(1.) bakrena žica → $\rho_{Cu} = 0.0175 \frac{\Omega \cdot mm^2}{m} =$

$= 0.0175 \cdot 10^{-6} \frac{\Omega \, m^2}{m} =$

$= 1.75 \cdot 10^{-8} \, \Omega m$

$L = 2 \, m$

$S = 2.5 \, mm^2$

$R = \rho \cdot \frac{L}{S} = 0.0175 \frac{\Omega \cancel{mm^2}}{\cancel{m}} \cdot \frac{2 \cancel{m}}{2.5 \cancel{mm^2}} = \boxed{0.014 \, \Omega} =$

$\boxed{= 14 \, m\Omega}$

(2.) grafit → $\rho_C = 1.5 \cdot 10^{-5} \, \Omega m$

$l = 10 \, cm = 0.1 \, m$

$S = 3.5 \, mm^2$

$\Rightarrow$ ista formula... $R = 1.5 \cdot 10^{-5} \, \Omega m \cdot \frac{0.1 \, m}{3.5 \, mm^2} =$

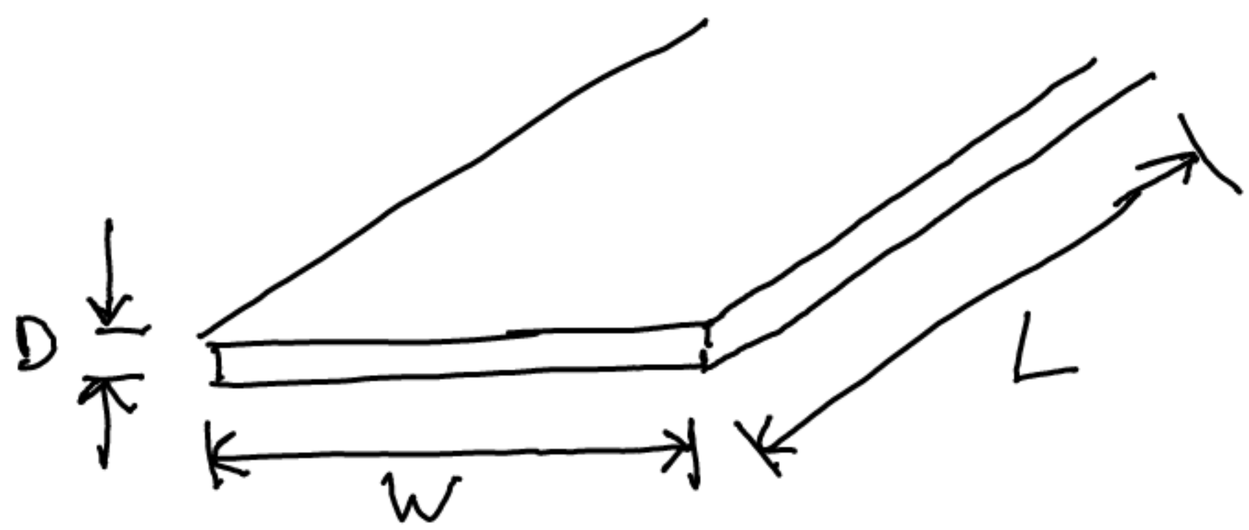
$= \frac{1.5 \cdot \cancel{10^{-6}} \, \Omega \cdot \cancel{m^2}}{3.5 \cdot \cancel{10^{-6}} \, \cancel{m^2}} = \boxed{0.43 \, \Omega}$

3. Aluminijska traka ... $\rho_{Al} = 2.8 \cdot 10^{-8}\ \Omega\cdot m$ (iz knjige)

$D = 5\ mm$

$w = 3\ cm$

$L = 2\ m$



$$\Rightarrow S = D \cdot w = 5\ mm \cdot 3\ cm = 5 \cdot 30\ mm^2 = 150\ mm^2 = 1.5 \cdot 10^{-4}\ m^2$$

$$R = \rho \cdot \frac{L}{S} = \frac{2.8 \cdot 10^{-8}\ \Omega m \cdot 2\ m}{1.5 \cdot 10^{-4}\ m^2} = 1.87 \cdot 10^{-4}\ \Omega = \boxed{0.187\ m\Omega}$$

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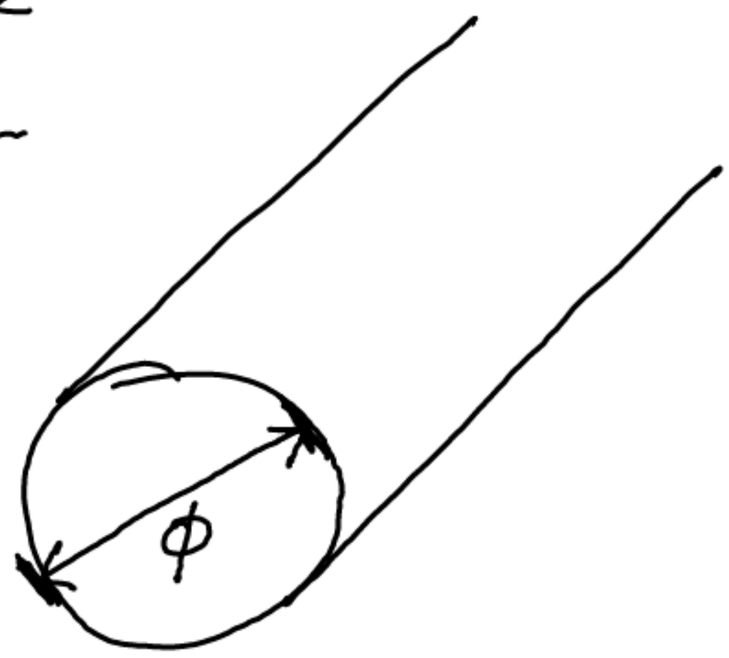
4. $\phi = 2\ mm$, $r = \frac{\phi}{2} = 1\ mm$ $\Rightarrow S = r^2 \cdot \pi = 3.14\ mm^2$

$L = 100\ m$



$$R = \rho \frac{L}{S} = \frac{1.75 \cdot 10^{-8}\ \Omega\cdot m \cdot 100 m}{3.14\ mm^2} = \dots$$

$$\boxed{= 0.557\ \Omega}$$

5. $T = 100^\circ C$

$T_0 = 20^\circ C$

$R_0 = 100\ \Omega$

$R_T = ?$

bakar ... $\alpha_{Cu} = 0.0039\ \frac{1}{K}$

$\Delta T = T - T_0 = 100^\circ C - 20^\circ C =$

$= 80^\circ C = \boxed{80\ K}$

$R_T = R_0 \cdot (1 + \alpha \cdot \Delta T) = 100 \cdot (1 + 0.0039\ \frac{1}{K} \cdot 80\ K)\ \Omega =$

$= 100 \cdot (1.312)\ \Omega =$

$\boxed{= 131.2\ \Omega}$

6. $T_0 = 20^\circ C$ (sobna temp.)

$T = 100^\circ C$

$R_0 = 100\ \Omega$

$\alpha_c = -0.0005\ \frac{1}{K}$ (grafit)

$R_T = ?$

$R_T = R_0 + R_0 \cdot \alpha \cdot \Delta T = \ldots$ $\boxed{= 96\ \Omega}$

7. $L = ?$

bakar ... $\rho_{Cu} = 1.75 \cdot 10^{-8}\ \Omega m$

$S = 5\ mm^2$

$R = 1\ \Omega$

$$R = \rho \cdot \frac{L}{S} \quad / \cdot \frac{S}{\rho}$$

$$\downarrow$$

$$L = \frac{R \cdot S}{\rho} = \frac{1\ \Omega \cdot 5\ mm^2}{1.75 \cdot 10^{-8}\ \Omega m} = \frac{5 \cdot 10^{-6}}{1.75 \cdot 10^{-8}} \frac{m^2}{m} =$$

$$= 2.86 \cdot 10^{2}\ m = \boxed{286\ m}$$

---

8. $\phi = ? \rightsquigarrow S = ?$

$L = 10\ m$

$R = 1\ \Omega$

bakar

$$R = \rho \cdot \frac{L}{S} \Rightarrow S = \frac{\rho \cdot L}{R} = \ldots = 0.175\ mm^2$$

$$S = r^2 \pi = \left(\frac{\phi}{2}\right)^2 \cdot \pi = \phi^2 \cdot \frac{\pi}{4}$$

$$\Rightarrow \phi = \sqrt{\frac{4 \cdot S}{\pi}} = \sqrt{0.2228\ mm^2} = \sqrt{0.2228} \cdot \sqrt{mm^2} \boxed{= 0.472\ mm}$$

9. $R \leq 1\ \Omega$ („ne veći od" = „manji ili jednak")

$L = 1\ km = 1000\ m$

$S_{min} = ?$

$\rho = 2.8 \cdot 10^{-8}\ \Omega m$ (Aluminij)

$$\rho \cdot \frac{L}{S} = R \leq 1\ \Omega$$

$$\Rightarrow S_{min} = \frac{\rho \cdot L}{R_{max}} = \dots = \boxed{= 28\ mm^2}$$

$\underline{\underline{S \geq S_{min}}}$ (veći presjek → manji otpor)

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10. $\Delta R = ?$

Konstantan ... $\alpha = 5 \cdot 10^{-5}\ \frac{1}{K}$ (iz knjige)

$\Delta T = 100\ °C = 100\ K$

$R_0 = 100\ \Omega$

$$R = R_0 (1 + \alpha \cdot \Delta T) = 100\ (1 + 5 \cdot 10^{-5} \cdot 100)\ \Omega =$$

$$= 100 \cdot (1 + 5 \cdot 10^{-3})\ \Omega = 100 \cdot 1.005 = \boxed{100.5\ \Omega}$$

$$\Rightarrow \Delta R = R - R_0 = 100.5 - 100 \boxed{= 0.5\ \Omega}$$

$$\Rightarrow \frac{\Delta R}{R_0} = \frac{0.5}{100} = \underline{\underline{0.5\ \%}}$$

(11.) $\alpha = ?$

$R_0 = 100\,\Omega$, $T_1 = 25\,^\circ C$

$R = 105\,\Omega$, $T_2 = 75\,^\circ C$

$\Delta T = T_2 - T_1 = 50\,^\circ C = 50\,K$

$$R = R_0 (1 + \alpha \cdot \Delta T) = R_0 + R_0 \cdot \alpha \cdot \Delta T \quad \{ -R_0 \text{ i zamjena strana}$$

$$\Rightarrow R_0 \cdot \alpha \cdot \Delta T = R - R_0 \quad \{ : R_0 \cdot \Delta T$$

$$\Rightarrow \alpha = \frac{(R - R_0)}{R_0 \cdot \Delta T} = \ldots = \frac{5\,\Omega}{100\,\Omega \cdot 50\,K} = \frac{1}{1000}\,\frac{1}{K} \boxed{= 0.001\,\frac{1}{K}}$$

12. $T = ?$

$S = 0.25\ cm^2$

$L = 20\ cm$

$R = 1\ \Omega$

$\rho_c = 1.5 \cdot 10^{-5}\ \Omega m$ (pri $\approx 20^\circ C$)

$\alpha = -0.5 \cdot 10^{-3}\ \frac{1}{K}$

$R = R_0 (1 + \alpha \cdot \Delta T)$

$\hookrightarrow \Delta T = \frac{(R - R_0)}{R_0 \cdot \alpha} = \ldots = \frac{0.88\ \Omega}{0.12\ \Omega \cdot (-0.5 \cdot 10^{-3}\ \frac{1}{K})} = 14.7 \cdot 10^3\ K =$

$= 14700\ ^\circ C$

$T_0 = 20^\circ C$; $R_0 = \rho_c \cdot \frac{L}{S} = \ldots = 0.12\ \Omega$

$\rightarrow T = T_0 + \Delta T = 20^\circ C + 14700\ K =$ **$14720\ ^\circ C$**

13. Okrugli bakreni vodič... $\rho_{Cu} = 1.75 \cdot 10^{-8}\ \Omega m$ (pri 20°C)

$L = 100\ m$

$T = 100\,^\circ C$

$R \leq 1\ \Omega$ $(R_{max} = 1\ \Omega)$

$\phi = ?$

$\alpha_{Cu} = 3.9 \cdot 10^{-3}\ \frac{1}{K}$

$\rightarrow S = \left(\frac{\phi}{2}\right)^2 \cdot \pi = \frac{\pi}{4} \cdot \phi^2$

$$R = R_0 (1 + \alpha \cdot \Delta T) \leq 1\ \Omega$$

$$\Delta T = 100\,^\circ C - 20\,^\circ C = 80\,^\circ C = \underline{80\ K}$$

$$R_0 = \rho \cdot \frac{L}{S}$$

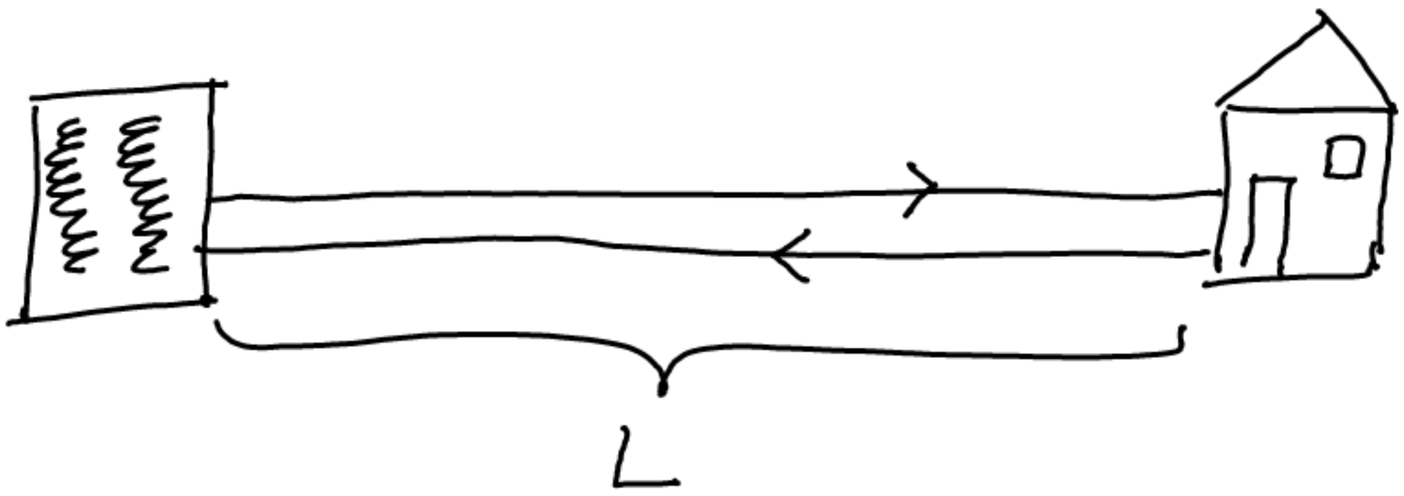
$$\Rightarrow \rho_{Cu} \cdot \frac{L}{S} \cdot (1 + \alpha_{Cu} \cdot \Delta T) \leq 1\ \Omega$$

$$\Rightarrow S \geq \frac{\rho_{Cu} \cdot L \cdot (1 + \alpha_{Cu} \cdot \Delta T)}{1\ \Omega} = \ldots = 2.30\ mm^2$$

$$S_{min} = r_{min}^2 \pi = \left(\frac{\phi_{min}}{2}\right)^2 \cdot \pi = \frac{\phi_{min}^2 \cdot \pi}{4}$$

$$\Rightarrow \phi_{min} = \sqrt{\frac{4 \cdot S_{min}}{\pi}} = \ldots \boxed{= 1.71\ mm} \qquad \underline{\underline{\phi \geq 1.71\ mm}}$$

14.



bakreni vod ... $\rho_{Cu} = 1.75 \cdot 10^{-8}\ \Omega m$

$S = 2.5\ mm^2$

$L = 50\ m$

$U = 230\ V$

$I = 10\ A$

---

otpor dalekovoda: $R_v = \rho \cdot \frac{(2 \cdot L)}{S} = \dots$ **$= 0.7\ \Omega$**

pad napona: $I = \frac{U}{R} \Rightarrow U_v = I \cdot R_v = 10 \cdot 0.7$ **$= 7\ V$**

↳ u postocima: $U_{\%} = \frac{U_v}{U} = \frac{7}{230} = 0.03$ **$= 3\%$**

snaga voda: $P_v = U_v \cdot I = 7 \cdot 10 =$ **$70\ W$**

↳ gubitak energije: $\Delta E = P_v \cdot t$

ukupna snaga trafostanice: $P_{uk} = U \cdot I = 230 \cdot 10 =$ **$2300\ W$**

↳ ukupna energija $E = P_{uk} \cdot t$

$\Rightarrow$ u postocima: $\frac{\Delta E}{E} = \frac{P_v \cdot \cancel{t}}{P_{uk} \cdot \cancel{t}} = \frac{70}{2300} = 0.03 =$ **3%**

15. Aluminijski vod... $\rho_{Al} = 2.8 \cdot 10^{-8}\ \Omega \cdot m$

$L = 100\ km$

$p_{\%} = u_{\%} \leq 1\% = 0.01$

$U = 400\ kV$

$P = 100\ MW$

$$P = U \cdot I \rightarrow I = \frac{P}{U} = \frac{100\ MW}{400\ kV} = \underline{\underline{250\ A}}$$

Gubitak na vodu dolazi od njegovog otpora...

$$R_V = \rho \cdot \frac{(2 \cdot L)}{S}$$ (2·L jer su 2 žice...)

...a gubitak je 1% napona...

$$U_V = u_{\%} \cdot U = 0.01 \cdot 400\ kV = \underline{\underline{4\ kV}}$$

To znači da je otpor voda (po Ohmovom zakonu)...

$$I = \frac{U}{R} \rightarrow R_V = \frac{U_V}{I} = \frac{4\ kV}{250\ A} = \frac{4000}{250}\ \Omega \boxed{= 16\ \Omega}$$

To je maksimalni dopustivi otpor (na 100 km)!

$$\Rightarrow S_{min} = \rho \frac{(2 \cdot L)}{R_{max}} = \ldots = 35 \cdot 10^{-5}\ m^2 = \underline{\underline{3.5\ cm^2}}$$

$$\Rightarrow \phi_{min} = \sqrt{\frac{4 \cdot S_{min}}{\pi}} = \boxed{2.11\ cm}$$ minimalni promjer Al dalekovoda!