OCR (A) Physics GCSE

Topic P4: Magnetism & Magnetic Fields

Summary Notes

(Content in bold is for Higher Tier only)

P4.1 Magnets and Magnetic Fields

Magnets

Magnets have a **north** and **south** pole. Between two magnets, two like poles **repel** whereas two opposite poles **attract**.

Permanent Magnets are always magnetic and always have poles.

Induced magnets can be produced from materials that are magnetic but do not have fixed poles. These can be made into temporary magnets by **'stroking'** them with a permanent magnet. This causes the **domains** to align within the material, all in the same direction creating a temporary magnet. Iron, Nickel and Cobalt are common induced magnetic materials.

Magnetic Fields

These are shown using field lines that point **from north to south.** Strength of the field decreases as distance from the magnet increases. The greater the concentration of field lines in an area, the greater the strength of the field in that area.

Small **plotting compasses** which show the direction of the magnetic field at a certain point can be used to plot the shape of a magnetic field around a small magnetised object.

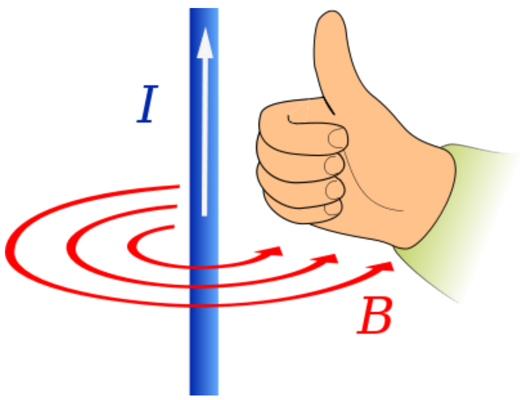
The Earth's Core

The Earth's **core is magnetic** and currents within it create a large magnetic field around the Earth. This is known because a freely **suspended magnetic compass will align itself with the earth's field lines** and point North. It doesn't point to the Geographic North pole, instead the magnetic north pole is over North Canada.

Also, the compass is effectively a suspended bar magnet, with its own north pole lining up with Earth's north pole. However, this cannot be right, as like poles repel. So, Earth's magnetic pole above Canada is actually a magnetic South Pole! (and the geographic south pole is close to the Magnetic North Pole).

Current

Current flowing in a wire produces a magnetic field around the wire. The direction of this field is dictated by the **'right hand grip rule'.** Plotting compasses on a piece of paper through which a wire runs will show this.



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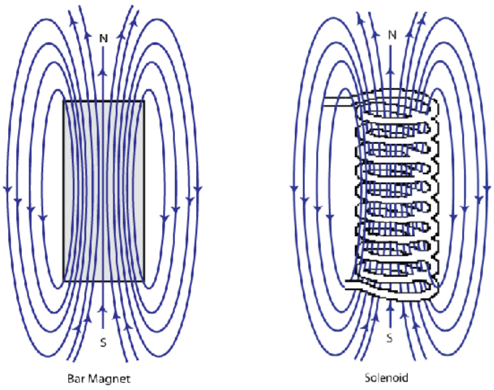
The greater the current flowing, the stronger the magnetic field. The greater the distance from the wire, the weaker the magnetic field becomes.

Solenoid

These are formed from a coil of wire with current flowing through. The shape of the resulting magnetic field is similar to that of a bar magnet. The magnetic effect is enhanced as coiling the wire causes the field to align and form a giant single field, rather than lots of them all perpendicular to the direction of the current.

Inserting an iron core in the centre increases its strength as it is easier for magnetic field lines to pass through than air.



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Several factors can affect the strength of the field produced:

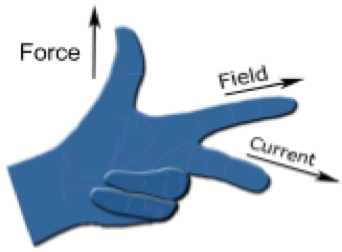
- Size of current
- Length of coil
- Cross sectional area
- Number of turns (coils)
- Type of core used

P4.2 Uses of magnetism

Force

Two magnets will interact, feeling a magnetic force of attraction or repulsion. Therefore a magnet and a wire will also exert a force, as the two magnetic fields (generated by the magnet and the current in the wire) will also interact.

The magnetic field around a wire is circular but the magnetic field between two magnets is straight. When the two interact, the wire is pushed away from the field between the poles, at right angles to the wire direction and the field direction.



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Fleming's Left-Hand Rule

Direction of this force can be found more easily using Fleming's left-hand rule. Each component is at 90° to one another. Using this the unknown factor can be found.

Remember current is conventional current, which moves in the opposite direction to the electrons.

$$Force = (magnetic\ flux\ density) \times (current) \times (length)$$

$$F = BIL$$

Where Magnetic Flux Density is measured in Tesla and is the number of flux lines per metre squared.

How Electric Motors work

An electric motor can be made using permanent magnets in fixed positions. In between, a coil of current-carrying wire lies on an axis and rotates because the induced force on one side moves upwards and the induced force of the opposite side moves downwards. This can be verified using Fleming's Left-Hand Rule.

Change in the Magnetic Field

A conductor (such as a wire) forms a potential difference as electrons within it move to one side as the field changes. If the conductor is connected to a circuit, a current will flow. This current will produce its own magnetic field. The direction of this new field is in the opposite direction to the first field.

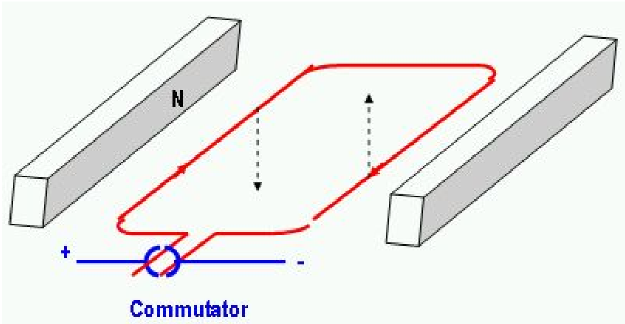
How Electric Generators (Dynamos) Work (Physics Only)

This uses the same setup as a motor, with a coil of wire able to rotate between two permanent magnets. A turbine spins turning the coil of wire.

The movement of the wire causes the wire to cut through the magnetic field so it experiences a change in magnetic field. This generates a potential difference. If the coil of wire is connected to a complete circuit, an alternating current will flow.

Alternating Current (Physics Only)

This is current that is constantly changing direction, therefore the magnetic field it produces also constantly changes.



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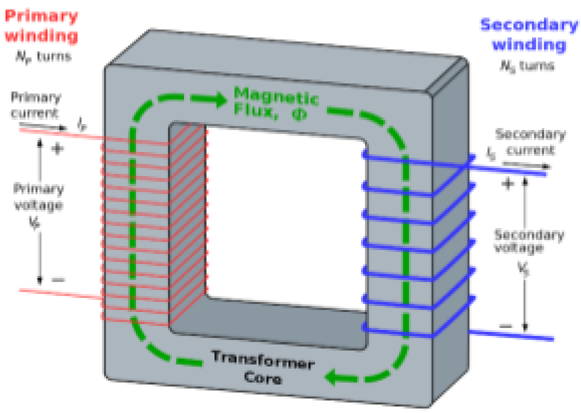
Transformers (Physics Only)

The alternating current in the first coil creates a changing magnetic field. This changing magnetic field cuts through the secondary coil. A current is then induced in the secondary coil which is also alternating.

If the primary current was direct, the magnetic field it produces would be constant, so nothing would be induced in the secondary coil.



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If there are more turns on the secondary coil, a step-up transformer is produced. Voltage is increased as the changing field will cut through more of the secondary wire inducing a larger pd.

If there are fewer coils on the secondary coil, a step-down transformer is produced, as a smaller pd is induced on the secondary coil.

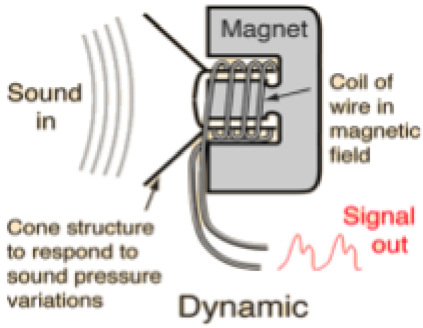
$$\frac{\text{number of coils on primary}}{\text{number of coils on secondary}} = \frac{\text{pd of primary}}{\text{pd of secondary}}$$

This works with current too but only if the transformer is 100% efficient.

How Dynamic Microphones Work (Physics Only)

They produce a current which is proportional to the sound signal. A fixed magnet is at the centre, and the coil of wire around the magnet is free to move.

Pressure variations in the sound waves cause the coil to move, and as it moves current is induced in the coil as it cuts the magnetic field.



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This current is then sent to a loudspeaker where the reverse occurs. The current flows into the coil. The magnetic field from magnet and from the current interact, causing the coil to move.
The cone of the speaker therefore moves, producing pressure variations which are sound waves.