Topic 7: Magnetism and electromagnetism

AQA GCSE Physics 8463 · spec 4.7 · sheets 7.1–7.3

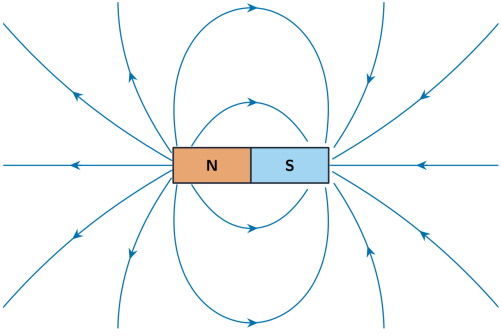
Magnetism and electromagnetism: motors, generators and transformers

- describe magnets, magnetic fields and the field around a current;
- explain electromagnets and (HT) the motor effect, using Fleming's left-hand rule and $F = BIl$;
- explain how electric motors and (physics only) loudspeakers work;
- (physics only, HT) explain the generator effect, alternators, dynamos, microphones and transformers.

Magnets and magnetic fields

- A **permanent magnet** produces its own magnetic field.
- An **induced magnet** is a material that becomes a magnet when it is placed in a magnetic field. Induced magnetism always causes attraction. When the **induced magnet** is taken out of the field, it loses most or all of its magnetism quickly.

Figure: Magnets and magnetic fields

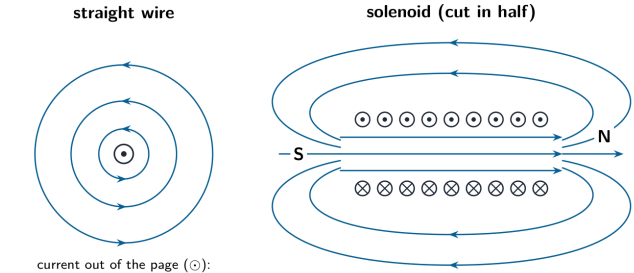


- Field lines run from north to south outside a bar magnet.
- Match each part of the diagram to the text.

Electromagnetism

- When a current flows through a wire, it produces a magnetic field around the wire.
- The field lines are circles around the wire.
- The field is stronger with a bigger current, and weaker further from the wire.
- Reversing the current reverses the direction of the field.

Figure: Electromagnetism



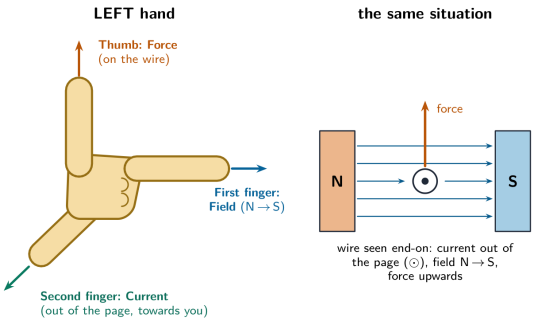
- Circular field lines around a straight wire, and the strong uniform field inside a **solenoid**.
- Match each part of the diagram to the text.

The motor effect (HT)

- When a wire carrying a current is placed in a magnetic field, the magnet and the wire exert a force on each other.
- This is the motor effect.
- **Fleming's left-hand rule.** Hold the thumb, first finger and second finger of your left hand at right angles to each other.
- The first finger points along the field (from north to south), the second finger points along the current, and the thumb shows the direction of the force (the motion).

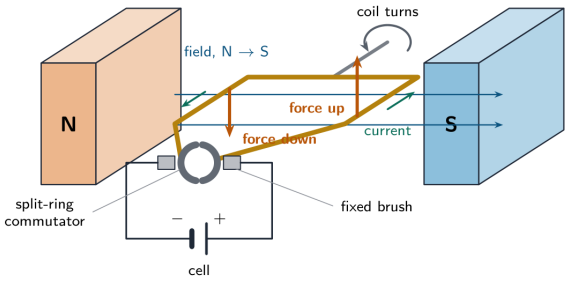
$$F = BIl$$

Figure: The motor effect (HT)



- Fleming's left-hand rule: force, field and current at right angles.
- Match each part of the diagram to the text.

Figure: The motor effect (HT) (2)

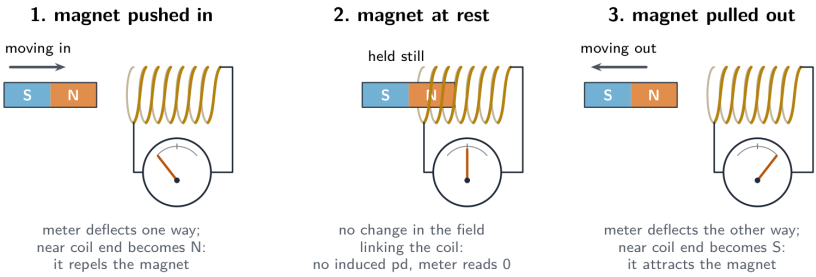


- A dc motor: the two sides of the coil are pushed in opposite directions, and the split-ring commutator keeps it turning.
- Match each part of the diagram to the text.

The generator effect (physics only, HT)

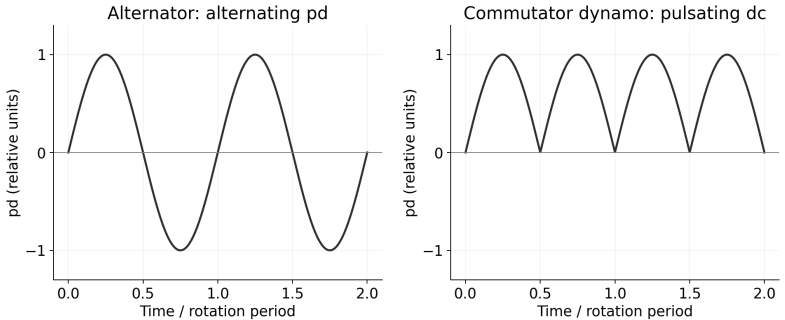
- the magnet or wire moves faster;
- the magnetic field is stronger;
- the coil has more turns.

Figure: The generator effect (physics only, HT)



- Moving a magnet into or out of a coil induces a potential difference; a still magnet induces none.
- Match each part of the diagram to the text.

Figure: The generator effect (physics only, HT) (2)



- An alternator gives an alternating pd that changes direction; a dynamo gives a pd that rises and falls but never reverses.
- Match each part of the diagram to the text.

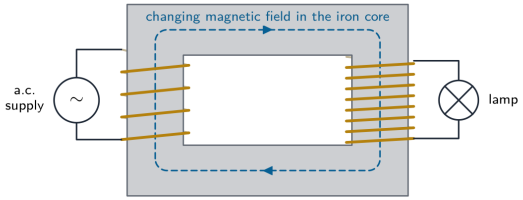
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Transformers (physics only, HT)

- A **transformer** has two coils of wire, the primary coil and the secondary coil, wound on an iron core.
- Iron is used because it is easily magnetised.
- An alternating current in the primary coil produces a changing magnetic field in the iron core.
- This changing field passes through the secondary coil and induces an alternating potential difference across it.

$$\frac{V_p}{V_s} = \frac{n_p}{n_s} \qquad V_s I_s = V_p I_p$$

Figure: Transformers (physics only, HT)



- A **transformer**: the changing field in the iron core links the primary and secondary coils.
- Match each part of the diagram to the text.

Sources for this lesson

- AQA, *GCSE Physics (8463) specification*, section 4.7 Magnetism and electromagnetism.
- H. C. Ørsted, *Experimenta circa effectum conflictus electrici in acum magneticam* (Copenhagen, July 1820); M. Faraday, laboratory diary, 29 August 1831, Royal Institution, London.
- AQA, *GCSE Physics* Paper 2 Higher (motor, generator and **transformer** questions, adapted).

Common errors

- Drawing field lines from south to north outside a magnet.
- Saying an **induced magnet** can repel; induced magnetism always attracts.
- Using the right hand for the motor effect; use Fleming's left-hand rule.

Common errors (2)

- Leaving the length in cm in $F = BIl$, or using the whole wire instead of the part in the field.
- Saying a pd is induced when a magnet sits still inside a coil; the field must change.
- Saying a **transformer** works with direct current.
- Saying a step-up transformer increases the power; the current goes down as the pd goes up.

Key terms

- **Magnetic field**: the region where a magnet or magnetic material feels a force.
- **Induced magnet**: a material that becomes magnetic only when placed in a magnetic field.
- **Electromagnet**: a **solenoid** with an iron core.

Key terms (2)

- **Motor effect**: the force on a current-carrying wire in a magnetic field.
- **Generator effect**: the induction of a potential difference by a changing magnetic field.
- **Transformer**: two coils on an iron core, used to change an alternating potential difference.

Check yourself

- 1.
- Name the four magnetic elements and alloys you need to know. 2.
- Describe the magnetic field inside a **solenoid**. 3.
- Give two advantages of an electromagnet over a **permanent magnet**. 4. (HT) A 0.30 m wire carries 2.0 A at right angles to a 0.50 T field.