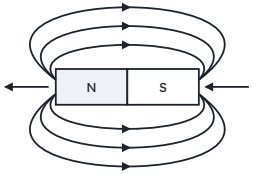
4.7 Magnetism and electromagnetism

AQA GCSE Physics 8463
Paper 2 · Physics only (PO) · Higher (HT)
All equations are on the Physics Equations Sheet

MAGNETS AND FIELDS

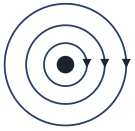


Field lines: N → S
closest at the poles,
where the field is strongest

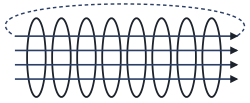
Like poles repel,
unlike poles attract

- Like poles repel; unlike poles attract.
- **Permanent magnet:** produces its own field. **Induced magnet:** becomes a magnet when placed in a magnetic field; always attracts; loses most magnetism when removed.
- Magnetic materials: iron, steel, cobalt, nickel.
- Plot field lines with a compass. A compass points north: evidence that the Earth's core is magnetic.

ELECTROMAGNETISM



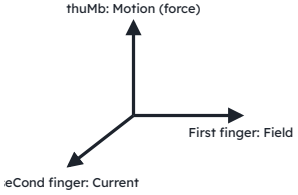
Wire (current into page):
circular field; stronger near the wire



Solenoid: strong, uniform field inside;
add an iron core → electromagnet

- Current in a wire produces a magnetic field around it; stronger with more current and closer to the wire.
- Solenoid: strong, uniform field inside. Stronger with more turns, more current, iron core (electromagnet).

MOTOR EFFECT (HT)



Fleming's left-hand rule (Higher)

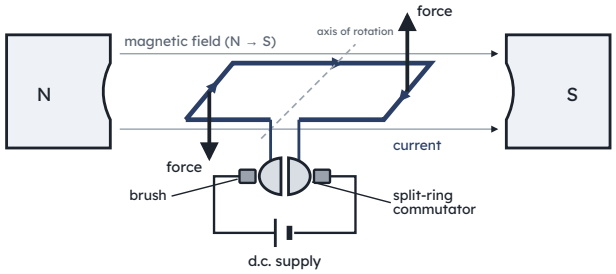
$F = B\,I\,l$

F = force (N)
B = magnetic flux density (T)
I = current (A); l = length (m)

Reverse the current or the field
→ the force reverses

- A current-carrying wire in a magnetic field experiences a force.
- Magnetic flux density B is measured in tesla (T).

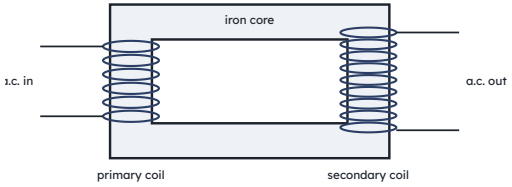
ELECTRIC MOTOR (HT)



GENERATOR EFFECT (PO, HT)

- A p.d. is induced when a conductor moves relative to a magnetic field, or the field around it changes. In a complete circuit, a current flows.
- The induced current's field opposes the original change.
- Bigger p.d.: move faster, stronger magnet, more turns.
- **Alternator:** generates a.c. **Dynamo:** generates d.c.
- **Microphone:** sound vibrates a coil in a magnetic field → induced p.d. (generator effect). **Loudspeaker:** a.c. in a coil → force → cone vibrates (motor effect).

TRANSFORMERS (PO, HT)



$V_p \div V_s = n_p \div n_s$
$V_s \times I_s = V_p \times I_p$
(Physics only, Higher)

- Primary and secondary coils on an iron core (easily magnetised).
- a.c. in the primary → changing field in the core → induced p.d. in the secondary. Doesn't work with d.c.
- Step-up: more secondary turns, higher p.d., lower current (National Grid).

EXAM TIPS

- Fleming's left-hand rule: First finger Field, seCond finger Current, thuMb Motion.
- Reverse the current or the field to reverse the force.

MODEL EXPLANATIONS (GRADE 7+ ANSWERS)

Explain how a loudspeaker produces sound. (Physics only, Higher)
An alternating current flows through a coil in a magnetic field, so the coil feels a force (motor effect) that keeps changing direction. The coil and cone vibrate in and out, creating pressure variations in the air: a sound wave.

Explain why a compass needle points north.
A compass contains a small bar magnet, which lines up with the Earth's magnetic field. So the Earth has a magnetic field, which is evidence that the Earth's core is magnetic.

Explain how a moving-coil microphone works. (Physics only, Higher)
Sound waves make the diaphragm and coil vibrate in the field of a permanent magnet. The coil moves relative to the field, inducing a p.d. (generator effect); the p.d. varies in the same pattern as the sound wave.

UNITS AND PREFIXES

giga (G)	$\times 10^{9}$
mega (M)	$\times 10^{6}$
kilo (k)	$\times 10^{3}$
centi (c)	$\times 10^{-2}$
milli (m)	$\times 10^{-3}$
micro (μ)	$\times 10^{-6}$
nano (n)	$\times 10^{-9}$

Convert to the base unit (m, kg, s, J, W) before you calculate.

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KEY EQUATIONS (ALL ON THE PHYSICS EQUATIONS SHEET)

Equation	Quantities (units)	Watch out
F = B I l	force (N), magnetic flux density (T), current (A), length (m) (Higher)	Wire at right angles to the field
Vp ÷ Vs = np ÷ ns	p.d. (V) and number of turns on the primary and secondary coils (Physics only, Higher)	Same ratio both sides
Vs × Is = Vp × Ip	for a 100% efficient transformer: power in = power out (Physics only, Higher)	Step up p.d. → current down

KEY WORDS

Permanent magnet: produces its own magnetic field.
Induced magnet: becomes a magnet when placed in a magnetic field; induced magnetism always causes attraction.
Magnetic field: the region around a magnet where a force acts on another magnet or magnetic material.
Solenoid: a coil of wire; the field inside is strong and uniform. With an iron core: an electromagnet.
Motor effect (Higher): a force on a current-carrying conductor in a magnetic field.
Generator effect (PO, Higher): a p.d. is induced when a conductor moves relative to a magnetic field, or the field changes.
Magnetic flux density: the strength of a magnetic field, in tesla (T).

PRACTICAL SKILLS

- Plot field lines with a compass: mark where the needle points, move the compass along, join the marks.
- Electromagnet investigation: independent = turns (or current); dependent = paper clips picked up; control = core, clip size.
- Repeat readings and calculate a mean to reduce random error.

MISCONCEPTIONS

× **All metals are magnetic.**	✓ Only iron, steel, cobalt and nickel.
× **Field lines can cross.**	✓ Field lines never cross.
× **Transformers work with d.c.**	✓ They need a changing (a.c.) field to induce a p.d.

AIM FOR GRADE 7+

- Rearrange F = BIl; convert cm to m.
- Two-step transformer questions: p.d. from turns ratio, then current from power in = power out.
- Explain motors, loudspeakers and microphones as chains of cause and effect.

COMMAND WORDS

State	a short answer, no explanation
Describe	say what happens, in order
Explain	say what and why: use "because" and "so"
Calculate	equation, substitution, answer, unit
Evaluate	both sides, then a justified conclusion

QUICK-FIRE QUIZ: COVER THE ANSWERS

Unit of magnetic flux density?	**Tesla (T)**
Field direction outside a magnet?	**North to south**
Rule for the motor effect?	**Fleming's left-hand rule**
Generator that makes a.c.?	**Alternator**
Why an iron core?	**Easily magnetised**
Does an induced magnet attract or repel?	**Always attracts**

PRACTICAL LANGUAGE

Accurate: close to the true value. **Precise:** measurements close to each other. **Repeatable:** same person, same method, similar results. **Reproducible:** similar results by another person or method. **Resolution:** smallest change an instrument can show. **Random error:** unpredictable scatter; reduce by repeating and averaging. **Systematic error:** every reading out by the same amount, e.g. a **zero error**.

GRAPH SKILLS

- Label both axes with quantity and unit; use more than half the grid.
- Draw a line (or smooth curve) of best fit; circle and ignore anomalous results.
- Straight line through the origin = directly proportional.
- Gradient = change in y ÷ change in x; use a big triangle.