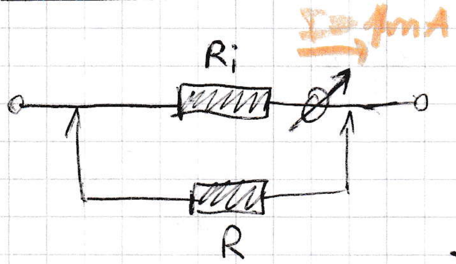
Ex 2 – Blatt 7

$\boxed{24}$ a)



$I_{ges} \overset{!}{=} 5A$

Parallel: $U = const$

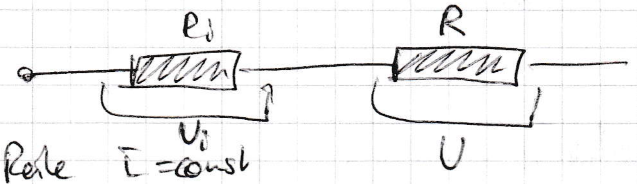
$I \cdot R_i = I_p \cdot R$

$I_p = I \cdot \frac{R_i}{R}$

$$I_{ges} = I\left(1 + \frac{R_i}{R}\right)$$

$$\left(\frac{I_{ges}}{I} - 1\right)^{-1} R_i = R \approx \underline{\underline{4 m\Omega}}$$

b)



Reihe $I = const$ $\qquad U_{ges} = U_i + U$

$$\frac{U_i}{R_i} = \frac{U}{R} \Rightarrow U_{ges} = U_i\left(1 + \frac{R}{R_i}\right)$$

$$\left(\frac{U_{ges}}{U_i} - 1\right) \cdot R_i = R \Rightarrow R = \left(\frac{U_{ges}}{I \cdot R_i} - 1\right) R_i \approx \underline{\underline{200 k\Omega}}$$

$\boxed{25}$ a) $I = \frac{\Delta q}{\Delta t}$ $\qquad \Delta t = \frac{\Delta x}{v}$ $\qquad \Delta x = 2\pi a_0$

$$\Rightarrow I = \frac{e v}{2\pi a_0} \qquad \frac{e^2}{4\pi\varepsilon_0 r^2} = \frac{m v^2}{r}$$

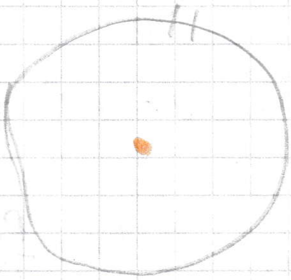
$$\Rightarrow v = \sqrt{\frac{e^2}{4\pi\varepsilon_0 m a_0}}$$

$$I = \frac{e^2}{2\pi a_0} \frac{1}{\sqrt{4\pi\varepsilon_0 m a_0}} = \underline{\underline{1{,}052 mA}}$$

b) $\vec m = I A \cdot \vec n_A \qquad A = \pi a_0^2$

$I = \frac{ev}{2\pi a_0} \Rightarrow \vec m = \frac{e v a_0}{2}$

$\Rightarrow |\vec m| = 0{,}93 \cdot 10^{-23}\ Am^2$



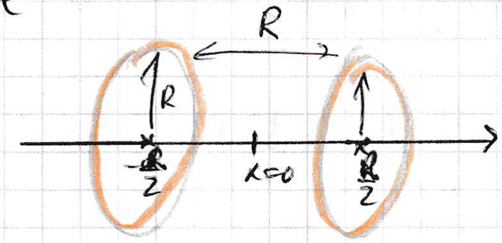
c) Bio-Savart $\quad dB = \frac{\mu_0 I}{4\pi} \frac{\vec r\, d\vec s}{r^3}$

$$\Rightarrow \vec B = \frac{\mu_0 I}{4\pi R^2} \underbrace{\int d\vec s}_{2\pi R}$$

$$= \frac{\mu_0 I}{2R} = 12{,}5\ \frac{Vs}{m^2}$$

$\boxed{26}$ Feld einer Leiterschleife

$$B(x) = \frac{\mu_0 \cancel{2\pi} R^2 I}{2(x^2+R^2)^{3/2}}$$



$$B(x) = \frac{N \mu_0 R^2 I}{2\left(\left(x-\frac{R}{2}\right)^2 + R^2\right)^{3/2}} + \frac{\mu_0 R^2 I \cdot N}{2\left(\left(x+\frac{R}{2}\right)^2 + R^2\right)^{3/2}}$$

Ableitungen: $$B'(x) = -\frac{3}{2} N \mu_0 I R^2 \left[\frac{\left(x-\frac{R}{2}\right)}{\left(\left(x-\frac{R}{2}\right)^2+R^2\right)^{5/2}} + \frac{\left(x+\frac{R}{2}\right)}{\left(\left(x+\frac{R}{2}\right)^2+R^2\right)^{5/2}} \right]$$

$$B''(x) = \frac{N \mu_0 R^2 I\, 15}{2} \left[\frac{\left(x-\frac{R}{2}\right)^2}{\left(\left(x-\frac{R}{2}\right)^2+R^2\right)^{7/2}} + \frac{\left(x+\frac{R}{2}\right)^2}{\left(\left(x+\frac{R}{2}\right)^2+R^2\right)^{7/2}} \right]$$

$$- \frac{N \mu_0 R^2 I\, 3}{2} \left[\frac{1}{\left(\left(x-\frac{R}{2}\right)^2+R^2\right)^{5/2}} + \frac{1}{\left(\left(x+\frac{R}{2}\right)^2+R^2\right)^{5/2}} \right]$$

$B'(0) = 0 \qquad B''(0) = 0$

$$\Rightarrow B_{Taylor}(x) = \left(\frac{4}{5}\right)^{3/2} \frac{N \mu_0 I}{R} + O(x^3) = \text{const.}$$

Entgegen-gesetzter Strom:

$$B(x) = \frac{N\mu_0 R^2 I}{2((x-\frac{R}{2})^2+R^2)^{3/2}} - \frac{\mu_0 R^2 I N}{2((x+\frac{R}{2})+R^2)^{3/2}}$$

$$B'(x) = \frac{3}{2} N\mu_0 R^2 I \left[\frac{-(x-\frac{R}{2})}{((x-\frac{R}{2})^2+R^2)^{5/2}} + \frac{(x+\frac{R}{2})}{((x+\frac{R}{2})^2+R^2)^{5/2}} \right]$$

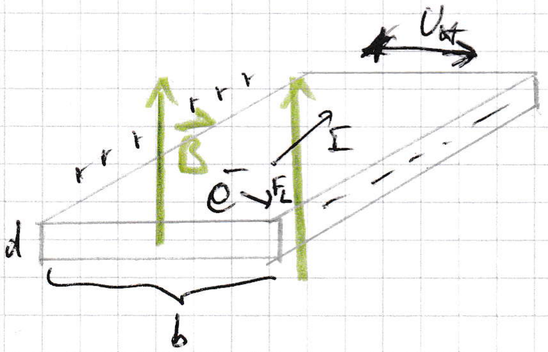
$$B''(x) = \frac{3}{2} N\mu_0 R^2 I \left[\frac{5(x-\frac{R}{2})^2}{((x-\frac{R}{2})^2+R^2)^{7/2}} - \frac{5(x+\frac{R}{2})^2}{((x+\frac{R}{2})^2+R^2)^{7/2}} \right.$$

$$\left. + \frac{1}{((x+\frac{R}{2})^2+R^2)^{5/2}} - \frac{1}{((x-\frac{R}{2})^2+R^2)^{5/2}} \right]$$

$B(0) = 0 \qquad B'(0) = \left(\frac{4}{5}\right)^{5/2} \frac{3}{2} \mu_0 N I \frac{1}{R^2} \qquad B''(0) = 0$

$$\Rightarrow B(x)_{Taylor} = \left(\frac{4}{5}\right)^{5/2} \frac{3}{2} \mu_0 N I \frac{1}{R^2} \cdot x + \mathcal{O}(x^3)$$

$\boxed{27}$ a)



Lorentzkraft des Magnetfeldes lenkt die Elektronen ab, Elektronen sammeln sich ⇒ elektrisches Feld, welches F_L entgegen wirkt, bis $F_L = F_e$ Gleichgewicht da ist.

b) $F_{el} = \frac{eU}{d} \qquad F_L = evB \qquad F_{el} = F_L \qquad \frac{U}{d} = vB$

$$U = \frac{\cancel{d}BI}{eb\cancel{d}n} = \frac{BI}{ebn} = \underline{\underline{1{,}18 \cdot 10^{-7}\ V}}$$

$~~v~~$: $I = ev \cdot A \cdot n \qquad n = \frac{\rho \cdot N_A}{M_{mol}}$

$$\Rightarrow v = \frac{I}{ebdn} = 5{,}89 \cdot 10^{-4} \frac{m}{s}$$

c) $F_L = B \cdot I \cdot l$ $\frac{F_L}{l} = I \cdot B = 16 \frac{N}{m}$