SUBJECT: Science

UNIT: P7 Electromagnetism

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Key Equations

Motor Effect

$$F = B \times I \times l$$

Transformers

$$P = V \times I$$

$$V_p I_p = V_s I_s$$

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

Quantities and Units

B = Magnetic Flux Density (T)
I = Current (A)
l = length (m)
F = Force (N)
P = Power (W)
V = Potential Difference (V)
n = number of turns in coil

Subscript $_p$ and $_s$ refer to primary and secondary.

Poles of a magnet

The two poles of a magnet are north and south. Two like poles repel whilst two opposite poles will attract.

Magnetic Fields

A permanent magnet has a magnetic field that cannot be turned on or off. An induced magnet has a magnetic field which can be turned on and off.
The magnetic field surrounding a permanent bar magnet has field lines that travel from the north to the south pole and is strongest where the field lines are the closest.
We can plot magnetic field lines using plotting compasses and placing them around a magnet.

Electromagnetism

A current carrying wire creates a circular magnetic field around it. By shaping the wire into a coil, we can create a magnetic field which is identical to a permanent magnetic field.
This is induced magnetism. We can turn the magnetism on and off. The strength of the electromagnet can be increased by:

1. Increasing the number of **C**oils
2. Increasing the **C**urrent
3. Including an iron **C**ore

Induced Current

Moving a magnet through a coil induces a current in the wire.

Electric Motors

When the wire carrying the current is coiled (similar to an electromagnet) and then placed in a permanent magnetic field then the coil will rotate. To avoid the coil stopping in the vertical position (where there is no force) a split ring commutator is used to provide current via graphite or metal brushes which changes direction every half turn to ensure constant rotation.

Generators

A generator uses induced potential to produce an alternating current. A permanent magnet is rotated in a coil of wire and the rotation creates alternating current. You can increase the strength of this by increasing the: strength of the magnet, number of turns, area of the coil, or the speed of the movement.

Microphones and Loudspeakers

Microphones transfer oscillations from sound waves into electrical signals by vibrating a diaphragm and therefore a coil which moves in a permanent magnetic field which induces potential and creates current. Loudspeakers work in reverse. A current is passed through a permanent magnetic field which creates a force, and this causes oscillations of air particles producing a sound.

Transformers

When an alternating current is supplied to the primary coil, it produces a magnetic field within the iron core. The magnetic field in the iron core constantly changes direction due to the alternating current and therefore induces current in the secondary coil. The changes in potential difference is a ratio identified by one of the equations.

Ambitious Vocabulary

Permanent Induced
Transformer Current

Magnetic Materials

There are three magnetic elements: cobalt, nickel, and iron.

Motor Effect

When a current carrying wire (induced magnet) is exposed to the magnetic field of another magnet (permanent magnet) a force is produced at a right angle. The force can be calculated using one of the equations.

Left Hand Rule

The direction of the force can be worked out by putting your thumb, first finger, and second finger at right angles from one another. The thumb shows the force direction. The first finger is the direction of the permanent field. The second finger is the direction of the current.

Transformers

A transformer changes voltage using induced potential and has two coils on opposite sides.
Step-up transformers increase the voltages, there are fewer primary coils than there are secondary coils.
Step-down transformers decrease the voltage. There are more primary coils than there are secondary coils.
The coils both have an iron core connecting them. There is no current flowing through this.