

AQA GCSE Physics

Topic 7: Magnetism and Electromagnetism

Notes

(Content in bold is for Higher Tier only)



Magnets

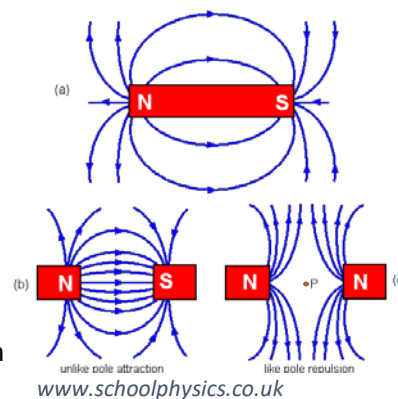
- North and South Poles
- Same Poles repel
- Opposite poles attract

Permanent Magnets

- Always magnetic, always have poles

Induced Magnets

- Materials that are “magnetic” but do not have fixed poles
- These can be made into temporary magnets by ‘stroking’ them with a permanent magnet
 - o These align the domains in the material all in the same direction, creating a temporary magnet
 - o Iron, Nickel, Cobalt

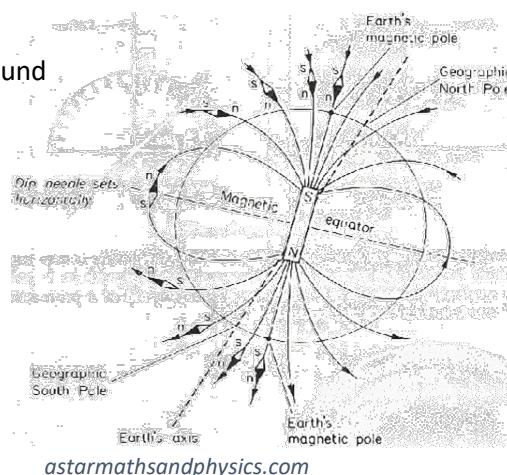


Magnetic Fields

- Field Lines point **from North to South**
- Strength decreases with distance from the magnet
- Direction always points to south pole and away from north pole, at any point
- Use Plotting Compasses
 - o Small compasses which show the direction of the magnetic field at a certain point

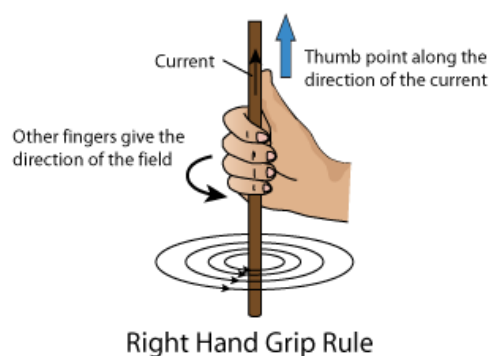
Earth's Core

- The core is magnetic, and creates a large magnetic field around the Earth
- We know this 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 – it 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'
 - o However this cannot be right, as like poles repel
 - o So in fact, Earth's magnetic pole above Canada is a magnetic South Pole! (and the geographic south pole is close to the Magnetic North Pole)



Current

- **Current produces a magnetic field around the wire**
- The direction is dictated by the “right hand grip rule”
- Plotting compasses on a piece of paper through which a wire is pierced shows this



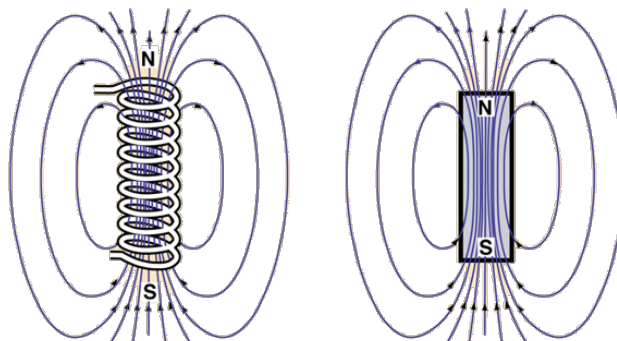
Strength of Magnetic Field

- Greater current, stronger magnetic field
- Greater distance from wire, weaker field



Solenoid

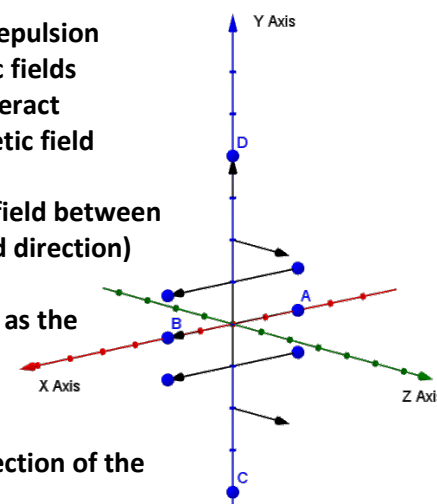
- Magnetic field **shape is similar to a bar magnet**
- It enhances the magnetic effect as coiling the wire causes the field to align and form a giant single field, rather than lots of them all perpendicular to the direction of the current
- Having an iron core in the centre increases its strength as it is easier for magnetic field lines to pass through than air
- Factors that affect the strength
 - o Size of current
 - o Length
 - o Cross sectional area
 - o Number of turns (coils)
 - o Using a soft iron core



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The Motor Effect

- **Two magnets will interact, feeling a magnetic force of attraction/repulsion**
- **So 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**
 - o The magnetic field around a wire is circular, but the magnetic field between two magnets is straight
 - o 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)
- **To visualise**
 - o Fixed permanent magnets have field lines along the x axis, as the magnets are at A and B and the field lines are shown
 - o Wire is along y axis, where current is moving up from C to D
 - o The Force felt on the wire is at right angles to both the direction of the current and magnetic field lines
 - Along the z axis



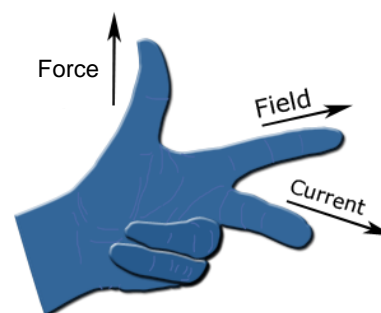
Fleming's Left Hand Rule

- Each direction is 90° to each other
- Use this to work out the unknown factor out of the three (usually the direction of the force felt)
- **Remember current is conventional current, which moves in opposite direction to the electrons**

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

$$F = BIL$$

- Where Magnetic Flux Density is measured in Tesla
 - o And it is the number of flux lines per metre squared



en.wikipedia.org



How Electric Motors work

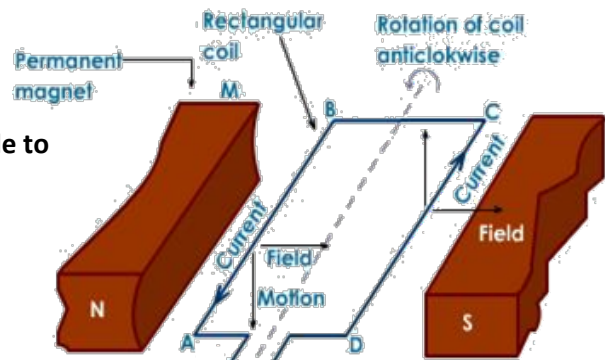
- Knowledge of structure is not expected
- Permanent Magnets lie in fixed positions
- In between, a coil of current-carrying wire lies on an axis
 - o Force on one side moves that side up
 - o Force on the other side (where current is flowing in opposite direction) moves down
 - o This can be verified using Fleming's Left Hand Rule
- Hence it rotates

Electromagnetic Induction (Physics only)

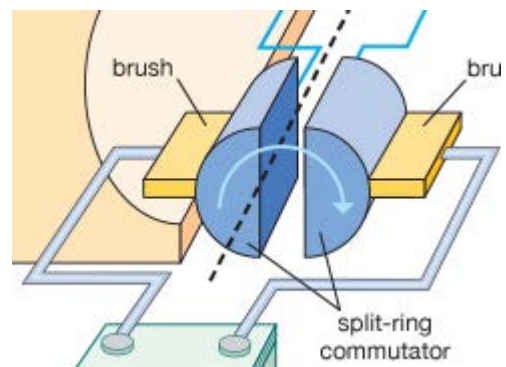
- When there is a relative **movement between a conductor and a magnetic field**, a potential difference is induced across the conductor.
- This happens if the **magnetic field changes** as well
- A current flows if the conductor forms a complete circuit.
- This current will produce its own magnetic field, which oppose the change inducing it

How Electric Generators (dynamoes) work (Physics only)

- 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
- It experiences a change in magnetic field
- This creates a potential difference
- If the coil of wire is connected to a complete circuit, an alternating current (AC) will flow – this is a basic alternator, as shown above
- Direct current (DC) current is produced if the ends, A and D in diagram above, are connected to a split ring commutator
- This reverses the current each half-rotation so current remains positive – this system is called a dynamo



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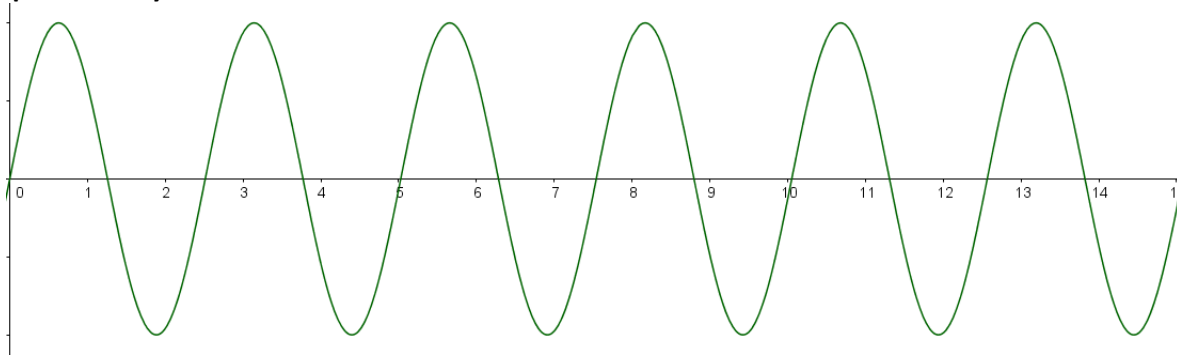


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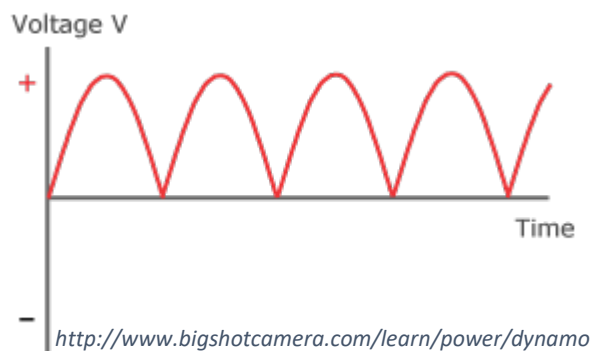
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AC produced by Alternator:

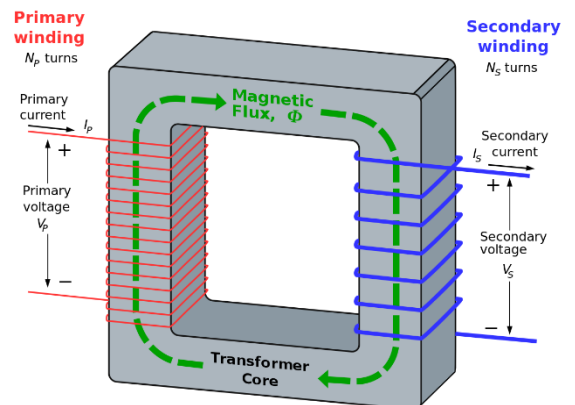


DC produced by Dynamo:



Transformers (Physics only)

- AC in first coil creates a changing magnetic field
- This changing magnetic field cuts through the secondary coil
- This induces a current in the secondary coil
 - o Which is also AC
 - o If primary current was DC, magnetic field it produces will be constant, not inducing anything in the secondary coil
- More coils on secondary: Step up transformer, as voltage will be increased, as changing field will cut through more of the secondary wire inducing a larger pd
- Fewer coils on secondary: Step down transformer, as smaller pd forms on secondary



en.wikipedia.org - step down transformer

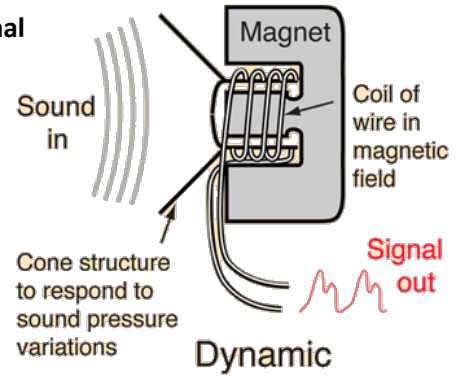
$$\frac{\text{number of coils on primary}}{\text{number of coils on secondary}} = \frac{\text{pd of primary}}{\text{pd of secondary}}$$

- This only works with current too if the transformer is 100% efficient. Unless it states this, assume not and just use this to find voltage



How Dynamic Microphones Work (Physics only)

- They produce a current which is proportional to the sound signal
- 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 (because it cuts the magnetic field)
- This current is then sent to a loudspeaker



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Loudspeakers (Physics only)

- The setup is identical, working in reverse
- The current flows into the coil
- The magnetic field from magnet and from current interact, causing the coil to move
- The cone therefore moves
- Producing pressure variations, making sound

