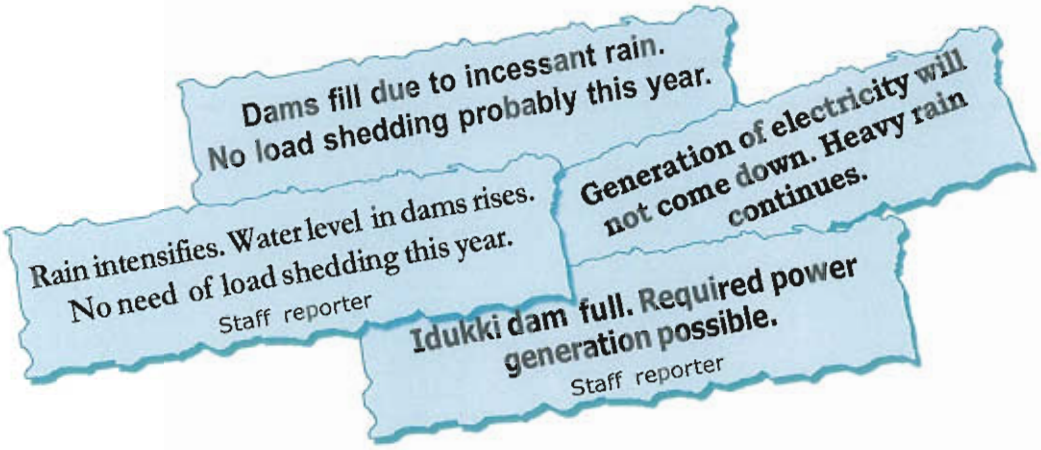
7 GENERATION AND DISTRIBUTION OF ELECTRIC POWER



Suraj had a doubt on reading the newspaper. What is the relation between rain and load shedding?

Can you suggest an answer for Suraj's doubt?

We know that a generator is a device for producing electricity.

★ What is the energy change that takes place in a generator?

What are the different ways of getting the mechanical energy required for working a generator? Discuss and record.

- Waterfalls
-

Hydroelectric power stations are power-stations where electricity is produced by rotating turbines of a generator by allowing water stored at a height to flow through pipes or tunnels.

In Kerala, which are the places where such power stations are set up? Find out and record.

In some power stations turbines are rotated using steam at high pressure. The steam required for this purpose can be produced by the combustion of coal, naphtha, lignite etc. or by using nuclear power. Power stations that make use of heat energy obtained by the combustion of fuels to produce electricity are known as thermal power stations.

Find the places where different kinds of power stations in India are situated and complete Table 7.1

Hydroelectric power station	Thermal power station	Nuclear power station
Pallivasal	Neyveli	Tharapur

Table 7.1

Whatever be the source of energy used for the production of electricity, the structure of a generator is the same.

★ What are the different parts of an electric generator?

★ What are the problems when a permanent magnet is used as the field magnet in the generator?

- The limitation of producing strong magnets.
-

★ How can these problems be solved? Discuss and record.

It is DC that must be supplied to electromagnets used as field magnets in generators. Auxiliary generators used for this purpose are the excitors.

Of the armature and the field magnet of a generator, the rotating part is the rotor and the stationary part is the stator.

The armature of a power generator will be heavy and so it is used as the stator. This helps to eliminate the graphite brush and avoid sparks.

★ Which part of the power generator is used as the rotor?

Single phase generator, Three phase generator

Haven't you seen small generators used in shops and houses? How many lines are taken out from them?

Such generators are single phase generators.

In a three phase generator there are three identical armature coils at an angle of 120° with one another against each pair of magnetic poles. Electric current in three different phases are obtained from such generators.

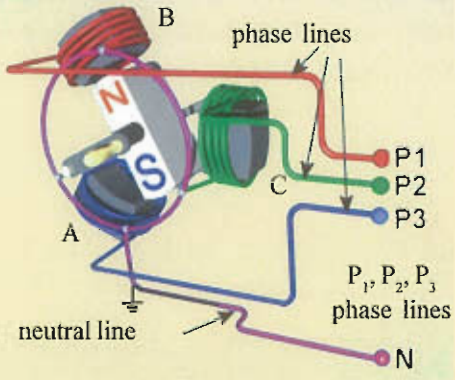


Fig. 7.1(a)
Structure of a three phase generator

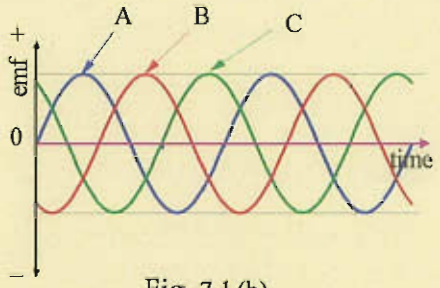


Fig. 7.1 (b)
Graphic representation of the emf obtained from the armature coils A, B,C of a three phase generator.

★ How many phase lines come out of a three phase generator?

★ How are the other ends of the armature coils connected?

★ If we touch the point where the ends of the coil are connected, we do not get a shock. What is the reason?

How is the electricity produced in huge generators distributed to distant places? Let's see.

Power transmission and distribution

Observe Fig. 7.2. In how many kV is electricity generated in our country?

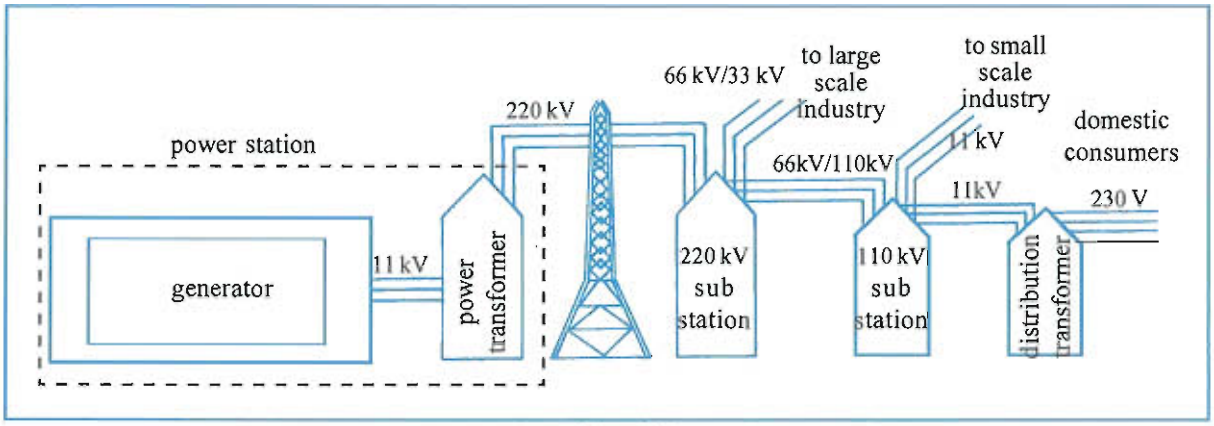


Fig. 7.2
Different stages of power distribution

★ Where is the step up transformer used?

★ Where do we use the step down transformer?

Transmission loss

When electric current is passed through a conductor heat is produced.

★ What are the factors on which this depends?

★ What are the different ways in which loss of energy in the form of heat, in electric lines, is reduced?

★ What is the relation between the electric current through a conductor and the heat developed in it?

We know, power P = V × I.

★ What is to be done for reducing I without changing power?

Isn't it now clear why a step up transformer is used at the initial stage of the transmission network? Thus by transmitting electricity at high voltage, energy loss can be minimised.

Star connection

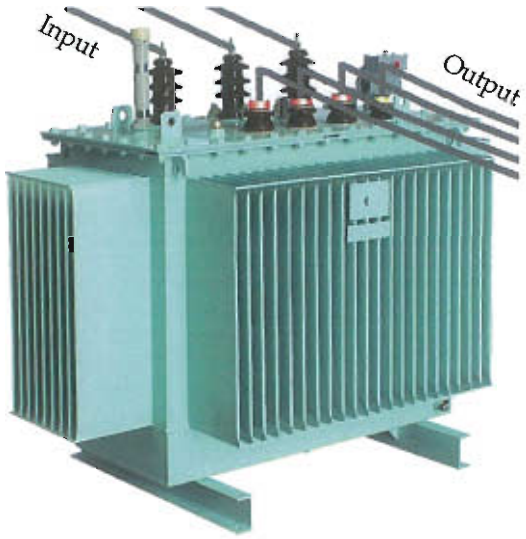


Fig. 7.3
Distribution transformer

Observe Fig. 7.3

How many lines come out of the distribution transformer meant for household and other purposes?

★ How many lines come into the transformer?

- -

Let's see how four lines come out of the secondary of a transformer.

Wires are connected in the star connection mode in the secondary of the distribution transformer

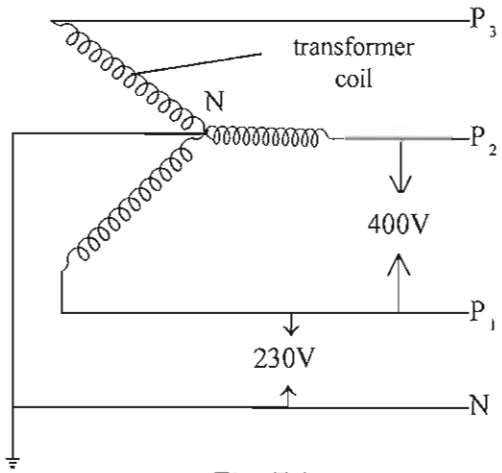


Fig. 7.4
Star connection

★ From where does the neutral line start in the star connection?

- -

★ What is the potential difference between two phase lines?

- -

★ In our country, what is the voltage at which household AC electrical equipments work? Find out and note it down.

- -

★ From the distribution system, which are the lines required for houses?

- -

Let's see how electric current flowing through these lines are supplied to electrical appliances in our houses.

Household wiring

What are the different electrical appliances that are usually used in our houses? Note them down.

- Bulb
- Mixie
-

★ What is the voltage at which these devices work?

- -

★ Do all of them require the same current?

- -

Let's see the mode in which electrical devices are to be connected in the house.

Arrange two circuits as shown in the figure using bulbs of the same power.

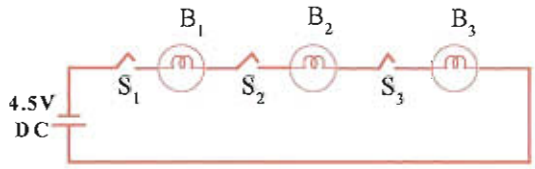


Fig. 7.5
Series circuit

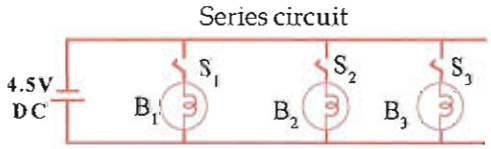


Fig. 7.6
Parallel circuit

★ In what way are the bulbs arranged in the first figure?

- -

★ And in the second?

You have already learnt how the strength of current differs when bulbs are connected in series and in parallel.

Switch on and operate the circuits.

★ In which circuit did the bulbs glow more brightly?

Now turn off one switch each in both circuits.

Record your observations.

Based on your experiments and inferences, discuss and record the way in which electrical appliances are connected in the household circuits. Note down in the science diary the advantages of connecting the appliances in the parallel mode.

Observe the diagram of the household circuit given in Fig. 7.7.

★ In which line is the fuse connected?

★ What is the position of the watthour meter?

★ What is the function of the main switch? Where is its position in the circuit?

★ In which line of the circuit are switches connected?

Nowadays, in the household circuits, the MCB (Miniature Circuit Breaker) is used after the main switch instead of fuse wire and the ELCB (Earth Leakage Circuit Breaker) is used to ensure safety.

Don't you see the earth wire connected to the three pin socket in the circuit?

Let's see the advantages of using three pin plugs.

Three pin plug and two pin plug

Observe Fig. 7.8. The electric iron in the circuit is connected to a two pin plug.

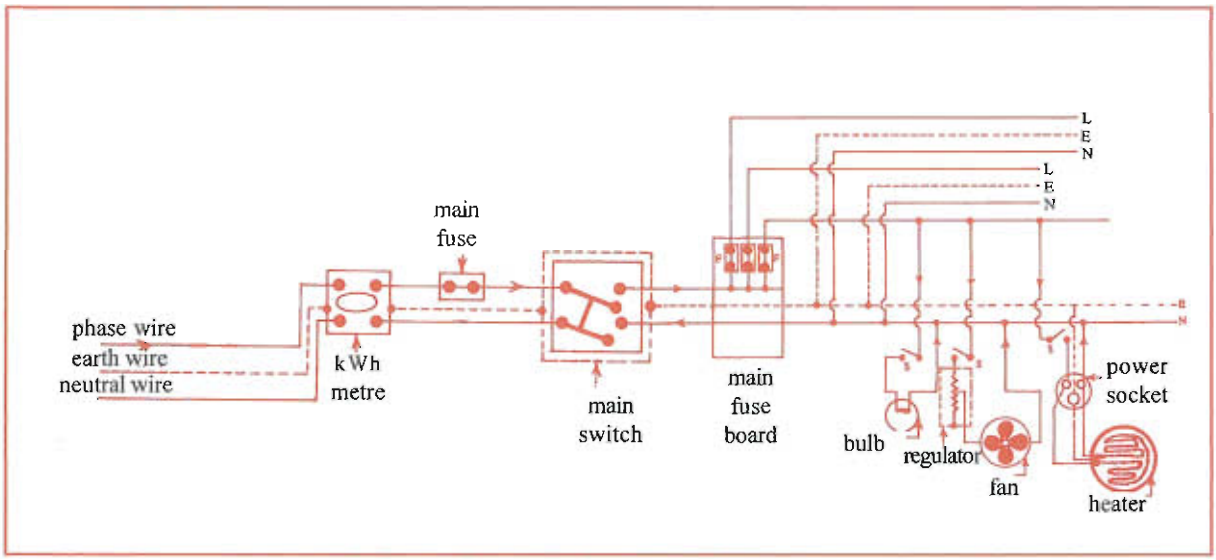


Fig. 7.7
Household wiring circuit

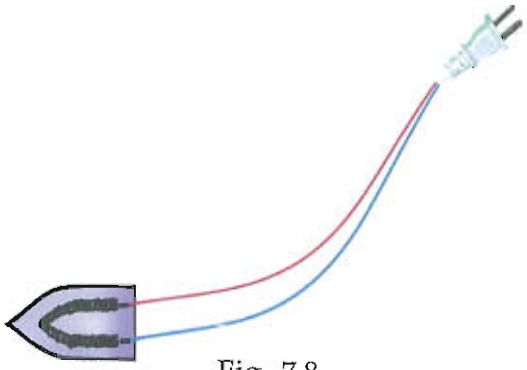


Fig. 7.8

★ Which are the lines to which the coil of the electric iron is connected?

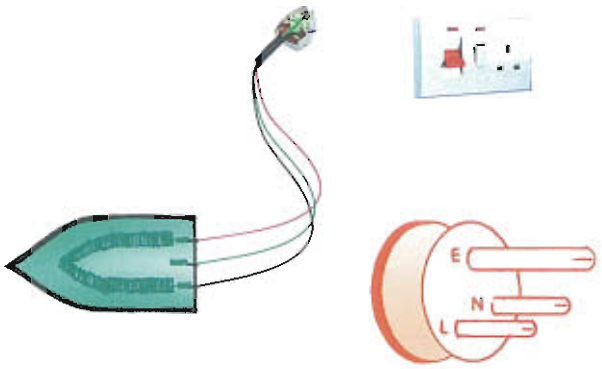
- -

★ What will happen to the person touching the metallic case, if the phase line comes in contact with the metallic case of the electric iron owing to insulation failure?

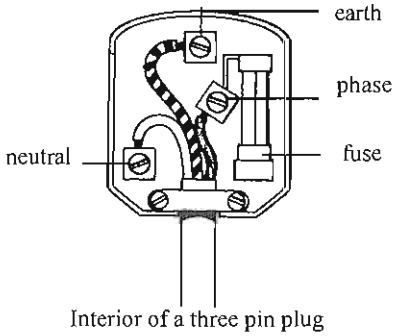
In Fig. 7.9, when the pins are in the socket,

★ which is the line that comes in contact with pin E? How is this pin different from other pins?

- -



Three pin plug



Interior of a three pin plug

Fig. 7.9

★ to which part of the appliance is this line connected?

- -

★ to which part of the appliance are the phase and neutral lines connected?

- -

★ when the phase line comes in contact with the outer metallic case where will the current flow to?

- -

In this case won't the current increase due to the low resistance of the circuit?

★ What happens to the fuse when the current in the circuit increases? Consequently what happens to the current in the circuit?

- -

From your findings record in the science diary how safety can be ensured by using a three pin socket.

To which device is the electric line in our houses connected first? What is the necessity of this device?

Measurement of electrical energy

We know that the electrical energy we consume depends upon the power of the appliances we use and the time interval for which they work.

★ What is the unit of power?

- -

★ What is the energy consumed when a device of power one watt is used for one second?

- -

★ What is the energy consumed when a device of power 1000 W is used for one hour?

- -

The energy consumed by a device of power 1000 W (1 kW) in one hour is one kilowatt hour. This is the commercial unit of electricity.

Energy consumed in kilowatt hour =

$$\frac{\text{Power (in watt) x time (in hour)}}{1000}$$

Complete Table 7.2, by calculating the energy consumed by the given devices.

Sl. No.	Device	Power W	Time of working hour	Energy consumed kWh
1	Electric Iron	750	0.5	----- -----
2	Fan	60	2	----- -----
3	Bulb	40	5	----- -----
4	LED	2	24	----- -----
5	CFL	20	4	----- -----

Table 7.2

- In your house 4 CF lamps of 18 W are used for 5 hours and 2 fans of 60 W are used for 3 hours daily. How many units of electricity are consumed in 30 days? What is the cost of electricity for one month at the rate of ₹ 3 per unit?

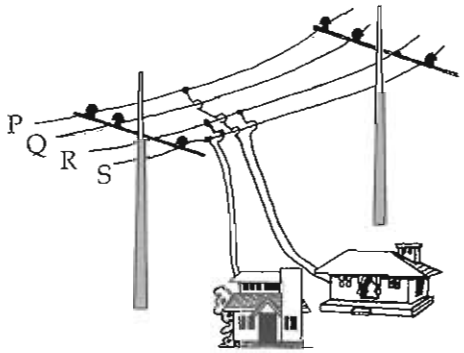
The light given out by a 100 W filament lamp and a 20 W CFL is approximately the same.

- In a house, five filament lamps of power 100 W are used daily for 3 hours. What is the cost of electrical energy consumed in a month at the rate of ₹ 3 per unit? Find the energy that is saved, if the filament lamps are replaced by CF lamps of 20 W, and record it in the science diary.

Estimate the electrical energy consumed by each of the electrical devices in your house for a day, by recording the time of their use and compare it with the meter reading.

Follow up Activities

1. (a) Compare nuclear power stations with thermal power stations and record the differences in power generation.
   (b) Nuclear power stations generate electricity at minimum cost. How do you respond to this statement? Justify your answer.
2. What are the important parts of a huge generator? What is the function of each? Why is it said that electricity has to be supplied in order to generate electricity from generators?
3. In power transmission, where is the step up transformer used? What is the need for different types of transformers in power transmission? What are the difficulties if transformers are not used?
4. Observe the electrical connections given to two adjacent houses.



   (a) Which is the neutral wire?
   (b) What is the potential difference between R and S?
   (c) What is the potential difference between P and R?
   (d) What is the potential difference between S and the earth?
5. In the household circuit, what are the different parts through which electricity is passed before reaching the filament of a lamp? Record them in order.
6. What are the problems arising when a two pin plug is used in an electric iron? How are they solved by using a three pin plug?
7. If 0.1 A current flows through a bulb working at 250 V, how many hours are required to consume one unit of electricity?