11

$\boxed{22}$

(a) $\rho = \frac{Q}{V} = \cancel{\frac{Q}{2\pi R L}} \quad \frac{Q}{\pi R^2 L} \qquad Q = \rho \cdot \pi R^2 L$

$r > R$: $\int_A \underline{E}\, d\underline{A} = \int_{\partial V} E\, dA = E \cdot 2\pi r L = \frac{Q}{\varepsilon_0}$

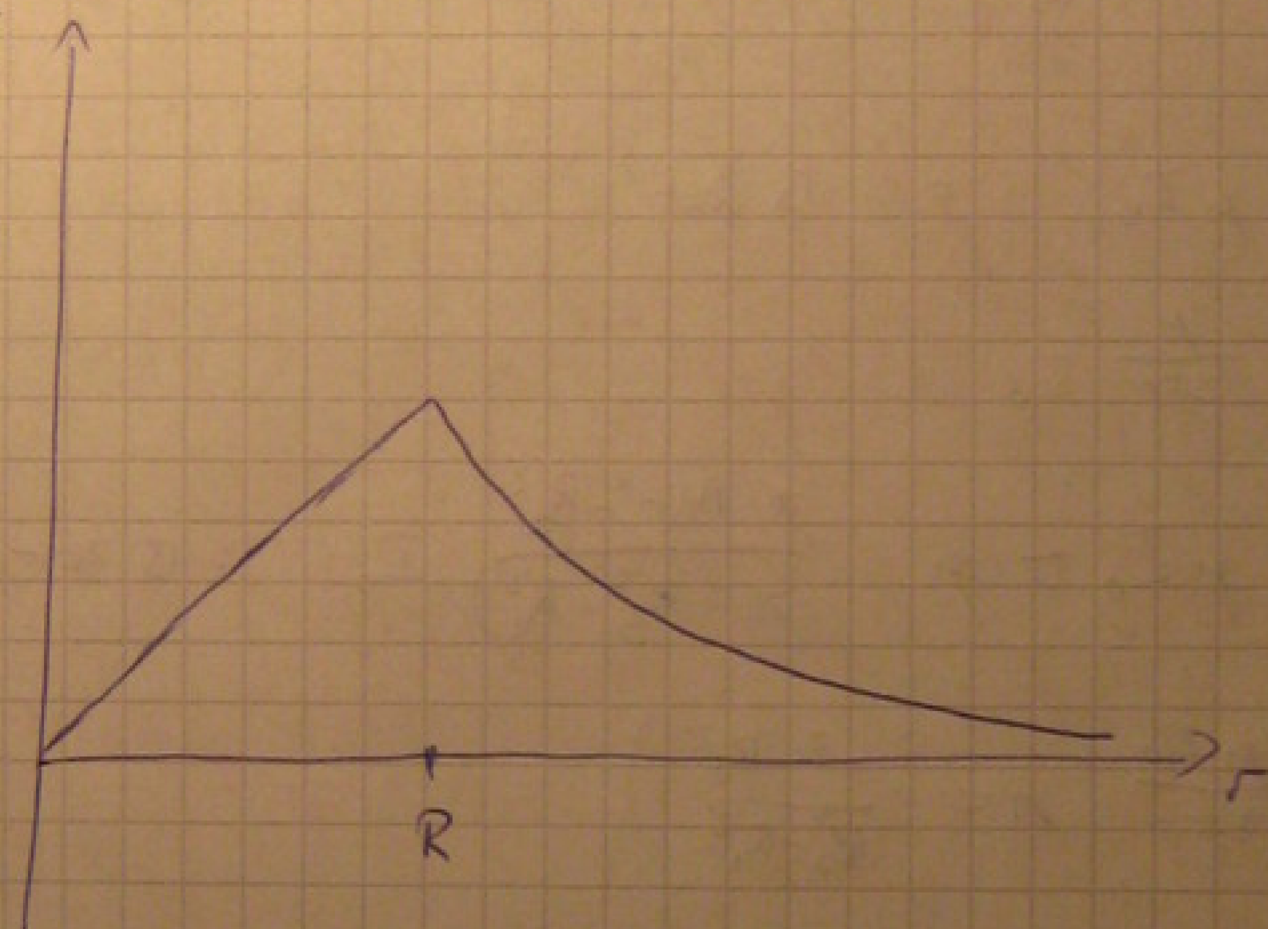
$E = \frac{Q}{2\pi r L \varepsilon_0} = \frac{\cancel{\pi} R^2 \cancel{L}}{2\cancel{\pi} \cancel{L} \varepsilon_0 r} = \frac{1}{2\varepsilon_0} \frac{R^2}{r}$

$\cancel{E \cdot 2\pi r L = \frac{Q}{\varepsilon}}$

$r \leq R$ $\int_A \underline{E}\, d\underline{A} = \int_{\partial V} E\, dA = E' \cdot 2\pi r L = \frac{Q'}{\varepsilon_0} = \frac{\rho \cdot \pi r^2 L}{\varepsilon_0}$

$E' = \frac{\rho \cancel{\pi} r^{\cancel{2}} \cancel{L}}{2\cancel{\pi} \cancel{r} \cancel{L} \varepsilon_0} = \frac{\rho}{2\varepsilon_0} \cdot r$

(b)



(c) $\rho(r) = \frac{Q}{2\pi R L} \cdot \delta(r - R) \Rightarrow$ Alle Ladung auf Rand verteilt.

Die Eingeschlossene Ladung wird $Q'' = 0$ und damit folgt $\int_V \nabla \underline{E}\, dV = 0$ Da $\underline{E}$ rotationssymm. wählen wir ein beliebiges Volumen, dann folgt $\underline{E} = \underline{0}$.
Das E-Feld verschwindet.

23

(a) trivial

(b) $$E_{Zn} = E^0_{Zn} + \frac{R\cdot T}{z\cdot F}\cdot \ln \frac{[Zn^{2+}]}{[Zn]}$$

$$E_{Cu} = E^0_{Cu} + \frac{R\cdot T}{z\cdot F}\cdot \ln \frac{[Cu^{2+}]}{[Cu]}$$

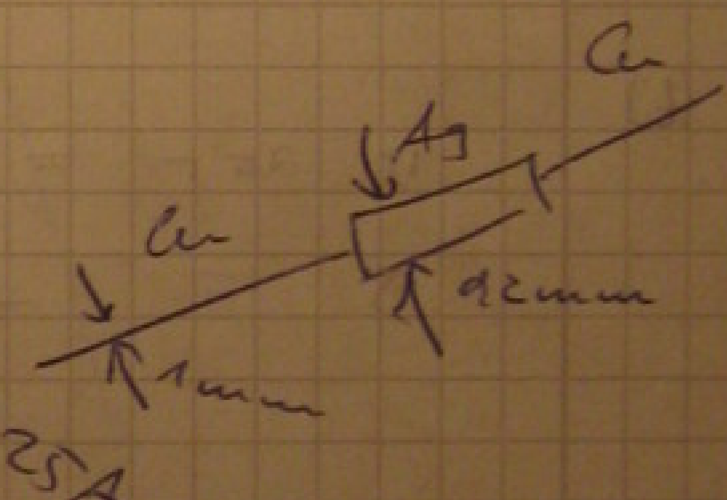
$$U = E_{Cu} - E_{Zn}$$

$$= (E^0_{Cu} - E^0_{Zn}) + \frac{RT}{zF} \ln \underbrace{\underbrace{\frac{\overset{=0{,}1}{[Cu^{2+}]}\;\overset{=1}{[Zn]}}{\underset{=1}{[Cu]}\;\underset{=0{,}1}{[Zn^{2+}]}}}_{1}}_{0}$$

$$= 1{,}1\ V$$

(c) $U = 1{,}1\,V + (-0{,}02)\,V = 1{,}08\ V$

24



$$R = \frac{U}{I} \Rightarrow R\cdot I = U$$

$$P = U\cdot I = RI^2$$

$$R = \rho_R \cdot \frac{L}{A}$$

$$P = \rho_R \frac{L}{A} I^2$$

$$\underset{\text{Wärme}}{Q} = P\cdot t = \rho_R \frac{L}{A} I^2 t$$

$$Q = cm\Delta T = c\cdot \rho_D \cdot L\cdot A\cdot \Delta T \Rightarrow \Delta T = \frac{Q}{c\,\rho_D\, L\, A}$$

$$\Delta T = \frac{\rho_R\, I^2\, t}{c\,\rho_D\, A^2}$$

$$\Delta T \equiv 941\,K$$

$$t = \frac{\Delta T\, c\, \rho_D\, A^2}{\rho_R\, I^2} \approx 0{,}224\ s$$

$$[t] = \frac{\cancel{K}\cdot \frac{J}{kg\,\cancel{K}}\cdot\frac{kg}{m^3}\cdot m^2 s^2}{\frac{mm^2}{m}\cdot C^2} = \frac{s^2}{1000^2\, m^2\, C^2} =$$

$$\Delta T\,(t \approx 0{,}224) \approx 1{,}14\,K$$

$\boxed{25}$ Stokes: $\int_A \operatorname{rot} \underline{f}\, d\underline{A} = \oint_{\gamma = \partial A} \underline{f}\, d\underline{s} =$

$$\oint_\gamma \underline{B}\, d\underline{s} = \int_A \mu_0 \underline{j}\, d\underline{A} = \mu \int_A \underline{j}\, d\underline{A} = \mu I$$

~~Ansatz~~ $\underline{B} \parallel d\underline{s}$

$$\oint_\gamma \underline{B}\, d\underline{s} = \oint_\gamma B\, ds = B \cdot 2\pi r$$

$$\int_A \mu\, \underline{j}\, d\underline{A} = \int_A \mu\, j\, dA = \mu \cdot j \cdot \pi r^2$$

(a) $j \cdot \pi R_1^2 = I_0 \;, \quad \mu j \pi r^2 = \mu \left(\frac{r}{R_1}\right)^2 \cdot I_0$

$$B\, 2\pi r = \mu \frac{r^2}{R_1^2} I_0 \Rightarrow B(r) = \mu \frac{r}{2\pi R_1^2} I_0$$

(b) $\mu \int_A \underline{j}\, d\underline{A} = \mu I_0 = B\, 2\pi r$

$$B(r) = \frac{\mu}{2\pi r} I_0$$

(c) $\mu \int_A \underline{j}\, d\underline{A} = \mu I_0 - \mu \frac{\cancel{\pi}(r^2 - R_2^2)}{\cancel{\pi}(R_3^2 - R_2^2)} \cdot I_0 = B\, 2\pi r$

$$B(r) = \frac{\mu I_0}{2\pi r}\left(1 - \frac{r^2 - R_2^2}{R_3^2 - R_2^2}\right)$$

(d) $\mu \int_A \underline{j}\, d\underline{A} = 0 \Rightarrow B(r) = 0$