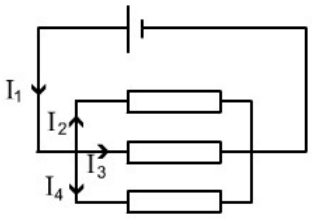
Kirchoff's Laws and Potential Dividers

Kirchhoff's Laws

Kirchhoff's Laws apply conservation of energy and charge principles to electrical circuits.

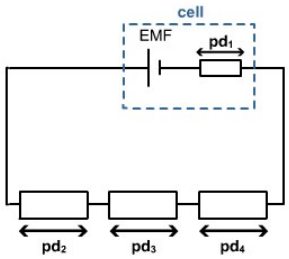


Kirchoff's First Law

Electric charge is conserved in all circuits, all the charge that arrives at a point must leave it.

Current going in = current going out.

In the diagram we can say that: $I_1 = I_2 + I_3 + I_4$



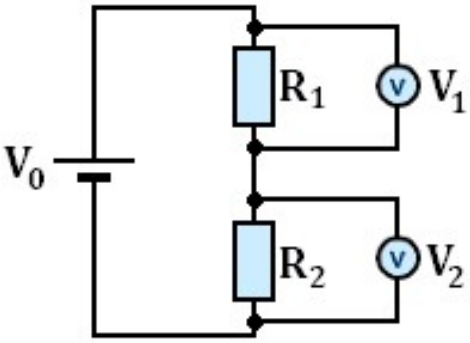
Kirchoff's Second Law

Energy is conserved in all circuits, for any complete circuit the sum of the EMF's is equal to the sum of the potential differences.

Energy givers = energy takers.

In the diagram we can say that: $\varepsilon = pd_1 + pd_2 + pd_3 + pd_4$.

Potential Dividers



A potential divider is used to produce a desired potential difference, it can be thought of as a potential selector.

A typical potential divider consists of two or more resistors that share the emf from the battery/cell.

The p.d.s across R_1 and R_2 can be calculated using the following equations:

$$V_1 = V_0 \frac{R_1}{R_1 + R_2} \qquad V_2 = V_0 \frac{R_2}{R_1 + R_2}$$

This actually shows us that the size of the potential difference is equal to the input potential multiplied by what proportion R_1 is of the total resistance.

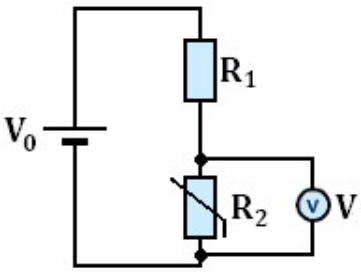
If R_1 is 10 Ω and R_2 is 90 Ω, R_1 contributes a tenth of the total resistance so R_1 has a tenth of the available potential. This can be represented using:

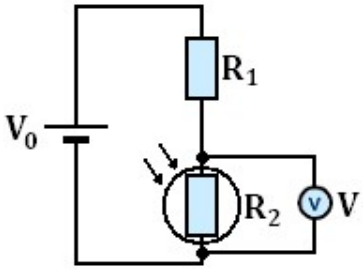
$$\frac{R_1}{R_2} = \frac{V_1}{V_2}$$

The ratio of the resistances is equal to the ratio of the output voltages.

Uses of potential dividers

In this potential divider the second resistor is a thermistor. When the temperature is low the resistance (R_2) is high, this makes the output voltage high. When the temperature is high the resistance (R_2) is low, this makes the output voltage low. A use of this would be a cooling fan that works harder when it is warm.





In the second potential divider the second resistor is a Light Dependant Resistor. When the light levels are low the resistance (R_2) is high, making the output voltage high. When the light levels increase the resistance (R_2) decreases, this makes the output voltage decrease. A use of this could be a street light sensor that switches the light on when the surroundings are dark.