5.12 $s = 7{,}0\,\text{cm}$, $E = 4{,}7\,\frac{\text{kV}}{\text{mm}}$

$U = Es = 4{,}7\,\frac{\text{kV}}{\text{mm}} \cdot 70\,\text{mm} = 329\,\text{kV} \approx \underline{330\,\text{kV}}$ (vaihtoehtoisesti)

6.6 a) $Q = It \quad | : I$

$\Leftrightarrow t = \frac{Q}{I} = \frac{12000\,\text{mAh}}{330\,\text{mA}} \approx 36{,}3636\,\text{h} \approx \underline{36\,\text{h}}$

b) $I = \frac{Q}{t} = \frac{ne}{t} \Leftrightarrow n = \frac{It}{e} = \frac{1{,}0\,\text{A} \cdot 1\,\text{s}}{1{,}60218 \cdot 10^{-19}\,\text{C}} \approx 6{,}24150 \cdot 10^{18} \approx \underline{6{,}2 \cdot 10^{18}}$

6.7 $Q = 4500\,\text{mAh}$

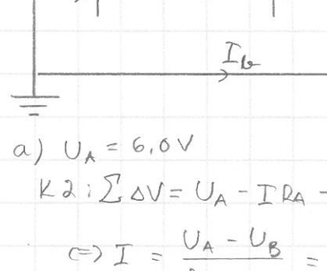
a) $Q = 4500 \cdot 10^{-3}\,\text{A} \cdot 60 \cdot 60\,\text{s} = 16200\,\text{C} \approx \underline{16000\,\text{C}}$

b) $Q = ne \Leftrightarrow n = \frac{Q}{e} = \frac{16200\,\text{C}}{1{,}60218 \cdot 10^{-19}\,\text{C}} \approx 1{,}01112 \cdot 10^{23} \approx \underline{1{,}0 \cdot 10^{23}}$

c) $0{,}25\,Q = It \quad | : t$

$\Leftrightarrow I = \frac{0{,}25\,Q}{t} = \frac{0{,}25 \cdot 4500\,\text{mAh}}{3{,}0\,\text{h}} = 375\,\text{mA} \approx \underline{0{,}38\,\text{A}}$

7.11



$U_1 = U_2 = 4{,}5\,\text{V}$

a) $U_{BA} = V_B - V_A = U_1 = \underline{4{,}5\,\text{V}}$

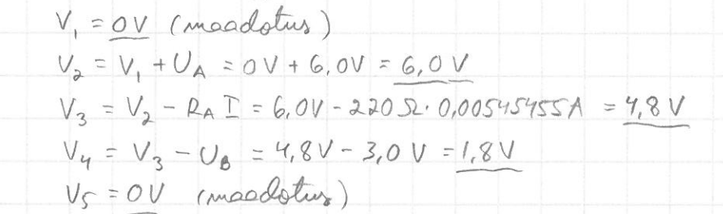
b) Kirchhoff 2.

$U_1 + U_2 - U - U - U = 0$

$\Leftrightarrow U = \frac{U_1 + U_2}{3} = \frac{4{,}5\,\text{V} + 4{,}5\,\text{V}}{3} = 3{,}0\,\text{V}$

$U_{DA} = V_D - V_A = U = \underline{3{,}0\,\text{V}}$

7.14



$U_1 = 1{,}5\,\text{V}$ $U_2 = 4{,}5\,\text{V}$

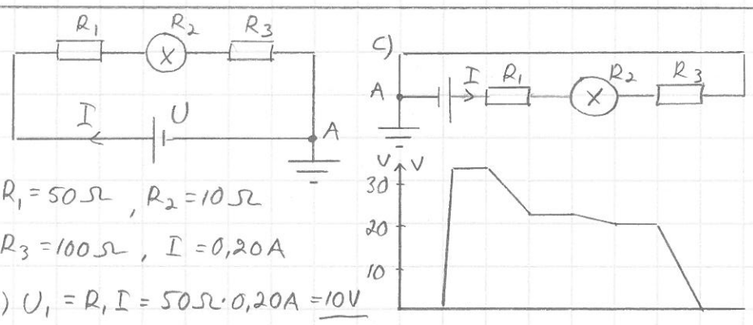
K2: $\sum \Delta V = U_1 + U_2 - U - U = 0$

$\Leftrightarrow U = \frac{U_1 + U_2}{2} = 3{,}0\,\text{V}$

8.7 $I = 2\,\text{mA}$, $U = 12\,\text{V}$

Ohmin laki: $U = RI \Leftrightarrow R = \frac{U}{I} = \frac{12\,\text{V}}{0{,}002\,\text{A}} = \underline{6000\,\Omega}$

8.15



$R_1 = 50\,\Omega$, $R_2 = 10\,\Omega$

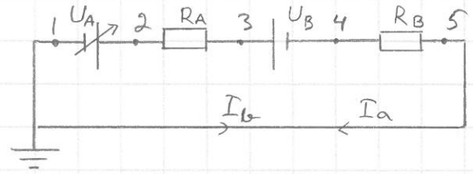
$R_3 = 100\,\Omega$, $I = 0{,}20\,\text{A}$

a) $U_1 = R_1 I = 50\,\Omega \cdot 0{,}20\,\text{A} = \underline{10\,\text{V}}$

$U_3 = R_3 I = 100\,\Omega \cdot 0{,}20\,\text{A} = \underline{20\,\text{V}}$

b) $U = R_1 I + R_2 I + R_3 I = (50\,\Omega + 10\,\Omega + 100\,\Omega) \cdot 0{,}20\,\text{A} = \underline{32\,\text{V}}$

8.17



$R_A = 220\,\Omega$

$R_B = 330\,\Omega$

$U_B = 3{,}0\,\text{V}$

a) $U_A = 6{,}0\,\text{V}$

K2: $\sum \Delta V = U_A - IR_A - U_B - IR_B = 0$

$\Leftrightarrow I = \frac{U_A - U_B}{R_A + R_B} = \frac{6{,}0\,\text{V} - 3{,}0\,\text{V}}{220\,\Omega + 330\,\Omega} \approx 0{,}00545455\,\text{A}$

$V_1 = \underline{0\,\text{V}}$ (maadoitus)

$V_2 = V_1 + U_A = 0\,\text{V} + 6{,}0\,\text{V} = \underline{6{,}0\,\text{V}}$

$V_3 = V_2 - R_A I = 6{,}0\,\text{V} - 220\,\Omega \cdot 0{,}00545455\,\text{A} = \underline{4{,}8\,\text{V}}$

$V_4 = V_3 - U_B = 4{,}8\,\text{V} - 3{,}0\,\text{V} = \underline{1{,}8\,\text{V}}$

$V_5 = \underline{0\,\text{V}}$ (maadoitus)

b) $U_A = 1{,}5\,\text{V}$

K2: $I = \frac{U_A - U_B}{220\,\Omega + 330\,\Omega} \approx -0{,}00272727\,\text{A}$

$I < 0 \Rightarrow I_B$ toisen suuntaan kuin I_A

$V_1 = \underline{0\,\text{V}}$

$V_2 = \underline{1{,}5\,\text{V}}$

$V_3 = V_2 + R_A I = 1{,}5\,\text{V} + 220\,\Omega \cdot 0{,}00272727\,\text{A} = \underline{2{,}1\,\text{V}}$

$V_4 = V_3 - U_B = 2{,}1\,\text{V} - 3{,}0\,\text{V} = \underline{-0{,}9\,\text{V}}$

$V_5 = \underline{0\,\text{V}}$

9.7 $R_{20} = 6{,}0\,\Omega$, $\alpha = 4{,}84 \cdot 10^{-3}\,\frac{1}{^\circ\text{C}}$, $t = 2100\,^\circ\text{C}$

$R = R_{20}(1 + \alpha \Delta t) = 6{,}0\,\Omega\,(1 + 4{,}84 \cdot 10^{-3}\,\frac{1}{^\circ\text{C}} \cdot (2100\,^\circ\text{C} - 20\,^\circ\text{C}))$

$\approx 66{,}4032\,\Omega \approx \underline{66\,\Omega}$

9.8 $\rho = 2{,}655 \cdot 10^{-8}\,\Omega\text{m}$

a) $R = \rho \frac{l}{A} = 2{,}655 \cdot 10^{-8}\,\Omega\text{m} \cdot \frac{12000\,\text{m}}{0{,}25\,(0{,}01\text{m})^2} = 12{,}744\,\Omega \approx \underline{13\,\Omega}$

b) $\frac{R_2}{R} = \frac{\rho \frac{l}{A_2}}{\rho \frac{l}{A}} = \frac{A}{A_2} = \frac{1}{2} \Leftrightarrow A_2 = 2A = 2 \cdot 0{,}25\,\text{cm}^2 = \underline{0{,}50\,\text{cm}^2}$

c) $U = RI = \rho \frac{l}{A} I = 2{,}655 \cdot 10^{-8}\,\Omega\text{m} \cdot \frac{1000\,\text{m}}{\pi \cdot (\frac{4{,}4 \cdot 10^{-3}\,\text{m}}{2})^2} \cdot 12\,\text{A}$

$\approx 1{,}74610\,\Omega \cdot 12\,\text{A} \approx 20{,}9532\,\text{V} \approx \underline{21\,\text{V}}$

9.14 $l_1 = 1{,}1\,\text{m}$; $d = 0{,}36\,\text{mm}$; $R_1 = 13\,\Omega$; $l_2 = 3{,}5\,\text{m}$

$\frac{R_2}{R_1} = \frac{\rho \frac{l_2}{A}}{\rho \frac{l_1}{A}} = \frac{l_2}{l_1} \quad | \cdot R_1$

$\Leftrightarrow R_2 = \frac{l_2}{l_1} \cdot R_1 = \frac{3{,}5\,\text{m}}{1{,}1\,\text{m}} \cdot 13\,\Omega \approx 41{,}3636\,\Omega \approx \underline{41\,\Omega}$

10.7 a) $P = UI \Leftrightarrow I = \frac{P}{U} = \frac{18\,\text{W}}{12\,\text{A}} = \underline{1{,}5\,\text{A}}$

b) $I = \frac{P}{U} = \frac{535\,\text{W}}{230\,\text{V}} \approx 2{,}32609\,\text{A} \approx \underline{2{,}3\,\text{A}}$

10.8 $P = UI = U \cdot \frac{U}{R} = \frac{U^2}{R}$

a) $P = \frac{(4{,}5\,\text{V})^2}{4{,}0\,\Omega} = 5{,}0625\,\text{W}$

b) $P = \frac{(4{,}5\,\text{V})^2}{6{,}0\,\Omega} = 3{,}375\,\text{W}$

c) $P = \frac{(9{,}0\,\text{V})^2}{1{,}5\,\Omega} = 54\,\text{W}$ ← suurin teho ⇒ riittää

d) $P = \frac{(9{,}0\,\text{V})^2}{7{,}0\,\Omega} \approx 11{,}5714\,\text{W}$

10.12 $P = 1800\,\text{W}$, $U = 230\,\text{V}$, $I_{max} = 10\,\text{A}$

a) $P = UI \Leftrightarrow I = \frac{P}{U} = \frac{1800\,\text{W}}{230\,\text{V}} \approx 7{,}82609\,\text{A} \approx \underline{7{,}8\,\text{A}}$

b) Sulake kestää tehon:

$P_{max} = U I_{max} = 230\,\text{V} \cdot 10\,\text{A} = 2300\,\text{W}$

Laitteiden kokonaisteho: $1800\,\text{W} + 800\,\text{W} = 2600\,\text{W} > P_{max}$

⇒ ei voi käyttää

10.17 $P = 3{,}2\,\text{kW}$, $t = 31{,}7\,\text{h}$

Ilmalämpöpumput kuluttavat energiaa:

$E = Pt = 3{,}2\,\text{kW} \cdot 31{,}7\,\text{h} = 694{,}4\,\text{kWh} < 780\,\text{kWh}$

⇒ kattaa

Säästö: $780\,\text{kWh} \cdot x = 110\,\text{e}$

$\Leftrightarrow x = \frac{110\,\text{e}}{780\,\text{kWh}} \approx 0{,}141026\,\frac{\text{e}}{\text{kWh}} \approx \underline{0{,}14\,\frac{\text{e}}{\text{kWh}}}$

11.5 a) $R = R_1 + R_2 + R_3 = 20\,\Omega + 30\,\Omega + 35\,\Omega = \underline{85\,\Omega}$

b) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \quad | ()^{-1}$

$\Leftrightarrow R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{20\,\Omega} + \frac{1}{30\,\Omega}} = 12\,\Omega \approx \underline{10\,\Omega}$