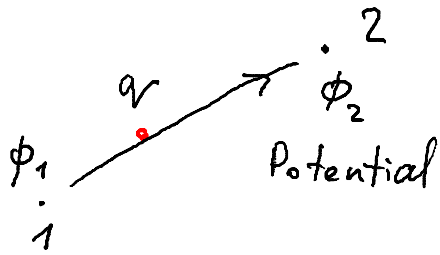


Stromleistung und Joulesche Wärme



Arbeit $W = q \cdot (\phi_1 - \phi_2)$
 $= q \cdot U$

elektrische Leistung

$$P = \frac{dW}{dt} = U \cdot \frac{dQ}{dt} = U \cdot I$$

$$[P] = 1 \text{ V} \cdot \text{A} = 1 \text{ Watt} = 1 \text{ W}$$

Strom während der Zeit $\Delta t = t_2 - t_1$

$$W = \int_{t_1}^{t_2} U \cdot I \, dt = U I \Delta t$$

$$[W] = 1 \text{ Joule} = 1 \text{ J} = 1 \text{ W} \cdot \text{s} \\ = 1 \text{ N} \cdot \text{m}$$

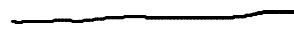
"Ohmscher" Leiter $U = I \cdot R$

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

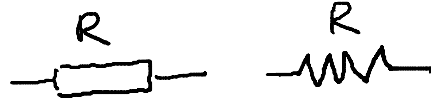
Schaltungen und Netzwerke

Symbole

Leiter ($R=0$)



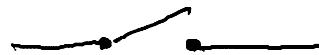
Ohmscher Widerstand



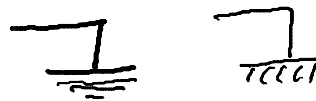
Lampe



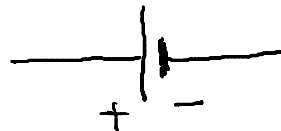
Schalter



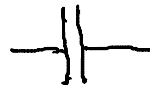
Erde ($v=0$)



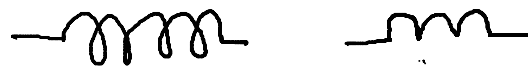
Spannungsquelle



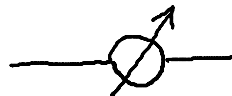
Kondensator



Spule
(Induktivität)



Messinstrument



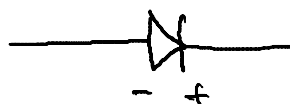
Amperemeter



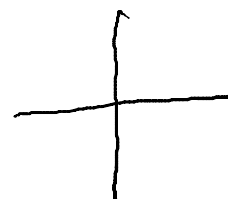
Voltmeter



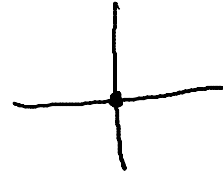
Diode



Kreuzen ohne Kontakt

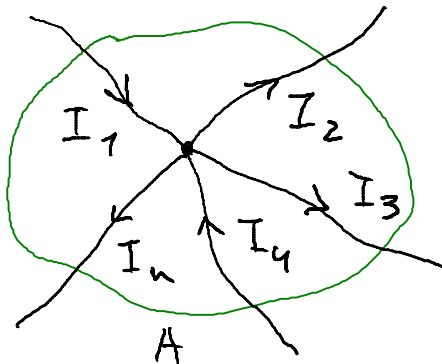


Kreuzen mit Kontakt
(elektrisch verbunden)

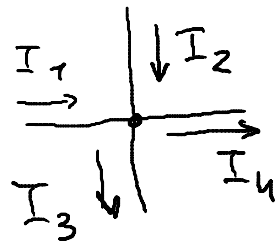


Netzwerke

1. Kirchhoffsche Regel



$$\sum_A I_n = 0$$



$$I_1 + I_2 = I_3 + I_4$$

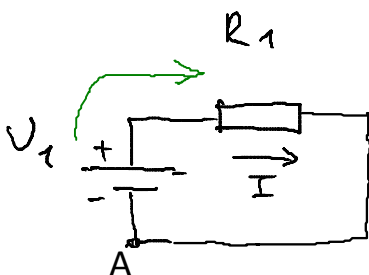
Kont. Gl. $-\frac{dQ}{dt} = -\frac{d}{dt} \int \rho_{el} dV$

$$= \int_A \vec{j} \cdot d\vec{A} = \sum_n I_n$$

2. Kirchhoffsche Regel

In jedem geschlossenen Stromkreis

$$\sum_{n=0}^N U_n = 0$$

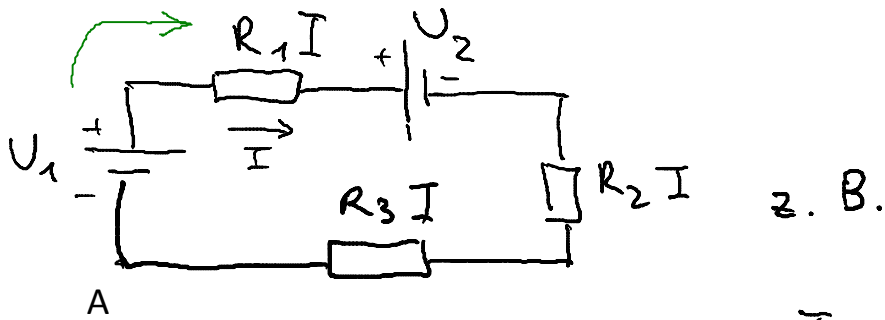


$$U_1 = R_1 I$$

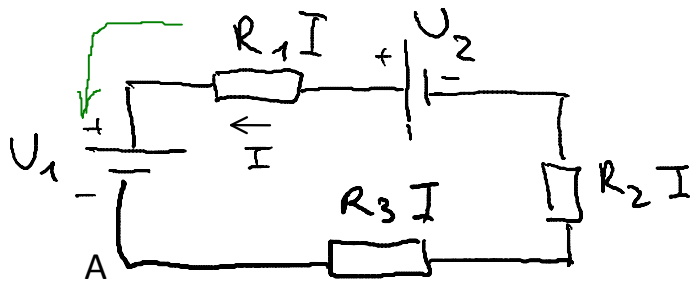
für geschl. Kreis von Punkt A zu Punkt A

$$-U_1 + R_1 I = 0$$





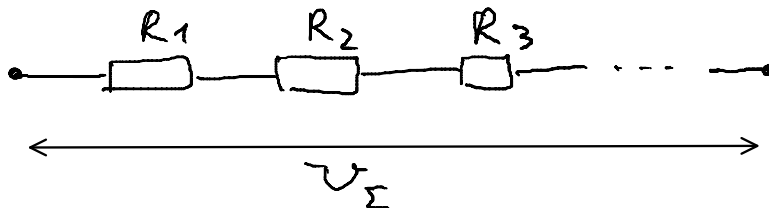
$$-U_1 + R_1 I + U_2 + R_2 I + R_3 I = 0$$



falls negative Stromrichtung
ausgewählt ist

$$+U_1 - R_1 I - U_2 - R_2 I - R_3 I = 0$$

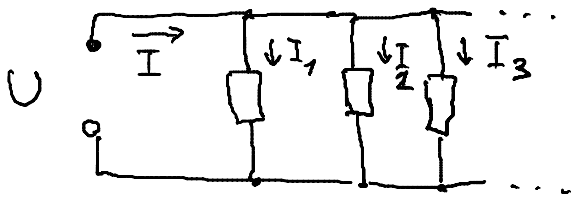
serielle Schaltung (Reihenschaltung)
von Widerständen



$$U_{\Sigma} = I \cdot \sum_n R_n = I \cdot R_{\Sigma}$$

$$R_{\Sigma} = \sum_n R_n$$

Parallelschaltung von Widerständen



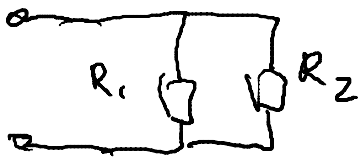
$$\frac{U}{R} = I = I_1 + I_2 + I_3 + \dots$$

$$= \frac{U}{R_1} + \frac{U}{R_2} + \frac{U}{R_3} + \dots$$

$$\frac{1}{R_{||}} = \sum_n \frac{1}{R_n}$$

$$\frac{1}{R_{||}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

2 Widerstände



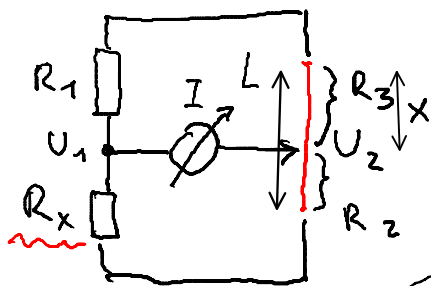
$$\frac{1}{R_{||}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_{||} = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Leitwert $G = \frac{1}{R}$

$$G_{||} = G_1 + G_2 + \dots$$

Wheatstone - Brücke



$$U_1 = U_0 \frac{R_x}{R_1 + R_x}$$

$$U_2 = U_0 \frac{R_2}{R_2 + R_3}$$

$$U_1 = U_2$$

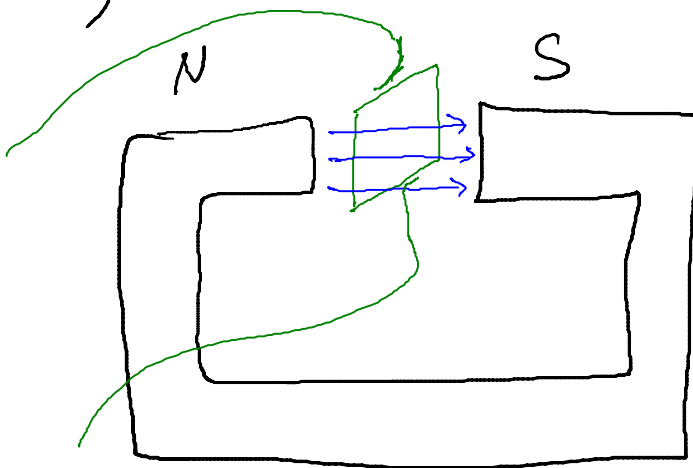
$$\frac{R_1}{R_x} = \frac{R_3}{R_2} = \frac{x}{L - x}$$

$$R_x = R_1 \frac{L-x}{x}$$

;

Messverfahren für elektrische Ströme

1) Galvanometer

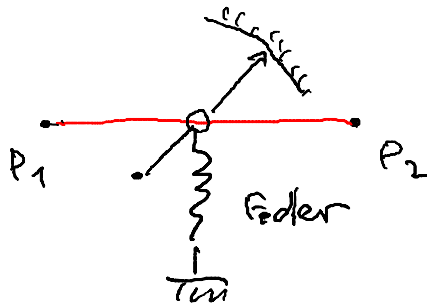


Das Drehmoment
auf die Spule

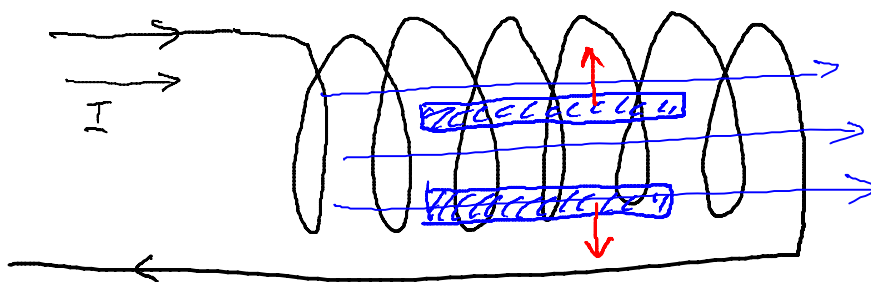
$$\sim B \cdot I$$

$$I \sim \text{mA}$$

2) Hitzendracht - Amperemeter ($I > 0.1 \text{ A}$)



3) Weicheisen - Instrument



Stromquellen

- Generatoren $\rightarrow$ magnetodynamische Stromerzeugung (aktiv)
- Netzgeräte $\rightarrow$ Strom- und Spannungswandlung (passive)
- Batterien, Akku
 $\hookrightarrow$ elektrochemische Strom-
erz. (aktiv)
- Solargeneratoren $\rightarrow$ Photoeffekt (aktiv)
 $h\nu$ Lichtquanten (Photonen)

- Thermoelektrizität $\rightarrow$
Stromerz. durch Berührungsspannungen

