

BEST TRICKS, BEST CONCEPT, BEST SOLUTIONS

FOUNDATION

ELECTRICITY

HALF-YEARLY EXAM MASTERY

1 HOUR HUNT
THE ULTIMATE RESULT

A portrait of a man with dark hair, wearing an orange shirt, looking directly at the camera. The background is a purple gradient with faint mathematical symbols like pi, infinity, and sigma.

Sourabh Gandhi Sir
Engineer | Foundation Mentor | Teen-Parent Coach

Electricity

*It is sometimes really difficult to imagine **how we could live without electricity.***

*As we move around we use electricity from **batteries and cells** for our mobile phones, mp3 players and other mobile devices.*

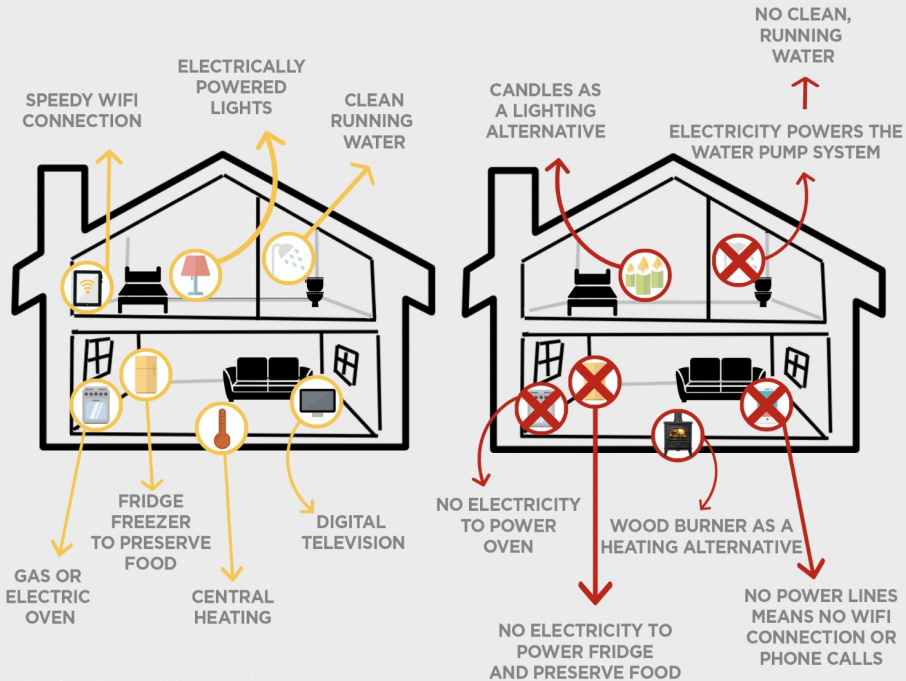
*In our homes and other buildings we use electricity **from the mains for heating, lighting and providing the energy for household appliances such as televisions, radios, computers and their printers.***

*Understanding what electricity is, where it comes from and how we can control it is important if we are to make **maximum use of this important source of energy.***

Is Electricity important?

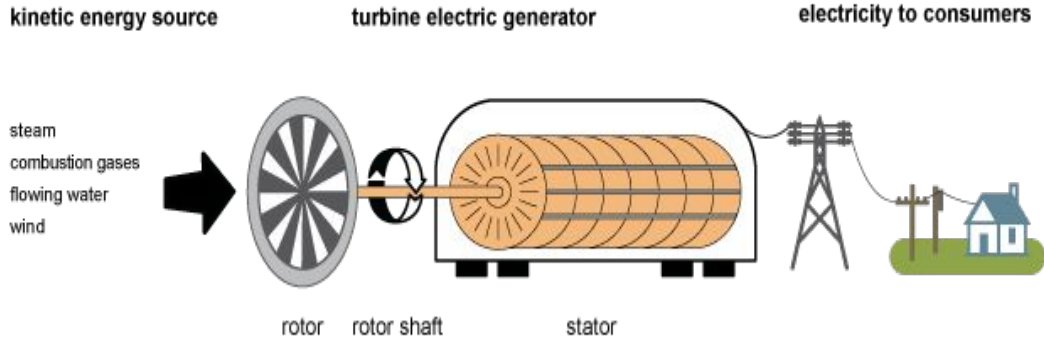
WITH ELECTRICITY

WITHOUT ELECTRICITY

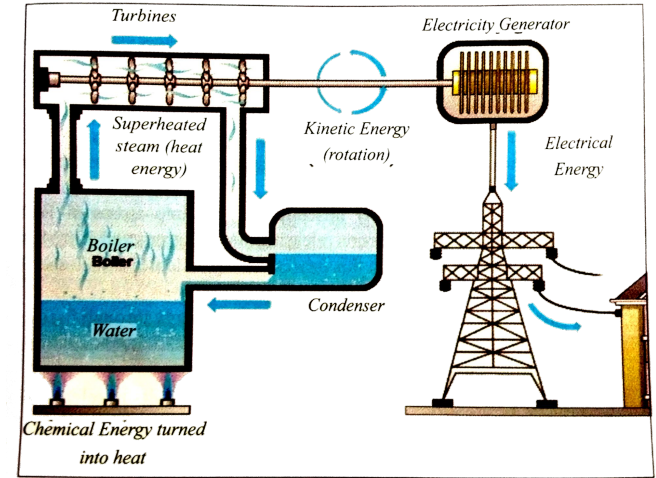


How is it produced?

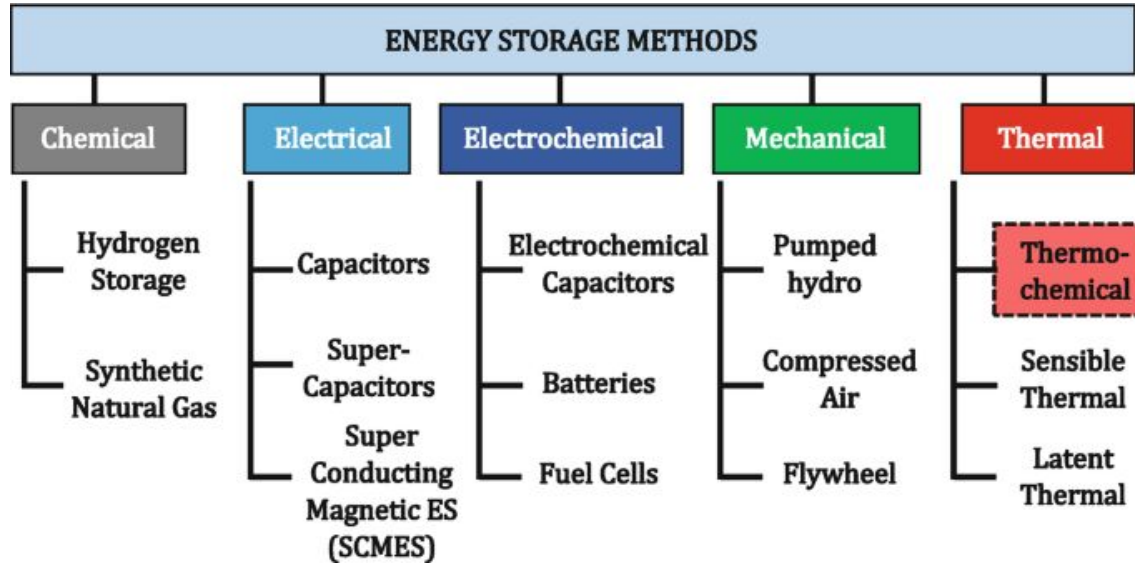
Electricity generation from an electric turbine



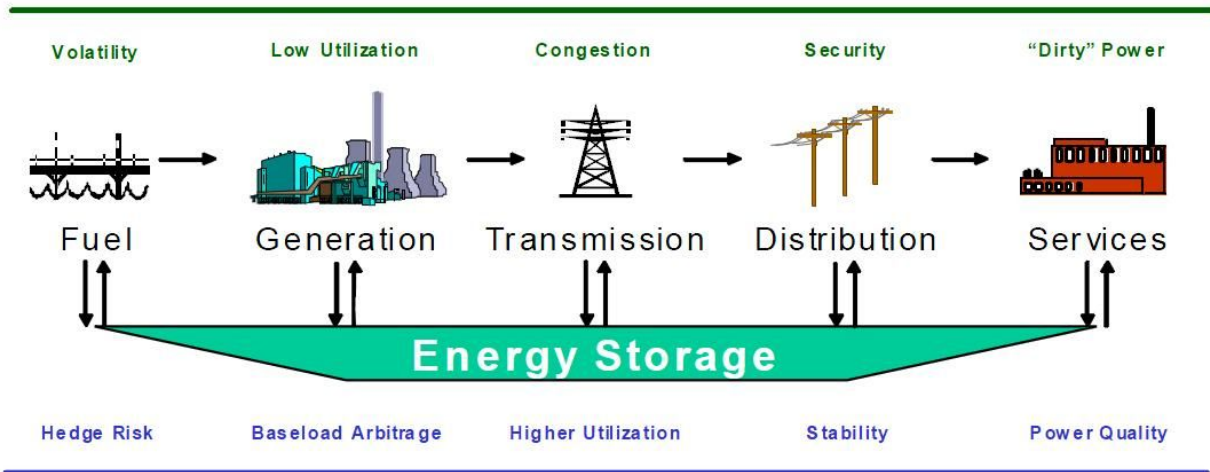
Source: U.S. Energy Information Administration



How is it stored?

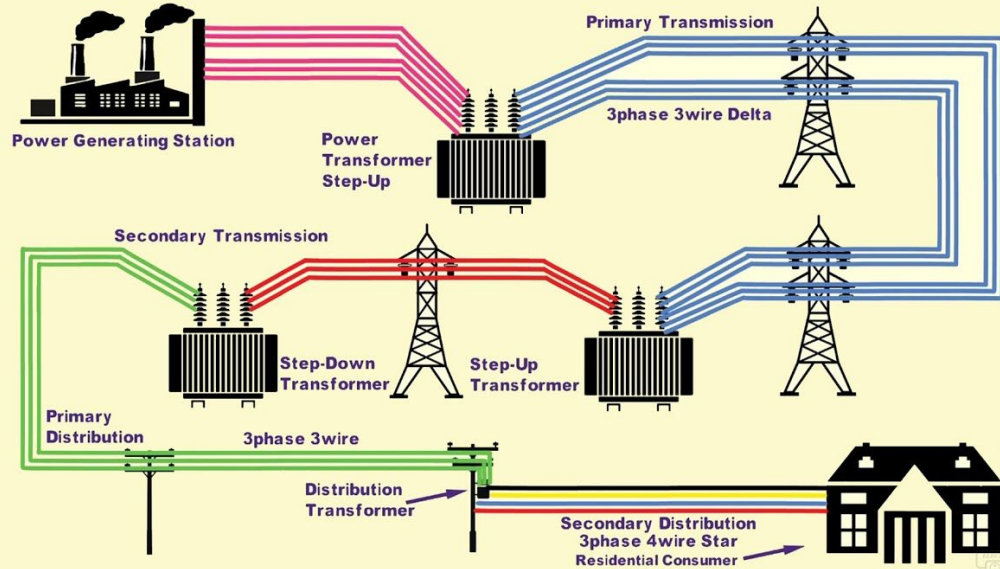


Challenges



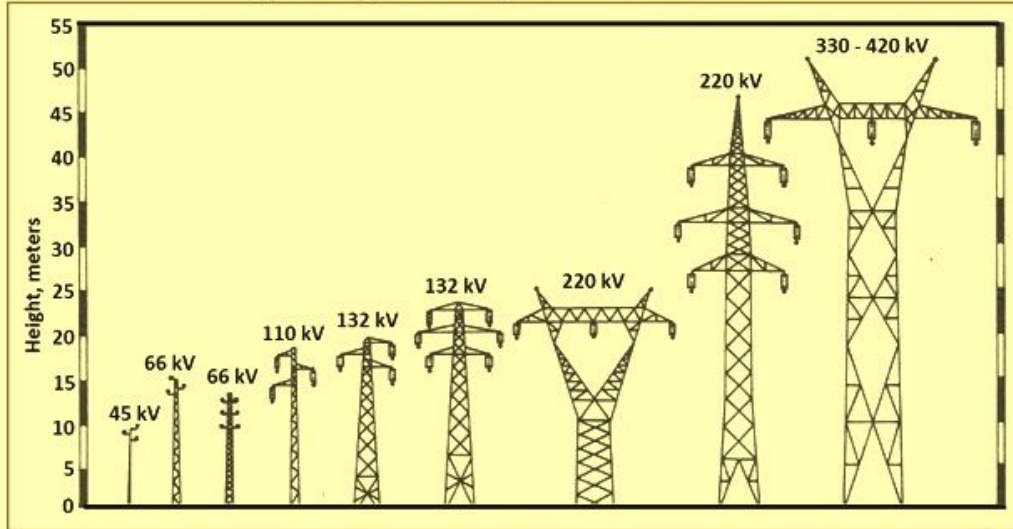
Benefits

How is it transmitted?



Types of Transmission Towers

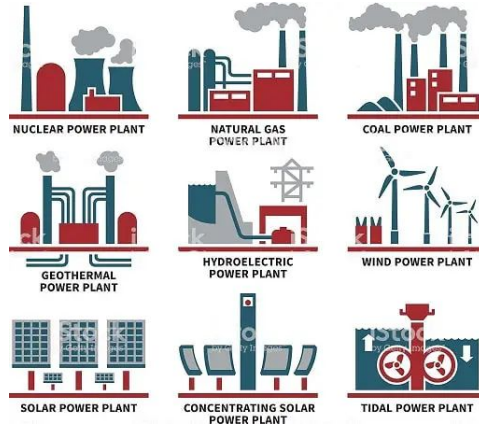
Typical shapes and heights of transmission towers



How dangerous is 440V?

Power Stations

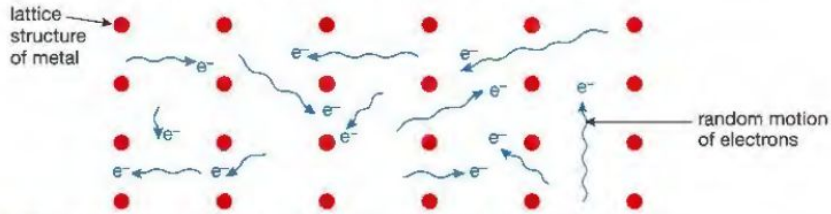
The electricity that we use for heating, lighting and air conditioning in our homes is called **mains electricity** and is supplied to us by **power stations**.



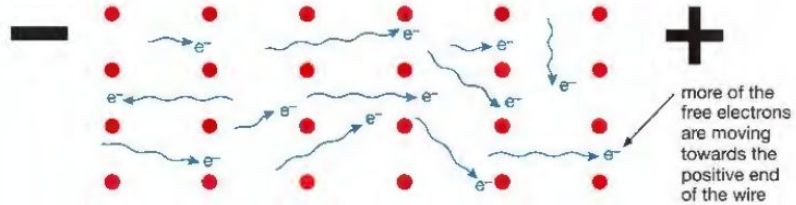
Types of Charges

- (i) **Opposite charges (or Unlike charges) attract each other.** For example, a positive charge attracts a negative charge.
- (ii) **Similar charges (or Like charges) repel each other.** For example, a positive charge repels a positive charge; and a negative charge repels a negative charge.

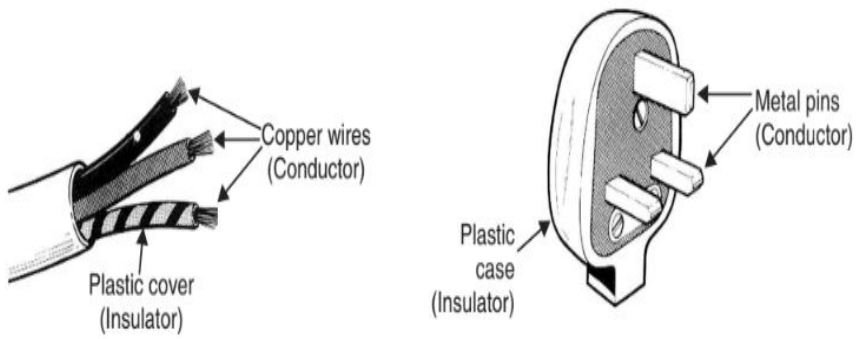
Flow of Charges



▲ Figure 7.2a With no voltage there is an equal flow of electrons in all directions.



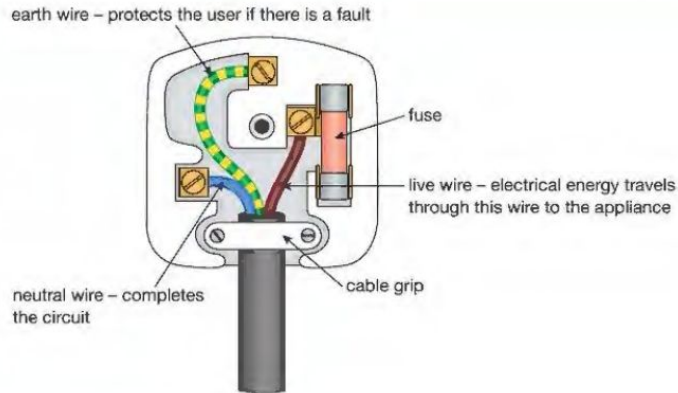
▲ Figure 7.2b When a voltage is applied more electrons will move towards the positive.



(a) An electric cable containing three insulated copper wires

(b) A three-pin plug

Figure 2. Conductors and insulators.



Problem. Calculate the number of electrons constituting one coulomb of charge.

One coulomb charge is equivalent to the charge contained in :

(a) 2.6×10^{19} electrons

(b) 6.2×10^{19} electrons

(c) 2.65×10^{18} electrons

(d) 6.25×10^{18} electrons

The study of electricity is classified into two parts.

1. **Static electricity:** It deals with electric charges at rest and their effects.
2. **Current electricity:** It deals with charges in motion and their effects.

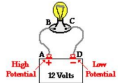
This chapter deals with charges in motion, i.e., current electricity.

Static Electricity vs. Electric Current

Static electricity is a one time event.



Electric current is a constant flow.



Static vs. Current Electricity

- **Static Electricity:** charges build up in one location
- **Current Electricity:** electrons on the move

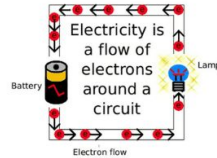


Figure 18.1 This child's hair contains an imbalance of electrical charge (commonly called *static electricity*), which causes it to stand on end. The sliding motion stripped electrons away from the child's body, leaving him with an excess of positive charges, which repel each other along each strand of hair. (credit: Ken Bosma, Wikimedia Commons)

ELECTRIC CURRENT

The rate of flow of charge is known as electric current. It is denoted by I . If ' q ' is the net charge passing through any cross section of a conductor in time ' t ', then

$$\text{Current } (I) = \frac{\text{Charge}(q)}{\text{Time}(t)}$$

Current is a scalar quantity. S.I. unit of current is ampere (A). Multiple units of current are kiloampere ($1 \text{ kA} = 10^3 \text{ A}$), Megaampere ($1 \text{ MA} = 10^6 \text{ A}$).

Submultiple units are mA ($1 \text{ milliampere} = 10^{-3} \text{ A}$) and microampere ($1 \mu\text{A} = 10^{-6} \text{ A}$).

One Ampere

The current passing through a conductor is said to be one ampere when the net flow of charge per second through its cross section is one coulomb.

The charge transferred is always an integral multiple of the fundamental charge (charge of a proton). This property is referred to as **quantization of charge**.

i.e., $Q = ne$

Since current (I) = $\frac{Q}{t}$ or $I = \frac{ne}{t}$

where e = magnitude of charge of an electron.

n = number of electrons flowing across any point in time ' t '

A current of 5.0 A flows through a circuit for 15 min. Calculate the amount of electric charge that flows through the circuit during this time.

An electric bulb draws a current of 0.25 A for 20 minutes. Calculate the amount of electric charge that flows through the circuit.

A TV set shoots out a beam of electrons. The beam current is $10 \mu\text{ A}$.

- (a) How many electrons strike the TV screen in each second ?
- (b) How much charge strikes the screen in a minute?

A current of 10A exists in a conductor. Assuming that this current is entirely due to the flow of electrons

- (a) find the number of electrons crossing the area of cross section per second,
- (b) if such a current is maintained for one hour, find the net flow of charge.

Ammeter

Current is measured by an instrument called ammeter (see Figure 6). The ammeter is always connected in **series** with the circuit in which the current is to be measured.

Since the entire current passes through the ammeter, therefore, an ammeter should have **very low resistance** so that it may **not change the value of the current** flowing in the circuit.

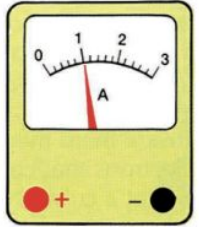


Figure 6. This is an ammeter.

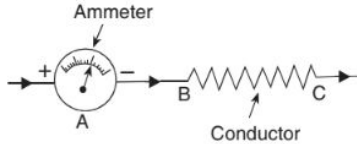


Figure 7. An ammeter connected in series with a conductor BC to measure the current passing through it.



Voltmeter

The potential difference is measured by means of an instrument called voltmeter. The voltmeter is always **connected in parallel** across the two points where the potential difference is to be measured. A **voltmeter has a high resistance** so that it **takes a negligible current** from the circuit.

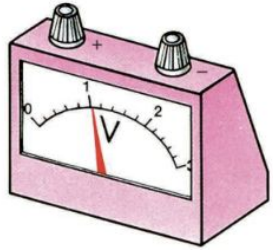


Figure 4. This is a voltmeter.

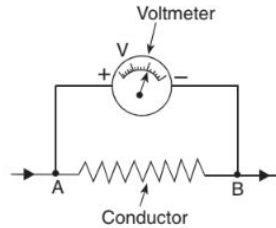
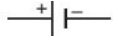


Figure 5. A voltmeter connected in parallel with conductor AB to measure the potential difference across its ends.

Electric Circuits



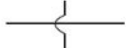
(a) Cell



(b) Battery of two cells



(d) A wire joint



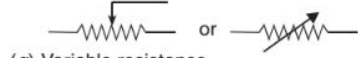
(e) Wires crossing without contact



(c) Connecting wire



(f) Fixed resistance (or Resistor)



(g) Variable resistance (or Rheostat)



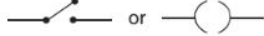
(h) Ammeter



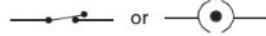
(i) Voltmeter



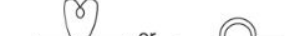
(j) Galvanometer



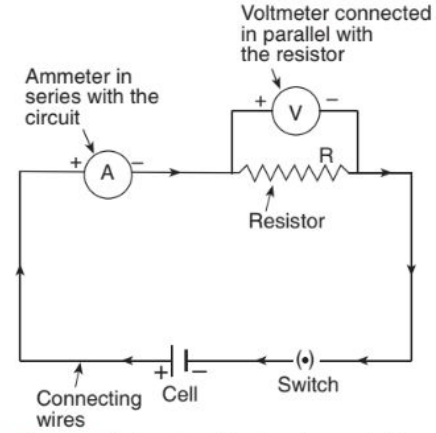
(k) An open switch (An open plug key)



(l) A closed switch (A closed plug key)



(m) Electric bulb (Electric lamp)



1. A cell, a resistor, a key and ammeter are arranged as shown in the circuit diagrams of Figure 12.1. The current recorded in the ammeter will be

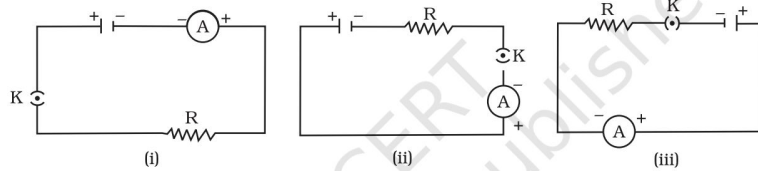


Fig. 12.1

- (a) maximum in (i)
(b) maximum in (ii)
(c) maximum in (iii)
(d) the same in all the cases

5. Identify the circuit (Figure 12.3) in which the electrical components have been properly connected.

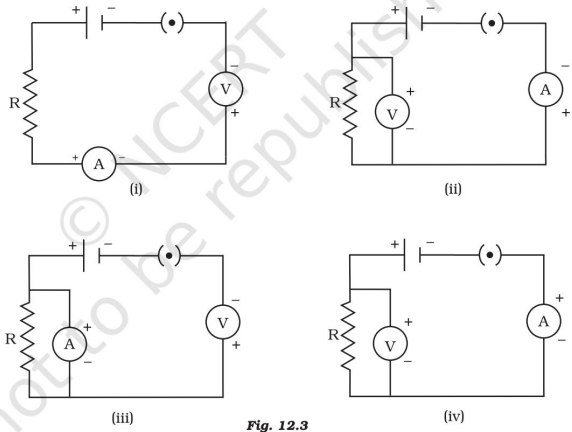
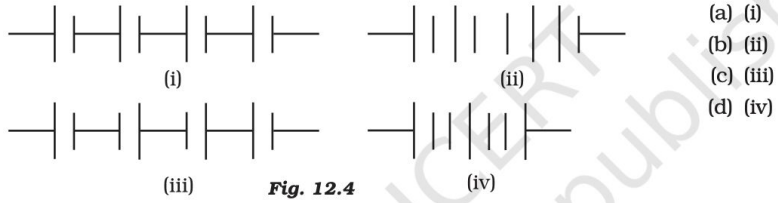


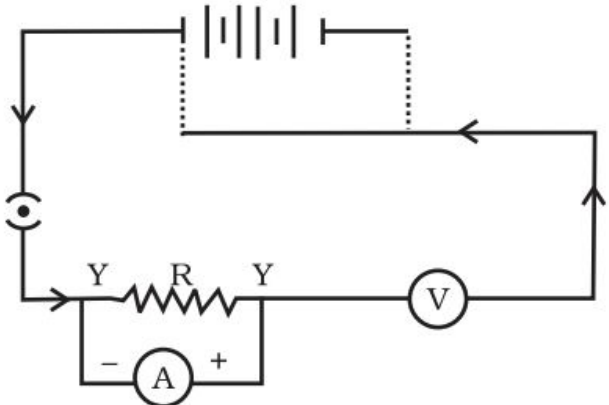
Fig. 12.3

- (a) (i)
- (b) (ii)
- (c) (iii)
- (d) (iv)

8. The proper representation of series combination of cells (Figure 12.4) obtaining maximum potential is



A child has drawn the electric circuit to study Ohm's law as shown in Figure. His teacher told that the circuit diagram needs correction. Study the circuit diagram and redraw it after making all corrections.



Galvanometer



A galvanometer is a highly sensitive scientific instrument used to detect and indicate the presence, direction, and relative magnitude of small electric currents in a circuit

Ohm's Law

