MAGNETIC EFFECT OF ELECTRIC CURRENT

Specification

Electromagnetism

understand that an electric current in a conductor produces a magnetic field round it

describe the construction of electromagnets

sketch and recognise magnetic field patterns for a straight wire, a flat circular coil and a solenoid when each is carrying a current

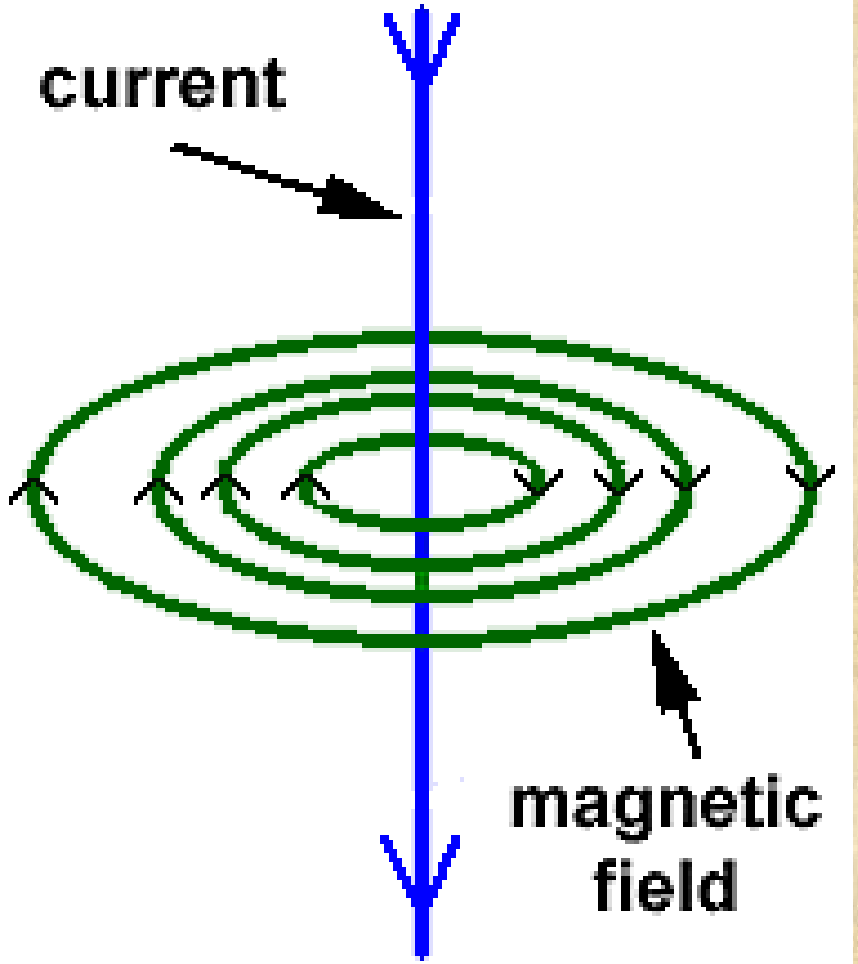
Electromagnetism

In 1820 Hans Ørsted noticed that a wire carrying an electric current caused a compass needle to deflect.

No current, compass points to north

Current, compass deflected

Magnetic field patterns around wires
1. Straight wire



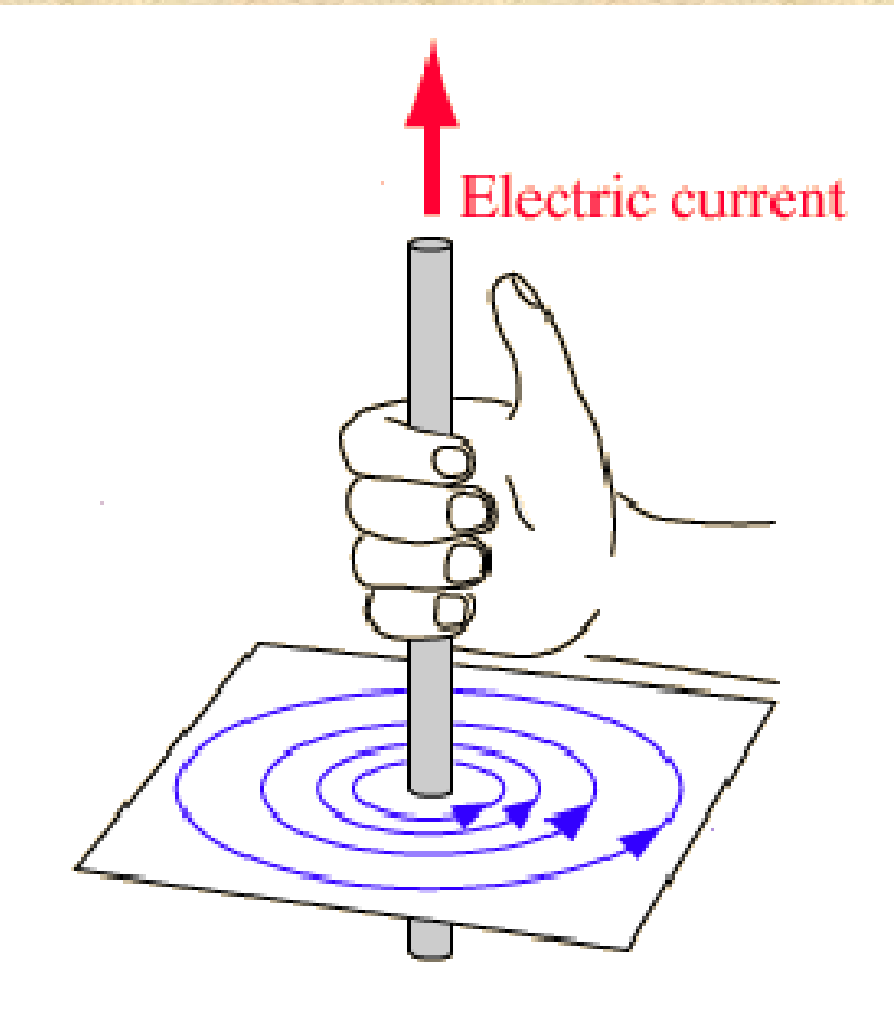
The magnetic field consists of concentric circles centred on the wire.

The magnetic field is strongest near the wire.

This is shown by the field lines being closest together near to the wire.

The strength of the field increases if the electric current is increased.

The right-hand grip rule (for fields)



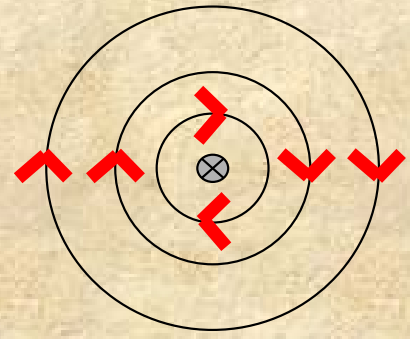
Grip the wire with the **RIGHT** hand.

The thumb is placed in the direction of the electric current.

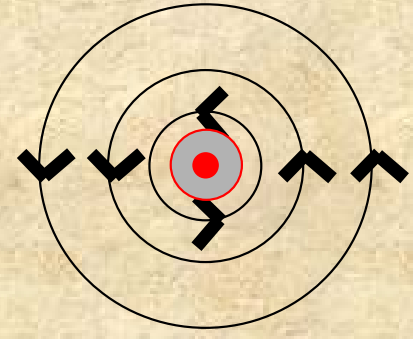
The fingers show the direction of the circular magnetic field.

Complete the diagrams below:

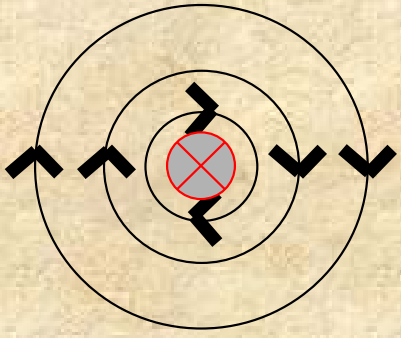
Add field arrows



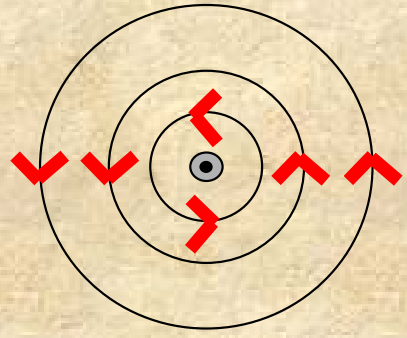
Add current direction



Add current direction



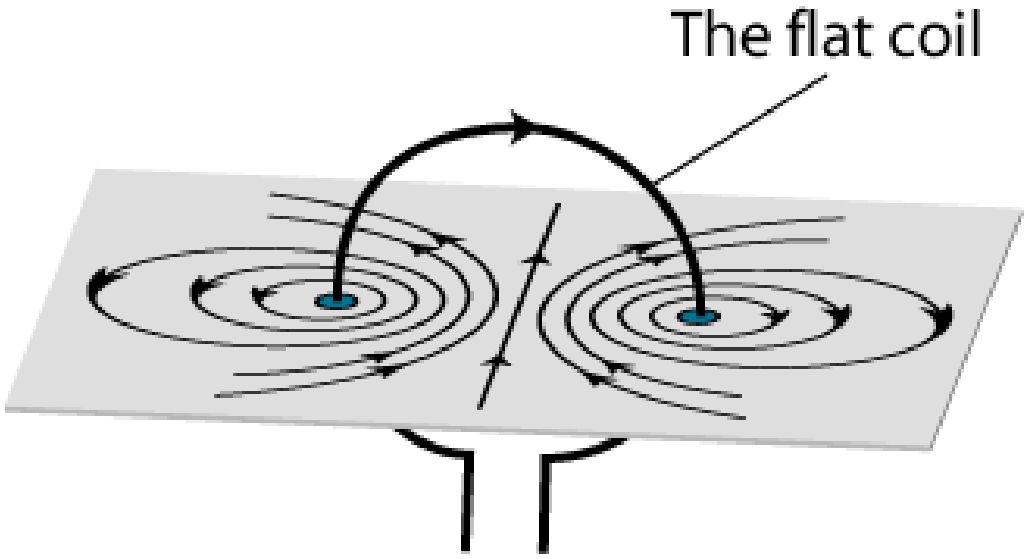
Add field arrows



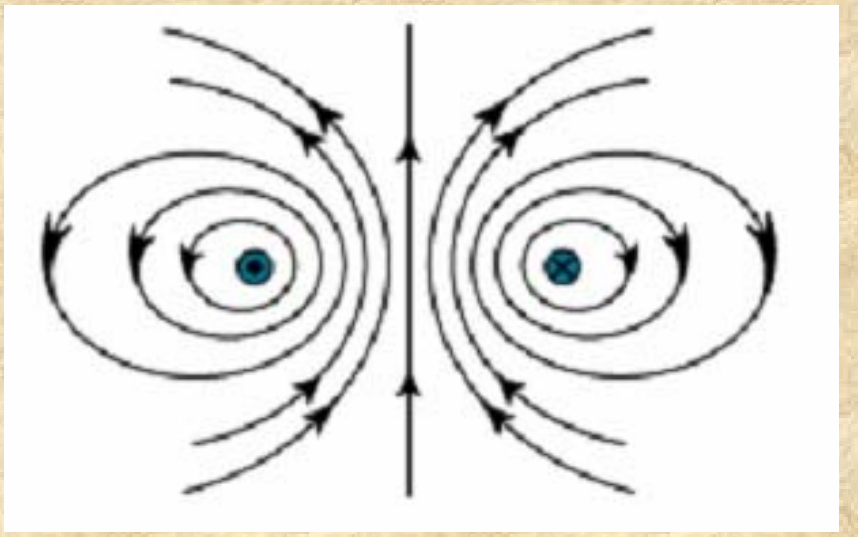
Electric current out of the page

Electric current into the page

2. Flat circular coil



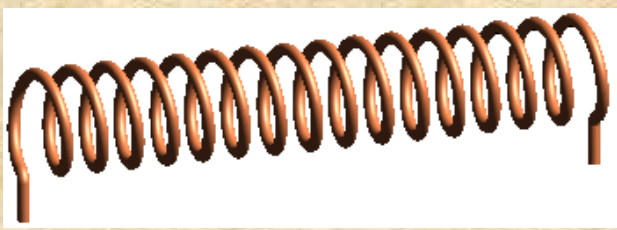
Magnetic field pattern generated by a flat coil



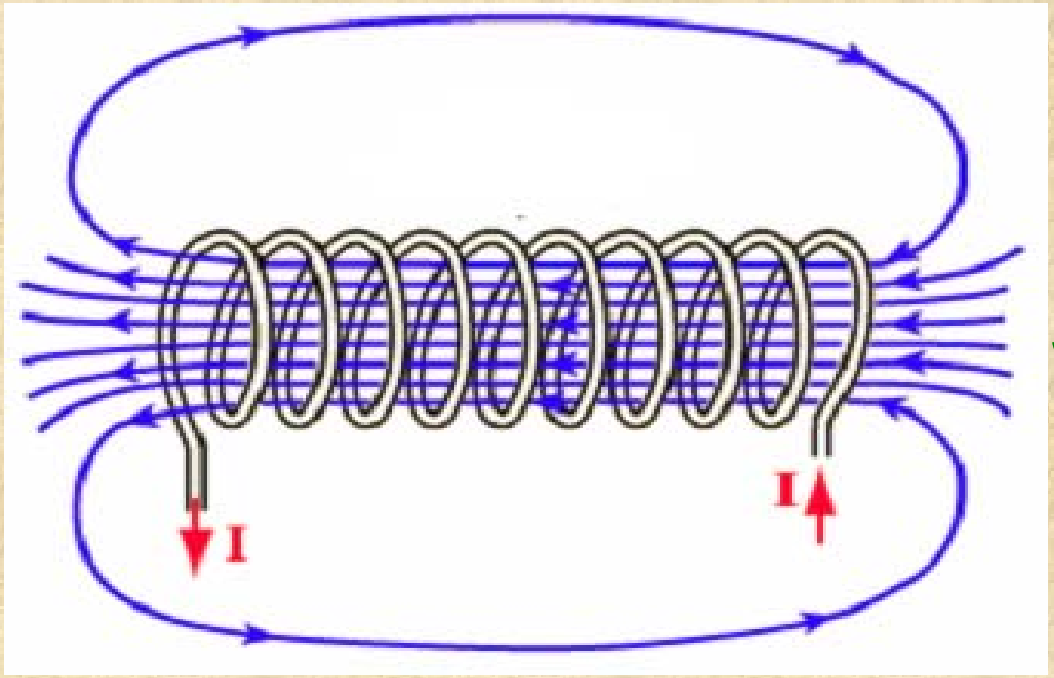
Plan view

3. Solenoid

A solenoid is a coil of wire carrying an electric current.



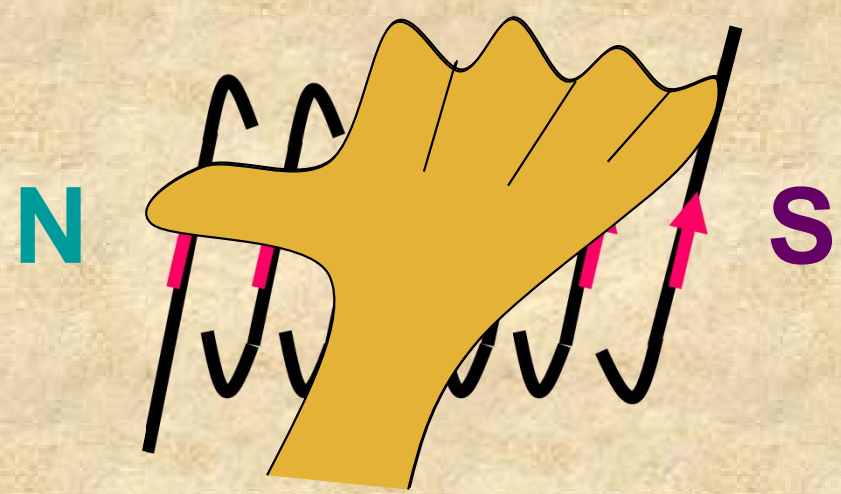
The magnetic field is similar shape to that around a bar magnet.

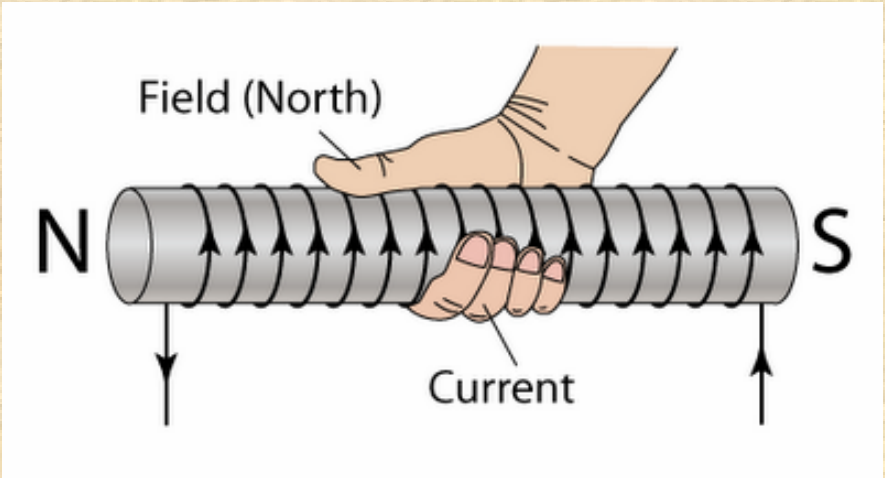


The strength of the field increases with:

1. the electric current
2. the number of turns in the coil

The right-hand grip rule (for poles)





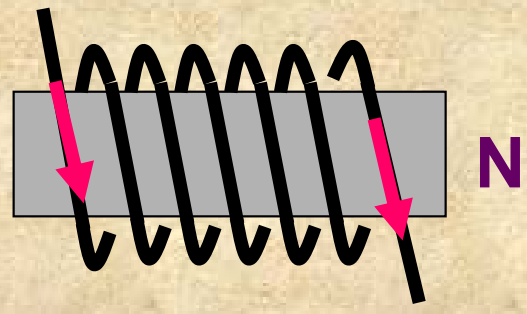
Grip the coil with the **RIGHT** hand.

The fingers are placed in the direction that the eclectic current flows around the coil.

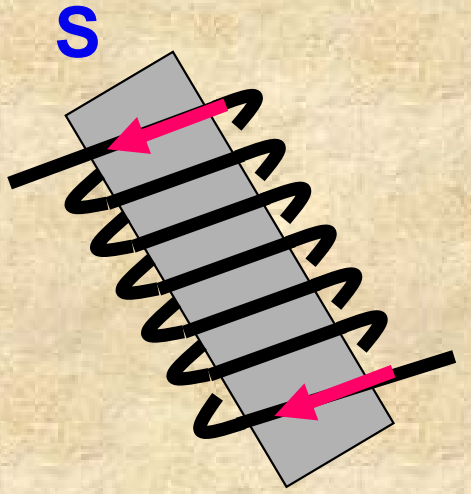
The thumb points towards the north pole end of the coil.

Complete the diagrams below:

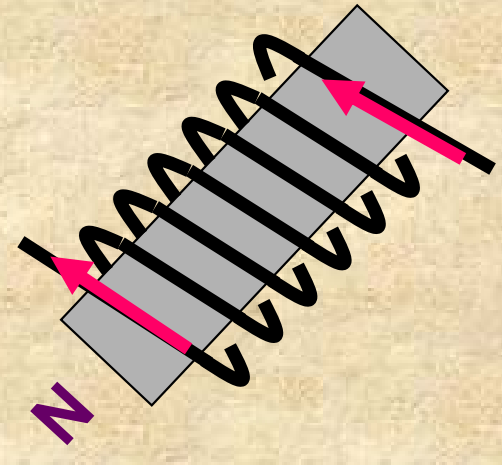
1. Locate north



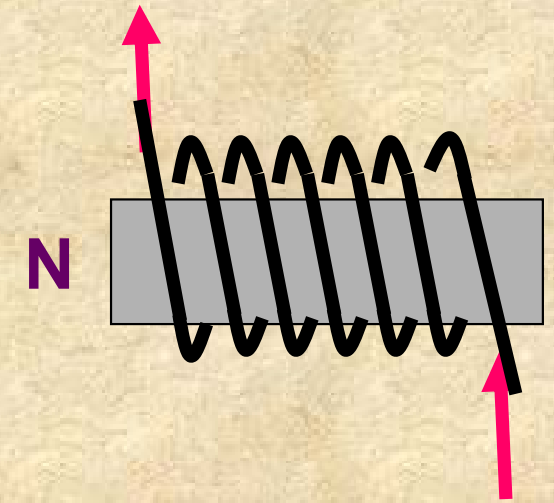
2. Locate south



3. Add current direction

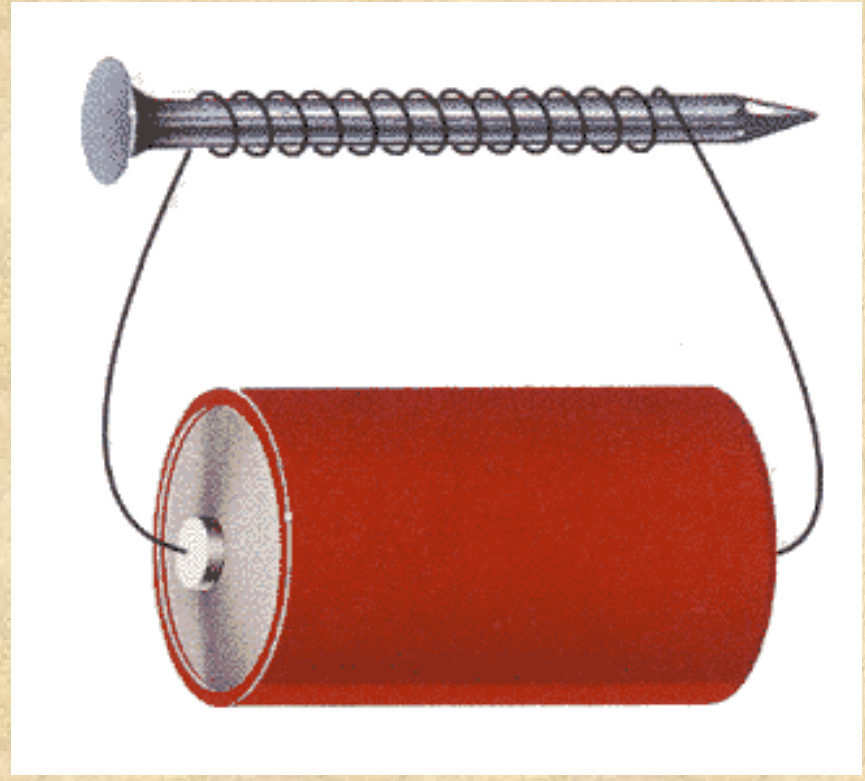


4. Add coils



Electromagnets

An electromagnet consists of a current carrying coil wrapped around an iron core.



Uses of electromagnets

1. Scrap yard crane

The iron core of the electromagnet is a **SOFT** magnetic material.

When current flows the iron becomes strongly magnetised and so picks up the scrap iron and steel.

When the current is turned off the iron loses its magnetisation and so releases the scrap.

2. The electric bell

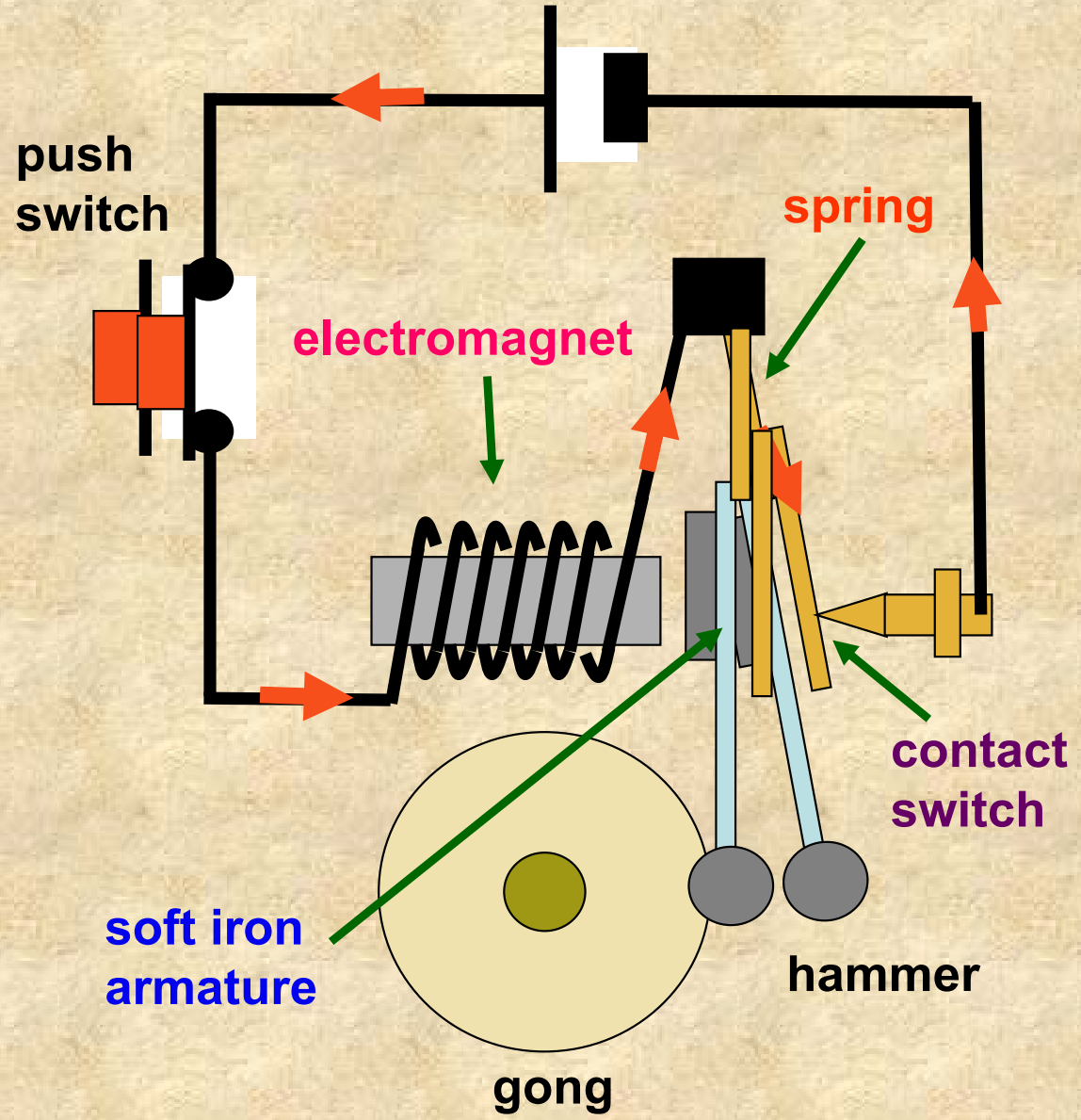
When the push switch is closed current flows around the circuit turning on the **electromagnet.**

The **soft iron armature** is pulled towards the electromagnet and the hammer hits the gong.

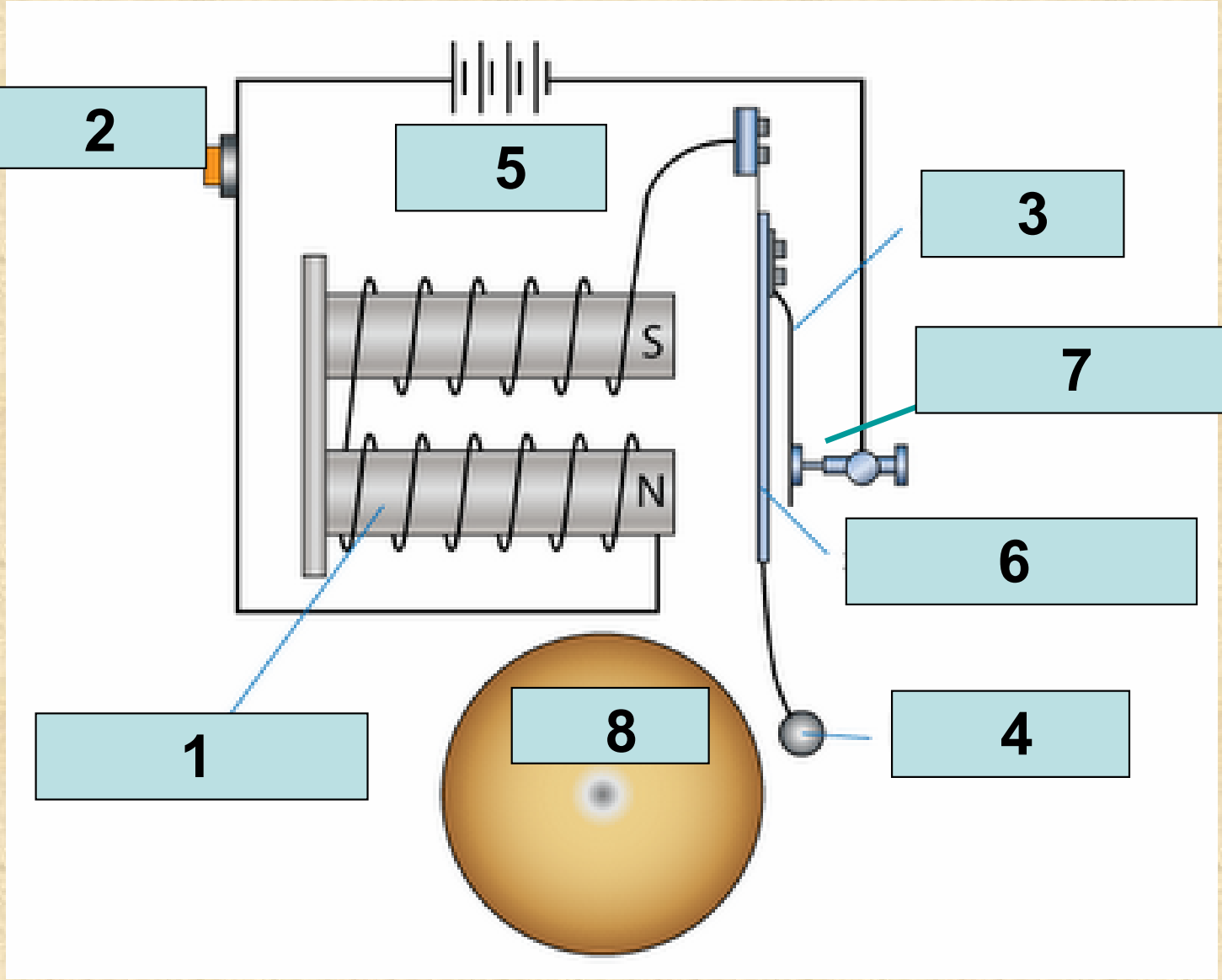
This causes the **contact switch** to open cutting off the electric current.

The **spring** now pulls the armature back again closing the contact switch.

Current now flows again and the hammer hits the gong again.



Label the diagram of the electric bell below:

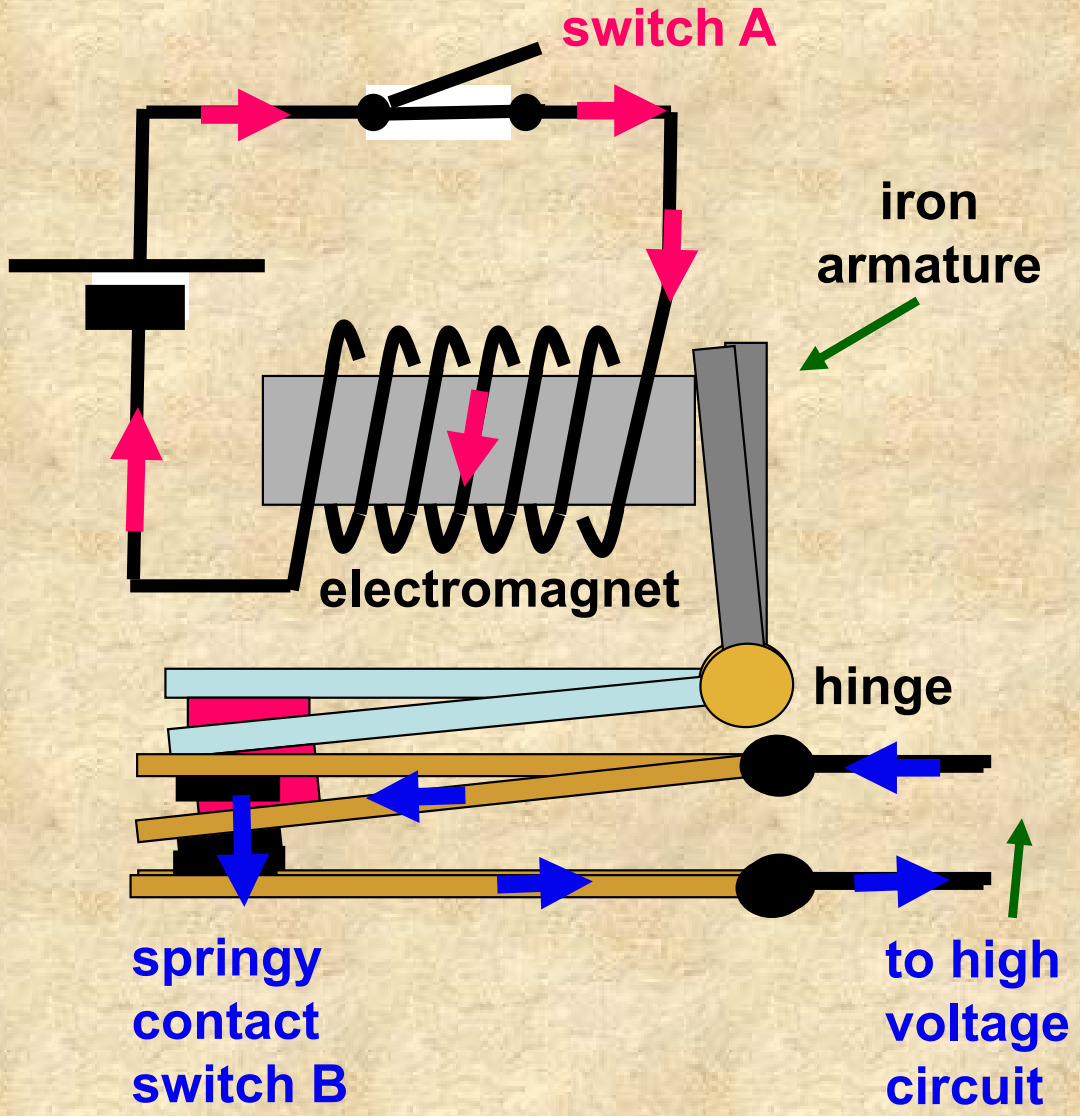


3. The relay switch

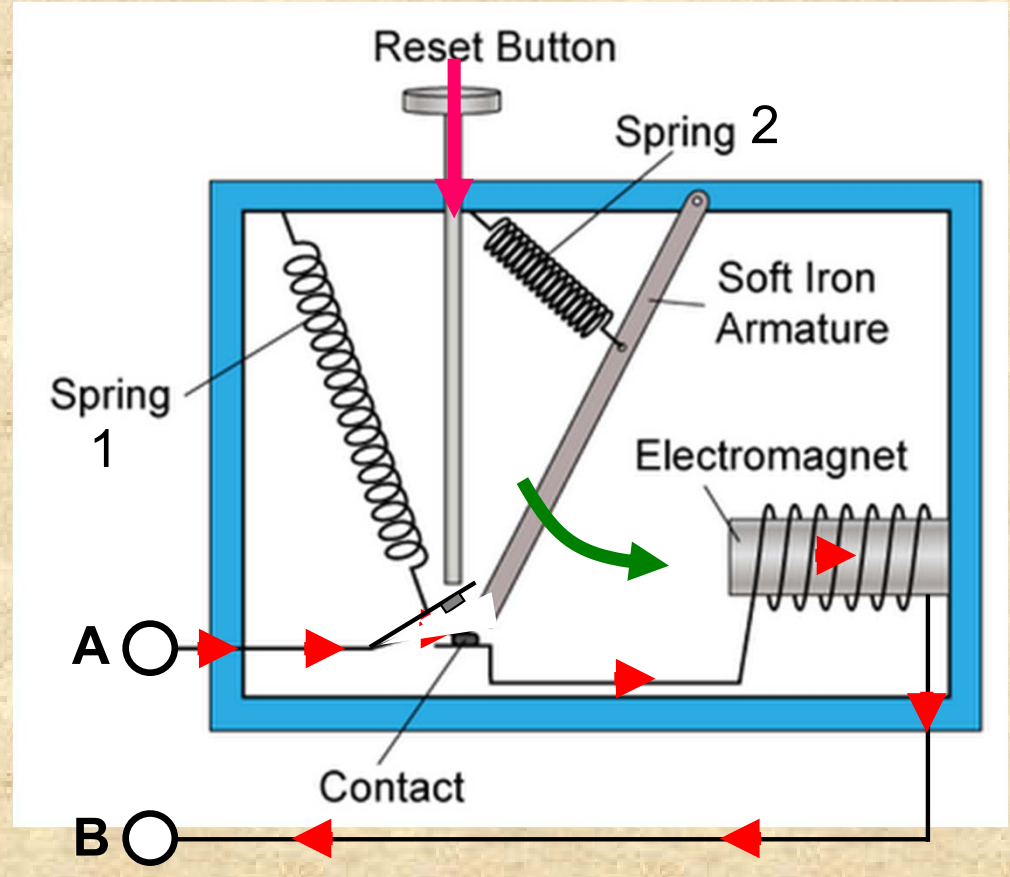
A relay switch is a way of using a low voltage circuit to switch remotely a high voltage (and possibly dangerous) circuit.

When switch A is closed, the small current provided by the cell causes the electromagnet to become magnetised..

The iron armature is then attracted to the electromagnet causing the springy contact switch B to close in the high voltage circuit.



4. Circuit breaker



Current normally flows between terminals **A** and **B** through the contact and the electromagnet.

When the current in a circuit increases, the strength of the electromagnet will also increase. This will pull the soft iron armature towards the electromagnet.

As a result, spring 1 pulls apart the contact and disconnecting the circuit immediately, and stopping current flow.

The reset button can be pushed to bring the contact back to its original position to reconnect the circuit

Domestic circuit breakers

Choose appropriate words to fill in the gaps below:

A wire carrying an electric _____ produces a magnetic field. This field increases in _____ if the current is increased.

A _____ is a coil of wire carrying an electric current. The field produced increases in strength if the number of _____ in the coil is increased or if _____ is placed inside the coil.

An _____ consists of a coil of a solenoid wrapped around an iron core. Iron is a _____ magnetic material that loses its magnetisation once the current in the coil is switched off.

WORD SELECTION:

solenoid iron strength turns electromagnet current soft

Choose appropriate words to fill in the gaps below:

A wire carrying an electric _current_ produces a magnetic field. This field increases in _strength_ if the current is increased.

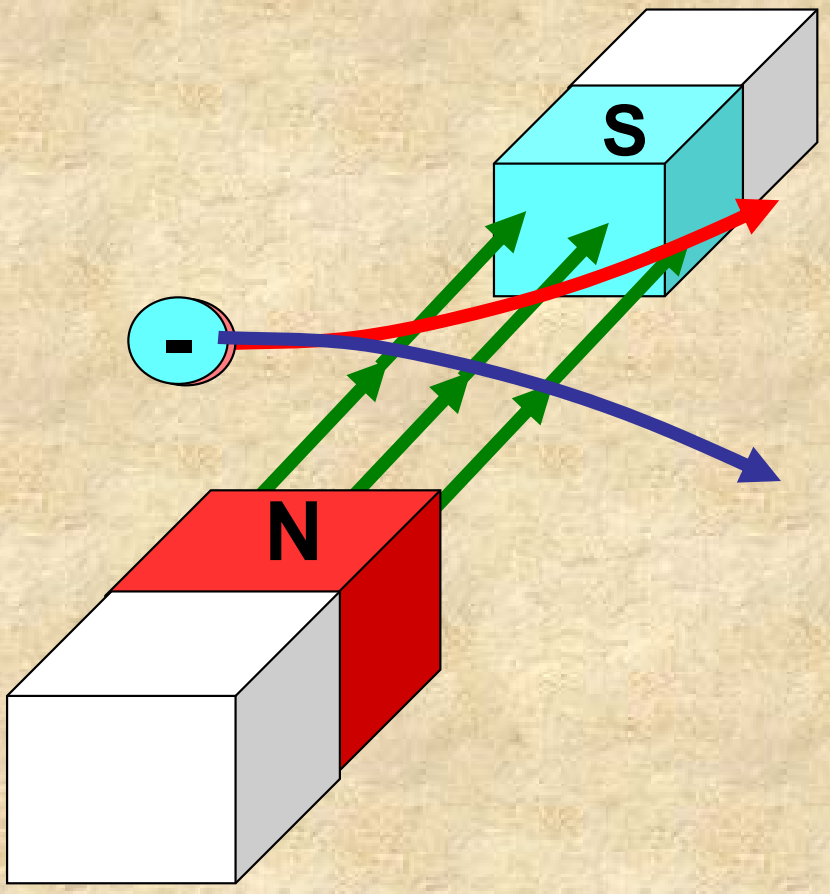
A _solenoid_ is a coil of wire carrying an electric current. The field produced increases in strength if the number of _turns_ in the coil is increased or if _iron_ is placed inside the coil.

An _electromagnet_ consists of a coil of a solenoid wrapped around an iron core. Iron is a _soft_ magnetic material that loses its magnetisation once the current in the coil is switched off.

WORD SELECTION:

solenoid iron strength turns electromagnet current soft

Charge deflection by a magnetic field



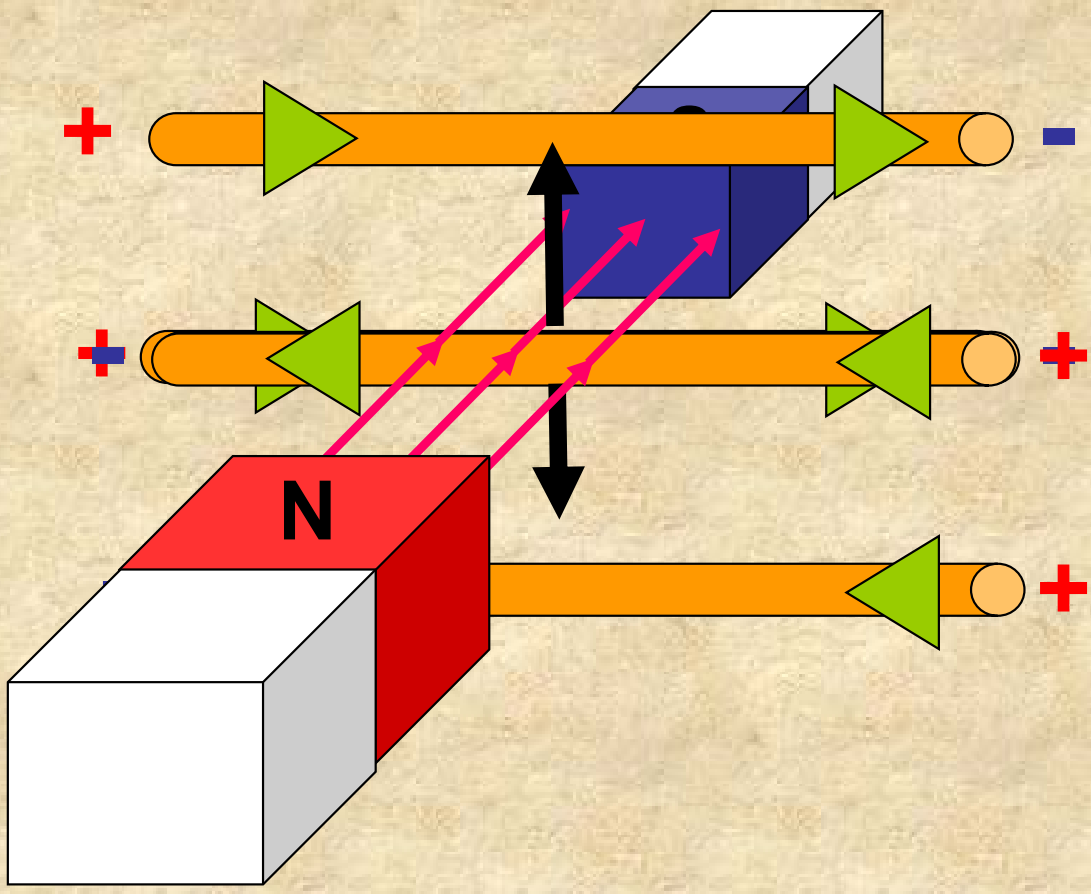
Electric charges are deflected by magnetic fields provided they are not travelling parallel to the field lines.

Positive and negative charges are deflected in opposite directions.

The motor effect

When a current carrying conductor carrying an electric current is placed in a magnetic field, it will experience a force provided that the conductor is not placed parallel to the field lines.

This is called the **motor effect**.

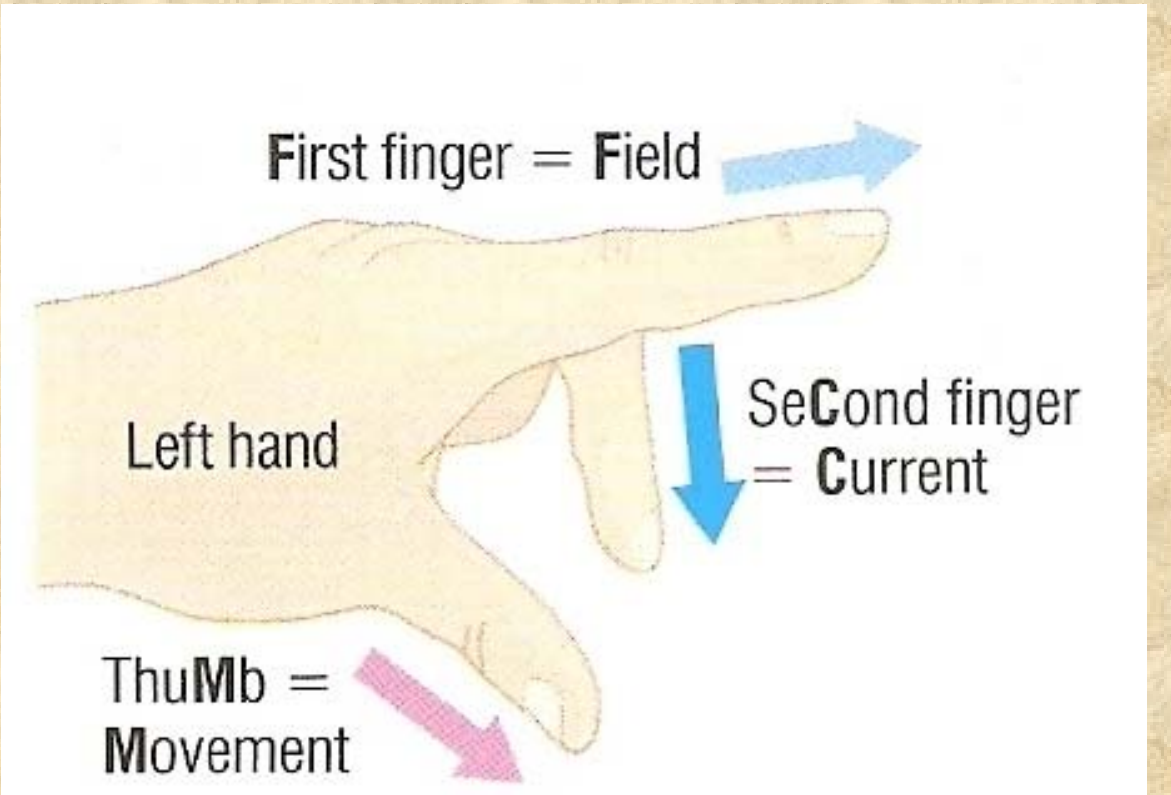


The force increases if:

- the strength of the magnetic field is increased
- the current is increased

The direction of the force is reversed if either the direction of the current or the direction of the magnetic field is reversed.

Fleming's left-hand motor rule



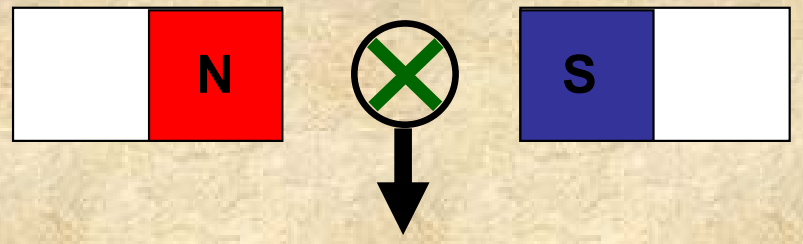
Note:

Magnetic field direction is from **NORTH** to **SOUTH**

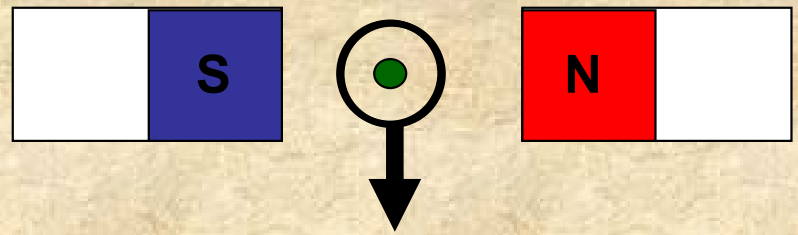
Current direction is from **PLUS** to **MINUS**

Insert the missing information

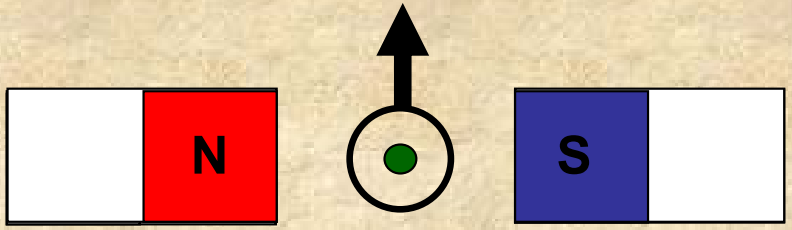
Q1. Force direction ?



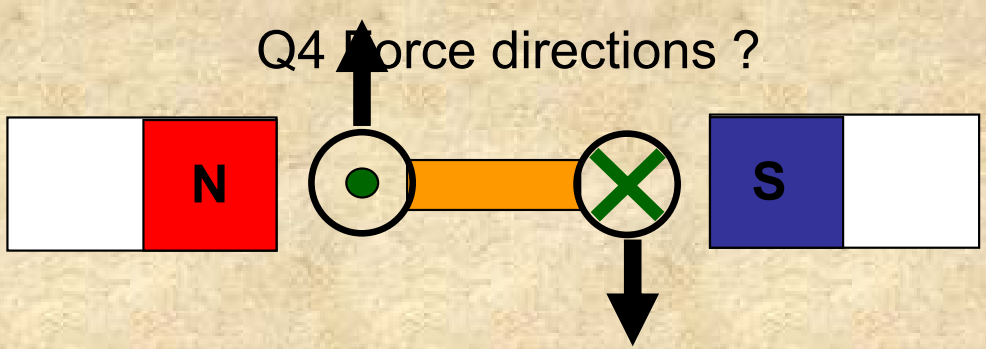
Q2 Current direction ?



Q3 N and S poles ?



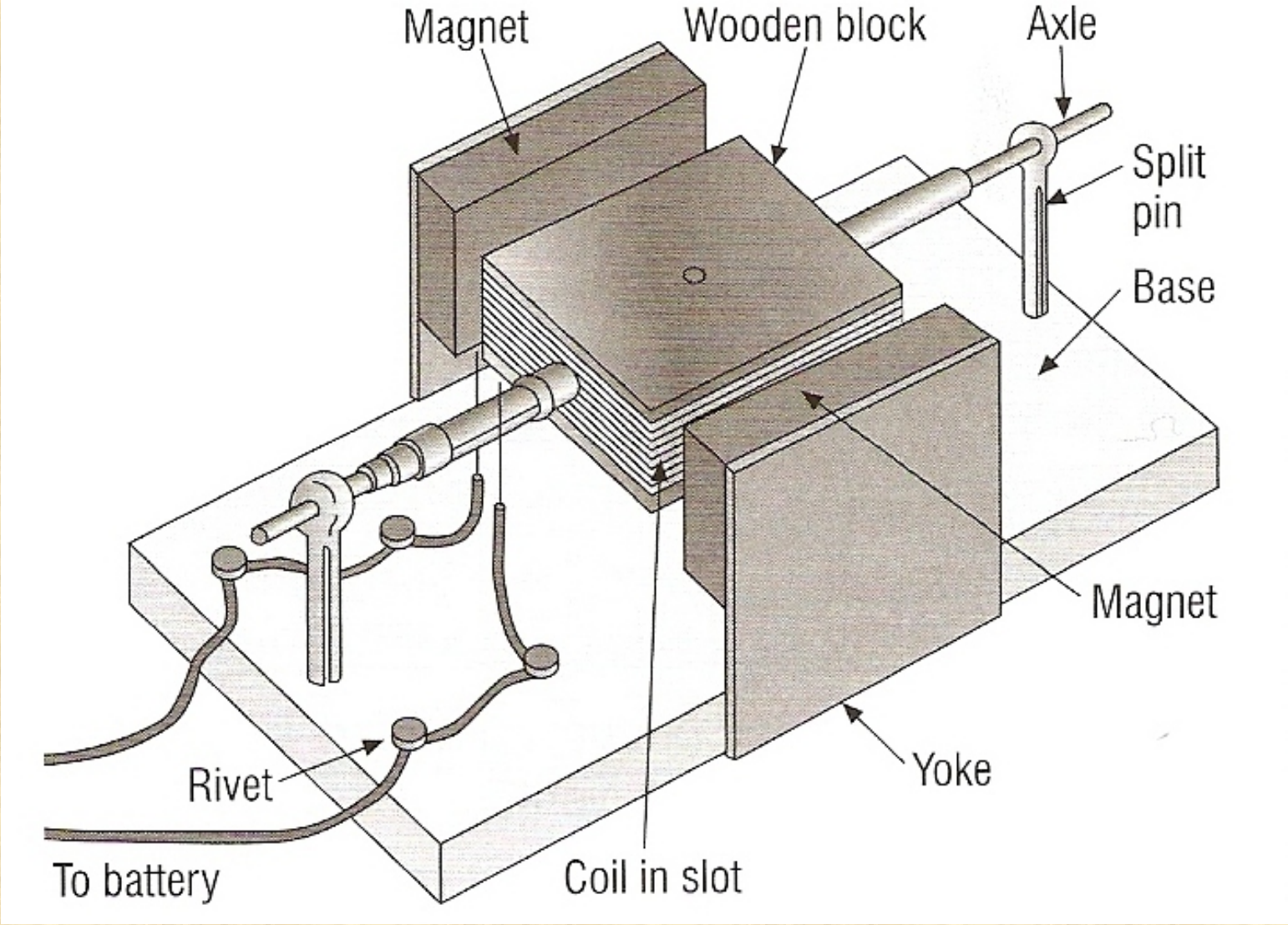
Q4 Force directions ?



Note: means current out of the page

means current into the page

Model electric motor



The loudspeaker

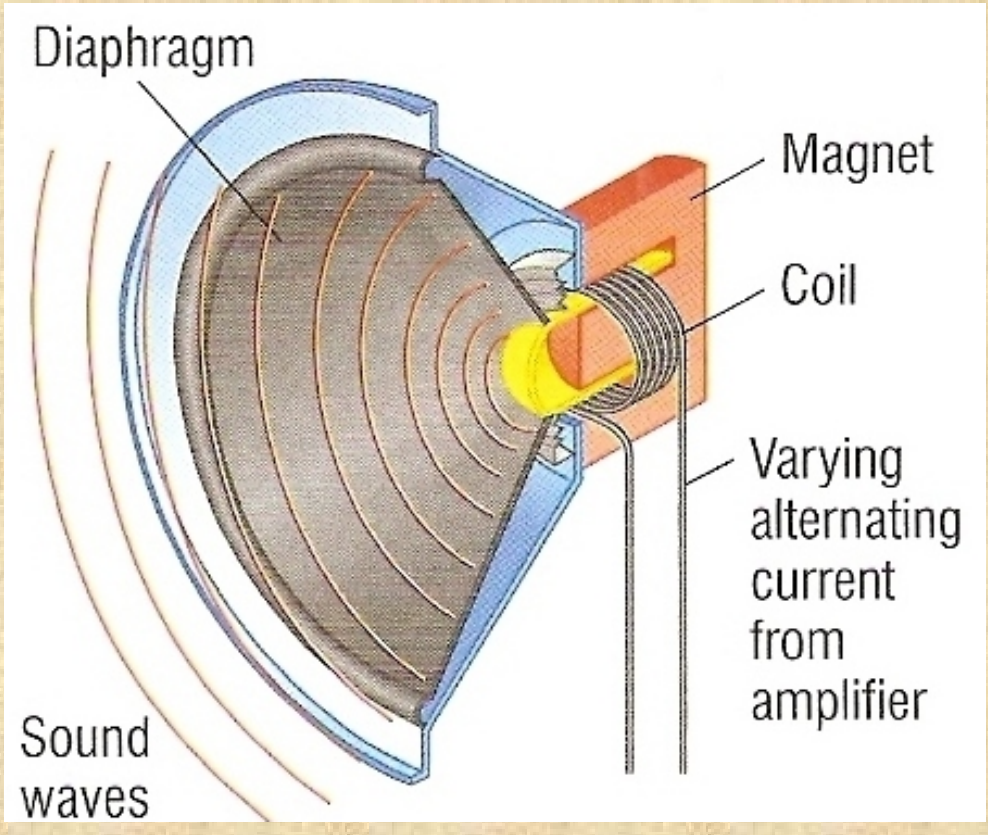
The sound signal consists of an alternating current supplied by the amplifier.

This current flows through the coil of the loudspeaker.

Due to the motor effect, the magnetic field around the coil causes the coil to vibrate in step with the alternating current.

The coil causes the diaphragm (speaker cone) to vibrate in step with the original sound signal.

The diaphragm causes air to vibrate and so produces a sound wave.



Question

Choose appropriate words to fill in the gaps below:

The motor effect occurs when a _____ carrying wire is placed inside a _____ field.

The force exerted is _____ when the wire is at 90° to the magnetic field _____ but is zero if the wire is _____ to the field.

The force increases with _____ or current strength, the force _____ in direction if either are reversed.

Applications include the electric motor and _____.

WORD SELECTION:

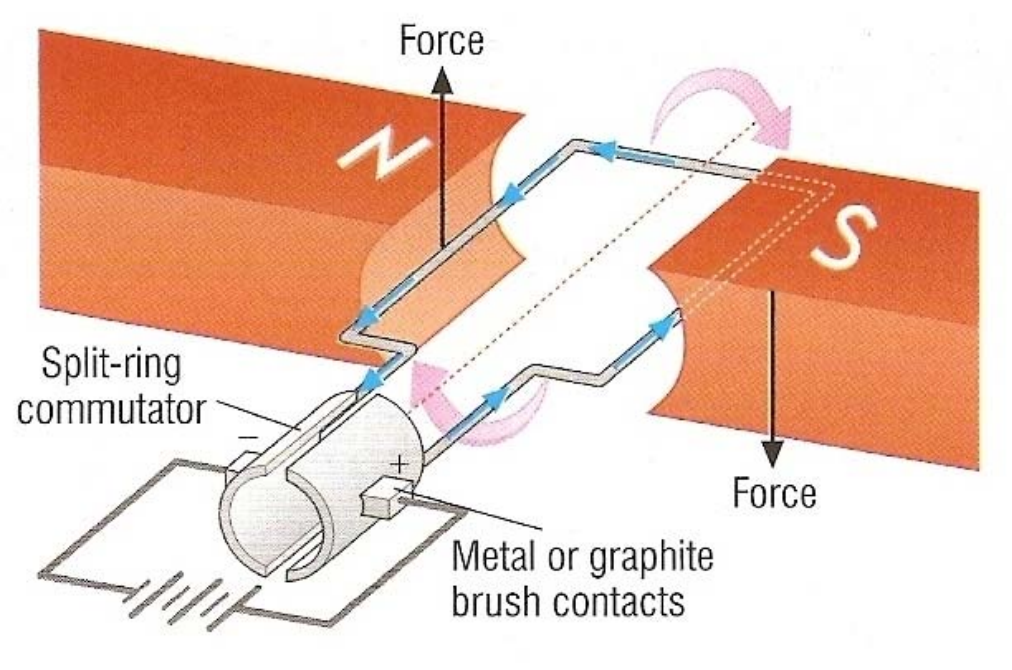
parallel reverses loudspeaker direction
current magnetic field maximum

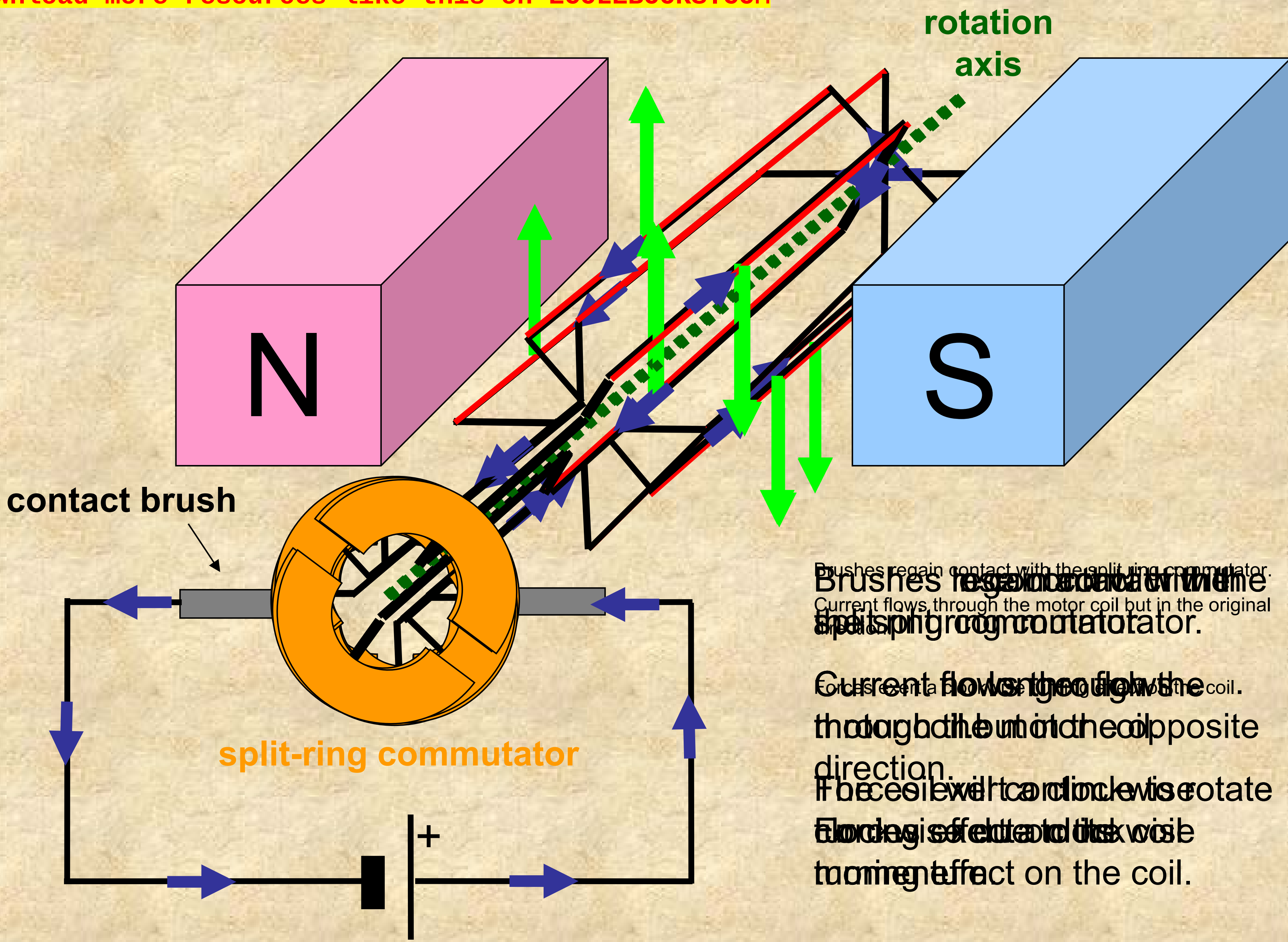
The electric motor

Electric current flowing around the coil of the electric motor produces oppositely directed forces on each side of the coil.

These forces cause the coil to rotate.

Every half revolution the split ring commutator causes the current in the coil to reverse otherwise the coil would stop in the vertical position.





Brushes regain contact with the split ring commutator.

Current flows through the motor coil but in the original direction.

Forces exert a clockwise turning effect on the coil.

Current flows through the motor coil in the opposite direction.

The coil will continue to rotate clockwise due to its momentum.

Forces exert a clockwise turning effect on the coil.

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