4. Effects of electric current

Note:

$(\rightarrow = step\ continued\ on\ new\ line)$

1. Tell the odd one out. Give proper explanation.
a. Fuse wire, bad conductor, rubber gloves, generator.
Ans. Generator. It converts mechanical energy into electric energy, the remaining three not.

b. Voltmeter, Ammeter, galvanometer, thermometer
Ans. Thermometer. It measures temperature, the remaining three measure electrical quantities.

c. Loud speaker, microphone, electric motor, magnet.
Ans. Magnet. It exerts a force on a magnetic material, the remaining three convert one form of energy into another.

2. Explain the construction and working of the following. Draw a neat diagram and label it.
a. Electric motor
Ans. Figure 4.19 shows the construction of an electric motor. Here, a rectangular loop ABCD of copper wire with resistive coating is placed between the northpole and south pole of a strong magnet, such as a horseshoe magnet, such that the branches AB and CD are perpendicular to the direction of the magnetic field. The ends of the loop are connected
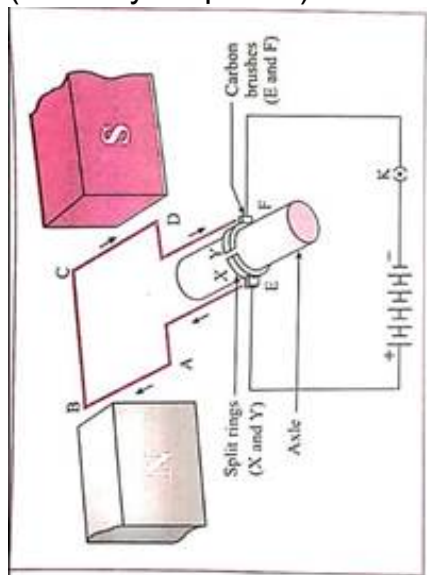(Rotate your phone)

Fig. 4.19 : Electric motor : Principle and working

to the two halves, X and Y, of split rings-X and Y have resistive coating on their inner surfaces and are tightly fitted on the axle. The outer conducting surfaces of X and Y are in contact with two stationary carbon brushes, E and F, respectively.

Working: (1) When the circuit is completed with a plug key or switch, the current flows in the direction E → A → B → C → D → F. As the magnetic field is directed from the northpole to the southpole, the force on AB is downward and that on CD is upward by Fleming's left hand rule. Hence, AB moves downward and CD upward. These forces are equal in magnitude and opposite in direction. Therefore, as observed from the side AD, the loop ABCD and the axle start rotating in anticlockwise direction.

(2) After half a rotation, X and Y come in contact with brushes F and E respectively and the current

flows in the direction EDCBAF. Hence the force on CD is downward and that on AB is upward. Therefore, the loop and the axle continue to rotate in the anticlockwise direction.

(3) After every half rotation, the current in the loop is reversed and the loop and the axle continue to rotate in anticlockwise direction.

When the current is switched off, the loop stops rotating after some time.

b. Electric generator (AC)

Ans. Figure 4.28 shows the construction of an AC electric generator. Here, a coil ABCD of copper wire is kept between the pole pieces (N and S) of a strong magnet. The ends of the coil are connected to
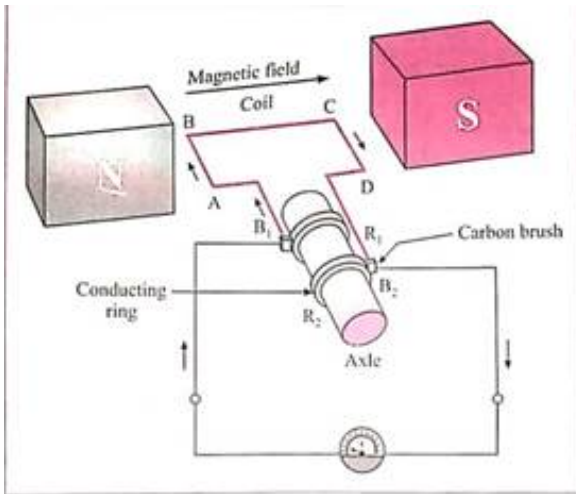
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Fig. 4.28 : Electric generator (AC)

the conducting rings R, and R via carbon brushes B, and B. The rings are fixed to the axle and there is a resistive coating in between the rings and the axle. The stationary brushes are connected to a galvanometer used to show the direction of the current in the circuit.

Working: When the axle is rotated with a machine from outside, the coil ABCD starts rotating. Suppose the coil rotates in clockwise direction, as observed from the side AD. Then as the branch AB moves upward, the branch CD moves downward. By Fleming's right hand rule, the induced current flows in the direction A → B → C → D and in the external circuit, it flows from B_2 to B_1 through the galvanometer.

The induced current is proportional to the number of turns of the copper wire in the coil. After half a rotation, AB and CD interchange their places. Hence, the induced current flows in the direction D → C → B → A. As AB is always in contact with B_1 and CD is in contact with B_2 the current in the external circuit flows from B_1 to B_2 through the galvanometer.

Thus, the direction of the current is the external circuit is opposite to that in the previous half rotation. The process goes on repeating and alternating current is generated.

3. Electromagnetic induction means.
a. Charging of an electric conductor.
b. Production of magnetic field due to a current flowing through a coil.
c. Generation of a current in a coil due to relative motion between the coil and the magnet
d. Motion of the coil around the axle in an electric motor.
Ans. Not available

4. Explain the difference:
AC generator and DC generator.

AC generator	DC generator
1. In an AC generator, the rings used are not split.	1. In a DC generator, split rings are used.
2. The direction of the current produced reverses after equal intervals of time.	2. The current produced flows in the same direction all the time.

6. How does the short circuit form? What is its effect?

Ans. If a bare live wire (phase wire) and a bare its effect? neutral wire touch each other (come in direct contact) or come very close to each other, the resistance of the circuit becomes very small and hence huge (very high) electric current flows through it. This condition is called a short circuit or short circuiting. In this case, a large amount of heat is produced and the temperature of the components involved becomes very high. Hence, the circuit catches fire.

7. Give Scientific reasons.

a. Tungsten metal is used to make a solenoid type coil in an electric bulb.

Ans. (1) The intensity of light emitted by the filament of a bulb depends on the temperature of the filament. It increases with the temperature.

(2) The melting point of the material used to make the filament of a bulb should be very high so that the filament can be heated to a high temperature by passing a current through it, without melting it.

This enables us to obtain more light. The melting point of tungsten is very high.

Hence, tungsten is used to make a solenoid type coil (filament) in an electric bulb.

b. In the electric equipment producing heat e.g. iron, electric heater, boiler, toaster etc, an alloy such as Nichrome is used, not pure metals.

Ans. (1) The working of heating devices such as a toaster and an electric iron is based on the heating effect of electric current, i.e., conversion of electric energy into heat by passage of electric current through a metallic conductor.

(2) An alloy, such as Nichrome, has high resistivity and it can be heated to a high temperature without oxidation, in contrast to pure metals Therefore, the coils in heating devices such as a toaster and an electric iron are made of an alloy. Such as Nichrome, rather than a pure metal.

c. For electric power transmission, copper or aluminium wire is used.

Ans. (1) Copper and aluminium are good conductors of electricity

(2) Copper and aluminium have very low resistivity. Hence, when an electric current flows through a wire of copper or aluminium, heat produced is comparatively low. Therefore, for electric power transmission, copper or aluminium wire is used.

d. In practice the unit kWh is used for the measurement of electrical energy, rather than joule.

Ans. (1) If an electric device rated 230 V. 5 A 1s operated for one hour, electric energy used
= VIt = 230 V x 5A x 3600s=4140000 joules.
(2) If this energy is expressed in kW.h, it will be

$$\frac{4140000}{3.6 \times 10^6}$$

kW.h = 1.15 kW.h (more convenient). Hence, in practice the unit kWh is used for the measurement of electric energy, rather than the joule.

8. Which of the statement given below correctly describes the magnetic field near a long, straight current carrying conductor?
a. The magnetic lines of force are in a plane, perpendicular to the conductor in the form of straight lines.
b. The magnetic lines of force are parallel to the conductor on all the sides of conductor.
c. The magnetic lines of force are perpendicular to the conductor going radially outword.
**do. The magnetic lines of force are in concentric circles with the wire as the center, in a plane perpendicular to the conductor.**
Ans. The magnetic lines of force are in concentric circles with the wire as the centre, in a plane perpendicular to the conductor

9. What is a solenoid? Compare the magnetic field produced by a solenoid with the magnetic field of a bar magnet. Draw neat figures and name various components.
Ans. When a copper wire with a resistive coating is wound in a chain of loops (like a spring), it is called a solenoid.
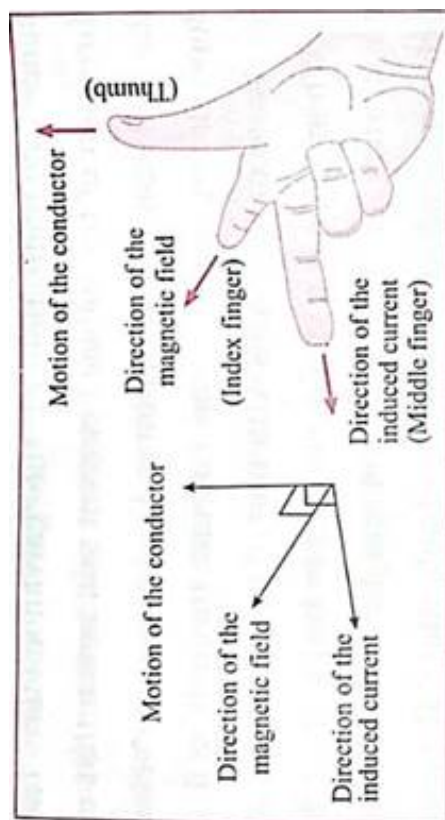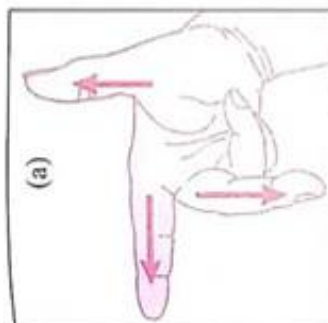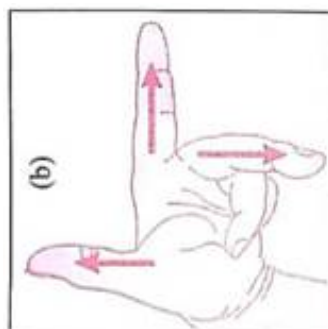(Rotate your phone)
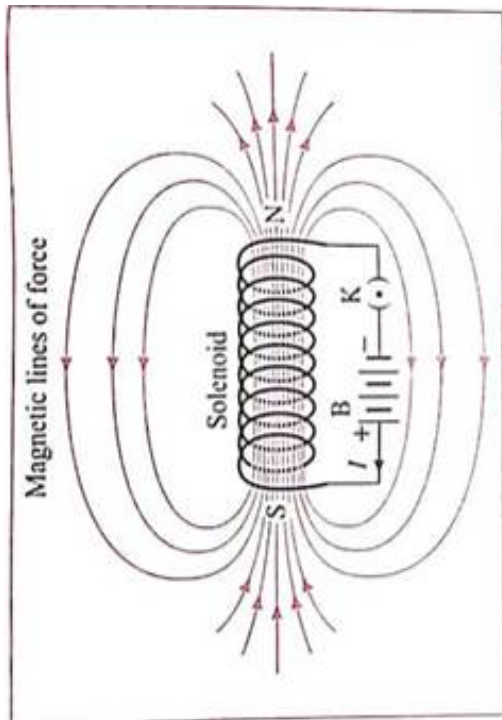
The magnetic field lines (magnetic lines of force) due to a current-carrying solenoid are similar to those of a bar magnet. One face of the coil acts as the southpole and the other face as the north pole.

10. Name the following diagrams and explain the concept behind them.

(Rotate your phone)

(b)

(a)

Motion of the conductor

Direction of the magnetic field

(Index finger)

Direction of the induced current (Middle finger)

(Thumb)

Motion of the conductor

Direction of the magnetic field

Direction of the induced current

Ans. A. Stretch the thumb, the index finger and the middle finger of the right hand in such a way that they are perpendicular to each other. In this position, the thumb indicates the direction of the motion of the conductor, the index finger the direction of the magnetic field, and the middle finger shows the direction of the induced current.

(Rotate your phone)

Force on the conductor

Direction of the magnetic field
(Index finger)

Direction of the current
(Middle finger)

(Thumb)

Force on the conductor

Direction of the magnetic field

Direction of the current
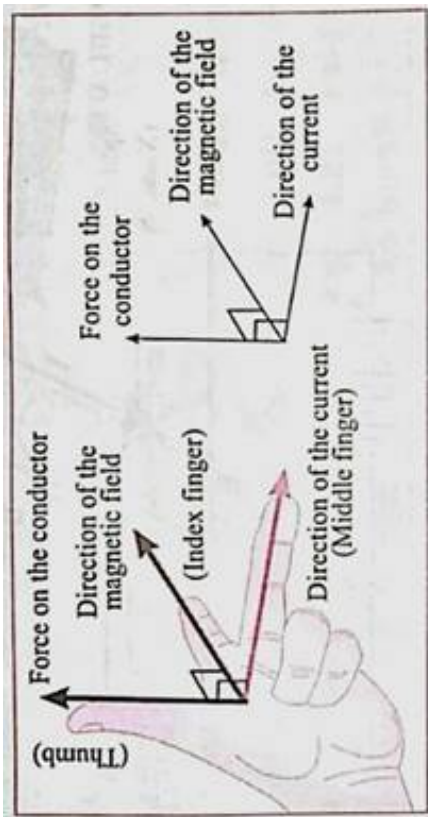
11. Identify the figures and explain their use.

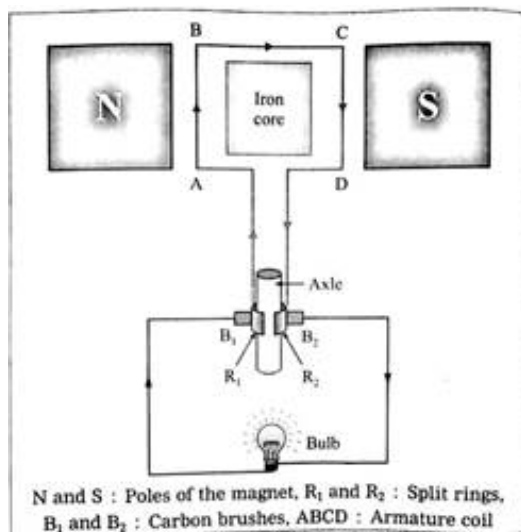(Rotate your phone)

(a)

(b)

(c)

S

N

A
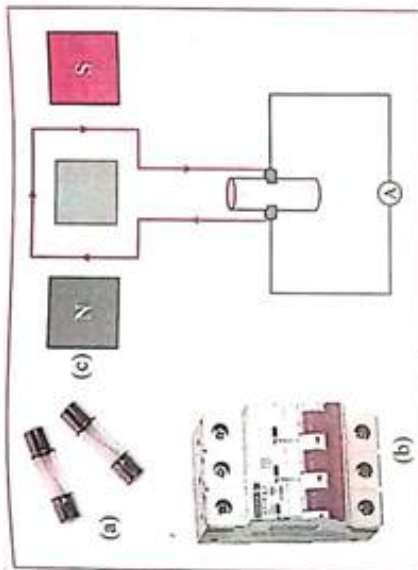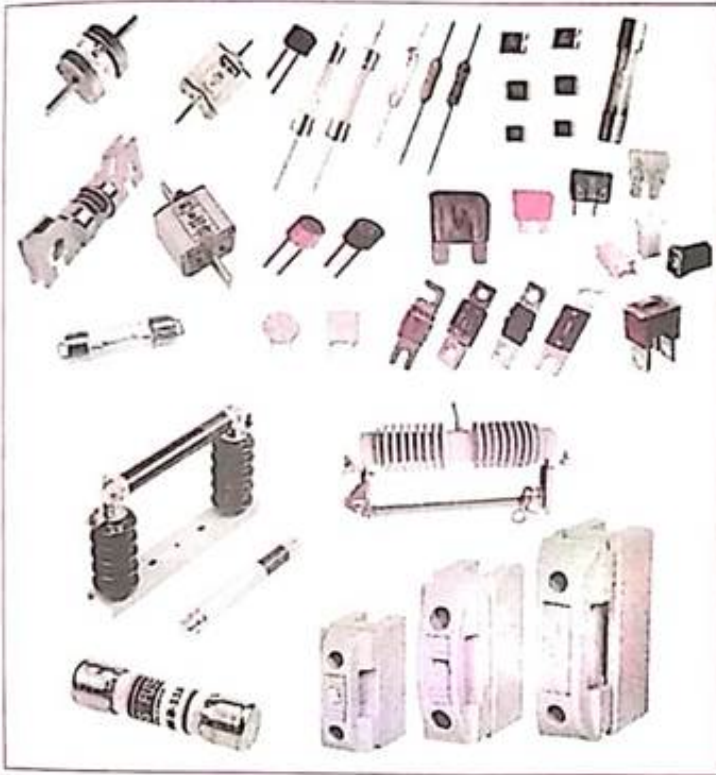
Ans. (a) A fuse protects electrical circuits and appliances by stopping the flow of electric current when it exceeds a specified value. For this, it 1s connected in series with the appliance (or circuit) to be protected. A fuse is a piece of wire made of an alloy of low melting point (e.g. an alloy of lead and tin). If a current larger than the specified value flows through the fuse, its temperature increases enough to melt it. Hence, the circuit breaks and the appliance is protected from damage. **(Rotate your phone)**

Ans. (b) These days miniature circuit breaker (MCB) switches are used in homes. When the current in the circuit suddenly increases this switch opens and current stops. Different types of MCBs are in use. For the entire house, however the usual fuse wire is used.

N and S : Poles of the magnet, R_1 and R_2 : Split rings,
B_1 and B_2 : Carbon brushes, ABCD : Armature coil

Working: The axle is rotated with a machine from outside. When the armature coil of the generator rotates in the magnetic field, electric potential difference is produced in the coil due to electromagnetic induction. This produces a current as shown by the glowing of the bulb or by a galvanometer. The direction of the current depends on the sense of rotation of the coil. In a DC generator, one brush is always in contact with the arm of the coil moving up while the other brush is in contact with the arm of the coil moving down in the magnetic field. Hence, the flow of the current in the circuit is always in the same direction and the current flows so long as the coil continues to rotate in the magnetic field.

12. Solve the following example.

a. Heat energy is being produced in a resistance in a circuit at the rate of 100 W. The current of 3 A is flowing in the circuit. What must be the value of the resistance?

Ans. Data: $P = 100$ W,

$I = 3A, R = ?, P = I^2R$

$\therefore$ Resistance,

$R = \dfrac{P}{I^2} = \dfrac{100W}{(3A)^2} = \dfrac{100}{9}$

b. Two tungsten bulbs of wattage 100 W and 60 W power work on 220 V potential difference. If they are connected in parallel, how much current will flow in the main con ductor?

Ans. Data

$: P_1 = 100W, P_2 = 60W, V = 220\,V,$

$I = ? \quad \therefore I = \dfrac{P}{V}$

$P = VI$

$\therefore I_1 = \dfrac{P_1}{V}$ and $I_2 = \dfrac{P_2}{V}$

Current in the main conductor,

$I = I_1 + I_2$

(parallel connection)

$= \dfrac{P_1}{V} + = \dfrac{P_2}{V} = \dfrac{P_1 + P_2}{V}$

$= \dfrac{100W + 60W}{220V} = \dfrac{160}{220}A$

= 0.727 A= **nearly 0.73 A.**

c. Who will spend more electrical energy? 500 W TV Set in 30 mins, or 600 W heater in 20 mins?

Ans. Data: $P_1 = 500\,W,$

$t_1 = 30\,min = \dfrac{30}{60}\,h$

$= \dfrac{1}{2}\,h, P_2 = 600W,$

$t_2 = 20\,min = \dfrac{20}{60}h = \dfrac{1}{3}\,h$

Electrical energy used = Pt

TV set: P_1t_1

$= 500W \times \dfrac{1}{2}h = 250\,W.h$

Heater: $P_2t_2 = 600W \times \dfrac{1}{3}$

$\rightarrow h = 200\,W.h$

Thus, The TV set will spend more electrical energy than the heater.

d. An electric iron of 1100 W is operated for 2 hrs daily. What will be the electrical consumption expenses for that in the month of April? (The electric company charges Rs 5 per unit of energy).

Ans. Data: P = 1100w, t = 2 × 30 = 60 h, ₹ 5 per unit of energy, expanses =?

$$N = \frac{Pt}{1000W.h \; unit}$$

$$= \frac{1100W \times 60h}{1000W . \frac{h}{unit}}$$

$$= 66 units$$

∴Electrical consumption expanses

= 66 units × ₹5 per units

= ₹ 330