Mapping magnetic fields with a compass

Student activity • observation and reasoning

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The question

How can a small compass map the direction of a magnetic field?

Trace field directions around one magnet and between two magnets without loose iron filings.

Equipment

- Two low-strength bar magnets, plotting compass, nonmagnetic spacers, paper and pencil

Use low-strength magnets and keep them apart under control to avoid pinching. Keep magnets away from sensitive devices and follow medical-device guidance. Do not use loose iron filings or powerful rare-earth magnets. Keep small compasses out of mouths.

Course coverage: Shared Physics / Double Award: 6.4, 6.6, 6.7. Bar-magnet fields and approximately uniform fields.

Plan, model or apparatus sketch

Draw the particle, pressure or magnetic-field model and label directions and quantities.

Method and reasoning

Read the whole sequence before starting

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1. Place a low-strength bar magnet on paper and mark its outline and poles. Keep other magnets and steel objects away from the working area.

2. Put a small plotting compass near one pole. Allow it to settle, then mark both ends and identify its north-seeking end. Move the compass so its tail sits at the previous north-end mark.

3. Repeat to trace a curve, then draw arrows in the north-seeking direction. Start at several positions to build a field pattern; outside the magnet the arrows go from north to south.

4. Place unlike poles of two magnets facing across a small secure gap. Map several directions in the central region and identify where lines are approximately straight, parallel and evenly spaced.

5. Repeat with like poles facing and compare the pattern. Do not force a direction at a point where the compass does not settle because competing fields nearly cancel.

6. Explain that field lines are a model, not physical threads. Their direction gives the force direction on a north pole, and a uniform field is only approximate in the central gap of suitable poles.

Cleanup

- Return magnets and compasses to storage and retain labelled field maps.

Record your evidence

Blank spaces are for your own work

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Reference and task data

A compass aligns with the total local magnetic field, including Earth's field. Nearby magnetic objects and weak-field regions affect the result. Magnetic field lines form closed loops; the north-to-south statement refers to the region outside the magnet.

Arrangement	Field direction / sketch	Limitations
Single magnet		
Unlike poles facing		
Like poles facing		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Which compass end defines field direction?

2. What is the direction outside a bar magnet?

3. Why keep other magnets away?

4. What pattern indicates an approximately uniform field?

5. Why might a compass fail to settle near a cancellation point?

6. Are field lines material threads?