Magnetic fields

6.7.1.2 · Physics · revision notes

A magnetic field is the region around a magnet where another magnet or a magnetic material feels a force. You need to draw the field of a bar magnet, describe how to plot it with a compass, and explain why a compass is evidence that the Earth's core is magnetic. Expect drawing questions, 'describe how' method questions and short explanations.

Key facts

- Magnetic field: region where another magnet or a magnetic material feels a force
- Field direction = direction of the force on a north pole placed there
- Closer field lines = stronger field; strongest at the poles
- Compass = small bar magnet that lines up with the field
- Magnetic materials: iron, steel, cobalt, nickel (always attracted)
- Field lines go from N to S outside the magnet; always draw arrows
- Field strength decreases with distance from the magnet
- A compass points north with no magnet nearby, so the Earth has a magnetic field (magnetic core)

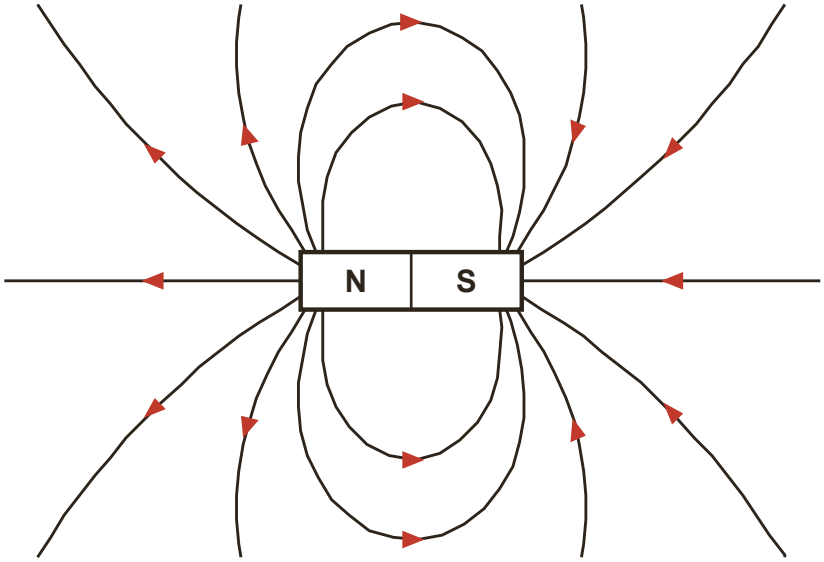
Notes

What a magnetic field is

- A **magnetic field** is the region around a magnet where a force acts on another magnet or on a magnetic material.
- The magnetic materials are **iron, steel, cobalt and nickel**. The force between a magnet and a magnetic material is always attraction.
- The field is **strongest at the poles**. It gets weaker as the distance from the magnet increases.
- The **direction** of the field at any point is the direction of the force that would act on a north pole placed at that point.

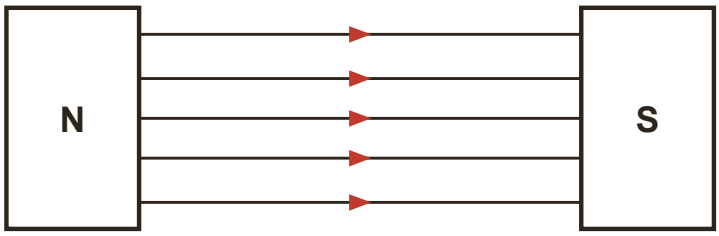
Drawing field lines

- Outside a magnet, field lines go from the **north pole to the south pole**. Always add arrows.
- The closer together the lines, the stronger the field. Draw them closest together at the poles and further apart away from the magnet.
- Field lines never cross.



Field lines go from N to S, never cross, and are closest together at the poles, where the field is strongest.

- Between a north pole and a south pole facing each other, the lines are straight, parallel and equally spaced. This is a **uniform** field (the same strength everywhere).

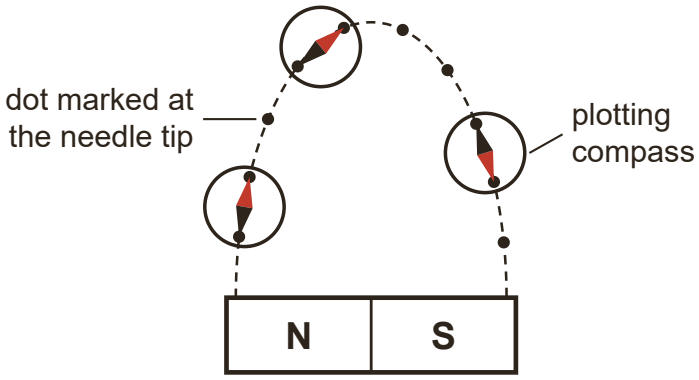


uniform field: same strength everywhere between the poles

Between facing N and S poles the field is uniform.

Plotting a field with a compass

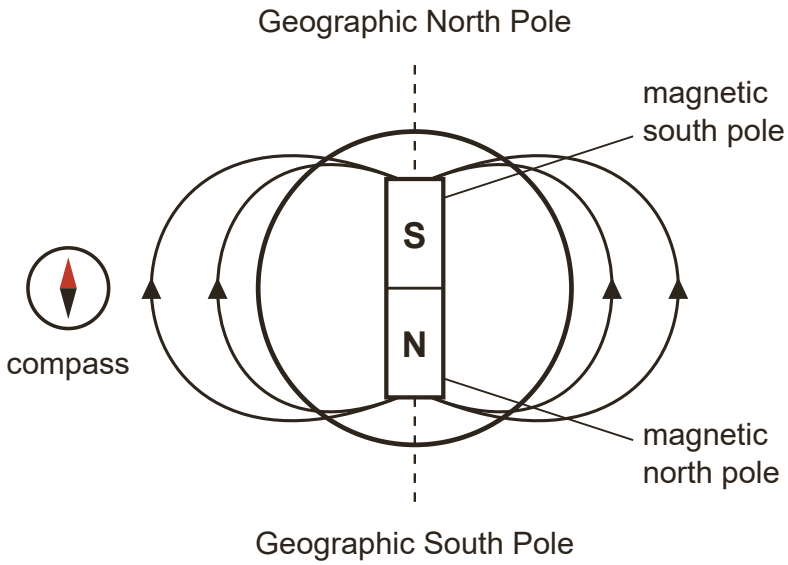
- A **plotting compass** contains a small bar magnet (the needle). The needle lines up with the magnetic field, and its north end points in the direction of the field.
- Put the bar magnet on a sheet of paper and draw round it.
- Place the compass near the north pole. Mark a dot at the end the needle points to.
- Move the compass so the tail of the needle is over the dot, then mark a new dot. Repeat until you reach the south pole.
- Join the dots with a smooth curve and add an arrow in the direction the needle pointed. Repeat from several starting points.



Each dot is marked at the tip of the needle. Move the compass so its tail is on the last dot, and repeat. The red north end of the needle shows the field direction.

The Earth's magnetic field

- A compass needle points north even when there is no magnet near it: it lines up with the **Earth's magnetic field**.
- This is evidence that the Earth has a magnetic field, so the Earth's **core must be magnetic**. The field has a similar shape to that of a bar magnet.



The Earth's field is like the field of a bar magnet inside it. The magnet's south pole is near the geographic North Pole, so the north end of a compass points north.

- The north pole of a compass points towards the Arctic. Unlike poles attract, so the Earth's magnetic pole near the geographic North Pole is actually a magnetic **south** pole. Grade 8+ only

How to answer each type of question

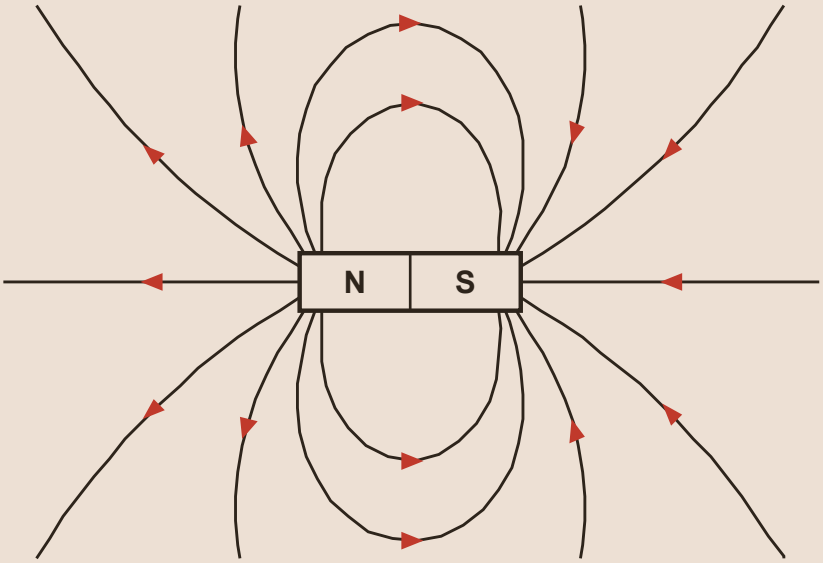
Draw the magnetic field pattern of a bar magnet

2 to 3 marks | **Grade 4**

1. Draw several continuous curved lines from one pole to the other, on both sides of the magnet.
2. Put an arrow on every line, pointing from N to S.
3. Draw the lines closest together near the poles, and make sure no lines cross.

Example. Sketch a bar magnet, label its poles, and draw the magnetic field pattern around it. Show the direction of the field. [3 marks]

Model answer.



A sketch like this scores all 3 marks.

Several continuous curved lines from one pole to the other on both sides of the magnet, not crossing (1). Arrows on the lines pointing from the north pole to the south pole (1). Lines closer together near the poles than further from the magnet (1).

Describe how to plot a magnetic field using a compass

3 to 4 marks **Grade 5**

1. Start with the set-up: magnet on paper, outline drawn round it.
2. Describe marking where the needle points, then moving the compass along to the dot.
3. Say you repeat until you reach the other pole, then join the dots.
4. Finish with arrows and repeating from different starting points.

Example. Describe how a student could use a plotting compass to find the shape of the magnetic field around a bar magnet. [4 marks]

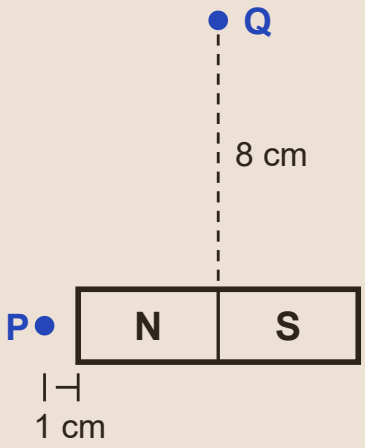
Model answer. Place the magnet on a sheet of paper and draw round it (1). Put the compass near one pole and mark a dot where the needle points (1). Move the compass so the tail of the needle is on the dot, mark the next dot, and repeat until the compass reaches the other pole (1). Join the dots to make a field line, add an arrow in the direction the needle points, and repeat from several different starting points (1).

Compare the field strength at two points

2 marks | Grade 5

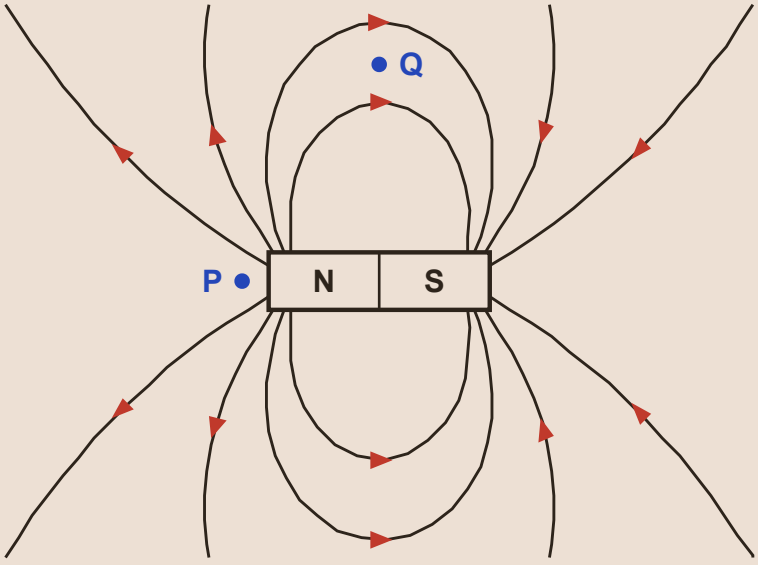
1. Choose the point nearer a pole, or where the field lines are closer together.
2. Give the reason using distance from the magnet or the spacing of the field lines.

Example. Point P is 1 cm from the north pole of a bar magnet. Point Q is 8 cm from the side of the same magnet.



State and explain at which point the magnetic field is stronger. [2 marks]

Model answer.



The field lines are close together at P and far apart at Q.

P (1). It is closer to the magnet, at a pole, where the field lines are closest together (1).

Explain the evidence that the Earth's core is magnetic 2 marks **Grade 7**

1. Say that the compass needle is a small magnet that lines up with a magnetic field.
2. Say that it lines up even when no magnet is nearby, so the Earth must have a magnetic field, coming from a magnetic core.

Example. A walker holds a compass far away from any magnets. The needle always settles pointing north.
Explain what this shows about the Earth. [2 marks]

Model answer. The compass needle is a magnet, which only settles in a particular direction if it is in a magnetic field (1). So the Earth has a magnetic field, which shows that the Earth's core must be magnetic (1).

Don’t lose marks

- Forgetting the arrows, or drawing them from S to N.
- Drawing field lines that cross or touch each other.
- Drawing the lines evenly spaced all the way round: they must be closest together at the poles.
- Plotting only one line: the method needs several lines from different starting points.
- In the Earth question, not saying that the compass needle is a magnet that lines up with a magnetic field.

More tips

Memory tricks

- 'North Out, South In': field lines leave the north pole and go into the south pole.
- Crowded lines mean a strong field; spread-out lines mean a weak field.
- The north end of a compass needle always points along the field lines, so it gives you the arrow direction.
- ICoNS: Iron, Cobalt, Nickel, Steel are the magnetic materials.

Exam technique

- Draw field lines as smooth curves with a sharp pencil: examiners check the shape, the arrows and the spacing.
- Write method answers as steps in order, and include marking the needle position and moving the compass on.
- When a question asks about a 'field', use the words 'magnetic field' in your answer, not just 'magnetism'.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 **Name the four magnetic materials**
Iron, steel, cobalt and nickel are always attracted by a magnet.

Grade 4 **Draw the field pattern of a bar magnet**
Curved lines from the north pole to the south pole, with arrows, closest together at the poles.

Grade 5

Plot a magnetic field using a compass

Mark where the compass needle points, move the compass on, repeat, then join the dots from N to S.

Grade 5

State how field strength depends on distance

The field is strongest at the poles and gets weaker further from the magnet.

Grade 5

Define the direction of a magnetic field

It is the direction of the force that would act on a north pole placed at that point.

Grade 5

Compare field strength using field-line spacing

Where the field lines are closer together, the field is stronger.

Grade 7

Explain the compass evidence for Earth's magnetic core

A compass lines up in a fixed direction even far from any magnet, so the Earth must have a magnetic field, which comes from its core.

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