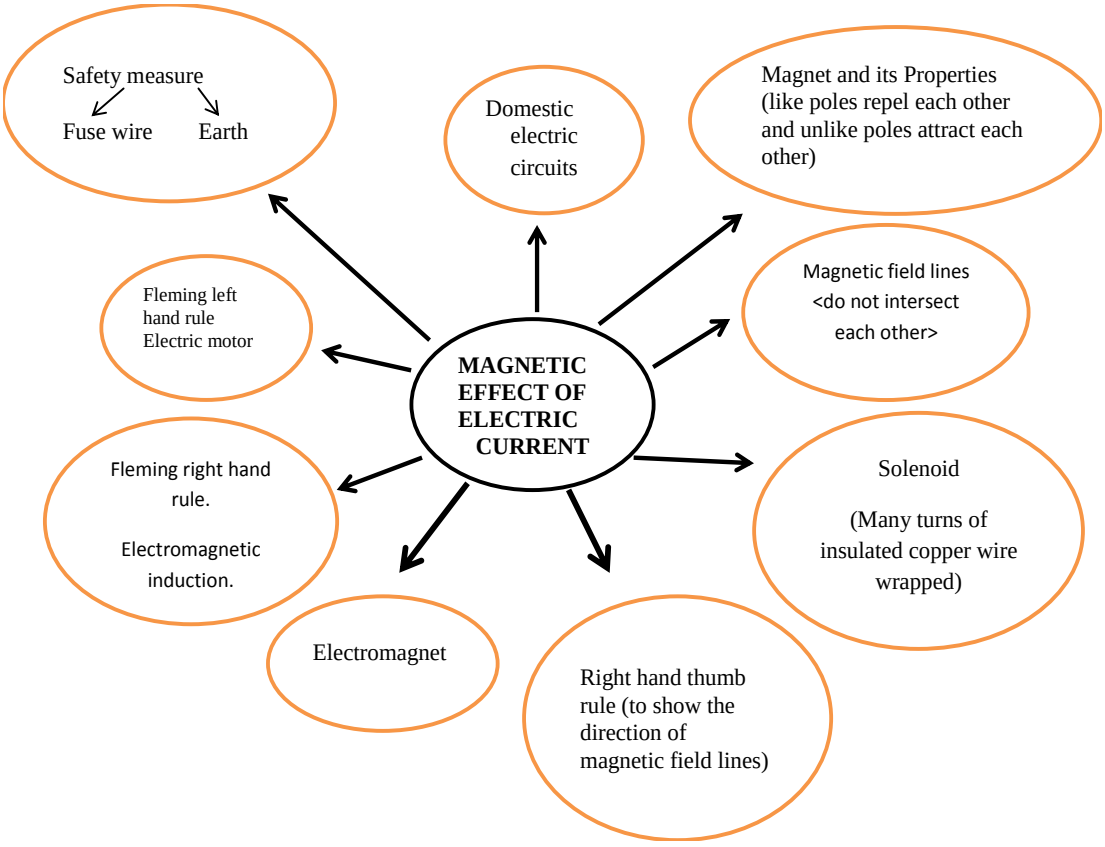
CHAPTER 13- MAGNETIC EFFECTS OF ELECTRIC CURRENT

Magnet is an object that attracts objects made of iron, cobalt & nickel.
When a magnet suspended freely it will align in North-South direction. Like poles repel each other and unlike poles attract each other
Magnets are used: (i) In radio & stereo speakers, (ii) In refrigerator doors, (iii) in audio & video cassettes players, (iv) in hard discs & floppies of computers & (v) in children's toys.
Magnetic field: The area around a magnet where a magnetic force is experienced is called a magnetic field. It is a quantity that has both direction & magnitude.
Magnetic field lines: Magnetic field is represented by field lines. They are lines drawn in a Magnetic field along which a unit North magnetic pole moves. Magnetic field lines are called as Magnetic lines of force.
Refer to figure 13.3 & 13.4 page no. 225 of N.C.E.R.T Text book)
Properties of Magnetic field lines:
(i)They do not intersect each other. (ii)It is taken by convention that magnetic field lines emerge from North Pole and merge at the South Pole. Inside the magnet, their direction is from South Pole to North Pole. Therefore magnetic field lines are closed curves.
Magnetic field lines due to a current through a straight conductor (wire)- consist of series of concentric circles whose direction is given by the Right hand thumb rule.
Right hand thumb rule: If a current carrying straight conductor is held in your right hand such that the thumb points towards the direction of current, then the wrapped fingers show the direction of magnetic field lines.
(Refer to figure 13.7, page no. 228 of N.C.E.R.T Text book)
Magnetic field lines due to a current through a circular loop
(Refer to figure 13.8, page no. 228 of N.C.E.R.T Text book)
The strength of the magnetic field at the centre of the loop (coil)depends on:
(i)The radius of the coil- The strength of the magnetic field is inversely proportional to the radius of the coil. If the radius increases, the magnetic strength at the centre decreases. (ii)The number of turns in the coil: As the number of turns in the coil increase, the magnetic strength at the centre increases, because the current in each circular turn is having the same direction, thus the field due to each turn adds up.
(iii)The strength of the current flowing in the coil: as the strength of the current increases, the strength of the magnetic fields also increases.
Solenoid: (Refer to figure 13.10, page no. 229 of N.C.E.R.T Text book)
(i) A coil of many turns of insulated copper wire wrapped in the shape of a cylinder is called a Solenoid.
Magnetic field produced by a Solenoid is similar to a bar magnet.
The strength of magnetic field is proportional to the number of turns & magnitude of current.
Electromagnet: An electromagnet consists of a long coil of insulated copper wire wrapped on a soft iron core. (Refer to figure 13.11, page no. 229 of N.C.E.R.T Text book)
Fleming's Left hand rule: Stretch the thumb, forefinger and middle finger of left hand such that they are mutually perpendicular. Forefinger points in the direction of magnetic field and centre finger in the direction of current, then the thumb gives the direction of force acting on the conductor.
(Refer to figure13.13, page no. 231 of N.C.E.R.T Text book)
Electric motor: A device that converts electric energy to mechanical energy.
(Refer to figure 13.15, page no. 232 of N.C.E.R.T Text book)

Principle of Electric motor: When a rectangular coil is placed in a magnetic field and a current is passed through it, force acts on the coil, which rotates it continuously. With the rotation of the coil, the shaft attached to it also rotates.
Electromagnetic induction: Electricity production as a result of magnetism (induced current) is called Electromagnetic induction.
Fleming's Right hand rule: gives the direction of induced current.
Stretch the thumb, forefinger and middle finger of right hand such that they are mutually perpendicular. Forefinger points in the direction of magnetic field and centre finger in the direction of induced current, then the thumb gives the direction of motion of the conductor.
Electric generator: A devise that converts mechanical energy to electric energy. (Refer to figure 13.19, page no. 236 of N.C.E.R.T Text book)
Electric generator is of two types- (i) A.C generator (ii) D. C generator
Principle of Electric generator: Electromagnetic induction
Domestic electric circuits: (Refer to figure 13.20, page 238 of N.C.E.R.T Text book)
We receive electric supply through mains supported through the poles or cables. In our houses we receive AC electric power of 220V with a frequency of 50Hz.
The 3 wires are as follows- (i) Live wire- (Red insulated, Positive)
(ii)Neutral wire- (Black insulated, Negative) (iii)Earth wire- (Green insulated) for safety measure to ensure that any leakage of current to a metallic body does not give any serious shock to a user.
Short circuit: is caused by touching of live wires and neutral wire
Fuse: is a protective device used for protecting the circuits from short circuiting and over loading



DIAGRAMS

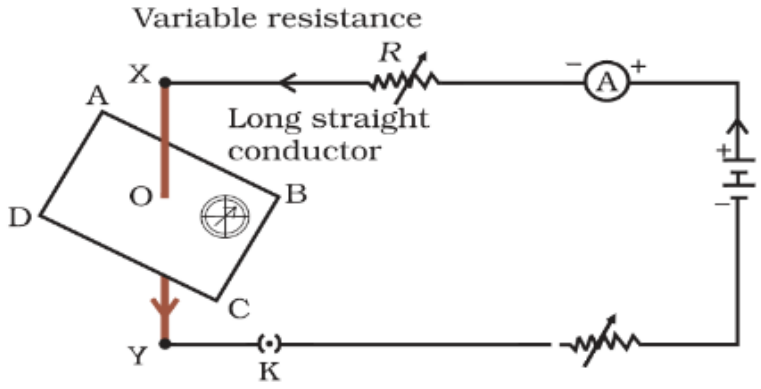


Figure 13.1
Compass needle is deflected on passing an electric current through a metallic conductor

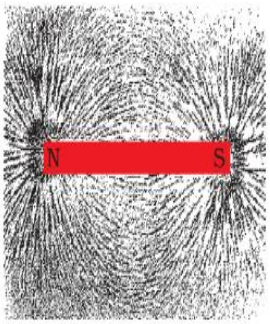


Figure 13.2
Iron filings near the bar magnet align themselves along the field lines.

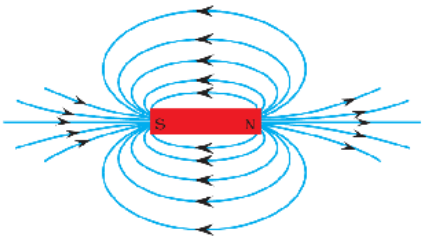


Figure 13.4
Field lines around a bar magnet

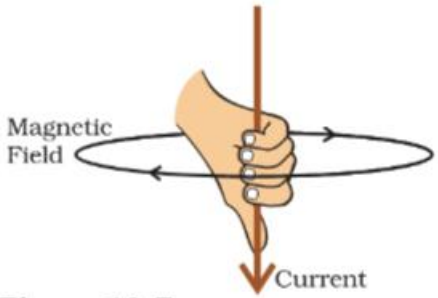


Figure 13.7
Right-hand thumb rule

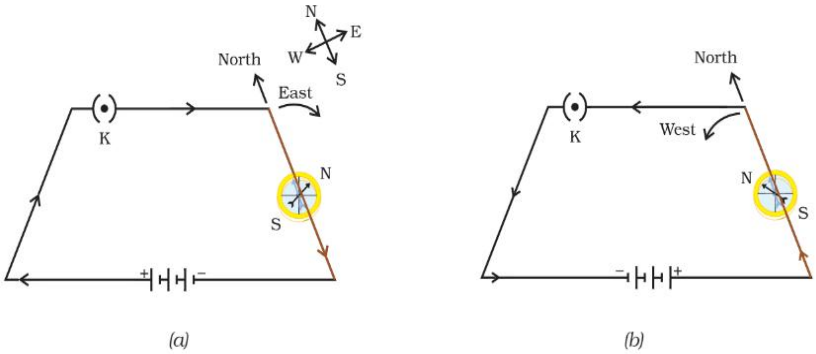


Figure 13.5 *A simple electric circuit in which a straight copper wire is placed parallel to and over a compass needle. The deflection in the needle becomes opposite when the direction of the current is reversed.*

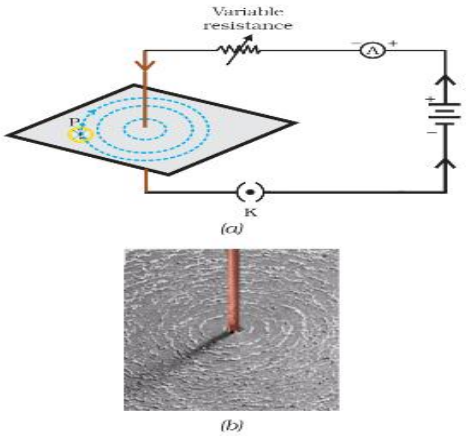


Figure 13.6
(a) A pattern of concentric circles indicating the field lines of a magnetic field around a straight conducting wire. The arrows in the circles show the direction of the field lines. (b) A close up of the pattern obtained.

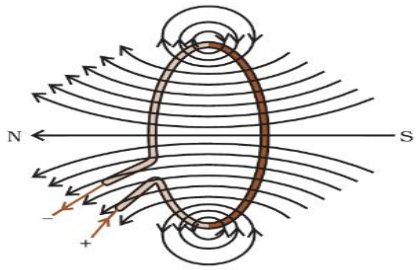


Figure 13.8
Magnetic field lines of the field produced by a current-carrying circular loop

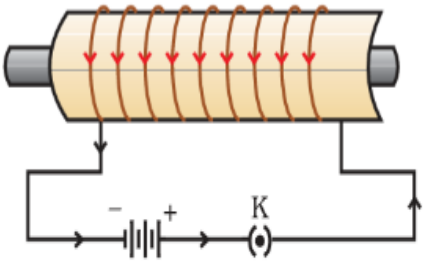


Figure 13.11
A current-carrying solenoid coil is used to magnetise steel rod inside it – an electromagnet.

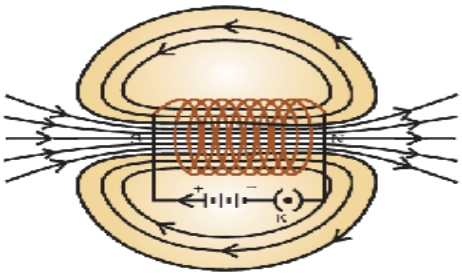


Figure 13.10
Field lines of the magnetic field through and around a current carrying solenoid.

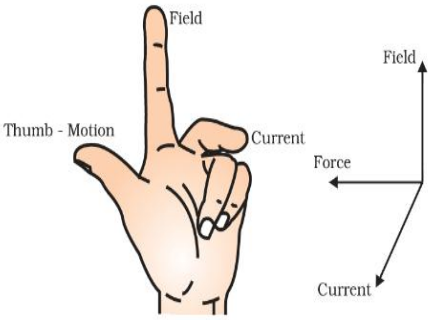


Figure 13.13
Fleming's left-hand rule

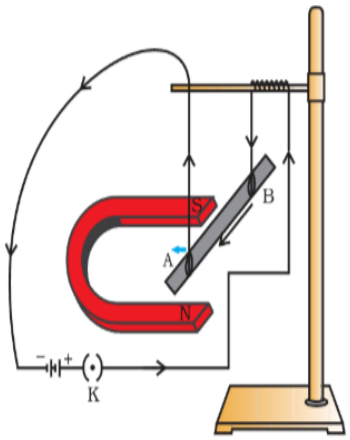


Figure 13.12
A current-carrying rod, AB, experiences a force perpendicular to its length and the magnetic field.

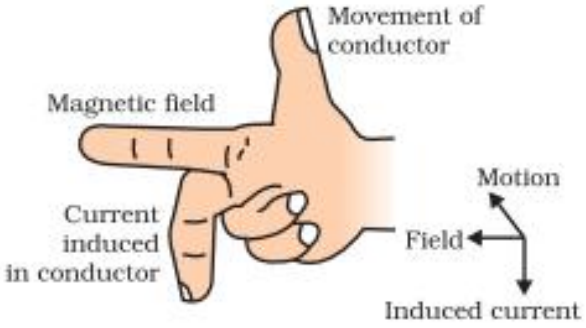


Figure 13.18
Fleming's right-hand rule

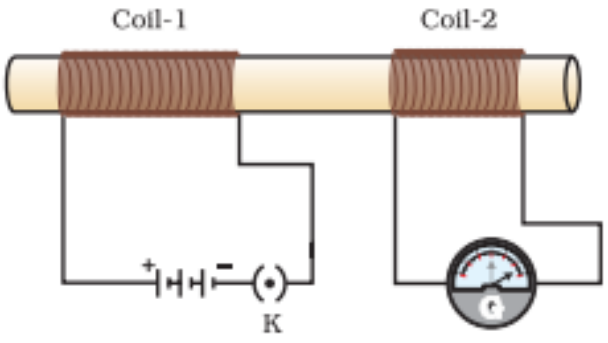


Figure 13.17
Current is induced in coil-2 when current in coil-1 is changed

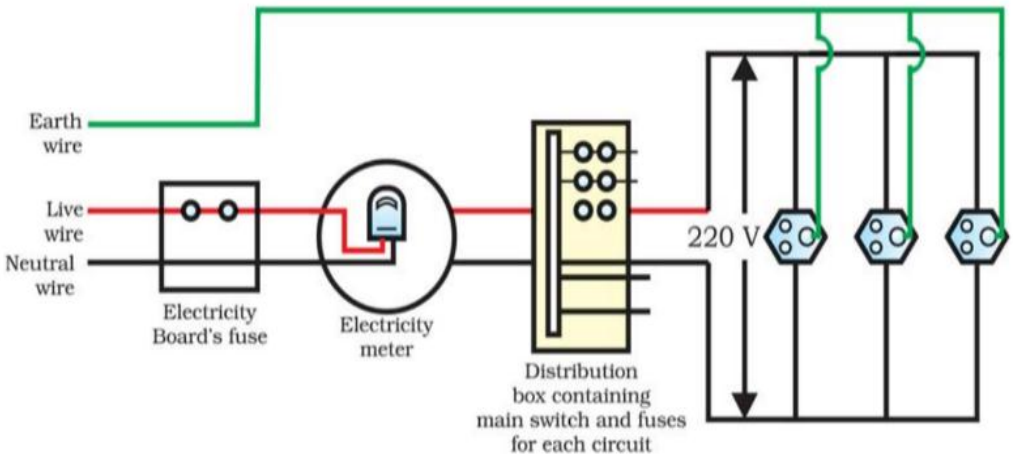


Figure 13.20 *A schematic diagram of one of the common domestic circuits*

Question Bank

Very Short Answer Type Questions (1mark)

Q.1What is a solenoid?

Q.2What is the direction of the magnetic field lines inside a bar magnet?

Q.3What is the direction of the magnetic field lines outside a bar magnet?

Short Answer Type Questions (2 mark)

Q.1What is an electromagnet?

Q.2What is the difference between a direct current and an alternating current? What is the frequency of AC in India?

Q.3 State the rule to find the direction of magnetic field produced around a current-carrying conductor**.**

Short Answer Type Questions (3 mark)

Q.1What is the role of fuse, used in series with any electrical appliance? Why should a fuse with defined rating not be replaced by one with a larger rating?

Q.2 Why does a magnetic compass needle deflect when a bar magnet or a current-carrying loop is brought near it.

Value Based Question

The students of class 10^{th} were excited as they were shown a documentary on "power consumption" during a Science Fair. The documentary explained that we use Alternating Current in our home and factory which is dangerous if not handled properly. Short circuiting and overloading are the two main causes for electrical hazards. Short circuiting occurs when the live wire and the neutral wire

come into direct contact. In this situation, the resistance of the circuit becomes very small and a very large current flows through the circuit which produces large amount of heat. This heat raises the temperature of the circuit and sparking at the point of short circuiting. Overloading means flow of current in the circuit beyond a specified limit. Overloading occurs due to an accidental rise in the supply voltage. Sometimes overloading is caused by connecting too many appliances of high power rating to a single socket. At the end students were happy as they got lot of information on power use.

1) What causes short circuit?
2) What do you mean by the term 'Overloading'?
3) What values do the students learn from the Documentary?

A.1) Short circuiting occurs when the live wire and the neutral wire come into direct contact.
2) Overloading means flow of current in the circuit beyond a specified limit.
3)Concern for safety /Scientific temperament