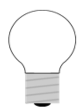
Resistivity and Resistance

Resistivity, ρ, is a property of a **material** describing the degree to which the material opposes the flow of charges through the material.

Resistance, *R*, is a property of a **device** describing the degree to which the device opposes the flow of charges through the device.

Power Ratings



Changes as a function of temperature.

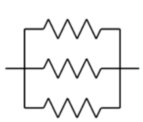
$$R = \rho\frac{L}{A} = \rho_0\frac{L}{A}[1+\alpha(T-T_0)] = R_0[1+\alpha(T-T_0)]$$

$$I = \frac{V}{R} = \frac{V}{\rho\frac{L}{A}} = \frac{V}{\rho_0\frac{L}{A}[1+\alpha(T-T_0)]} = \frac{I_0}{1+\alpha(T-T_0)}$$

$$P = \frac{V^2}{R} = \frac{V^2}{\rho\frac{L}{A}} = \frac{V^2}{\rho_0\frac{L}{A}[1+\alpha(T-T_0)]} = \frac{P_0}{1+\alpha(T-T_0)}$$

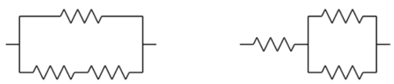
Combinations of resistors

Series: 

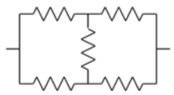
Parallel: 

Combinations of resistors

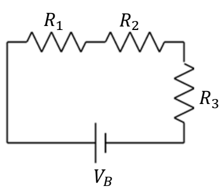
Combination of series and parallel:



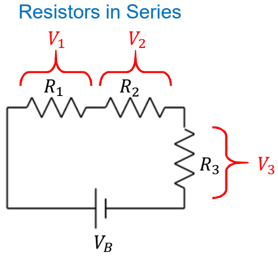
Neither series nor parallel:



Resistors in Series

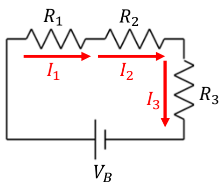


Resistors in Series



$$V_T = V_1 + V_2 + V_3$$

Resistors in Series

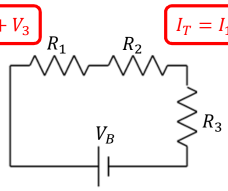


$$I_T = I_1 = I_2 = I_3$$

Resistors in Series

$$V_T = V_1 + V_2 + V_3$$

$$I_T = I_1 = I_2 = I_3$$



$$R_T = \frac{V_T}{I_T} = \frac{V_1 + V_2 + V_3}{I_T} = \frac{V_1}{I_1} + \frac{V_2}{I_2} + \frac{V_3}{I_3}$$

$$R_T = R_1 + R_2 + R_3$$

Resistors in Series

$$V_T = V_1 + V_2 + V_3$$

$$I_T = I_1 = I_2 = I_3$$

$$R_T = R_1 + R_2 + R_3$$

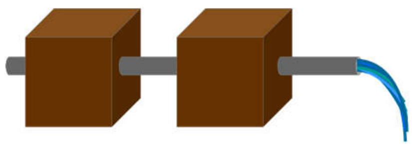
Consider connecting two resistors of the same cross-sectional area in series:

$$R_T = \rho\frac{L_T}{A} = \rho\,\frac{L_1 + L_2}{A} = \rho\frac{L_1}{A} + \rho\frac{L_2}{A} = R_1 + R_2$$

Resistors in Series

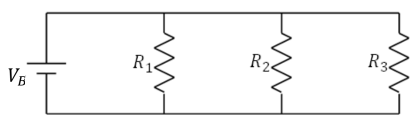
Pipe Analogy

$$R_T = R_1 + R_2 + R_3$$

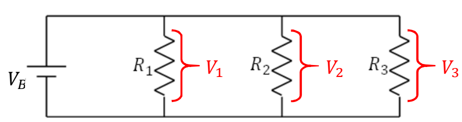


A set of pipes in series is more resistant to flow than any of the individual pipes in the series.

Resistors in Parallel

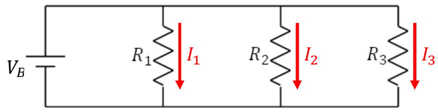


Resistors in Parallel



$$V_T = V_1 = V_2 = V_3$$

Resistors in Parallel

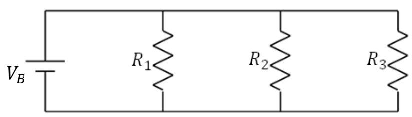


$$I_T = I_1 + I_2 + I_3$$

Resistors in Parallel

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$



$$\frac{1}{R_T} = \frac{I_T}{V_T} = \frac{I_1 + I_2 + I_3}{V_T} = \frac{I_1}{V_1} + \frac{I_2}{V_2} + \frac{I_3}{V_3}$$

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

Resistors in Parallel

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

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

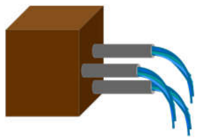
Consider connecting two resistors of the same length in parallel:

$$\frac{1}{R_T} = \frac{A_T}{\rho L} = \frac{A_1 + A_2}{\rho L} = \frac{A_1}{\rho L} + \frac{A_2}{\rho L} = \frac{1}{R_1} + \frac{1}{R_2}$$

Resistors in Parallel

Pipe Analogy

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



A set of pipes in parallel is less resistant to flow than any of the individual pipes in the series.

	Series	Parallel
Capacitance	$\frac{1}{C_T} = \sum \frac{1}{C_i}$	$C_T = \sum C_i$
Resistance	$R_T = \sum R_i$	$\frac{1}{R_T} = \sum \frac{1}{R_i}$
Potential Difference	$V_T = \sum V_i$	$V_T = V_i$
Current	$I_T = I_i$	$I_T = \sum I_i$
Charge on Capacitor	$Q_T = Q_i$	$Q_T = \sum Q_i$

OSE's

	Series	Parallel
Capacitance	$\frac{1}{C_T} = \sum \frac{1}{C_i}$	$C_T = \sum C_i$
Resistance	$R_T = \sum R_i$	$\frac{1}{R_T} = \sum \frac{1}{R_i}$
Potential Difference	$V_T = \sum V_i$	$V_T = V_i$
Current	$I_T = I_i$	$I_T = \sum I_i$
Charge on Capacitor	$Q_T = Q_i$	$Q_T = \sum Q_i$

Not provided. May be used.

	Series	Parallel
Capacitance	$\frac{1}{C_T} = \sum \frac{1}{C_i}$	$C_T = \sum C_i$
Resistance	$R_T = \sum R_i$	$\frac{1}{R_T} = \sum \frac{1}{R_i}$
Potential Difference	$V_T = \sum V_i$	$V_T = V_i$
Current	$I_T = I_i$	$I_T = \sum I_i$
Charge on Capacitor	$Q_T = Q_i$	$Q_T = \sum Q_i$