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
  - These align the domains in the material all in the same direction, creating a temporary magnet
  - 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
  - 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’
  - However this cannot be right, as like poles repel
  - 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

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
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
  - Force on one side moves that side up
  - Force on the other side (where current is flowing in opposite direction) moves down
  - 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 (dynamos) 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
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
  - Which is also AC
  - 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

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

- 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

**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