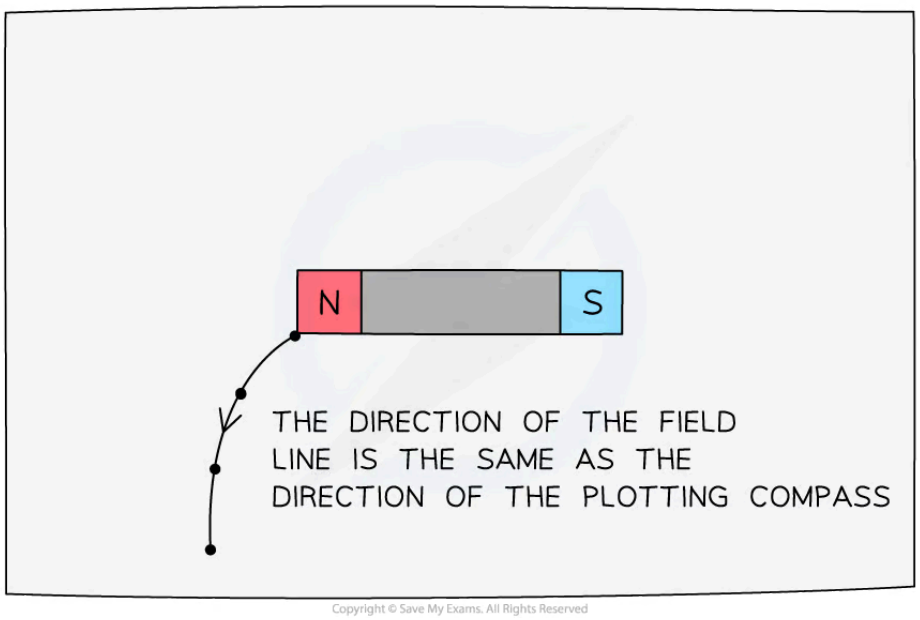
Step 3:

- Move the compass so that it points away from the new dot, and repeat the process above



Step 4:

- Keep repeating the previous process until there is a chain of dots going from one end of the magnet to the other
- Then remove the compass, and link the dots using a smooth curve – this will be the magnetic field line



Step 5:

- Repeat the whole process several times to create several other magnetic field lines

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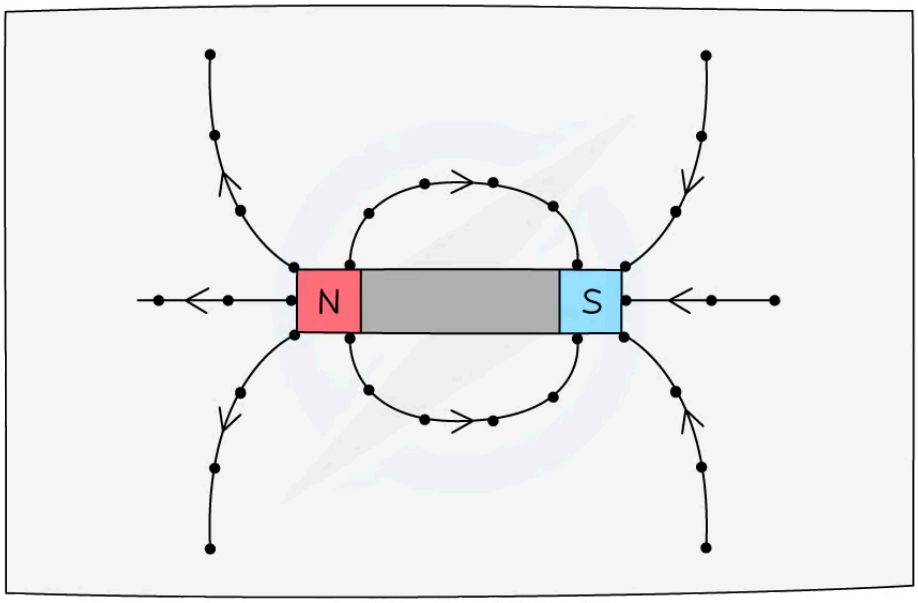

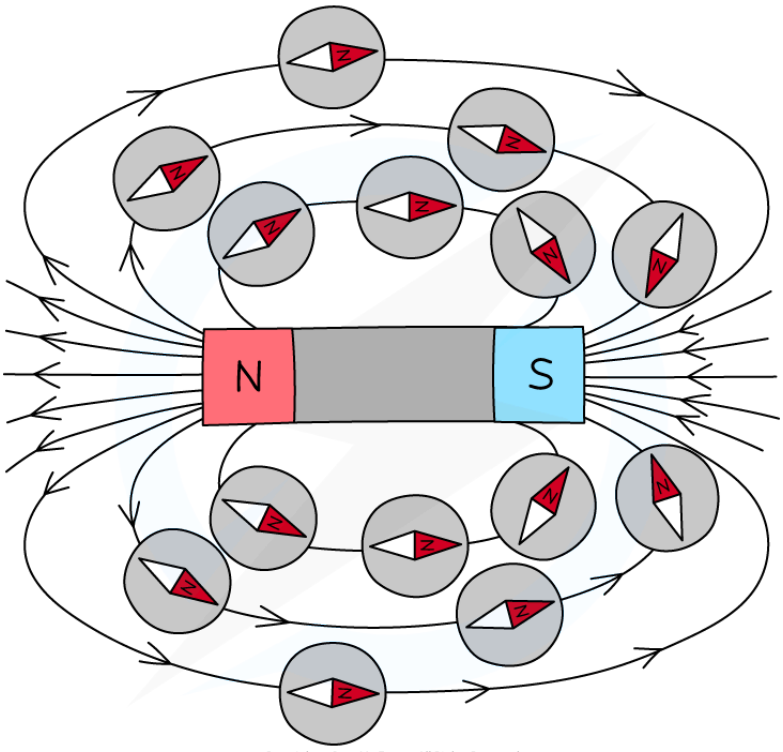

Compasses around a bar magnet show the direction of the magnetic field from north to south

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Examiner Tips and Tricks

Remember that the direction of the field line at a point is the same as the direction of the force a north pole would experience at that point

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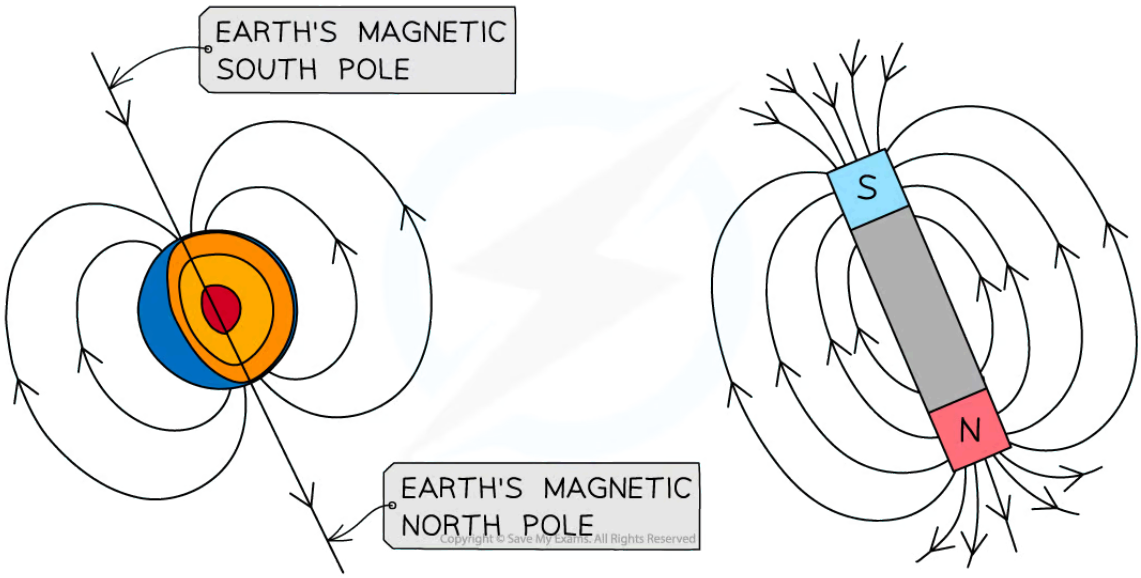
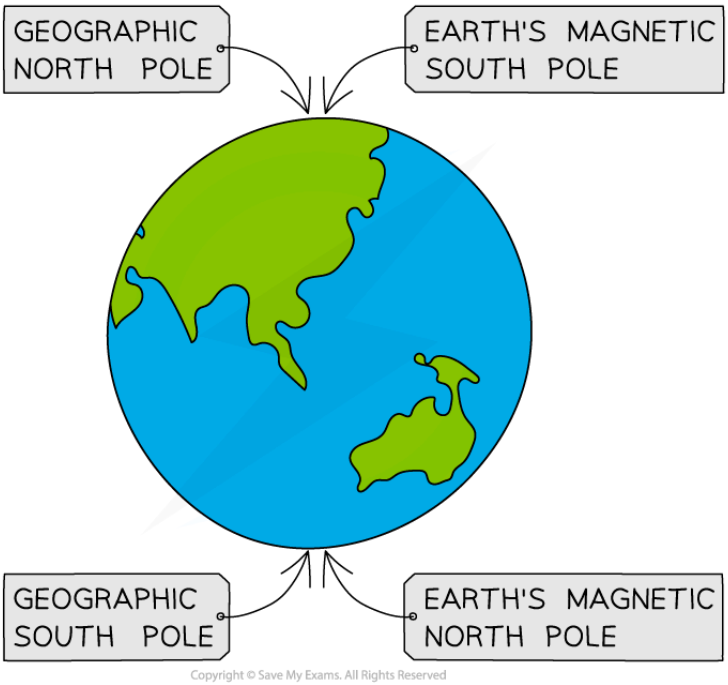
The Earth's Magnetic Field

- On Earth, in the absence of any magnet or magnetic materials, a magnetic compass will always point **north**
  - This is evidence that the **core** of the Earth is magnetic and creates its own magnetic field
- The Earth's magnetic field is similar to that of a **bar magnet**



Comparison between the Earth's Magnetic Field and a Bar Magnet

- On Earth, the north arrow on a magnetic compass will point towards the geographic North Pole (in the Arctic Ocean)
  - This is because the geographic North Pole is a magnetic south pole (the magnetic field lines point **out of the pole**)
  - The north pole of the magnetic compass is **attracted** to the Earth's magnetic south pole
- The geographic South Pole (in Antarctica) is a magnetic north pole (the magnetic field lines point **into the pole**)
- The north pole of the magnetic compass is **repelled** from the Earth's magnetic north pole



Geographic and Magnetic Poles of the Earth

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Examiner Tips and Tricks

The Earth's north pole actually acts like the south pole of a magnet: That's why the north pole of a magnet is attracted to it.