Aim ↬ To study the series and parallel connections of Resistors.

Equipment Required ↬

Power supply, resistors, breadboard, connecting wires, multimeter.

Theory ↬

Resistors are passive electrical components that limit the flow of electric current in a circuit. They are used to control the amount of current flowing through electronic devices, protect components from excessive current, and set voltage levels in circuits. Understanding the behavior of resistors in different configurations is fundamental in electrical engineering and circuit design.

In a series connection, resistors are connected end-to-end, forming a single pathway for current flow. The total resistance in a series circuit increases as more resistors are added. The formula for total resistance [R_T] in a series circuit is:

$$R_T = R_1 + R_2 + R_3 + \cdots + R_n$$

In this case, the current [I] through each resistor is the same, while the voltage drop [V] across each resistor can vary depending on its resistance value, as described by Ohm's Law:

$$V = I \times R$$

The sum of the voltage drops across each resistor equals the total voltage supplied by the power source. This relationship can be expressed as:

$$V_T = V_1 + V_2 + V_3 + \cdots + V_n$$

In contrast, in a parallel connection, resistors are connected across the same voltage source, creating multiple pathways for current to flow. The total resistance in a parallel circuit is always less than the smallest individual resistor, making it easier for current to flow. The formula for total resistance [R_T] in a parallel circuit is calculated using:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}$$

In this configuration, the voltage [V] across each resistor remains the same, equal to the total supply voltage, while the total current [I_T] is the sum of the individual currents through each resistor. Each branch can carry a different amount of current, which can be expressed as:

$$I_T = I_1 + I_2 + I_3 + \cdots + I_n$$

The relationship between current and voltage in each branch is also governed by Ohm's Law:

$$I_n = \frac{V}{R_n}$$

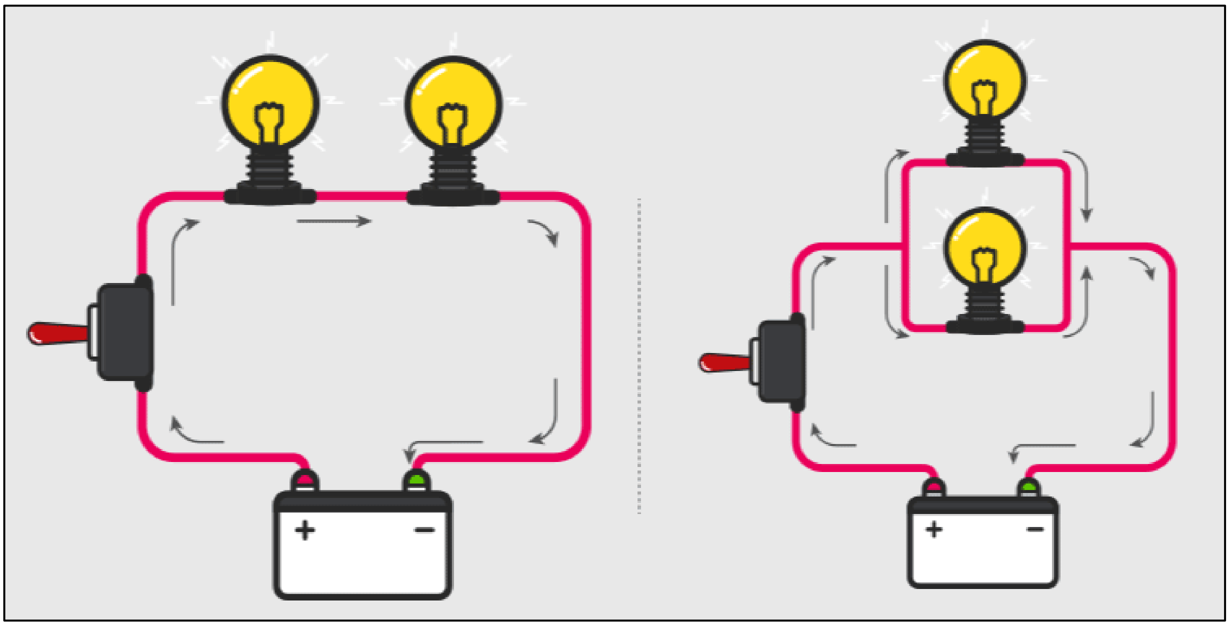

Fig. i) Series Connection of R   Fig. ii) Parallel Connection of R

This distinction between series and parallel connections is crucial in circuit design, as series circuits are often used in applications where the same current must flow through all components [e.g., string lights], while parallel circuits are favored in applications requiring equal voltage distribution [e.g., household wiring]. Understanding these principles allows for more effective troubleshooting, design, and optimization of electrical circuits.

Procedure ↬

1. Place the breadboard on a flat surface.
2. For the series connection, connect the resistors in a line and attach the power supply across the ends.
3. For the parallel connection, connect one terminal of each resistor to the positive terminal of the power supply and the other to the negative terminal.
4. Ensure secure connections using jumper wires.
5. Measure total resistance with a multimeter for both configurations.

6. Turn on the power supply and record the current flowing through the circuit using the multimeter.
7. Measure the voltage across each resistor, then calculate the resistance using Ohm's Law: $R = \frac{V}{I}$

Output ↬

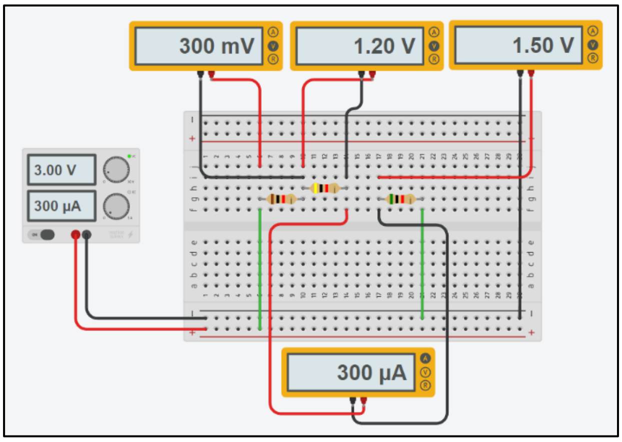

Fig. iii) Series Connection in Tinkercad

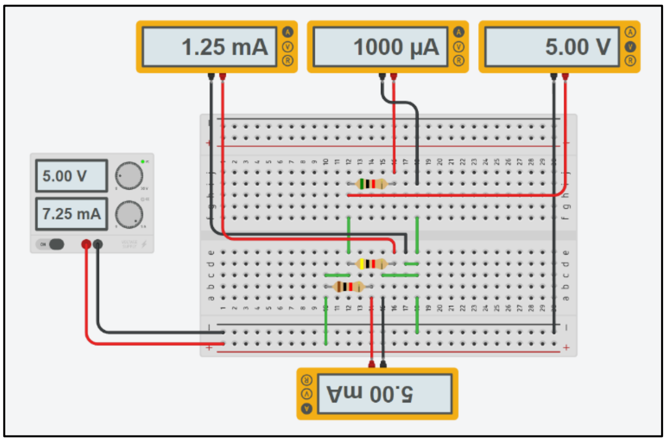

Fig. iv) Parallel Connection in Tinkercad

Calculation ↬

Resistances used – $R_1 = 1k\Omega, R_2 = 4k\Omega, R_3 = 5k\Omega$

Series Combination ↴

$$R_S = (1 + 4 + 5)k\Omega$$

$$R_S = 10k\Omega$$

$$V_1 = 0.3V, V_2 = 1.2V, V_3 = 5k\Omega \qquad \& \qquad I = 300\mu A$$

$$R_{calc} = \frac{V_1 + V_2 + V_3}{I} = \frac{0.3 + 1.2 + 5}{300 \times 10^{-6}}$$

$$R_{calc} = 10k\Omega$$

Parallel Combination ↴

$$\frac{1}{R_P} = \left(\frac{1}{1} + \frac{1}{4} + \frac{1}{5}\right) k\Omega^{-1}$$

$$R_P = 0.69k\Omega$$

$$I_1 = 5mA, I_2 = 1.25mA, I_3 = 1mA \quad \& \qquad V = 5V$$

$$R_{calc} = \frac{1}{\left(\frac{5}{5} + \frac{1.25}{5} + \frac{1}{5}\right) \times 10^3}$$

$$R_{calc} = 0.69k\Omega$$

Result ↬

The experiment showed that series connections resulted in a higher total resistance and uniform current through each resistor, while parallel connections led to lower total resistance and equal voltage across each resistor.

Conclusion ↬

This experiment successfully demonstrated the principles of series and parallel resistor connections, illustrating how these configurations affect total resistance, current distribution, and voltage drops in a circuit.

Precautions ↬

- Ensure correct connections to prevent short circuits.
- Do not exceed the power ratings of the resistors.
- Use appropriate resistor values to maintain safe current levels.