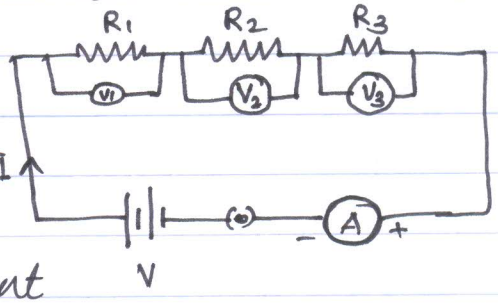
Grade X - PHYSICS - ELECTRICITY NOTES

Resistance of a system of resistors.

Resistors in series :- Consider three resistors of resistances R_1, R_2 and R_3 connected in series as shown.



In series combination,

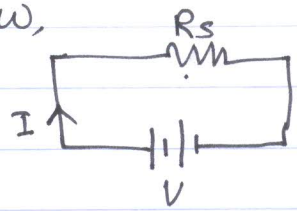
1. the current is same in every part of the circuit or same current flows through each resistor.

2. the p.d V is equal to the sum of potential differences V_1, V_2 and V_3.

$$V = V_1 + V_2 + V_3 \quad \text{——} (1)$$

The series combination of resistors R_1, R_2 and R_3 can be replaced with a single resistance R_S such that R_S when connected ~~in~~ to a battery of 'V' potential difference, draws I current. Applying Ohm's law,

$$V = I R_S \quad \text{——} (2)$$



Applying Ohms law across R_1, R_2 and R_3

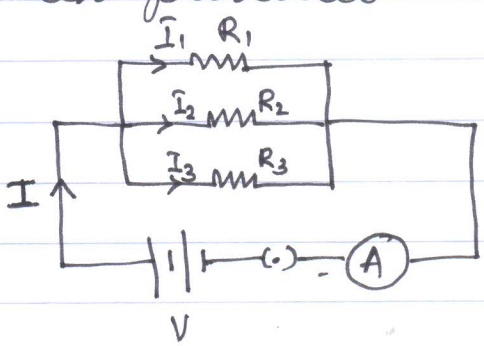
$$V_1 = IR_1, \quad V_2 = IR_2 \text{ and } V_3 = IR_3 \quad \text{——} (3).$$

Substituting (2) and (3) in (1),

$$IR_S = IR_1 + IR_2 + IR_3$$

$$R_S = R_1 + R_2 + R_3.$$

Resistors in parallel :- Consider three resistors R_1, R_2 and R_3 connected in parallel as shown.



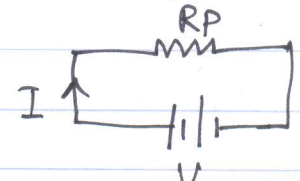
In parallel combination of resistors,

1. the p.d. across each resistor is the same.

2. the total current I is equal to the sum of the currents through each branch.

ie, $I = I_1 + I_2 + I_3$. —①

Let R_p be the equivalent resistance of the parallel combination of resistors, ie by connecting R_p across the same cell, the same current is drawn from it.



Using Ohm's law across, R_p, R_1, R_2 and R_3,

$V = IR_p$, $V = I_1 R_1$, $V = I_2 R_2$, $V = I_3 R_3$, Substituting in ①,

$$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}.$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad —②$$

ie, the reciprocal of the equivalent resistance of a group of resistances in parallel combination is equal to the sum of the reciprocals of the individual resistances.

Heating effect of electric current.

Electric power P Power is defined as the rate of electrical energy consumed by a device. If 'E' energy is consumed in t second by a device, its power

$$P = \frac{E}{t} \quad \left(\text{or } P = \frac{W}{t}\right)$$

But we have $W = V.Q$.

$E = V.Q$.

$$\therefore P = V.\frac{Q}{t} = VI.$$

Energy $E = P.t = VIt$. —①

Using Ohms law, $V = IR$.

$E = I^2Rt$. —②.

From ①, using $I = V/R$.

$$E = \frac{V^2}{R}t. \quad —③.$$

Joules law of heating :- The heat produced in

a resistor is directly proportional to,

1. square of the current for a given resistance
2. resistance of the resistor for a given current.
3. the time for which the current flows through the resistor.

or $H \propto I^2Rt$, $H = I^2Rt$.

This law is known as Joules Law of heating.

Applications of Heating effect of electric Current.

Heating effect is useful in devices such as electric iron, toaster, electric oven, water heater etc. In a bulb, electric heating is used to produce light. Electric fuse also works on the same principle - heating effect. It protects circuits and appliances by stopping the flow of any unduly high electric current. It is placed in series with the device. It consists of a piece of wire made of a metal or an alloy of appropriate melting point. If a current larger than the specified value flows through the circuit, the temperature of the fuse wire increases and it melts and the circuit breaks.