

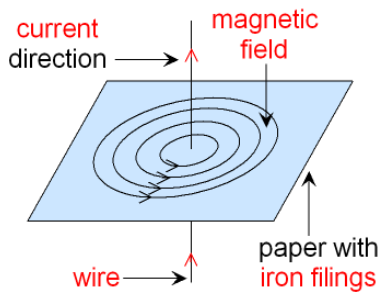


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P20 Electromagnetic forces

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P20.02 The magnetic effect of a current



→ the magnetic field around a current in a straight wire

- the further away from the wire, the weaker the field is
- **right hand grip rule**
- winding the wire into coil(**solenoid**) → magnetic field is concentrated
- using this, electromagnetic can be formed

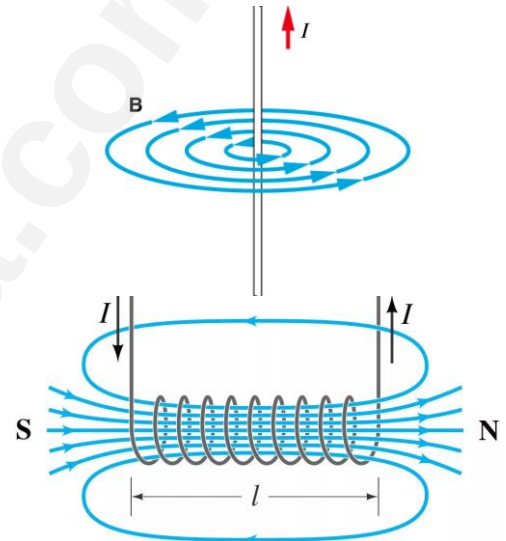
1. comparing magnetic field

Current in a wire

- field lines are circles around the wire
- further from the wire they are further apart, field is weaker
- current $\uparrow$ = field strength $\uparrow$ = lines are closer

current in a solenoid

- field lines are closer together at the poles of the electromagnet
- further from the coil, the lines are further apart, field is weaker
- inside the coil, field strength is constant, and lines are parallel
- current $\uparrow$ = field strength $\uparrow$ = lines are closer



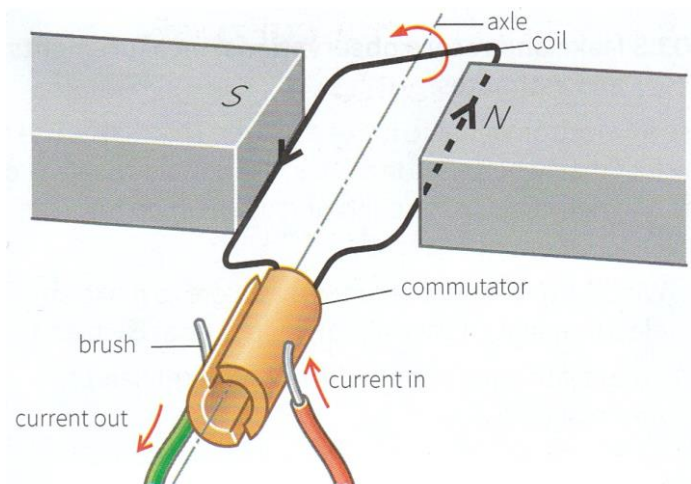
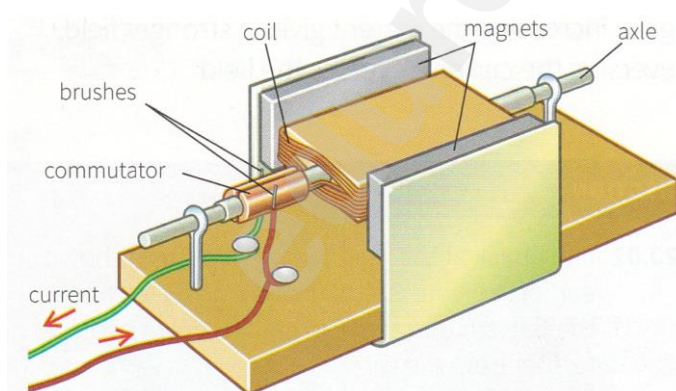
2. Electric motors

1. a coil of wire has a current so that it has its own magnetic field
2. coil is in a separate, steady magnetic field which is produced by permanent magnets or electromagnets
3. result - turning effect on the coil

Reinforcing the strength

- increase the current in the electromagnet
- have more turns of wire on the coil
- make the permanent magnets stronger

3. A motor that keeps running



Essential features

1. coil of wire, which acts as an electromagnet when direct current flows
2. 2 magnets to provide a steady magnetic field
3. **commutator** which current reaches the coil
4. two brushes which are springy wires that press against the two metal sections of the commutator

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Process

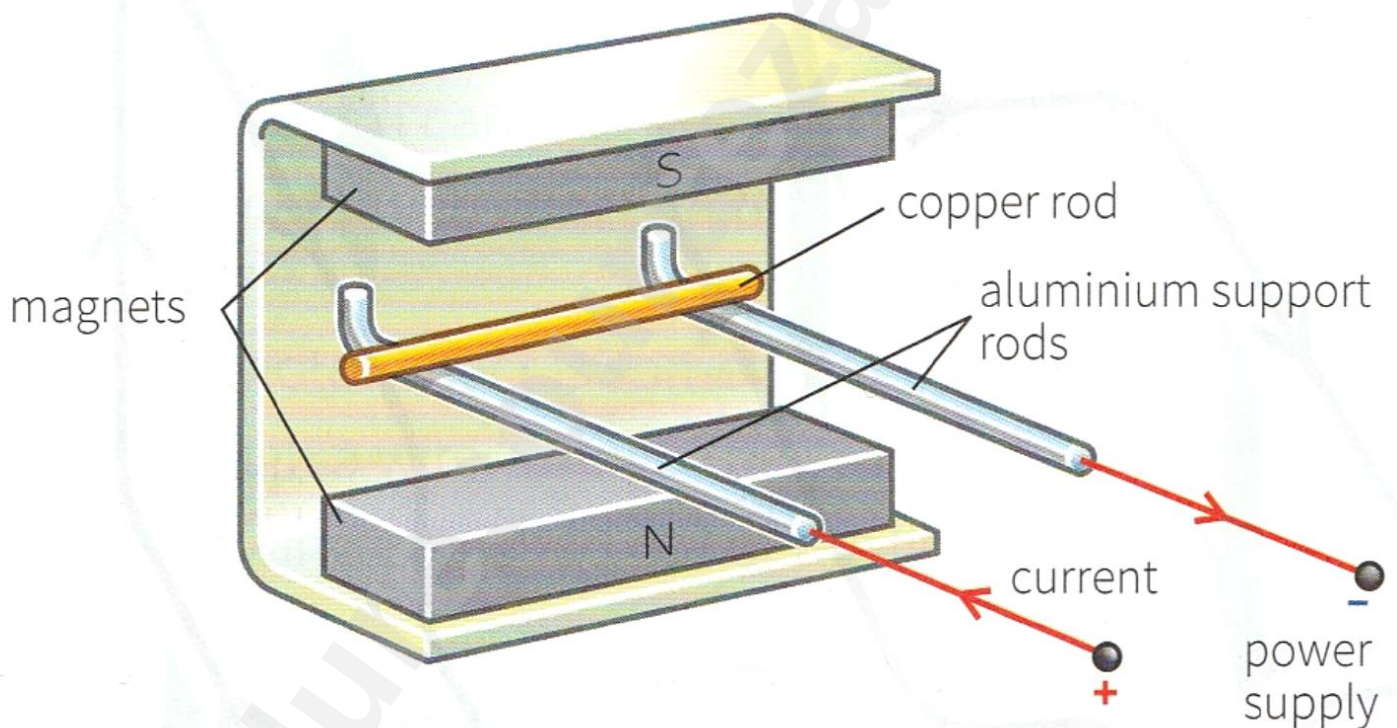
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1. A current flows through the right-hand brush, around the coil, and out through the other brush
2. when the current is flowing, coil becomes an electromagnet
 - a. uppermost - north pole
 - b. lowermost - south pole
3. north pole of the coil is attracted to the south pole of the permanent magnet on the left
4. starts to turn anticlockwise
5. commutator - coil is attracted by the two permanent magnets
 - a. **momentum** carries after vertical position
 - b. brush connection to the two halves of the commutator are reversed
 - c. current flows the opposite way around the coil
6. again have a north pole on the uppermost side of the coil, so it turns again anticlockwise

Commutator

- without it, coil will turn until it is vertical
- it reverses the current through the coil every half turn, so that the coil keeps on turning

P20.03 Force on a current-carrying conductor



- copper rod is free to roll along the two aluminium rods
- current from the power flows / two magnets provide a vertical magnetic field
- copper rod rolls horizontally - pushed by horizontal force
 - magnetic field around the current is repelled by permanent magnetic field

Motor effect reverse

- when the direction of the current is reversed
- when the direction of the magnetic field is reversed

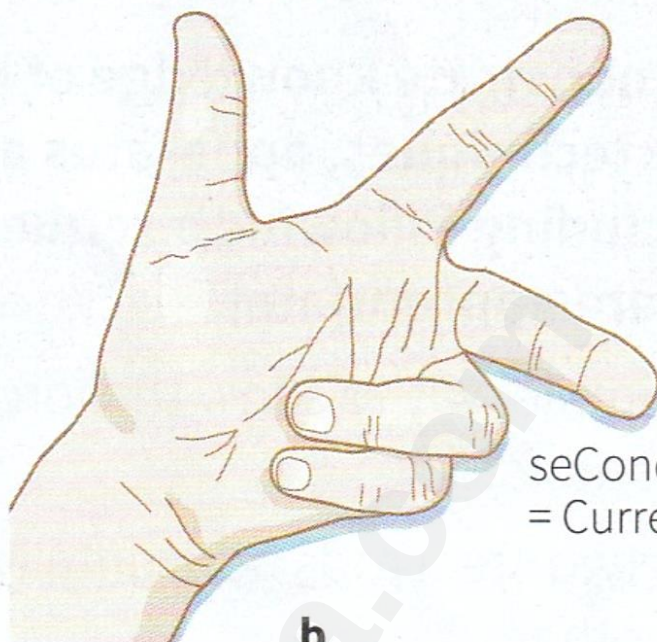
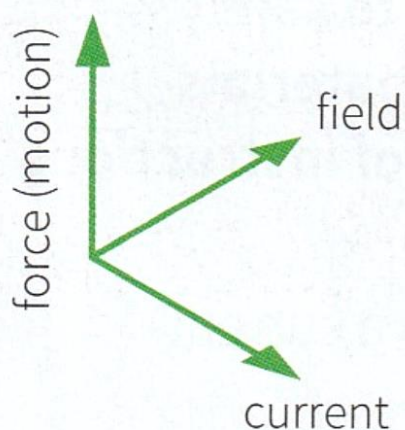
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1. Fleming's left-hand rule

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thumb = Motion

First finger = Field



a

b

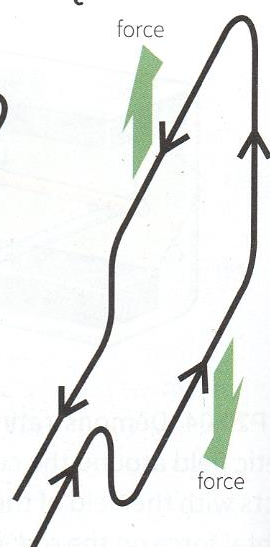
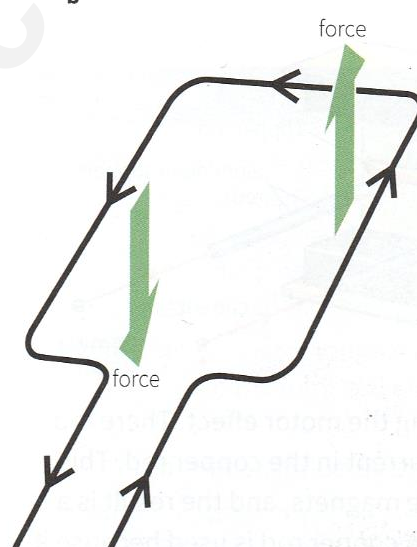
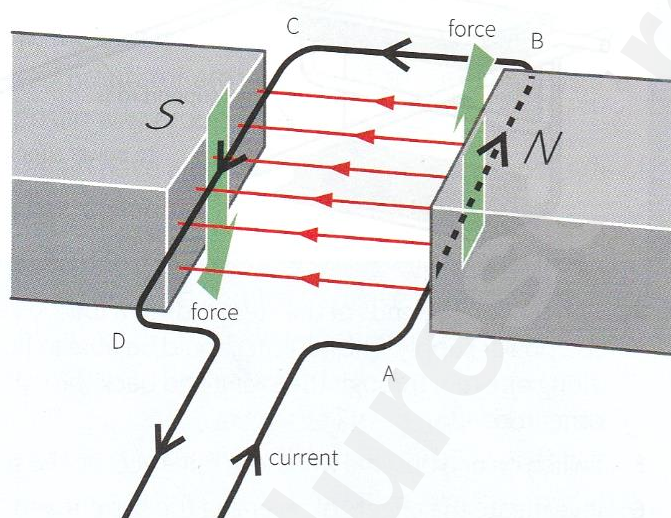
Used to predict the **direction of the force**

2. Electric motors revisited

a

b

c



✂ C - vertical position - the current is parallel to the magnetic field

- need to rely on the momentum