CHAPTER – 12

ELECTRICITY

ELECTRIC CURRENT (I)

The rate of flow of electric charge through a cross section of a conductor is called electric current.

$$I = \frac{Q}{t}$$

SI UNIT: ampere (A) [One ampere of electric current passes through a cross section of a conductor when one coulomb charge passes through it in one second.]

1) 1 electron charge = 1.6 * 10^{-19}
2) 1 coulomb charge = 6.25 * 10^{18} electron charge

Electric Circuit: A continuous and closed path consisting of connecting wire and electric devices is called electric circuit.

Ammeter is used to measure electric current through a conductor.

1) Low Resistance
2) Must be connected in series

ELECTRIC POTENTIAL AND POTENTIAL DIFFERENCE (V)

The electric potential difference between two points in an electric circuit carrying some current is defined as the work done to move a unit positive charge from one point to the other.

$$V = \frac{W}{Q}$$

SI UNIT: volt (V) [One volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done in carrying 1C of charge through the two points.]

Voltmeter is used to measure potential difference between two points in an electric circuit.

1) High Resistance
2) Must be connected in parallel

CIRCUIT DIAGRAM

A pictorial representation of an electric circuit in which different circuit elements are represented by simple symbols.

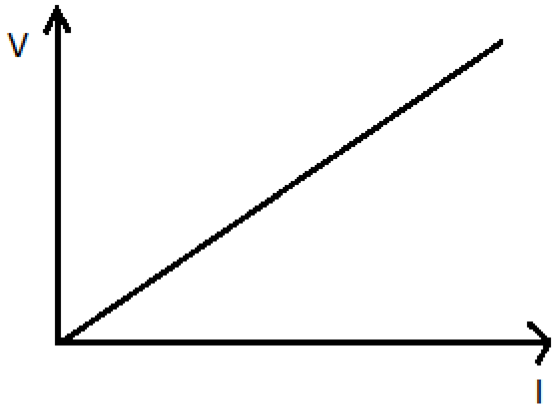
[Learn Table 12.1 from NCERT]

OHM'S LAW

Under identical physical conditions (temperature, pressure, stress, strain, etc) , the electric current flowing through the conductor is directly proportional to the potential difference between the two points.

V is directly proportional to I

$$V = IR$$



R is the constant of proportionality called resistance.

RESISTANCE: The property of a current carrying conductor by virtue of which it resists the flow of electric current.

The factors on which resistance of a wire depends are listed as follows:

1) LENGTH OF THE CONDUCTOR: The resistance of a current carrying conductor is directly proportional to the length of the conductor.
2) AREA OF CROSS-SECTION: The resistance of a current carrying conductor is directly proportional to the area of cross-section of the conductor.
3) MATERIAL OF THE WIRE: Out of the two wires of same length and area of cross section , one made of copper is less resistive than the one made of nichrome. Thus the resistance of a conductor depends on the material of the conductor.
4) TEMPERATURE: generally the resistance of a conductor increases with an increase in temperature. But, it depends upon the material that whether it is a conductor, insulator or a semi-conductor.

$$R = \frac{pL}{A}$$

COMBINATION OF RESISTANCES

There are two ways in which resistors can be combined:

1) Series combination of resistors
2) Parallel combination of resistors

A) Series Combination of Resistors:

i) Same amount of current flows through every resistor
ii) Potential difference along each resistor is different

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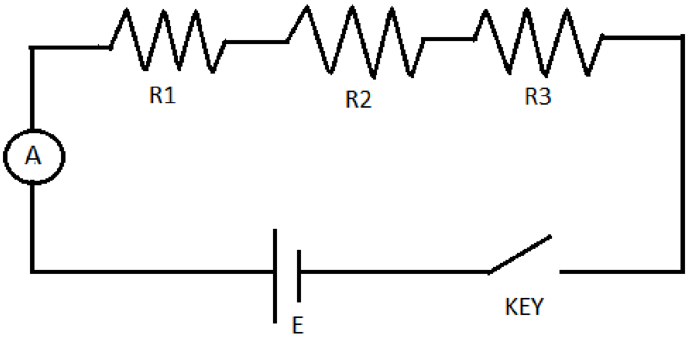
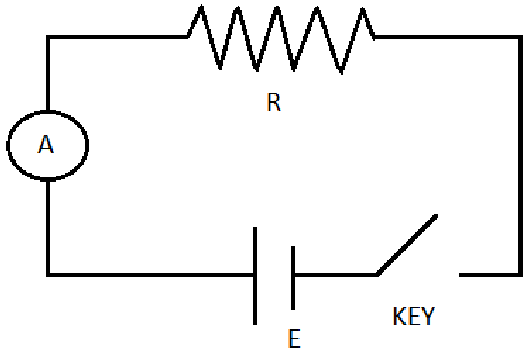
iii) The sum of potential difference along each resistor is equal to the net potential difference applied along the combination of resistors.

RESULT OF EQUIVALENT RESISTANCE UNDER COMBINATION OF RESISTORS IN SERIES

$$R_{eq} = R_1 + R_2 + R_3 + ... + R_n$$





Let us assume that there are 3 resistors connected in series with a battery of potential difference E along with a ammeter.

Resistor R 1	Resistor R2	Resistor R3
Current = I	Current = I	Current = I
Potential Diiference = V1	Potential Difference = V2	Potential Difference = V3
Resistance = $R_1 = \frac{V1}{I}$	Resistance = $R_2 = \frac{V2}{I}$	Resistance = $R_3 = \frac{V3}{I}$

Since the sum of potential differences throught the different resistors is equal the potential difference along the combination of resistors.

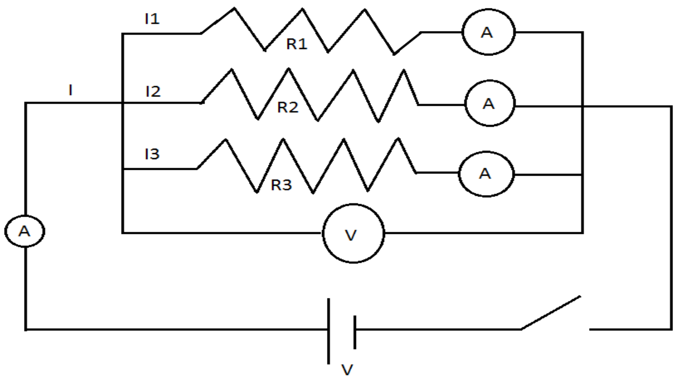
$$V = V_1 + V_2 + V_3$$

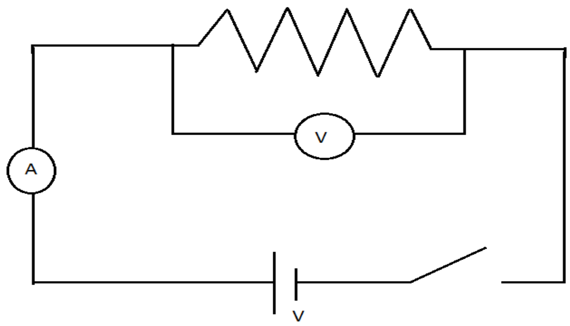
$$IR = IR_1 + IR_2 + IR_3$$

$$R = R_1 + R_2 + R_3$$

Which is the required result. Hence Proved!!

RESULT OF EQUIVALENT RESISTANCE UNDER COMBINATION OF RESISTORS IN PARALLEL





Let us assume that there are 3 resistors connected in series with a battery of potential difference E along with a ammeter.

Resistor R 1	Resistor R2	Resistor R3
Current = I1	Current = I2	Current = I3
Potential Diiference = V	Potential Difference = V	Potential Difference = V
Resistance = $R_1 = \frac{V}{I1}$	Resistance = $R_2 = \frac{V}{I2}$	Resistance = $R_3 = \frac{V}{I3}$

Since the sum of electric currents throught the different resistors is equal the electric currents along the combination of resistors in parallel.

$$I = I_1 + I_2 + I_3$$

$$\frac{V}{R} = \frac{V}{R1} + \frac{V}{R2} + \frac{V}{R3}$$

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$

Which is the required result. Hence Proved!!

HEATING EFFECT OF ELECTRIC CURRENT

In order to drive electrons the cell need to continously expend its energy. This energy goes in the form of heat energy. This energy goes completely into heat enegy if the circuit is purely resistive.

DERIVATION:

Consider a current I flowing through a resistor of resistance R. Let the potential difference across it be V. Let t be the time t during during which a charge Q flows across.

The work done in moving a charge Q through a potential difference V is QV.

The work done goes into heat energy if the system is purely resistive.

Thus, the power dissipated is $$P = \frac{W}{t}$$

$$P = \frac{QV}{t}$$

$$P = VI$$

Therefore, $$W = VIt$$

$$W = I^2Rt$$

APPLICATIONS:

1) ELECTRIC HEATER
2) ELECTRIC BULB
3) ELECTRIC FUSE

ELECTRIC POWER

$$P = VI$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

Q. Define the commercial unit of electric energy.

Ans. The commercial unit of electric energy is kilowatt hour (kWh)

One kilowatt hour is the electric energy consumed when 1 kilowatt power is used for 1 hour.

$$1kWh = 1000\ W * 3600s$$

$$1kWh = 3600000\ J$$

$$1kWh = 3.6 * 10^6\ J$$