CHAPTER-1

# SSLC - PHYSICS - SHORT NOTE

# EFFECTS OF ELECTRIC CURRENT

## Energy change

| Device | Use | Energy change |
|---|---|---|
| • Electric bulb | To get light | Electrical energy → light energy |
| • Induction cooker | To get heat | Electrical energy → heat energy |
| • Storage battery (while charging) | To get potential difference | Electrical energy → chemical energy |
| • Mixie | For mechanical work | Electrical energy → mechanical energy |
| • Fan | For mechanical work | Electrical energy → mechanical energy |

- Electrical energy can be easily transformed into other forms
- The useful form of energy into which a device converts electrical energy, is considered as the effect of electric current on each of them.

**LAW OF CONSERVATION OF ENERGY**

Energy cannot be created or destroyed but
it can be transformed from one form to another

## HEATING EFFECT OF ELECTRIC CURRENT

Heat is developed in a circuit on passing current through it is known as the joule heating or ohmic heating

### Joule's law

The heat generated (H) in a current carrying conductor is directly proportional to the product of the square of the current (I) in the conductor, the resistance of the conductor (R) and the time (t) of flow of current

$$H = I^2 Rt$$

**What are the factors on which joules law of heating depends?**

- Current – $H \propto I^2$
- Resistance – $H \propto R$
- Time – $H \propto t$

The most important factor that influences the heat developed is the **Current (I)**

## EQUATIONS FOR FINDING HEAT ENERGY

- $H = I^2Rt$
- $H = \frac{V^2}{R} t$
- $H = V I t$

***Question***

How much will be the heat (in calorie) developed if 0.2A current flows through a conductor of resistance 200Ω for 5 minute?

1 calorie = 4.2 J

$\frac{\text{Joule}}{4.2}$ = calorie

***Question***

Calculate the heat developed in 30minutes when 3A current flows through an electric iron box designed to work under 230 V.

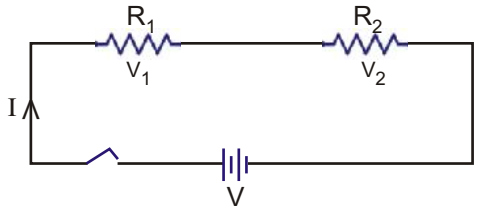
***Question***

Let's find out the heat developed in 3 minute by a device of resistance 920Ω working under 230V

# ARRANGEMENT OF RESISTORS IN CIRCUITS

## 1. Series Connection

When a circuit is completed by connecting the resistors one after the other, it is called series connection.




**In series connection**

In each Resistors

- Same current
- Different voltage

Effective Resistance

$R = R_1 + R_2$

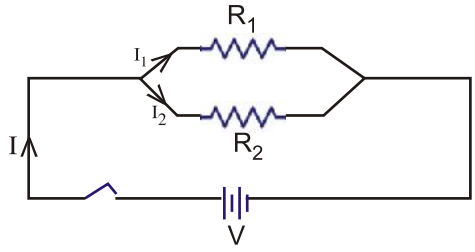
***Question***

If 4Ω and 2Ω resistors are connected in series and 6V potential difference is applied

a) Draw the circuit Diagram
b) Find the Effective Resistance of the circuit
c) What is the current in the circuit

## 2. Parallel Connection

The current completes the circuit by getting divided into each branch since the resistors are connected in parallel




**Parallel connection**

In each Resistors

- Different current
- Same voltage

Effective Resistance

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

➤ If resistors of the same value are connected in parallel, then effective Resistance $R = \frac{r}{n}$ when **'n'** is the number of resistors and **'r'** is the resistance of one resistor.

***Question***

If 12 Ω and 4 Ω resistors are connected in parallel and 12 V Potential difference is applied

*a)* Draw the circuit diagram.

*b)* Find the effective Resistance

*c)* What is the current in the circuit

***Question***

10 resistors of 2 Ω each are connected in parallel. Calculate the effective Resistance

## SERIES CONNECTION PARALLEL CONNECTION: COMPARISON

| SERIES CONNECTION | PARALLEL CONNECTION |
|---|---|
| Effective Resistance (R) increases | Effective Resistance (R) is less |
| The current (I) through each resistors will be the same | The current (I) through each resistors is different |
| The potential difference (V) across each resistors is different | The potential difference (V) across each resister is same |
| Each resistors court be controlled by using separate switches | Each resistors can be controlled by using by using separate switches |

## HEATING EFFECT OF ELECTRICITY USES

Electric heating appliances are the devices which are used to convert electrical energy into heat energy. In such instruments, heat is produced in the **heating coil**.

eg: Iron Box, Water Heater, Soldering Iron

- ★ Heating coils are made of Nichrome
- ★ Nichrome is an alloy of Nickel, Chromium and Iron

**Peculiarities of Nichrome (heating coil)**

- ★ High resistivity
- ★ High melting point
- ★ Ability to remain in red hot condition for a long time without getting oxidised

## SAFETY FUSE

Safety fuse is a device which protects us and the appliances from danger when an excess current flow through the circuit.

**Circumstances that cause high electric current flow through the circuits**

| Short circuit | Over loading |
|---|---|
| If the positive and negative terminals of a battery or the two wires from the mains come into contact without the presence of a resistance | If the total power of all the appliances connected to it is more than what the circuit can withstand. |

- Safety fuse works on the heating effect of electric current.
- Main part of safety fuse: fuse wire
- Alloy of **tin and lead** used to make fuse wire

**Peculiarities of fuse wire**

- Low melting point
- High ductility
- Alloy of tin and lead

What are the precautions to be taken when a fuse wire is included in a household wiring?

- The end of the wire must be connected firmly at appropriate points
- The fuse wire should not project out of the carrier base
- Must be connected in series
- Fuse wire should have appropriate amperage

**Working of Fuse wire**

Overloading or Short circuit occurs

↓

Current in the circuit increases

↓

Excess heat is generated in the fuse wire

↓

Due to this excess heat, fuse wire melts because of its low melting point

↓

The circuit is broken

## Amperage :

It is the ratio of the power of an equipments to the voltage applied

$$\text{Amperage} = \frac{\text{Wattage}}{\text{Voltage}}$$

★ Amperage increases with the thickness of the conductor

## ELECTRIC POWER (P)

It is the amount of energy consumed by an electrical appliancein one second

$$\textbf{Power} = \frac{\textbf{Work}}{\textbf{Time}}$$

★ Unit of Power : J/s or W (Watt)

$P = I^2 R$ $P = V^2 / R$ $P = V I$ $P = H / t$

***Question***

An appliance of power 540 W is used in a branch circuit. If the voltage is 230 V, what is its amperage ?

***Question***

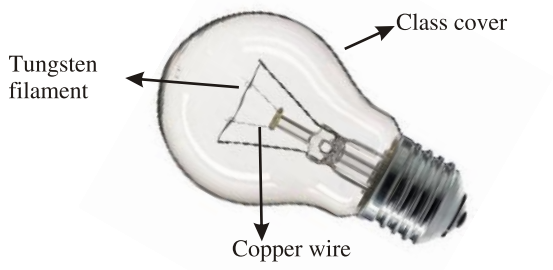
An heating appliance has a resistance of 115 Ω . If 2 A current flows through it, what is the power of the appliance ?

***Question***

A current of 0.4 A flows through an electric bulb working at 230 V. What is the power of the bulb?

## LIGHTING EFFECT OF ELECTRIC CURRENT

### Incandescent lamps (Filament Lamp)




**Characteristic of tungsten**

- High resistivity
- High melting point
- High ductility
- Ability to emit white light in the white hot condition

➤ The bulb is evacuated to avoid oxidation of tungsten

➤ Vaporisation can be reduced by filling sum inert gas (Nitrogen) at low pressure inside the bulb

*Question*

Nichrome is not used as filament in incandescent lamps. Why?

Ans: Nichrome cannot becomes white hot & emits white light

## Demerits of incandescent lamp

A major part of the electrical energy given to the lamp is lost as heat, Hence the efficiency of incandescent lamp is less.

## Discharge Lamps

- Discharge lamps are glass tubes fitted with two electrodes. They emit light as a result of discharge of electricity through the gases filled in tubes. When a high potential difference is applied the gas molecules get exited. Exited atoms come back to their original states for attaining stability. During this process the energy stored in them will be radiated as light.
- Depending on the difference in the energy levels lights of different colours and other radiations are emitted.

Both fluorescent lamp and CFL contains mercury vapor and fluorescent material, which is harmful to environment

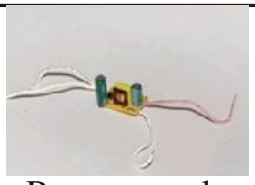
## LED ( Light Emitting Diode) Bulb

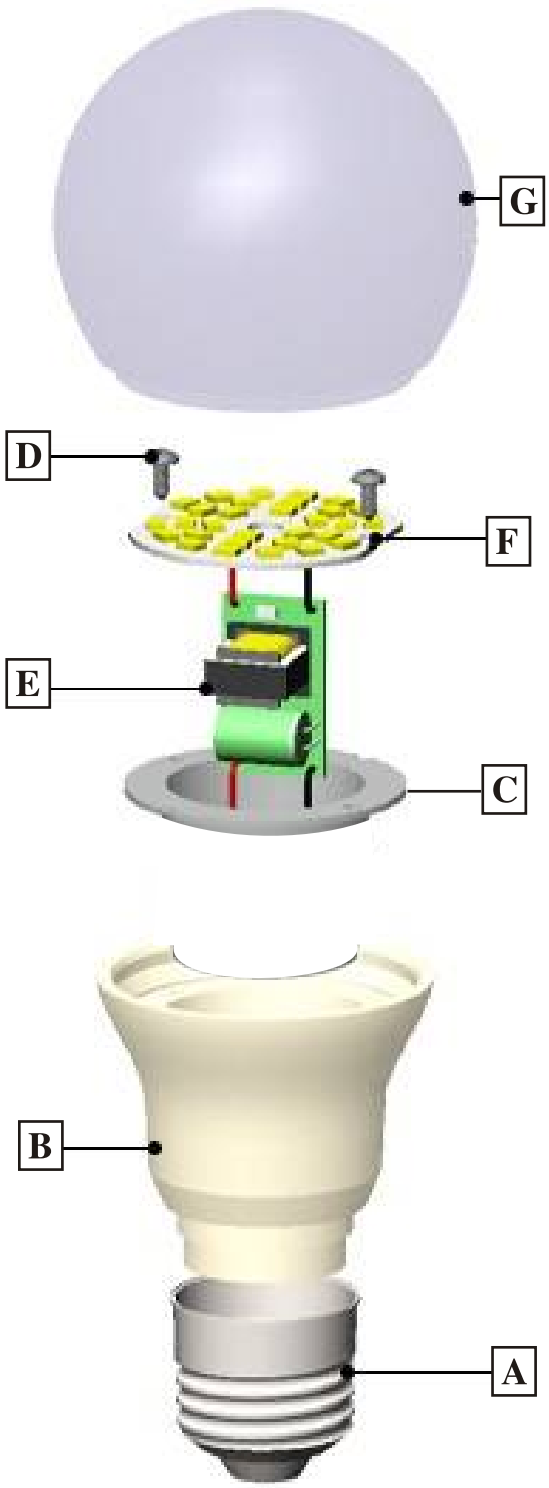
LED bulbs are devices that give more light than discharge lamps and incandescent lamps. They work using low power.

### Advantages Of LED Bulb

- There is no filament, there is no loss of energy in the form of heat.
- There is no mercury in it, it is not harmful to environment.
- Requires only small quantity of power.
- Long lasting
- High efficiency

## PARTS OF LED BULB

| | Part | Use |
|---|---|---|
| A |  Base Unit | Connects the bulb to the holder |
| B |  Heat sink | It is an arrangement of absorbing heat |
| C |  Base Plate | Metal plate that fixes it to the holder |
| D |  Back conductor screws. | Screws for fixing wires form LED drive to the base unit. |
| E |  Power supply Board | Function of this is to convert AC into DC and supply necessary output voltage |
| F |  Printed Circuit Board (LED Chip Board) | LEDs are fixed on this board. In this the positive and negative polarities are marked. |
| G |  Diffuser cup | This is the part from which light comes out of the bulb. |



**EQUATIONS**

Heat

- $H = I^2Rt$
- $H = \frac{V^2}{R} t$
- $H = V I t$

Power

- $P = I^2R$
- $P = V^2 / R$
- $P = V I$
- $P = H / t$

Amperage

$$\text{Amperage} = \frac{\text{Wattage}}{\text{Voltage}}$$

Effective Resistance

- Series connection

  $R = R_1 + R_2$

- Parallel connection

  $R = \frac{R_1 R_2}{R_1 + R_2}$

- If resistors of the same value are connected in parallel, then effective Resistance $R = \frac{r}{n}$ . When **'n'** is the number of resistors and **'r'** is the resistance of one resistor.

Units

- Heat (H) ⟶ J
- Current (I) ⟶ A
- Resistance (R) ⟶ Ω
- Time (t) ⟶ Second
- Power (P) ⟶ W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***Layout***

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