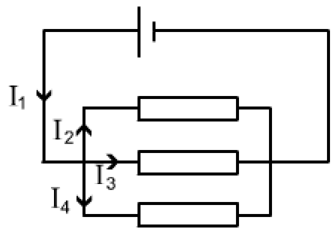
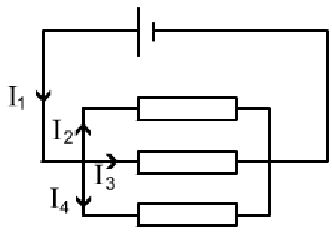
Kirchhoff's Laws and Potential Dividers

To know Kirchoff's Laws and be able to apply them to questions
To know what a potential divider is and be able to calculate the output voltage
To be able to explain an application of a potential divider



Kirchhoff's Laws

Kirchhoff came up with two laws concerning conservation in electrical circuits.

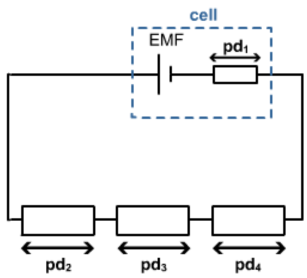


First Law

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: $I_1 = I_2 + I_3 + I_4$



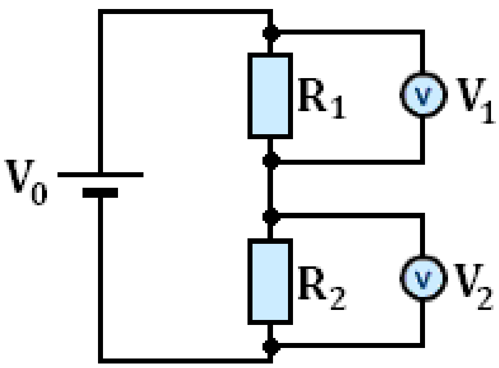
Second Law

Energy is conserved in all circuits, for any complete circuit the sum of the emfs 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:

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

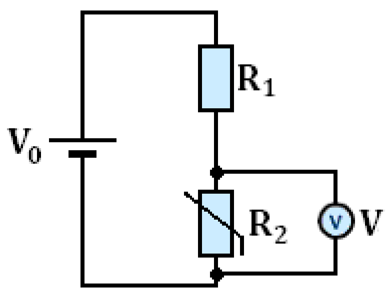
This actually shows us that the size of the potential difference is equal to the input potential multiplied by what proportion of R_1 is of the total resistance.
If R_1 is 10 Ω and R_2 is 90 Ω, R_1 contributes a tenth of the total resistance so R_1 has a tenth of the available potential. This can be represented using:

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

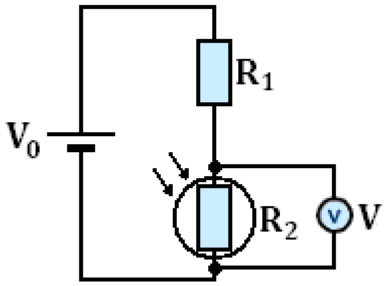
The ratio of the resistances is equal to the ratio of the output voltages.

Uses

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 Resisitor. 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 lights up when the surrounding are dark.