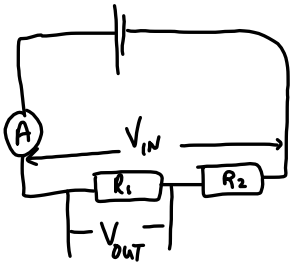
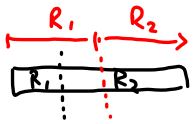
The potential Divider formula

- negligible internal resistance
- the potential diff across the two resistors is the input V_{IN} (input voltage)
- the potential diff across R_1 is the output voltage, V_{OUT}



Potential Divider Circuit.



The current through the resistors is: $I = \frac{V_{IN}}{R_1 + R_2}$

So the potential diff across R_1 is: $V_{OUT} = I \cdot R_1$

$$V_{OUT} = \frac{V_{IN}}{R_1 + R_2} \cdot R_1$$

$$V_{OUT} = V_{IN} \frac{R_1}{R_1 + R_2}$$

By using a slider/wiper we can vary R_1 and R_2

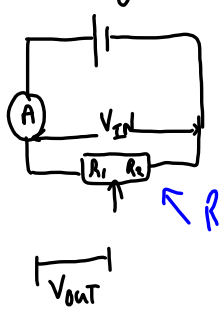
Minimum $V_{OUT} = 0$ when $R_1 = 0$

Maximum $V_{OUT} = V_{IN}$ when $R_2 = 0$

The output voltage is adjusted by continuously varying R_1 and as a result R_2 (the total remains constant)

This is done with a rheostat or potentiometer

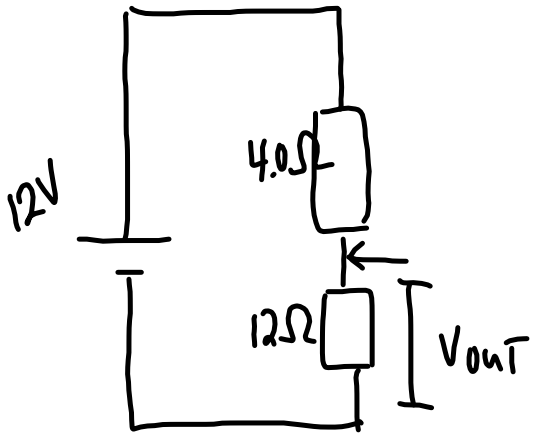
Another way to show in a circuit diagram:



↖ $R_1 + R_2$ is constant.

Example

Calculate the output potential difference for the potential divider shown below. Assume the battery has negligible internal resistance.



$$V_{OUT} = V_{IN} \frac{R_1}{R_1 + R_2}$$

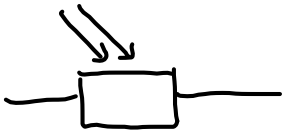
$$V_{OUT} = 12V \left(\frac{12\Omega}{16\Omega} \right)$$

$$V_{OUT} = 9V$$

The light dependent resistor (LDR)

An LDR is a type of resistor whose resistance decreases when light falls on it.

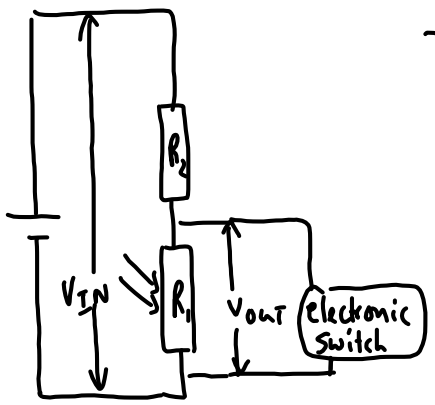
- typical resistance values may be 1 MΩ in the dark and 100 Ω in bright light.
- made of a semiconductor material (cadmium sulfide)



circuit symbol

- light sensitive due to photoelectric effect (more on this later)
- used in light sensitive switches, light meters, lighting control devices for street lamps etc.

Use of an LDR in a potential divider circuit as an automatic light switch:



- The electronic switch is activated when the pot. diff across it reaches a certain level
- The pot diff across the switch is given by V_{OUT}:

$$V_{OUT} = V_{IN} \frac{R_1}{R_1 + R_2}$$

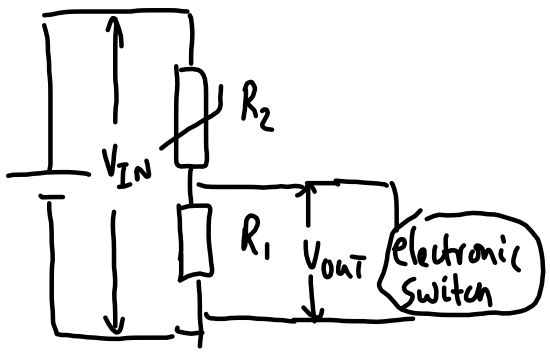
- When the light falls on the LDR, its resistance is low and V_{OUT} is low
- When the light stops falling on the LDR, its resistance increases, so V_{OUT} increases.
- this causes the electronic switch to activate the lights.

Thermistor (NTC)

A thermistor (more specifically "a negative temperature coefficient thermistor") is a device whose resistance decreases as the temperature increases.

- made of a semiconductor material
- non-conducting at low temperatures
- resistance decreases as the temperature increases (electrons are excited into conduction band)
- used in devices like fire alarm, temperature sensors in engines, current-limiting devices (replacing fuses)

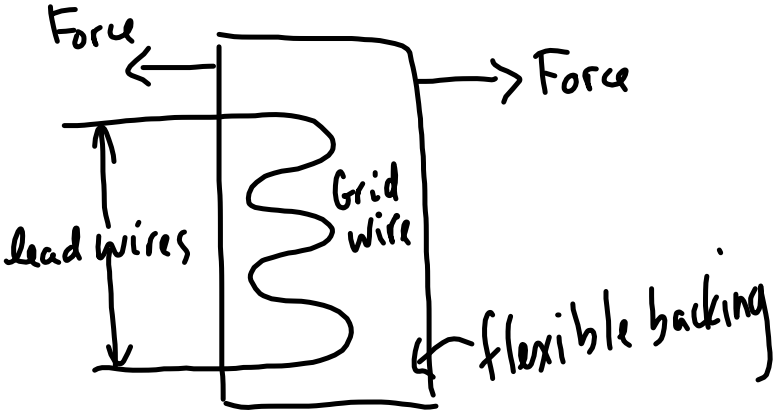
Thermistor circuit in a fire alarm:

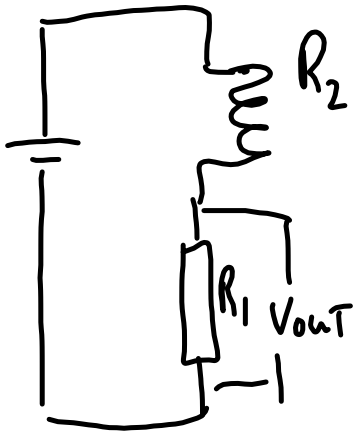


- the thermistor is R_2
- if the the temp is low, then R_2 is high, making V_{OUT} decrease
- if the temp is high, then R_2 is low, making V_{OUT} increase.
- When V_{OUT} reaches a certain level, the fire alarm goes off.

Strain Gauge

- related to compression + stretching a coil of wire
- compression + stretching affect the resistance.
  - ↓ decreases
  - ↓ increases





Kirchoff's Circuit Laws

$\Sigma V = 0$ (loop rule)

$\Sigma I = 0$ (junction rule)