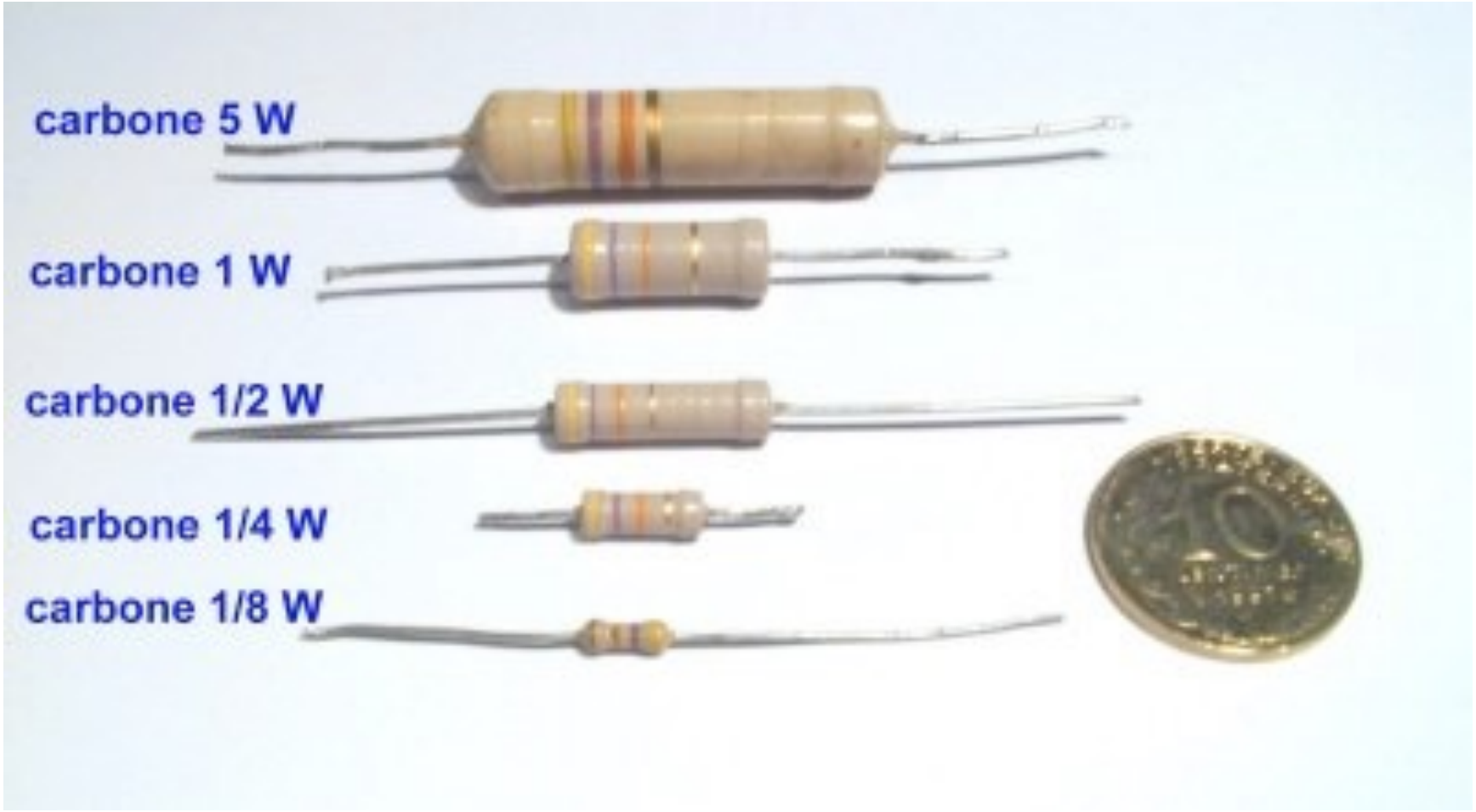
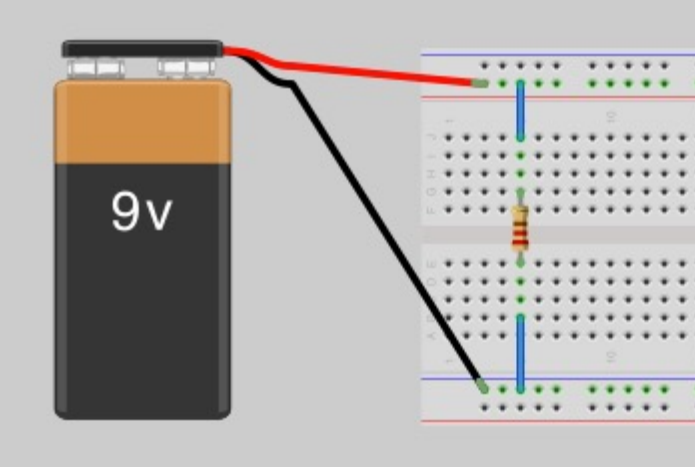
# Notions of electronics

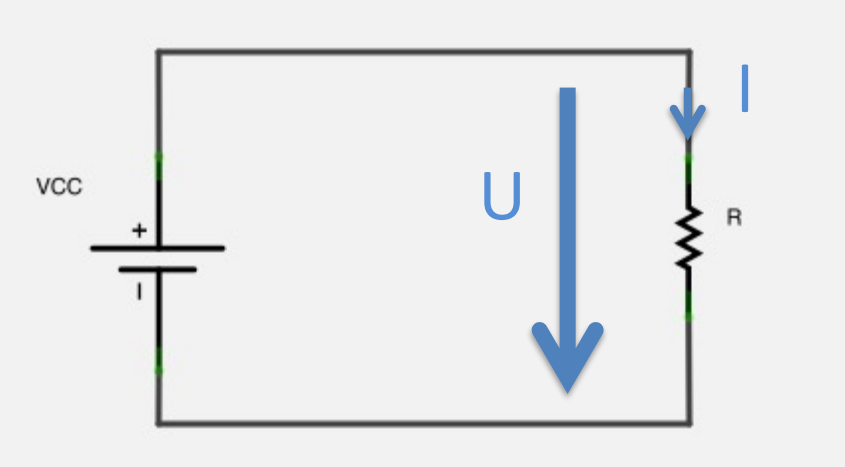
Pierre Rossel

# Resistor



# Resistor



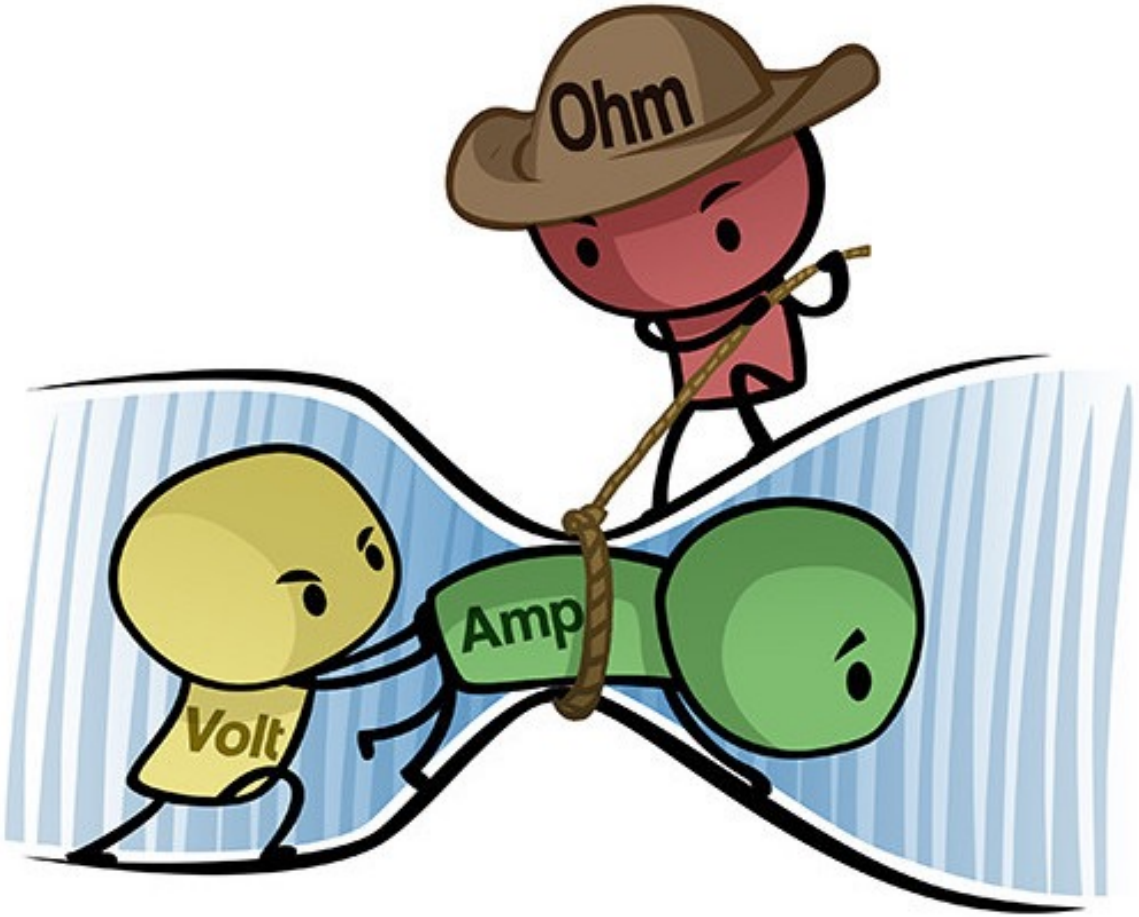

- A voltage across a resistor causes a current
- The higher the voltage, the higher the current
- The higher the resistance, the lower the current

# Resistor

- Units and symbols

| Element | Unit | Symbol | Name in schematics |
|---|---|---|---|
| Voltage | Volt | [V] | U or V |
| Resistance | Ohm | [Ω] or [ohm] | R |
| Current | Ampere | [A] | I |

# Resistor



# Resistor

**Open circuit**

- Infinite resistance
- Zero current: the current does not flow

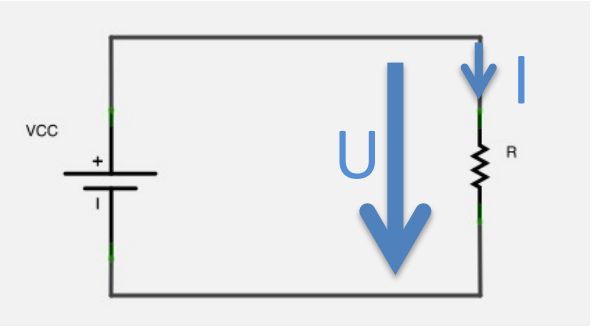
**Short circuit**

- Zero resistance
- Infinite current (theoretically, but not in practice because the resistance is never really zero, even in a copper wire)

# Measuring a voltage

- Using a voltmeter or a multimeter configured as a voltmeter
- High resistance
- Low current
- Parallel connection
- Little risk, a weak current flows through the instrument

# Ohm's law




- Voltage
  - Name: U
  - Unit: volt
  - Symbol: [V]
- Current
  - Name: I
  - Unit: ampere
  - Symbol: [A]
- Resistance
  - Name: R
  - Unit: ohm
  - Symbol: [Ω] or [ohm].

$$U_{[V]} = R_{[\Omega]} \cdot I_{[A]}$$

$$I_{[A]} = \frac{U_{[V]}}{R_{[\Omega]}}$$

$$R_{[\Omega]} = \frac{U_{[V]}}{I_{[A]}}$$

# Calculation of current 1

- On a 12 V battery, we connect a bulb with a resistance of 12 Ω.
- Draw the diagram.
- Calculate the current.

- $I = U / R$
- $I = 12\ [V] / 12\ [\Omega]$
- $I = 1\ [A]$

# Current calculation 2

- On a 12 V battery, we power a bulb that is 220 Ω.
- Draw the diagram
- Calculate the current

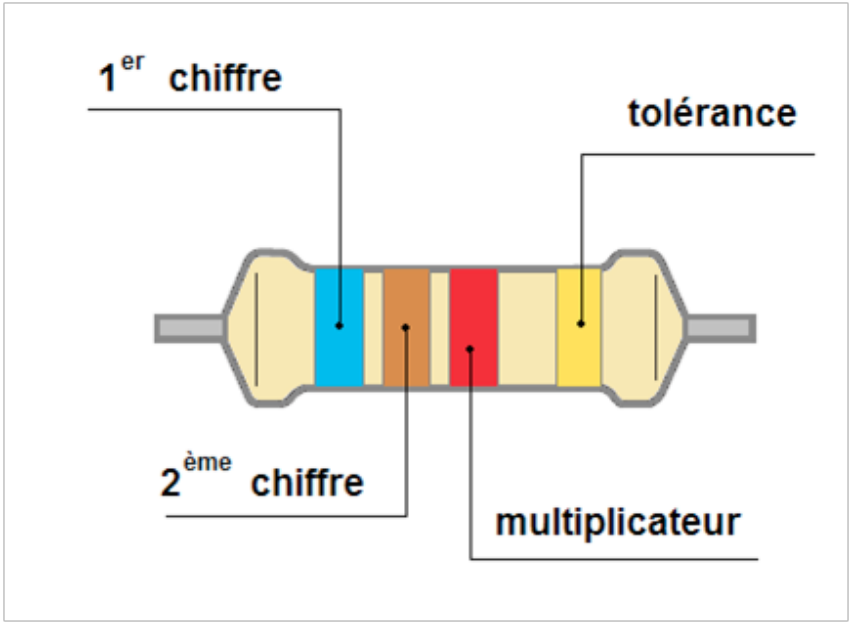
- $I = U / R$
- $I = 12\ [V] / 220\ [\Omega]$
- $I = 0.0545\ [A]$
- $I = 54.5\ [mA]$

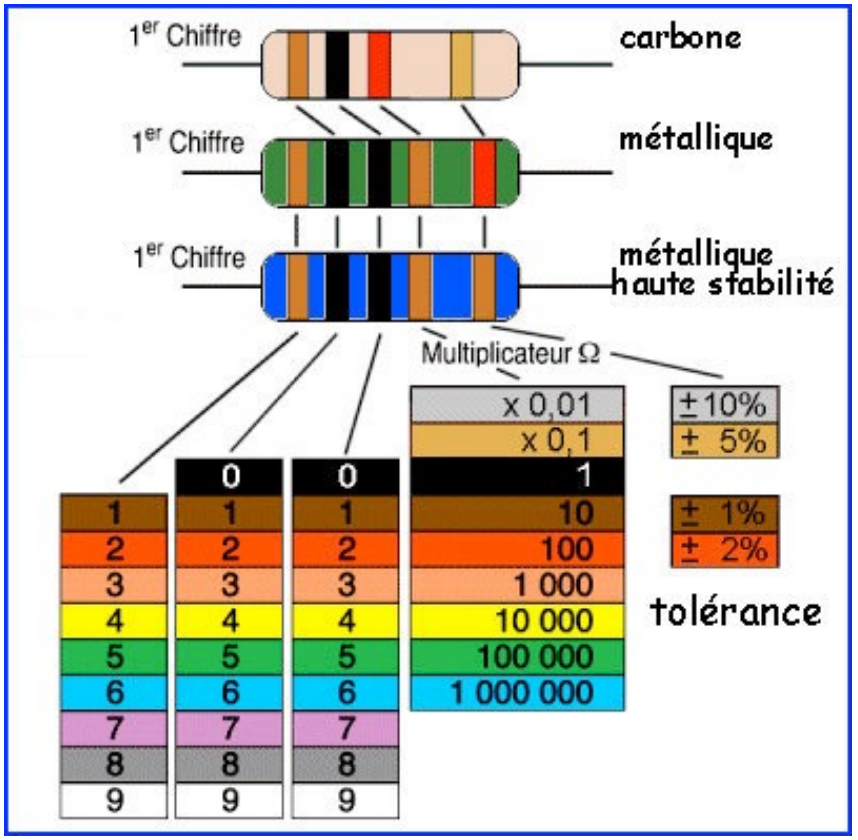
# Resistance calculation

- I want a voltage of 2.5 V at the terminal of a resistor to limit the current to 10 mA.
- What resistance value should I choose?

- $R = U / I$
- $R = 2.5\ [V] / 0.010\ [A]$
- $R = 250\ [\Omega]$

# Color code


1er chiffre
tolérance
2ème chiffre
multiplicateur


1er Chiffre
carbone
1er Chiffre
métallique
1er Chiffre
métallique
haute stabilité
Multiplicateur Ω
x 0,01
x 0,1
1
10
100
1 000
10 000
100 000
1 000 000
±10%
± 5%
± 1%
± 2%
tolérance
0 1 2 3 4 5 6 7 8 9
0 1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9

# Power

- Joule effect
  - A resistor through which a current flows consumes a certain amount of electrical energy and transforms it into heat
- Power
  - Name: P
  - Unit: Watt
  - Symbol: [W]

$$P = U \cdot I$$

$$P = R \cdot I^2$$

$$P = \frac{U^2}{R}$$

# Power calculation 1

- On a 12 V battery, we connect a bulb with a resistance of 12 Ω.
- Draw the diagram
- Calculate the power dissipated by the bulb

- $P = U^2 / R$
- $P = 12^2 / 12$
- $P = 12$ [W]

# Power calculation 2

- On a 12 V battery, we power a 220 Ω bulb.
- Draw the diagram
- Calculate the power dissipated by the bulb

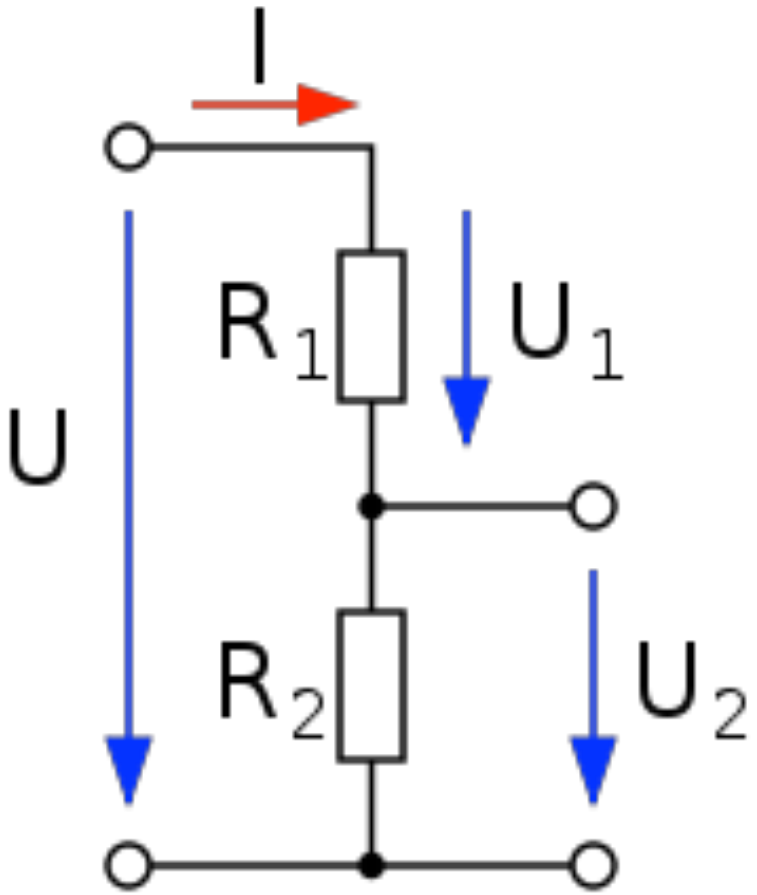
- $P = U^2 / R$
- $P = 12^2 / 220$
- $P = 0.65$ [W]

# Power calculation 3

- On a 12 V battery, we connect a 60 Watt bulb
- Draw the diagram
- Calculate the current flowing through the bulb

- $P = U * I$
- $I = P / U$
- $I = 60 / 12 = 5$ [A]

# Voltage divider




- In series, the voltages add up

$$U = U_1 + U_2$$

- The current through the two resistors is the same

$$U_1 = R_1 * I$$

$$U_2 = R_2 * I$$

$$U = (R_1 + R_2) * I$$

# Calculation of a divisor 1

- From a 5 V voltage source, I want to have a 5 mA current through a 330 Ω resistor. To do this, I decide to add a resistor in series.
- Draw the diagram
- Calculate the value of the additional resistance

- $U2 = R * I = 330 * 0.005 = 1.65$ V
- $U1 = U - U2 = 5 - 1.65 = 3.35$ V
- $R1 = U1 / I = 3.35 \text{ V} / 0.005 \text{ A} = 670$ Ω

# Calculation of a divisor 2

- Using a voltage divider, I want to go from 12 V to 4 V across a 1 kΩ resistor (R2)
- Draw the diagram and calculate R1

- I = U2 / R2 = 4 V / 1000 Ω = 0.004 A
- U1 = U - U2 = 12 - 4 = 8 V
- R1 = U1 / I = 8 V / 0.004 A = 2000 Ω = 2 kΩ

# LED (Light-Emitting Diode)
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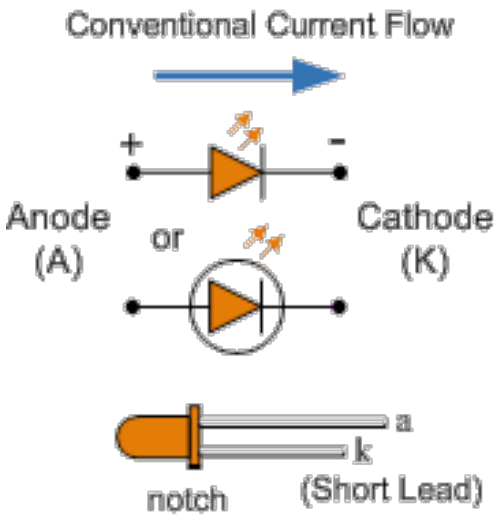
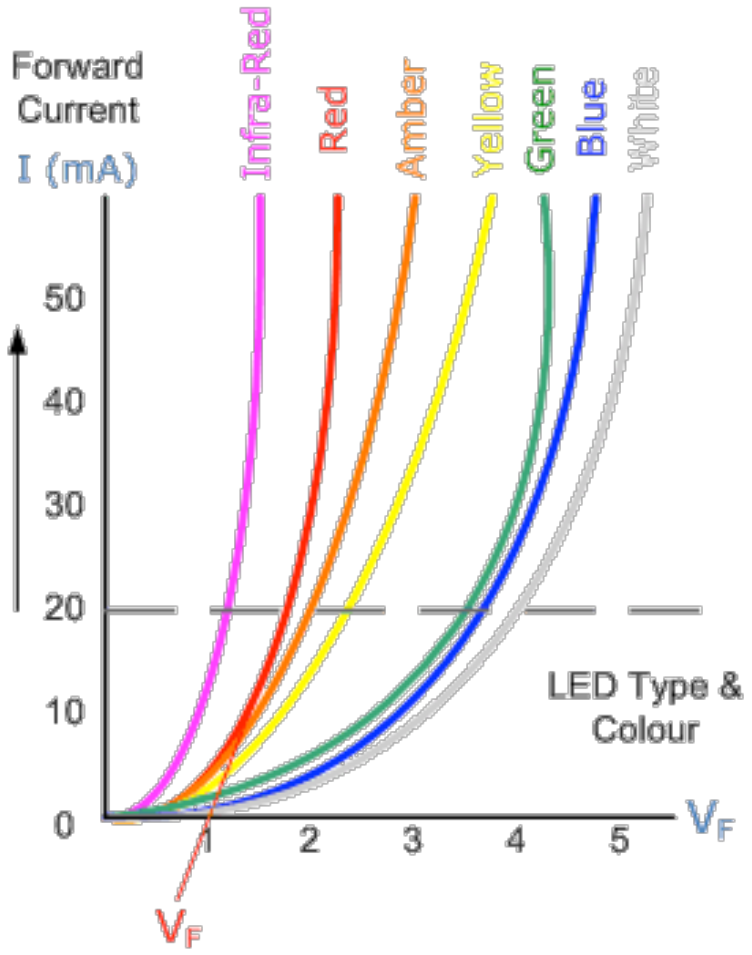
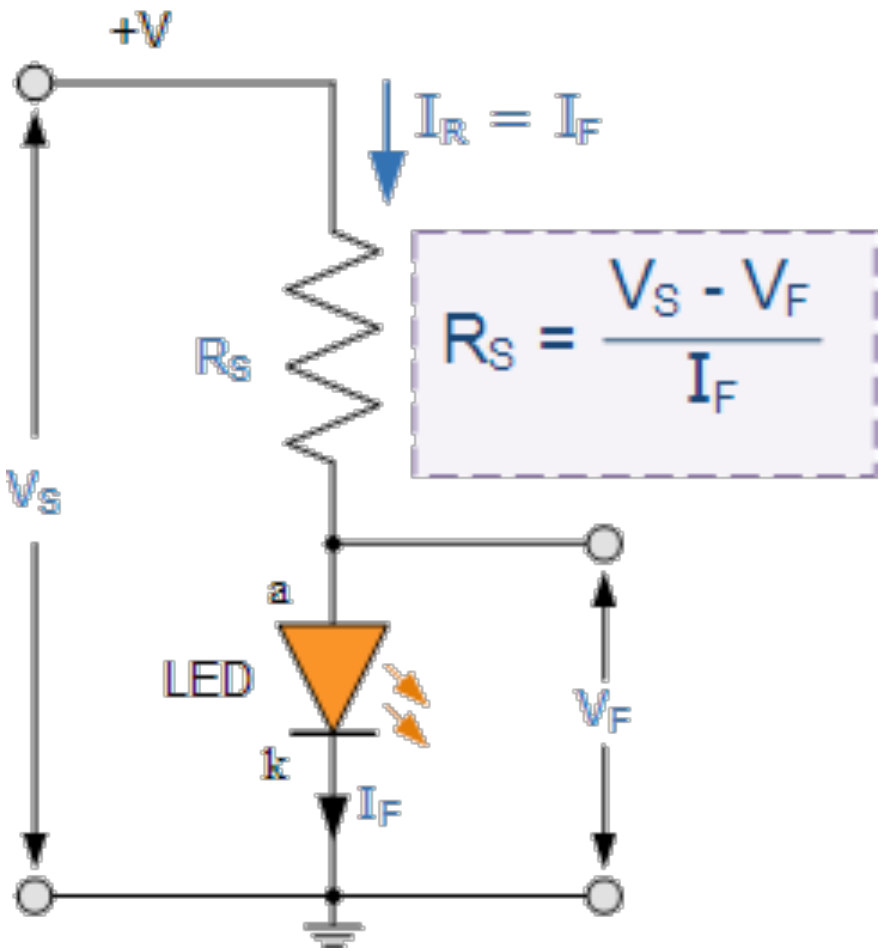
# LED




LED and its
I-V Characteristics



# Resistance calculation for LED



# Resistance calculation for LED

- Using a 12 V battery, I want to power an LED that has a voltage drop of 3 V with a current of 20 mA.
- What value of resistor should I put in series with it?
- U (resistance) = 12V - 3V = 9 V
- R = U / I = 9 V / 0.020 A
- R = 450 Ω