Ratna Sagar

RATNA SAGAR | PRIMUS | BYWORD | E-LIVE

Education, Our Mission

ICSE
Living Science
Physics

Class 10

Chapter 12 Electricity

As per the latest ICSE syllabus

9

Revised and Updated

Living Science PHYSICS

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EDUCATION, OUR MISSION

LEARNING OBJECTIVES

Direction of Electric Current

Electric Potential

- **Potential difference**
- **Electric current**
- **Instrument used for measuring current**
- **Ohm's law**

Electrical Resistance

- **Units of resistance**

Sources of Electric Current

- **Electrochemical cells**

Conductors and Insulators

- **Electric symbols**

Closed and Open Circuits

- **Circuit diagram**

Combination of Resistances

Social Initiative for Energy Conservation

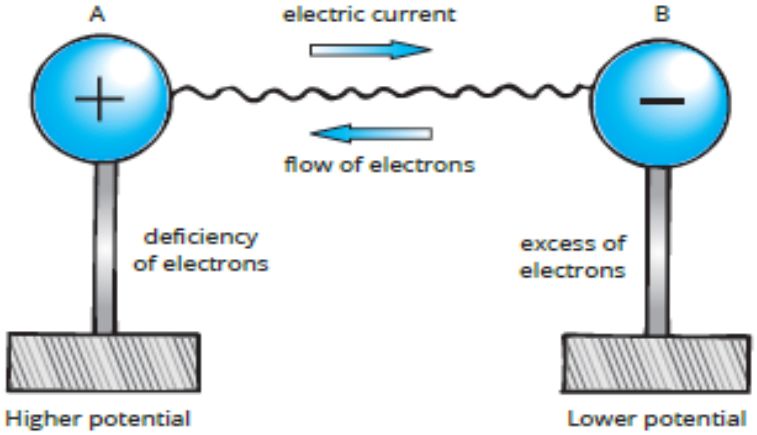
What is Electric Current?

All the objects around us are made up of tiny particles called atoms. Every atom contains two types of charged particles: protons and electrons. Protons carry a positive (+) charge whereas electrons carry a negative (–) charge.

The flow of electrons in a definite direction constitutes an electric current.

Direction of Electric Current

If two charged conductors are joined by a metallic wire (or they are placed in contact), then the direction of flow of electrons is determined by a quantity called the **potential** of the conductor. The conductor having excess of electrons is negatively charged and said to be at a lower potential, while the conductor having deficiency of electrons is positively charged and said to be at a higher potential. Keeping the convention of flow from the higher to the lower level, the electric current is said to flow from the region of higher potential to the region of lower potential (conventional direction of electric current), i.e. in the direction opposite to the direction of flow of electrons which actually constitutes the electric current.



Conventional current flows from A to B. Electronic current flows from B to A.

The movement of electrons (or the flow of current) continues as long as there is a difference in potential between the two conductors. Once the two conductors have the same potential, the flow of current stops.

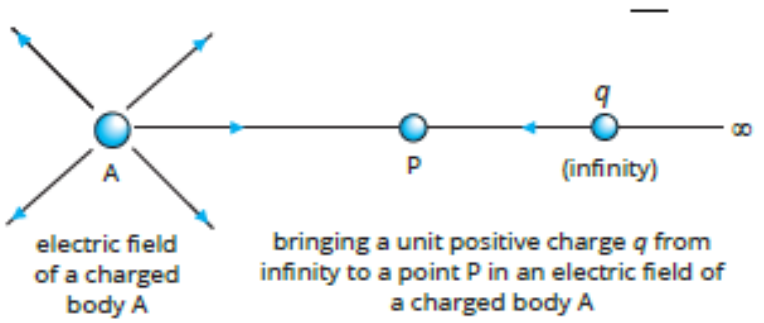
Electric Potential

The electric potential (or simply potential) at a point in an electric field is defined as the amount of work done in bringing a unit positive charge from infinity to that point .

If *W* is the amount of work done in bringing a unit charge (*q*) from infinity to a point, then the electric potential (*V*) at that point is given by,

Electric potential (*V*) = Work done/ Charge

$= W/q$



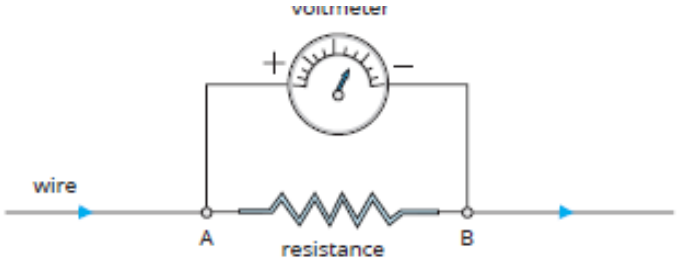
The unit J C–1 (joule per coulomb) is called volt (V). So, the SI unit of electric potential is volt which is denoted by V. Thus, if 1 joule of work is done in bringing 1 coulomb of positive charge from infinity to a point in an electric field, then the potential at that point is 1 volt.

Potential Difference

The potential difference (p.d.) between two points in an electric field is defined as the amount of work done in moving a unit positive charge from one point to the other point

Potential difference is the amount of work done in moving a unit positive charge *q* from point B to point A in an electric field created by the charge *Q*.

The potential difference is measured by an instrument called **voltmeter.** Voltmeter is always connected in parallel to the two points across which the potential difference is to be measured.



Electric current

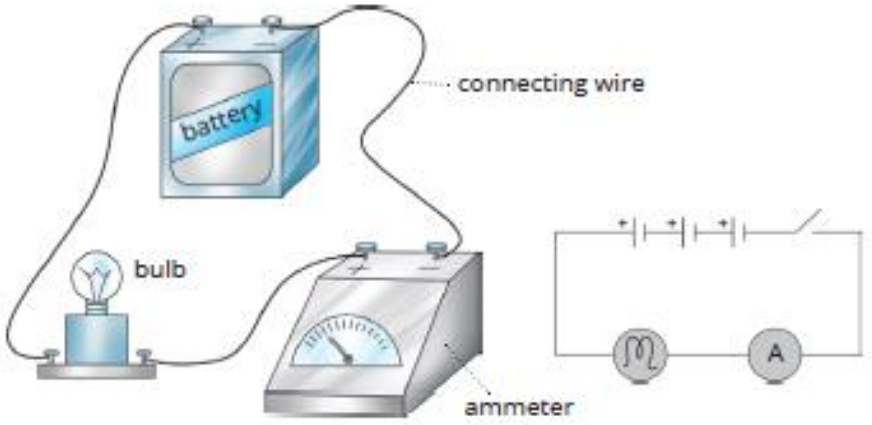
The rate of flow of charge in a circuit is called electric current. In other words, it is the amount of charge flowing per second. It is denoted by the letter '*I* '.
If *Q* is the charge which is flowing through a conductor in time *t*, then current *I* is given by

$$I = Q/t$$

The SI unit of current is ampere and it is denoted by the letter 'A'.

Instruments used for measuring currents

An ammeter is used for measuring electric current flowing in a circuit.
Galvanometer is used for measuring low currents. Like ammeter it is also connected in series in a circuit.



Ohm's Law

The electric current (I) flowing through a conductor is directly proportional to the potential difference (V) across its ends, provided the physical conditions (like temperature, pressure, etc.) do not change.

$I \propto V$ [At constant physical conditions like temperature and pressure, etc.]

or $V \propto I$

This can also be written as

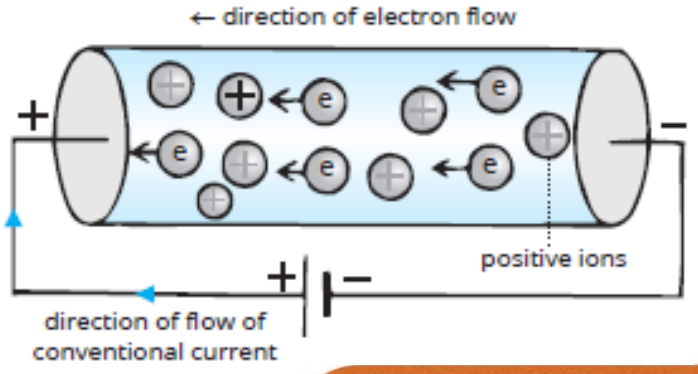
$V = R \times I$ where R is a constant called **resistance of the conductor**. The value of this constant (resistance) depends on the nature, length, temperature and area of cross section of the conductor. The above equation can also be written as:

$R = V/I$ where R = Resistance, I = Current and V = Potential difference

So, current $I = V / R$

Electrical Resistance

The property of a conductor by virtue of which it opposes the flow of electric current through it is called its resistance. The SI unit of resistance is ohm, which is denoted by the symbol Ω called 'omega'.



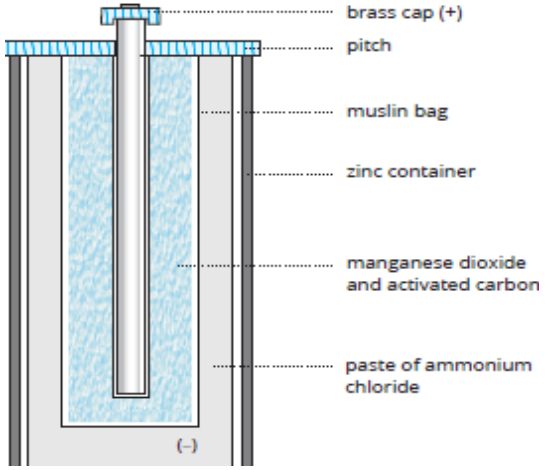
Sources of Electric Current

The various sources of electric current (electrical energy) are:

1. Electrochemical cells (like Voltaic cell, Daniel cell and dry cell)

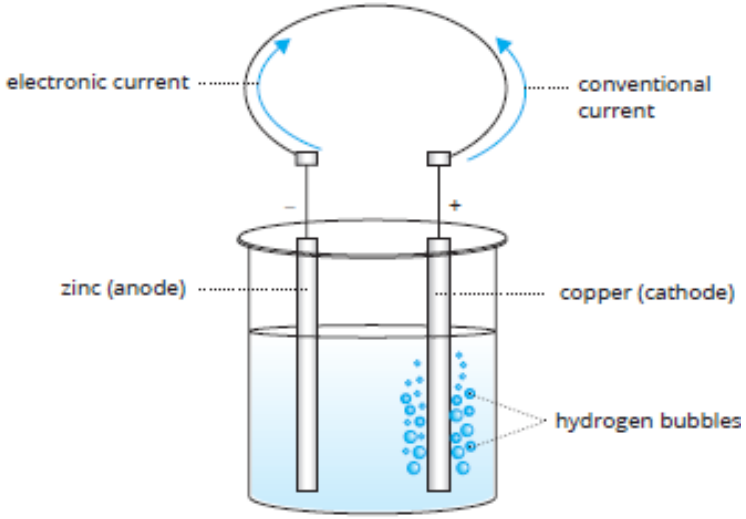
2. Storage cells

3. Electric generators (or Dynamos)



Electrochemical cells

An electrochemical cell is an apparatus which is used to produce electric current from spontaneous chemical reactions. An electrochemical cell converts the stored chemical energy of substances into electrical energy (electric current).



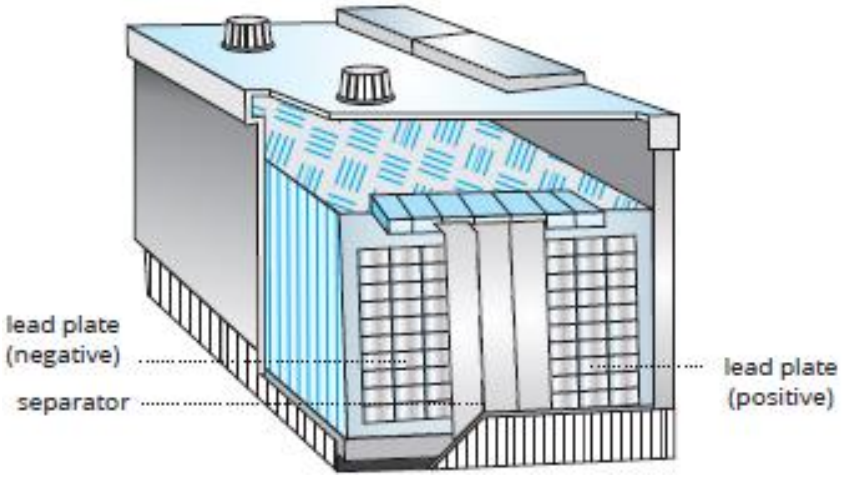
A substance which conducts electricity when in molten state (or when dissolved in water) is known as electrolyte. Sulphuric acid solution, zinc sulphate solution, copper sulphate solution and ammonium chloride paste can be used as electrolytes.

The metal strips (or carbon rods) through which current leaves and enters the cell are called the electrodes. The electrodes are of two types: **anode** and **cathode**.

The electrochemical cells are of two kinds:

1. Primary cells: A cell in which the chemical reactions which convert chemical energy into electrical energy cannot be reversed is called a primary cell. Therefore, once the chemicals used in a primary cell are consumed, the cell gets discharged. Simple Voltaic cell, Leclanche cell, Daniel cell, dry cell, etc. are the primary cells.

2. Secondary cells or accumulators: A cell in which the chemical reactions which convert chemical energy into electrical energy can be reversed by passing electricity is called a secondary cell. Thus, a secondary cell can be recharged. Lead storage cell (or lead accumulator) and nickel–cadmium cell (or nickel–cadmium accumulator) are the secondary cells.



Note: Refer Table 12.1 for Differences between a Primary and Secondary cell

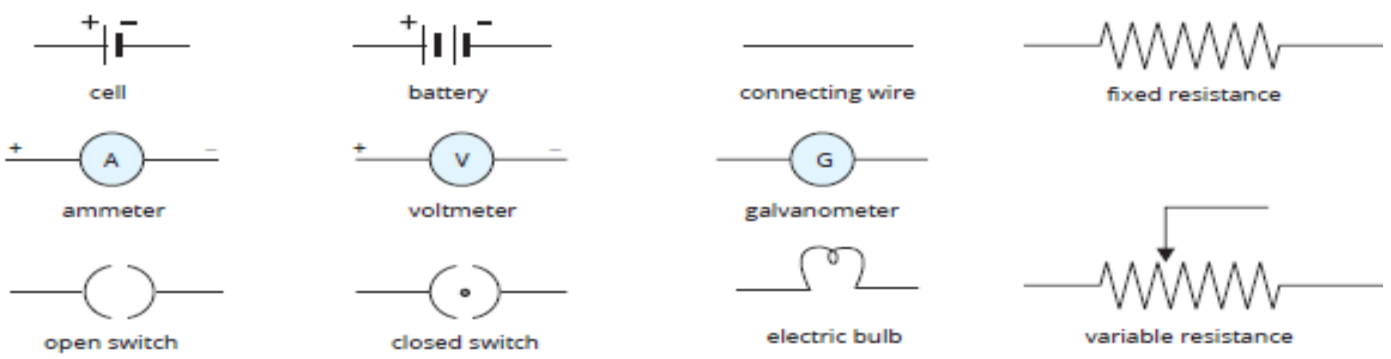
Conductors and Insulators

Insulators: The substances which have very high resistance and hence, do not allow the electric current to flow through them are called the **insulators**. For example, rubber, plastic, wood, glass, leather, etc. are insulators. Insulators do not have free electrons in them to carry current.

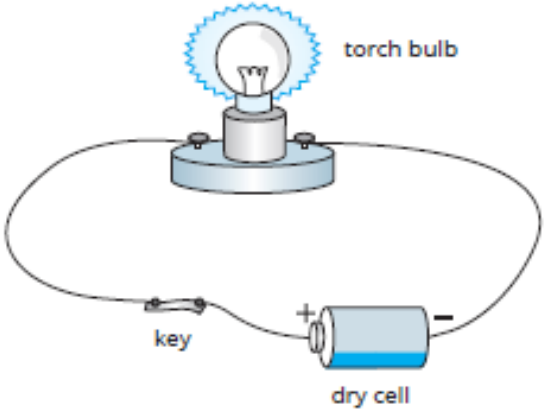
Conductors: The substances which have very low resistance and hence allow the electric current to flow through them are called **conductors**. For example, copper, gold, silver, aluminium and electrolytic solutions are conductors.

Electric Symbols

The components such as cells, bulbs, wires, switches, etc. are called elements of an electrical circuit. Each element of an electrical circuit can be described by its symbol.



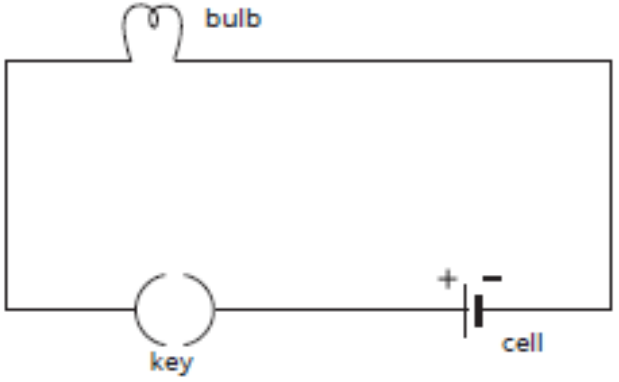
Closed and Open Circuits



1. The path along which the current flows is called a **circuit**.
2. The circuit in which electric current flows is called a **closed circuit**. The bulb in the above activity glows because the circuit is complete. It is said to be a closed circuit.
3. The circuit in which electrical contact at any point is broken and hence no current flows is called an **open circuit**. When the key in the above activity is opened, the bulb does not glow, because the circuit is incomplete. It is said to be an open circuit.

Circuit diagram

A diagram which shows the arrangement of various electrical components used in an electric circuit with the help of their electrical symbols is called a **circuit diagram**.



Note: **Refer Table 12.2 for Components of an electric circuit**

Combination of Resistances

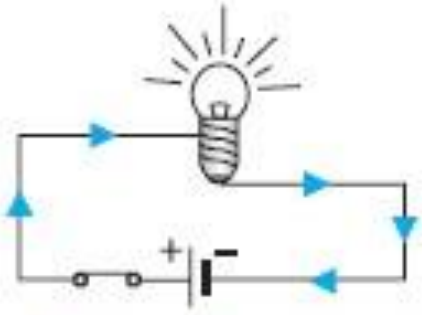
Various resistances can be connected with one another in the following ways:
a. in series **b.** in parallel.

Resistances is series

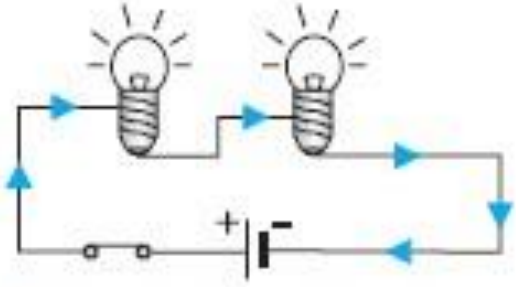
When the bulbs are connected in series:

1. The sum total of resistances in series increases with the increase in the number of bulbs, so the current flowing through each bulb decreases and each bulb glows dimly.

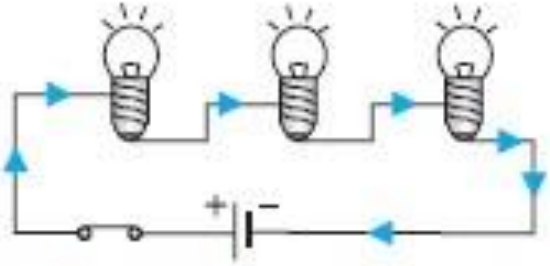
2. The bulbs in series work simultaneously in the circuit. If the circuit is broken anywhere between the bulbs, none of the bulbs glow.



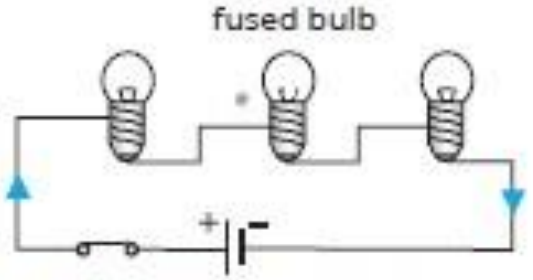
a. One bulb connected to a dry cell, glows brightly.



b. Two bulbs connected in series, glow dimly.



c. Three bulbs connected in series, glow very dimly.



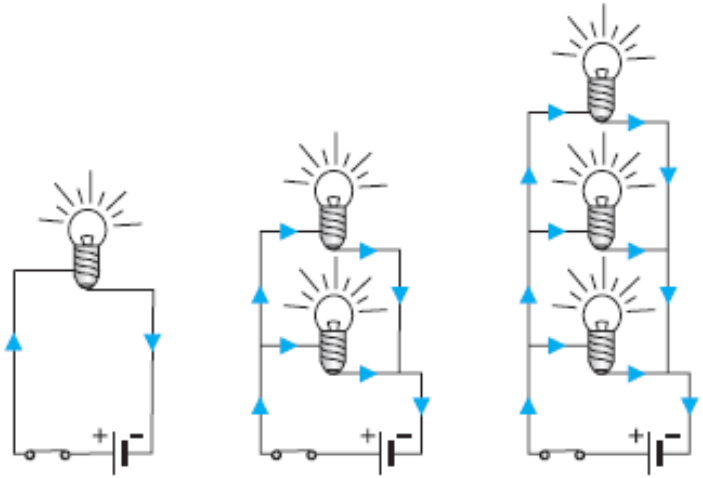
d. No bulb glows when a fused bulb is connected with other bulbs in series.

Resistances is parallel

When the bulbs are connected in parallel:

1. The sum total of resistances in parallel decreases with the increase in the number of bulbs. So according to Ohm's law, more current is drawn from the cell. However, the current passing through each bulb remains the same, so each bulb glows with the same brightness as in case of a single bulb connected to the cell.

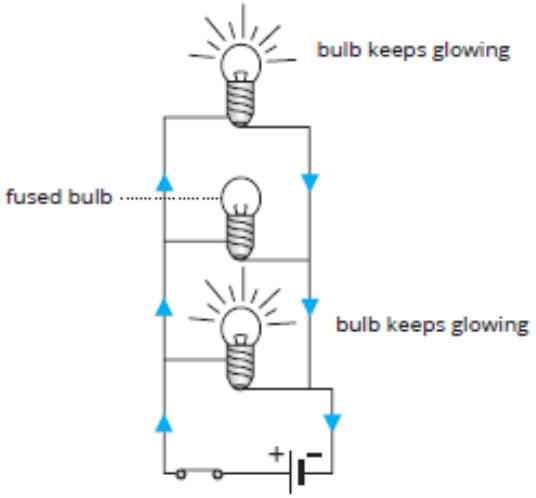
2. The bulbs in parallel work independently in the circuit. If the circuit is broken anywhere between the bulbs, the remaining bulbs keep glowing.



a. One bulb connected to a dry cell

b. Two bulbs connected in parallel glow with the same brightness.

c. Three bulbs connected in parallel glow with the same brightness.



d. Other bulbs keep on glowing even on connecting a fused bulb in parallel.

Social Initiatives for Energy Conservation

It is common saying that **energy saved is energy produced**. So we should try to prevent the energy from being wasted uselessly. This can be done everywhere, in homes, in schools, in offices and in industries. We should also take all efforts to save electricity.

We can contribute to save electricity in the following ways:

1. Switch off all fans and lights when not required.

2. Don’t leave electrical appliances like computers, television, stereo, etc. on standby mode.

3. Ensure all electrical appliances are used as per their requirements.

4. Light-emitting diodes (LEDs) help to save more electricity as compared to bulbs and fluorescent lights.

5. We should use electrical appliances with higher star ratings.

6. We should use public transport and car pools. Make your family, friends and relatives aware of energy crisis. Encourage them to save electricity.

SUMMARY...

1. Electric current: The flow of electrons in a definite direction is called electric current. It is defined as the rate of flow of charge in a circuit.

2. Electric potential: The electric potential at a point in an electric field is defined as the amount of work done in bringing a unit positive charge from infinity to that point.

3. Potential difference: The potential difference between two points in an electric field is defined as the amount of work done in moving a unit positive charge from one point to the other point.

4. Ohm's law: According to Ohm's law, the electric current flowing through a conductor is directly proportional to the potential difference across its ends, provided the physical conditions (like temperature, pressure, etc.) do not change.

5. Resistance: The property of a conductor by virtue of which it opposes the flow of electric current through it is called its resistance.

6. Sources of electric current: a. Electrochemical cells **b.** Storage cells **c.** Electric generators.

7. Primary cell: A cell in which the chemical reactions which convert chemical energy into electrical energy cannot be reversed is called a primary cell.

8. Electric circuit diagram: A diagram which shows the arrangement of various electrical components used in an electric circuit with the help of their electrical symbols is called an electric circuit diagram.

9. Resistances in series: When two or more bulbs are connected in series, their resistances add up and hence the net resistance increases. With the potential difference remaining the same, the current flowing in each bulb decreases and hence, the bulbs glow with less brightness.

10. Resistances in parallel: When two or more bulbs are connected in parallel, their resistance divides and the resistance decreases, so the current drawn from the cell increases but the current in each bulb remains the same since the potential difference across each bulb remains same. Therefore, each bulb glows with the same brightness as in case of a single bulb connected to the cell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