➢ Artificial Magnet

The magnet prepared by man-made methods is called artificial magnet. It is classified as

(a) Permanent magnet, and

(b) Temporary magnet or electromagnet.

- *Permanent magnet*

The magnet which retains it's magnetic properties for a long period is known as Permanent Magnet. Any change in its properties comes about only on account of some external cause, e.g. great shock or heat.

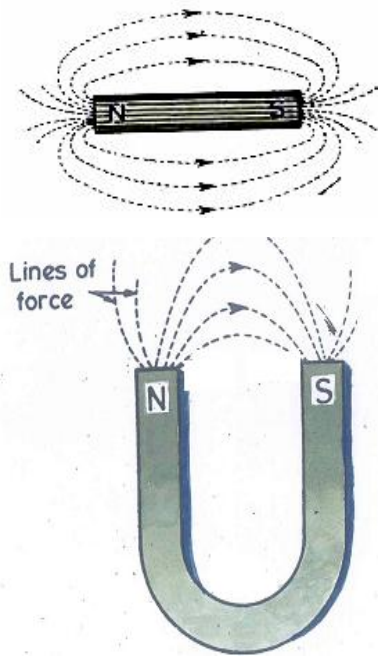

Figure 1.11 : Permanent Magnet

- *Temporary Magnet or Electromagnet*

A temporary magnet is a piece of some ferromagnetic material. In its normal state, it does not show any magnetic property. However, by subjecting it to some external magnetizing influence, it gains magnetic property. As soon as the external influence is removed, the induced behavior also vanishes.

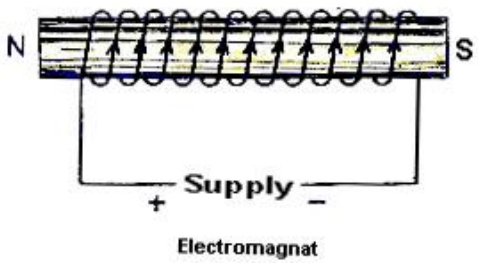

Figure 1.12 : Electro Magnet

The simplest external influence is the presence of a powerful magnet in the vicinity. Of interest to us is the use of electricity to create an electromagnet. By putting the temporary magnet inside a conducting coil and passing a current through the coil, the magnetic behavior is manifested. As soon as the current is stopped, the magnetic behavior also vanishes. Such an electromagnet is very useful part of a magnetic crane, or inside a generator or a motor.

1.3 LET US SUM UP

We have learnt about basics of electricity and magnetism.

Electricity is basically measured in terms of Voltage and Current. We saw the difference between Direct and Alternating Current (DC and AC). AC voltage and current keep changing with time and if we were to draw a graph, the voltage or the current would be shown as a sine-wave. Ohm's law defines the relation between Voltage and Current passing through a material. The ratio of voltage to current is the impedance of that material or circuit. In case of steady state DC, the impedance is same as the resistance. However, in all other cases, we have added possibility of inductance and/or capacitance being added to the circuit, leading to a complex value of impedance. In this case there could also be an angular difference between the voltage and the current. This difference is the phase, and cosine of the angle is named as the power factor.

We have learnt the types of magnets. We also understand that electricity passing through a coil produces magnetism. On the other hand, a changing magnetic field crossing a coil produces voltage across it. Thus, Electricity and Magnetism are related. In fact, theses two topics are normally addressed together under a common heading, namely, Electro-magnetism.

Electro-magnetism helps us to understand the working of generator for producing electricity as well as working of motor to produce force for providing motion to the rotor . There are other diverse uses, e.g. electromagnetic cranes, magnetic levitation trains, etc.

Electricity is an extremely useful form of energy. Only, it is not available in nature in a useful form. We produce electricity, transmit it over long distances, and distribute it to be used productively.

1.4 KEY WORDS

Current **:** Flow of electrons through a material.

Voltage : The potential difference between the two ends of a material, which causes the electrons to flow between them.

Magnetism : A property of magnets (Natural/ Electro-Magnets) to attract Ferro-magnetic substances.

Impedance : The property of any material to restrict the flow of electrons, hence the current through, itself.

Resistance : The impedance offered by a material to steady-state DC.

Inductance : The impedance offered by a coil or a coil like device to AC.

Capacitance : The impedance offered by a pair of conducting plates separated by a non-conducting material, to AC.

Natural Magnet : An ore consisting of Iron Oxide, which shows magnetic properties.

Electromagnet : A conducting coil connected to a source of electrical power, displaying magnetic properties perpendicular to the plane of the coil. In many cases, a soft iron core is inserted within the coil.

1.5 TERMINAL QUESTIONS ?

(a) How is electricity related to matter?

(b) What would be preferred to transmit power over a distance, conductor or insulator?

(c) If air is non-conducting, how does lighting flow from the clouds to ground?

(d) Which component of power is useful, active or reactive?

(e) How is a natural magnet useful to travelers?

(f) Which property of an electromagnet makes it a controllable device?

1.6 ANSWERS TO CHECK YOUR PROGRESS

Ans. 1

Electrons are very light particles with a unit negative charge, whereas, Protons have a unit positive charge and are many times heavier than the electrons. Also, Protons reside in the nucleus of an atom, while Electrons revolve around it.

Ans. 2

Resistance is the property of a material by virtue of which it opposes the flow of current through itself. The value of the resistance is related to the property of the material and not to the presence of a voltage or current. However, it should be noted that the resistance is only 'noticed' (and can be measured) when a voltage is applied and a current flows through the material.

Ans. 3

Energy is the total capacity available to do work, whereas, power is the rate of doing work, i.e. the amount of work done in one unit of time.

Ans. 4

In case of DC, there is no concept of frequency. Hence, there cannot be any phase differential between the voltage and the current. Therefore DC shall always phase angle 0, and power factor value 1.

1.7 ANSWERS TO TERMINAL QUESTIONS

(a) We have learnt that matter consists of atoms, which, in turn, has free electrons in its outer shell, and these free electrons can easily leave the atom and move around. We have also learnt that electricity is the accumulation or depletion of electrons. Hence, matter is a basic requirement for electricity.

(b) By definition, a non-conductor is bad for the flow of current, and hence, power. Therefore, presence of a conducting material is a necessary requirement for transmission of power over a distance.

(c) As we saw, non-conductors impede the flow of current. This is true for air, as well. However, the voltage built up in the clouds is so high (in millions of volts!) that it removes some electrons

from the air atoms and it is these forcibly removed electrons which become responsible for electricity to flow from the clouds to Earth, is the form of lightning.

(d) Active power is available to do work. Reactive power, in general, does not perform any usable work.

(e) Since a natural magnet always aligns itself in the (approximately) north-south direction, it may be used by a traveler to identify his direction of travel. This is the principle of a compass.

(f) As we saw, an electromagnet gains its magnetic property only while a current flows though its coil. Therefore, by controlling the flow of current, we can control the magnet. For example, in a crane, to lift a ferro-magnetic material, the electromagnet would be energized. And when the material is in the desired position, the current would be switched off, thereby releasing the material.