VIVEKANAND EDUCATION SOCIETY'S POLYTECHNIC

Study Material

Program Code: All Program

Semester: First

Course Name: Basic Science (Physics)

Course Code: 22102

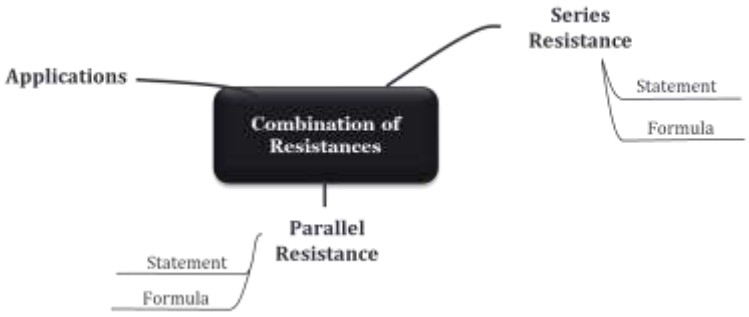
Topic Name: Electricity, Magnetism & Semiconductors

UO2d: Apply laws of series and parallel combination in the given electric circuits.

LO7: Student will be able to apply laws of series and parallel combination of resistance in the given electric circuits.

Course Expert: S. K. Rawat	**Date: 28/08/2020**

Concept Map:



Key words: Resistance, equivalent resistance, series, parallel

Key Questions:

1. What is the effective resistance of series combination of resistances?
2. What is the effective resistance of parallel combination of resistances?

Key Definition:

1. If different resistances are joined with each other such that there is only one path for the flow of electric current then the combination of such resistances is called Series Combination.
2. If there is more than one path for the flow of current in a circuit then the combination of resistances is called Parallel Combination.

Formula:

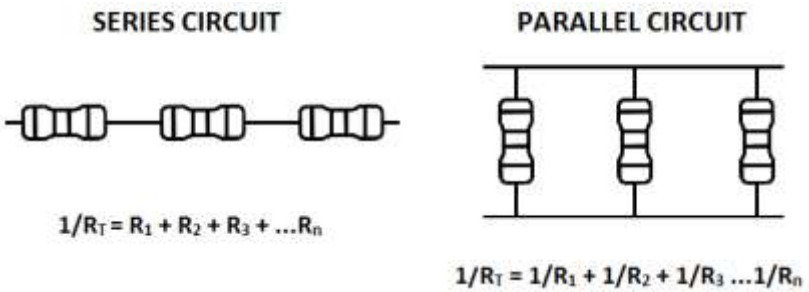
1. Series combination $\mathbf{R = R_1 + R_2 + R_3}$
2. Parallel combination $\frac{\mathbf{1}}{\mathbf{R}} = \frac{\mathbf{1}}{\mathbf{R_1}} + \frac{\mathbf{1}}{\mathbf{R_2}} + \frac{\mathbf{1}}{\mathbf{R_3}}$

Notes

Combination of Resistance

Resistors (Resistance) can be joined to each other by two ways:

1. Series combination
2. Parallel combination



Series Combination

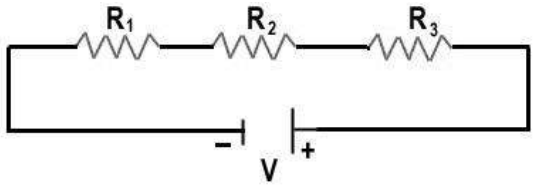
If different resistances are joined with each other such that there is only one path for the flow of electric current then the combination of such resistances is called Series Combination.

In series combination current through each resistor is constant.

In series combination potential difference across each resistor is different depending upon the value of resistance.

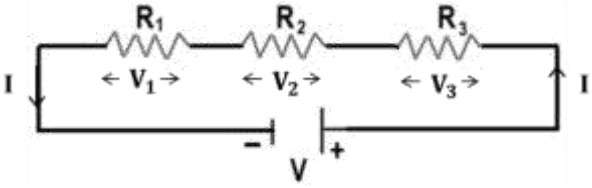
Equivalent resistance of circuit is equal to the sum of individual resistances.

i.e., $\mathbf{R_S = R_1 + R_2 + R_3}$



Mathematical Derivation:

Consider three resistances R_1, R_2, & R_3 connected in series combination with a power supply of voltage V.



Let electric current I is passing through the circuit.

Potential difference of each resistor is V_1, V_2, & V_3 respectively.

Now $\mathbf{V = V_1 + V_2 + V_3}$

According to Ohms Law, $\mathbf{V = IR}$

Therefore $\mathbf{IR = IR_1 + IR_2 + IR_3}$ → $\mathbf{IR = I(R_1 + R_2 + R_3)}$

Thus $\mathbf{R = R_1 + R_2 + R_3}$

Lamps in Series

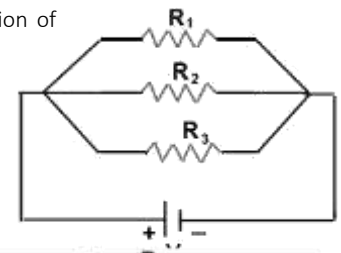
Parallel Combination

If there is more than one path for the flow of current in a circuit then the combination of resistances is called Parallel Combination.

In parallel combination current through each resistor is different.

Potential difference across each resistor is constant.

Equivalent resistance of circuit is always less than either of the resistances included in the circuit.



Mathematical Derivation:

Consider three resistances R_1, R_2, & R_3 connected in parallel combination with a power supply of voltage V.

Let electric current I is passing through the circuit.

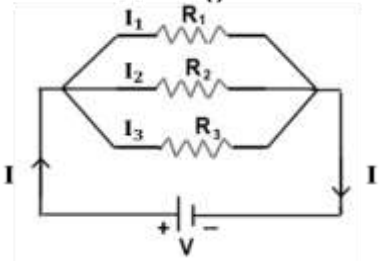
Current through each resistor is I_1, I_2, & I_3 respectively.

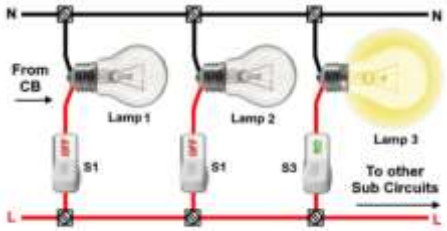
Now $\mathbf{I = I_1 + I_2 + I_3}$ and according to Ohms law, $\mathbf{I = \frac{V}{R}}$

Therefore $\mathbf{\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}}$ →

$$V\left(\frac{1}{R}\right) = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

Thus $\mathbf{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$





Lamps in Parallel

Applications

Series combination

Series circuit connections are common and greatly employed in electrical equipment's. The tube filaments in small radios are usually in series. Current controlling devices are always connected in series with the device that they protect. Fuses are connected in series with the device they protect, Automatic house-heating equipment has a thermostat, electromagnetic coils, and safety cut-outs connected in series with a voltage source etc.

Parallel combination

Parallel circuit connection is very common in use. Various lamps and electrical appliances in our homes are connected in parallel so that each of the lamps or bobs and appliances can be operated independently. For us to have control over the individual lamps or loads, they have to be wired in parallel.

Link to YouTube/ OER/ video/e-book:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
2. https://www.electricaltechnology.org/2015/03/parallel-connection-is-preferred-over-series.html

Key Take away:

1. Series combination of resistances.
2. Parallel combination of resistances.

Formative Assessments

<22102> : <All Program> : < All Program >: <Electricity, Magnetism & Semiconductors>: <UO2d> : <LO7> : <Assessments> : <Formative>

<S. K. Rawat>

Assessment Type: Formative Assessments: Embedded questions in video/ PPT

Set 1		
Question No 1	Question No 2	Question No 3
Combined resistance of 5 Ω and 10 Ω is equal to	When number of resistances are connected in _____ combination, its equivalent resistance increases.	When cells are connected in series, we get _____
Applications	Understanding	Applications
a) 10 Ω	a) series	a) Dynamo
b) 16 Ω	b) parallel	b) Generator
c) 15 Ω	c) parallel and series	c) Battery
d) 20 Ω	d) none of the above	d) None of the above
Ans: <15 Ω >	Ans: <series>	Ans: <Battery >

Set 2		
Question No 1	Question No 2	Question No 3
When number of resistances are connected in _____ combination, its equivalent resistance decreases.	In parallel combination voltage passing through each resistor is	The effect of connecting an additional parallel load to an electrical supply source is to increase the:
Remembering	Remembering	Understanding
a) series	a) same	a) resistance of the load
b) parallel	b) different	b) voltage of the source
c) parallel and series	c) low voltage	c) current taken from the source
d) none of the above	d) high voltage	d) p.d. across the load
Ans: <parallel >	Ans: <same >	Ans: < current taken from the source >

Practice Worksheets

<22102> : <All Program> : < All Program >: <Electricity, Magnetism & Semiconductors>: <UO2d> : <LO7> : <Assessments> : <Formative>

<S. K. Rawat>

A. Current through each resistor when they are connected in series is _____. a) different b) same c) increasing d) decreasing	B. Three resistances 20 Ω, 30 Ω and 60 Ω are connected in parallel, their combined resistance is given by a) 110 Ω b) 50 Ω c) 20 Ω d) 10 Ω
Ans A:	Ans B:
C. Ammeter should always have a a) high resistance b) low resistance c) low voltage d) high voltage	D. Resistors are connected end to end in a) series combination b) parallel combination c) circular combination d) random combination
Ans C:	Ans D:
E. In series combination current passing through each resistor is a) different b) same c) zero d) high	F. The effect of connecting an additional parallel load to an electrical supply source is to increase the: a) resistance of the load b) voltage of the source c) current taken from the source d) p.d. across the load
Ans E:	Ans F:
G. The total resistance of two resistors R1 and R2 when connected in parallel is given by: a) R1 + R2 b) 1/R1 + 1/R2 c) (R1 + R2)/ R1R2 d) R1R2/ (R1+R2)	H. The total resistance of two resistors R1and R2 when connected in series is given by: a) R1 + R2 b) 1/R1 + 1/R2 c) (R1 + R2)/ R1R2 d) R1R2/ (R1+R2)
Ans G:	Ans H:
I. In household connection electric bulbs are connected in _____ a) series b) parallel c) series and parallel d) none of the above	J. When cells are connected in series, we get _____ a) Dynamo b) Generator c) Battery d) None of the above
Ans I:	Ans J: