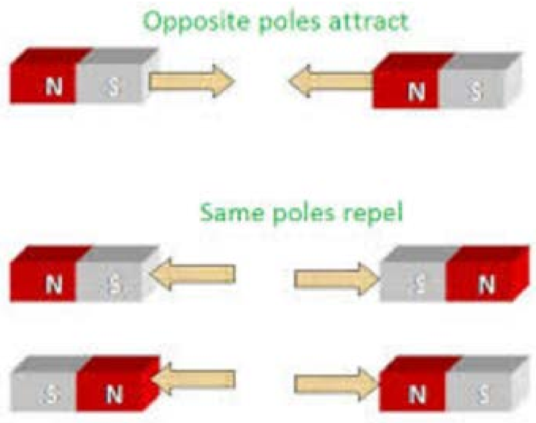
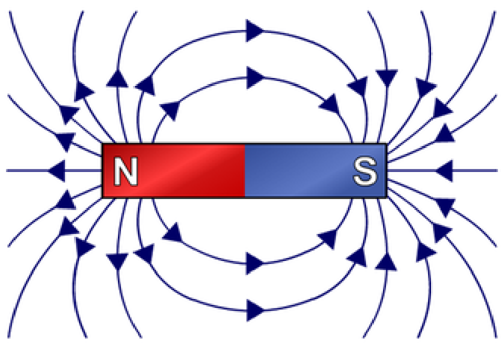
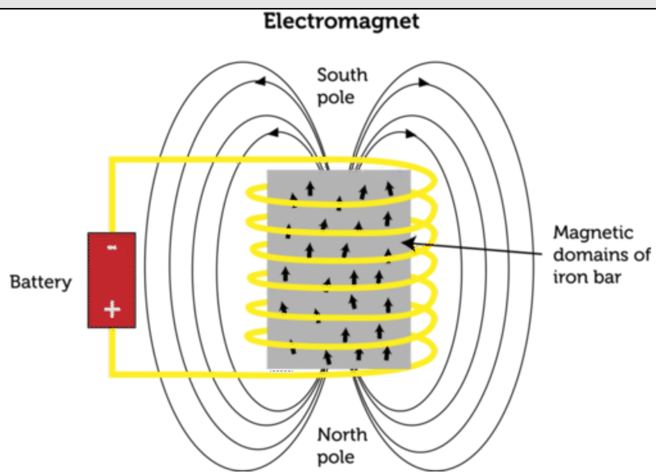
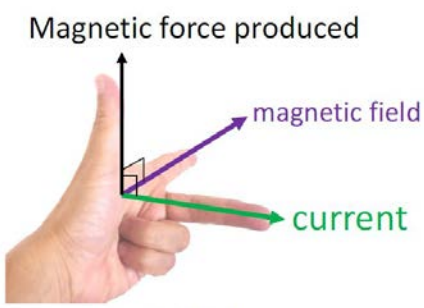
4.7 Magnetism and electromagnetism

4.7.1	Permanent and induced magnetism, magnetic forces and fields
4.7.1.1 Poles of a magnet	 Around the poles of a magnet are the places where the magnetic forces are strongest. When two magnets are brought close together they exert a force on each other. The diagrams show these forces. These are examples of non-contact forces. A permanent magnet produces its own magnetic field. An induced magnet is a material that becomes a magnet when it is placed in a magnetic field. Induced magnetism always causes a force of attraction. When removed from the magnetic field an induced magnet loses most/all of its magnetism quickly.
4.7.1.2 Magnetic fields	 The region around a magnet where a force acts on another magnet or on a magnetic material (iron, steel, cobalt and nickel) is called the magnetic field. The diagram shows the magnetic field lines. The force between a magnet and a magnetic material is always one of attraction. The strength of the magnetic field depends on the distance from the magnet; the magnetic field lines are further apart where it is weaker. The field is strongest at the poles of the magnet; where the magnetic field lines are closer. The direction of the magnetic field at any point is given by the direction of the force is shown by the arrows on the diagram. The direction of a magnetic field line is from the north to the south pole of the magnet. A magnetic compass contains a small bar magnet. The Earth has a magnetic field. The compass needle points in the direction of the Earth's magnetic field, this is evidence that the core of the Earth must be magnetic.
4.7.2	**The motor effect**
4.7.2.1 Electromagnetism	When a current flows through a conducting wire a magnetic field is produced around the wire. To make the magnetic field stronger: -increase the current -form a solenoid by wrapping the wire into coil; more coils make a stronger field -add an iron core. An electromagnet is a solenoid with an iron core. 

4.7.2.2 Fleming's left-hand rule (HT only)	 Fleming's Left Hand Rule When a conductor carrying a current is placed in a magnetic field the magnet producing the field and the conductor exert a force on each other. Fleming's left-hand rule is shown in the picture and shows the relative direction of the force, the current in the wire and the magnetic field. To put a bigger force on the wire: -increase current -increase the strength of the magnetic field. For a conductor at right angles to a magnetic field and carrying a current: force = magnetic flux density × current × length F = B I l F = force in newtons (N) B = magnetic flux density in tesla (T) I = current in amperes or amps (A) L = length in metres (m)
4.7.2.3 Electric motors (HT only)	A coil of wire carrying a current in a magnetic field tends to rotate. This is the basis of an electric motor. Students should be able to explain how the force on a conductor in a magnetic field causes the rotation of the coil in an electric motor.
4.7.2.4 Loudspeakers (physics only) (HT only)	Loudspeakers and headphones use the motor effect to convert variations in current in electrical circuits to the pressure variations in sound waves. Students should be able to explain how a moving-coil loudspeaker and headphones work.
4.7.3	**Induced potential, transformers and the National Grid (physics only) (HT only)**
4.7.3.1 Induced potential (HT only)	If an electrical conductor such as a wire cuts through a magnetic field, a potential difference is induced (made to happen) across the ends of the conductor. If the conductor is part of a complete circuit, an **electric current** will flow in the circuit. For induction to happen, the conductor must cut through the magnetic field. This can be achieved in two ways: • a conductor can be moved in a magnetic field • a magnet can be moved in a coil of wire • Induction does not happen if the conductor moves in the same direction as the magnetic field.

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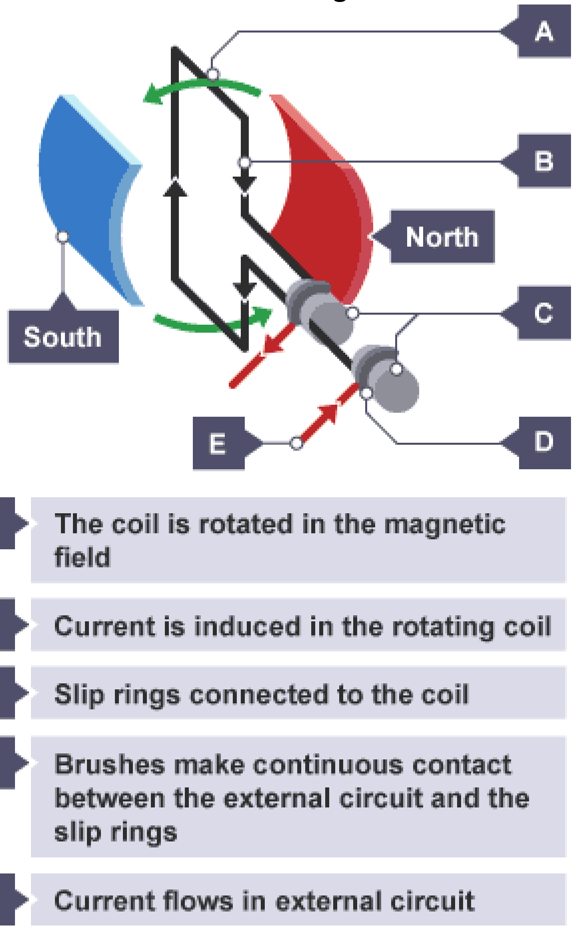
- If the conductor is part of a complete circuit, a current is induced in the conductor. This is called the generator effect.



- An induced current generates a magnetic field that opposes the original change, either the movement of the conductor or the change in magnetic field.

The size of the induced current can be made bigger by:

- Using a stronger magnet.
- Moving the magnet at a faster speed.
- Using more turns of wire on the coil.

The direction of the current can be reversed by:

- Moving the magnet in the opposite direction.
- Using a magnet facing the opposite way round (with North becoming South).

These both result in the pointer on the galvanometer moving to the left.

If the magnet stops moving, even though it may still be inside the coil of wire, <u>no current is induced</u> in the wire.

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<td>4.7.3.2 Uses of the generator effect (HT only)</td>
<td>The generator effect is used in an alternator to generate ac and in a dynamo to generate dc. Students should be able to:
• explain how the generator effect is used in an alternator to generate ac and in a dynamo to generate dc</td>
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	• draw/interpret graphs of potential difference generated in the coil against time.
4.7.3.3 Microphones (HT only)	Microphones use the generator effect to convert the pressure variations in sound waves into variations in current in electrical circuits. Explain how a moving-coil microphone works.
4.7.3.4 Transformers (HT only)	Transformers are used to increase or decrease the voltage of alternating currents. A **transformer** consists of two coils of wire wound on a metal core. The ratio of the potential differences across the primary and secondary coils of a transformer V p and Vs depends on the ratio of the number of turns on each coil, n p and ns . Vp Vs = Np Ns potential difference, V p and Vs in volts, V In a step-up transformer Vs > V p In a step-down transformer Vs < V p If transformers were 100% efficient, the electrical power output would equal the electrical power input. MS 3b, c Students should be able to apply this equation which is given on the Physics equation sheet. Vs × Is = Vp × Ip Where Vs × I s is the power output (secondary coil) and V p × I p is the power input (primary coil).