AQA Physics - Magnetism and electromagnetism

Context and introduction to the unit:
Electromagnetic effects are used in a wide variety of devices. Engineers make use of the fact that a magnet moving in a coil can produce electric current and also that when current flows around a magnet it can produce movement. It means that systems that involve control or communications can take full advantage of this.
KS3: Forces, Electricity, Magnets and electromagnets

CORE KNOWLEDGE

6.7.1 Permanent and induced magnetism, magnetic forces and fields

6.7.1.1 Poles of a magnet –
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. Two like poles repel each other. Two unlike poles attract each other. Attraction and repulsion between two magnetic poles are examples of non-contact force. 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.

6.7.1.2 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 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 field is strongest at the poles of the magnet. The direction of the magnetic field at any point is given by the direction of the force that would act on another north pole placed at that point. The direction of a magnetic field line is from the north (seeking) pole of a magnet to the south(seeking) 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.

6.7.2 The motor effect

6.7.2.1 Electromagnetism –
When a current flows through a conducting wire a magnetic field is produced around the wire. The strength of the magnetic field depends on the current through the wire and the distance from the wire. Shaping a wire to form a solenoid increases the strength of the magnetic field created by a current through the wire. The magnetic field inside a solenoid is strong and uniform. The magnetic field around a solenoid has a similar shape to that of a bar magnet. Adding an iron core increases the strength of the magnetic field of a solenoid. An electromagnet is a solenoid with an iron core.

6.7.2.2 Fleming's left-hand rule (HT only) –
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. This is called the motor effect. Show that Fleming's left-hand rule represents the relative orientation of the force, the current in the conductor and the magnetic field. Recall the factors that affect the size of the force on the conductor.
For a conductor at right angles to a magnetic field and carrying a current:

force = magnetic flux density × current × length ($F = B \times I \times l$)

Force, F, in newtons. N. Magnetic flux density, B, in tesla, T. Current, I, in amps, A. Length, l, in metres, m.

6.7.2.3 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. The force on a conductor in a magnetic field causes the rotation of the coil in an electric motor.

Disciplinary knowledge
WS 2.2

Vocabulary
Pole, magnet, electromagnet, repulsion, attraction, induced magnetism, magnetic field, motor effect, solenoid, Fleming left hand rule, conductor, tesla, electric motor, magnetic flux density

Reading is Power
60 second science – Electromagnetism

Where next?
A Level Fields and their consequences

AQA Physics - Magnetism and electromagnetism Part 2 SEPS only

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CORE KNOWLEDGE

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.

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 moves relative to a magnetic field or if there is a change in the magnetic field around a conductor, a potential difference is induced across the ends of the conductor. 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.

4.7.3.2 Uses of the generator effect (HT only)
The generator effect is used in an alternator to generate ac and in a dynamo to generate dc.

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.

4.7.3.4 Transformers (HT only)
A basic transformer consists of a primary coil and a secondary coil wound on an iron core. Iron is used as it is easily magnetised. Knowledge of laminations and eddy currents in the core is not required. The ratio of the potential differences across the primary and secondary coils of a transformer Vp and Vs depends on the ratio of the number of turns on each coil, np and ns .

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

Potential difference, V_p and V_s n in volts, V. In a step-up transformer $V_s > V_p$ In a step-down transformer $V_s < V_p$. If transformers were 100% efficient, the electrical power output would equal the electrical power input.

$$V_s \times I_s = V_p \times I_p$$

Where Vs × Is is the power output (secondary coil) and Vp × Ip is the power input (primary coil). power input and output, in watts, W.

Disciplinary knowledge
WS 2.2

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