# Experiment 1: Resistors

## Student Group

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## Table of Contents

# Experiment 1: Resistors

## Objectives of the Experiment

Getting to know the following components

- Digital multimeter
- Function generator
- Breadboard

Applying

- direct/indirect resistance measurement
- resistor standard series
- mesh/node equations
- differential resistance of an incandescent lamp

## Preparation for the lab

# Voltage divider as voltage source

The voltage divider shown in figure 5 is initially in the unloaded condition, because the entire current supplied by the power supply flows through the series-connected resistors $R_{\rm 1}$ and $R_{\rm 2}$. A resistor connected in parallel with $R_{\rm 2}$ loads the voltage divider.

Set the voltage on the power supply to $12 ~{\rm V}$ and measure the exact voltage with a multimeter.

For the connected load $R_{\rm L} = 10 ~{\rm k}\Omega$, the voltage divider represents a voltage source. Like any voltage source, it has a source voltage $U_0$ and an internal resistance $R_{\rm i}$.

The internal resistance of the voltage divider, considered as a voltage source, results from the parallel combination of the divider resistors $R_{\rm 1}$ and $R_{\rm 2}$:

$R_{\rm i} = R_{\rm 1} \parallel R_{\rm 2} = \frac{R_{\rm 1} \cdot R_{\rm 2}}{R_{\rm 1} + R_{\rm 2}}$

Use the measured values of resistors $R_{\rm 1}$ and $R_{\rm 2}$ to calculate the internal resistance $R_{\rm i}$ of the voltage source and determine the source voltage:

$R_{\rm i} =$

$U_0 =$ <

The power $P_0$ supplied by the power supply can be calculated using:

$P_0 = U \cdot I_{\rm 1}$

The power consumed by the load resistor can be determined using:
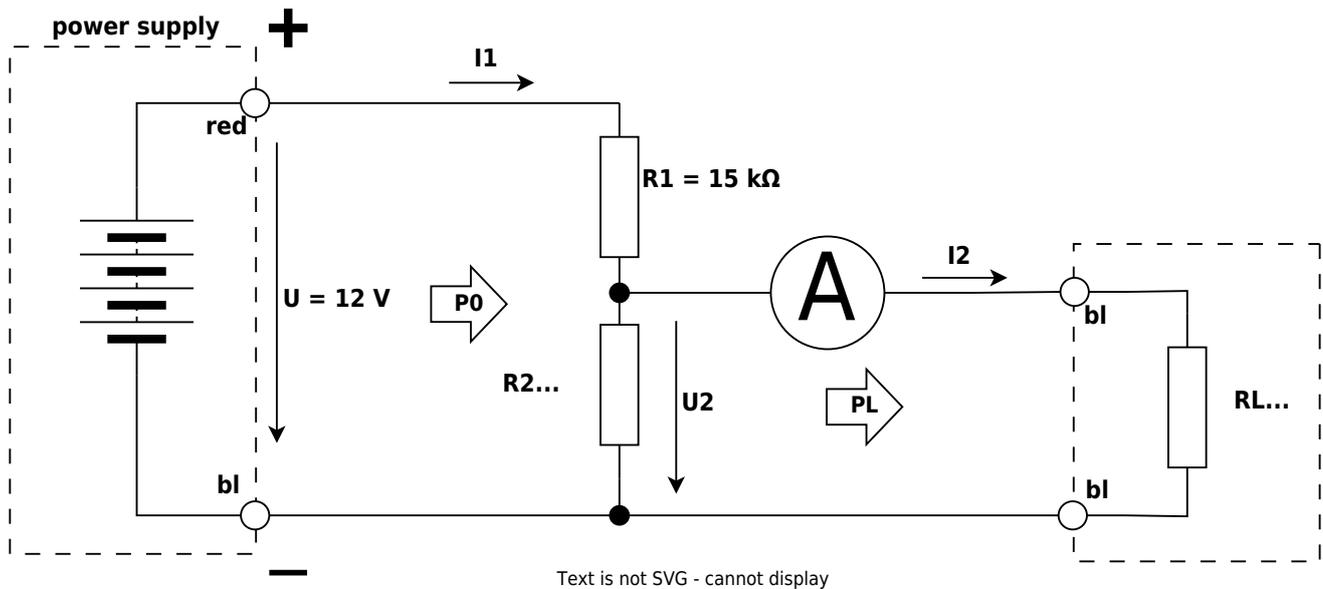
$P_{\rm L} = R_{\rm L} \cdot I_{\rm 2}^2$

**power supply**



Fig. 5: Loaded voltage divider

Draw the equivalent voltage source of the voltage divider.

What value would $U_{\rm 2}$ have without $R_{\rm L}$?

$U_{\rm 2,0} =$

Calculate $U_{\rm 2L}$ and $I_{\rm 2}$ for $R_{\rm L} = 10 ~{\rm k}\Omega$ using the values of the equivalent voltage source. State the formulae used.

$U_{\rm 2L}:$

$I_{\rm 2}:$

Verify the values by measurement.

$U_{\rm 2L,meas}:$

$I_{\rm 2,meas}:$

Verify the values using Kirchhoff's laws. State the formulae used.

$U_{\rm 2L}:$

$I_{\rm 2}:$

# Preparation for the oral short test

For this experiment you should

1. be able to apply and explain the following concepts:
    1. current- and voltage-correct measurement
    2. series and parallel connection of resistors
    3. mesh and node equations (Kirchhoff's laws)
    4. passive sign convention and active sign convention
    5. ideal and real sources

You should be able to answer the following questions:

1. Which operating mode does the source use? Which quantity is kept constant by the source?
2. Power supplies operate in quadrants. In which quadrant is the power supply operated? What can the source then correspondingly not do?
3. What must be considered for the (loaded and unloaded) voltage divider?
4. How do you measure a voltage with a current meter? How a current with a voltage meter?
5. How does an ohmmeter measure resistance?
6. Where are the limits of linearity in real resistors?
7. What examples are there of linear and non-linear resistors?
8. What else can the resistance depend on?