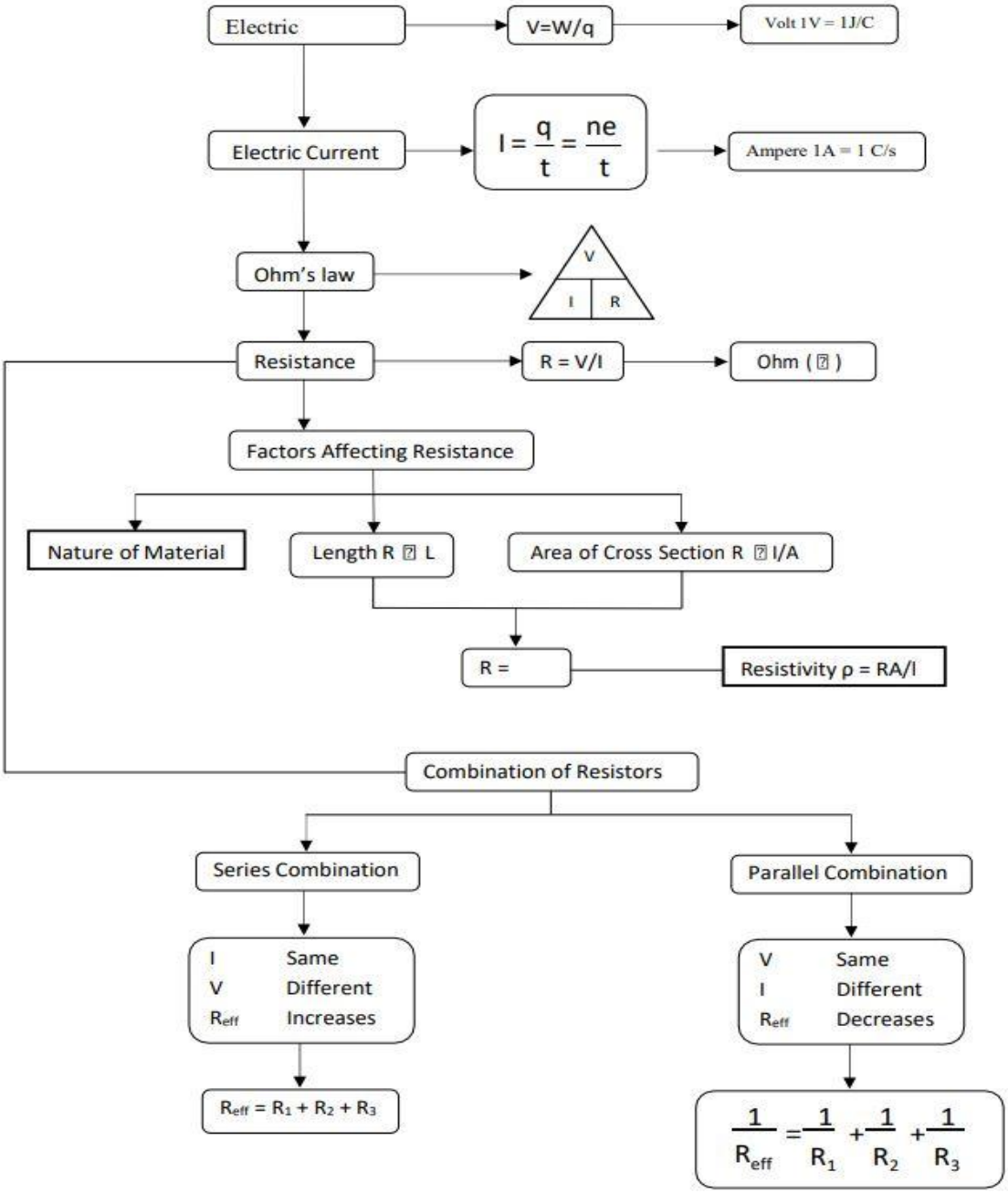
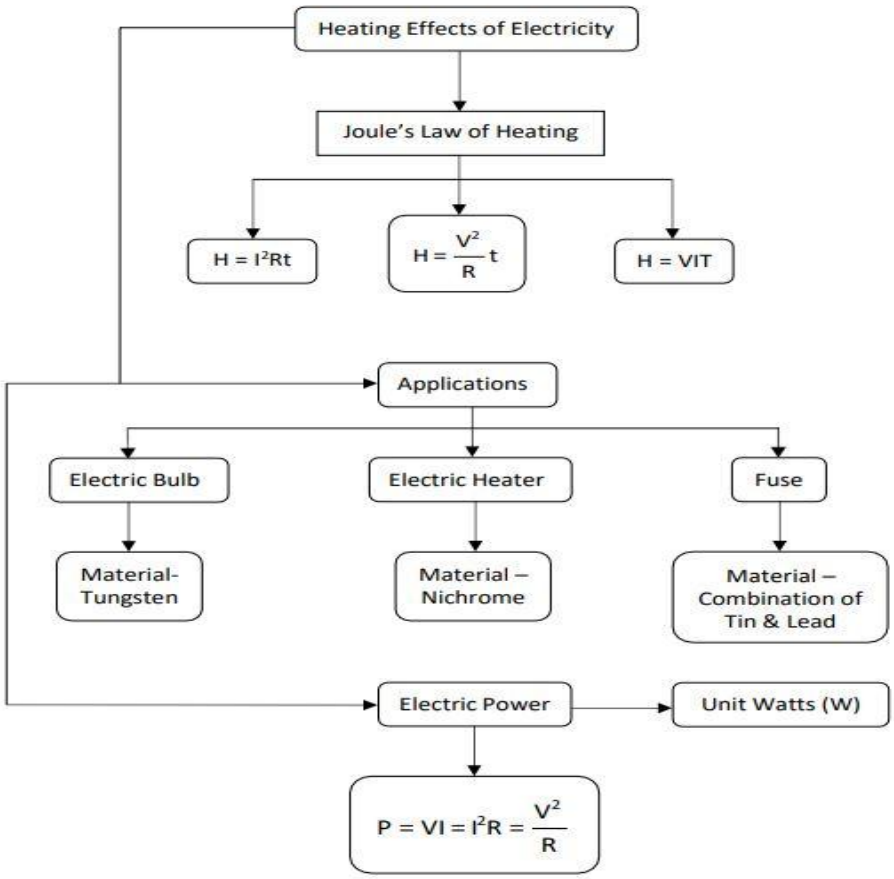
CHAPTER-11

ELECTRICITY

CHAPTER MAPPING





NOTES

Electric Current: The rate of flow of electric charges in unit time is called current. Charge flows through the conductor only when the potential at two ends of the conductor is different. The direction of current is taken as the direction of flow of positive charge.

If a net electric charge (Q) flows through a cross-section of a conductor in time t, then,

$$\text{Electric current (I)} = \frac{\text{Net charge (Q)}}{\text{Time } (t)} \quad \text{or,} \quad \boxed{I = \frac{Q}{t}}$$

Where I is electric current, Q is a net charge and t is a time in second.

S.I. Unit of Electric Charge- coulomb (C). One coulomb is nearly equal to 6×10^{18} electrons.

S.I. unit of electric current is ampere (A). 1 A = 1 C/1

When 1 coulomb of electric charge flows through a cross section for 1 second, the current is said to be 1 ampere.

Ammeter: An apparatus to measure electric current in a circuit.,

➢ **Electric Potential Difference:** We define the electric potential difference between two points in an electric circuit carrying some current as the work done to move a unit charge from one point to the other

Therefore, Voltage = $\frac{Workdone}{Charge}$

Voltage or electric potential difference is denoted by V'. Therefore, **V** = $\frac{W}{Q}$
Where, W = Work done and Q = Charge

S.I. unit of electric potential difference is volt and denoted by 'V'

When1 joule of work is done to move a charge of 1 coulomb from one point to another in an electric circuit the potential difference is said to be 1 volt.
1V = 1Joule/1Coulomb = 1J/1C

Voltmeter: An apparatus to measure the potential difference or electric potential difference between two points in an electric circuit.

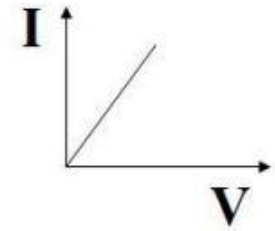
The voltmeter is always connected in parallel across the points between which the potential difference is to be measured.

Electric Circuit: Electric circuit is a continuous and closed path of electric current.

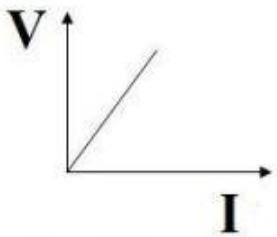
➢ **Ohm's Law:** Ohm's law states that at constant temperature the current passing through the conductor is directly proportional to the potential difference between the ends of the conductor. i.e.,
V α I or V= IR or R=V/I

Where R is a constant known as the resistance of the conductor. Resistance is something which opposes the flow of electric charges. The unit resistance is Ohm (Ω)

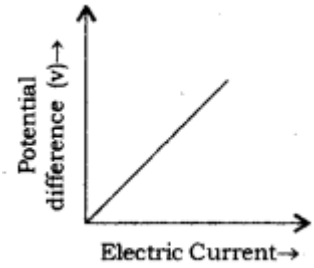
Graph



Slope of this graph gives 1/R. i.e. as slope increases R decreases



Slope of this graph gives R. i.e. as slope increases R also increases



Factors on Which Resistance of a Conductor Depends:

(i) Nature of Material: Some materials allow current to pass and are called good conductors. Materials which do not allow flow of electrons through them are called bad conductors or insulators.

(ii) Length of Conductor: Resistance (R) is directly proportional to the length of the conductor. This means, resistance increases with increase in length of the conductor.

or, $R \propto l$ …(i)

(iii) Area of Cross Section: Resistance R is inversely proportional to the area of cross section (A) of the conductor.

or, $R \propto \frac{l}{A}$….(ii)
From equations (i) and (ii)
$R \propto \frac{l}{A}$
$R = \rho \frac{l}{A}$
Where, ρ (rho) is the proportionality constant. It is called the electrical resistivity of the material of conductor.
or $\rho = \frac{RA}{l}$

Resistivity: It is defined as the resistance offered by a cube of a material of side 1m when current flows perpendicular to its opposite faces.

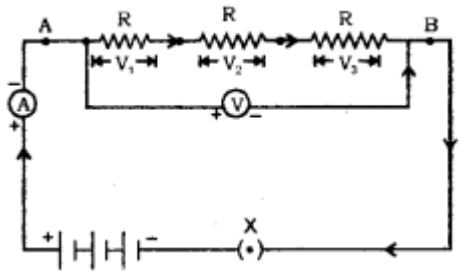
Note: Resistivity of a given material does not change with length or area of cross section. (i.e., there will not be any change in resistivity when the area or length of the conductor increases or decreases.)

➢ Combination of resistors

Resistors in Series: When resistors are joined from end to end, it is called in series. In this case, the total resistance of the system is equal to the sum of the resistance of all the resistors in the system**.**

In series combination (i) effective resistance increases. (ii) current (I) flows through all resistors are equal. (iii) Potential difference across each resistor may different.

1.

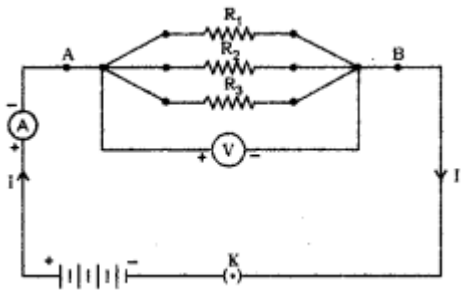


$R_s = R_1 + R_2 + R_3$

When the resistors are connected in series, the current flowing through each resistor is the same and is equal to the total current.

Resistors in Parallel: When resistors are joined in parallel, the reciprocal of the total resistance of the system is equal to the sum of reciprocal of the resistance of resistors.

In parallel combination of resistors, Effective resistance decreases. Current (I) flows through each resistor may be different. Potential difference for every resistance is same.



$1/R_p = 1/R_1 + 1/R_2 + 1/R_3$

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➢ **Joule's law of heating effect :** This law implies that heat produced in a resistor is (i) directly proportional to the square of current for a given resistance, (ii) directly proportional to resistance for

a given current, and (iii) directly proportional to the time for which the current flows through the resistor

$$H = I^2Rt$$

Electric Power

The rate of doing work or rate of consumption of electrical energy is called Electric Power. If W is work done in time t, then

$P=W/t.$

S.I unit is Watt(W).

One watt of power is consumed when 1 A of current flows at a potential difference of 1 V.

$P= VI$ or $P=I^2R$ or $P=V^2/R$

The commercial unit of electrical energy is a kilowatt-hour (kWh) or unit.

$1kWh = 3.6\times10^6 J$

One kilowatt-hour is defined as the amount of energy consumed when 1kW of power is used for 1 hour.

➢ **Practical Applications of Heating Effect of Electric Current**

➢ **Electric Bulb:** It produces light when it becomes too hot. Therefore, a material which can produce high heat without burning is required to make the filament of a bulb. Tungsten is used for making bulb because it has high resistivity and high melting point.

➢ **Fuse:** It has to be work in a manner that it should burn when high current is passing through it. Therefore, a material which can produce high heat but should melt at high temperature. An alloy of tin and lead is used for making fuse wire because it has high resistivity and low melting point.

➢ **Electric Heater:** Its produces heat when current is passing through it. The commonly used material for making heater is Nichrome wire. It has high resistivity and high melting point.