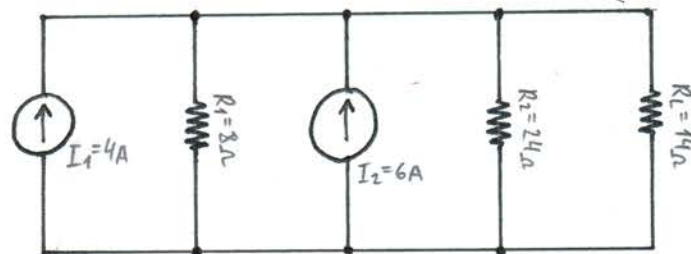
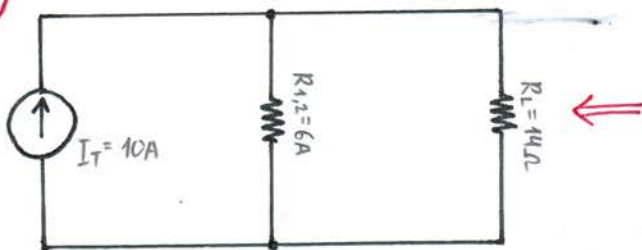


המרות - חלק ב' - עבודה הנסה

1

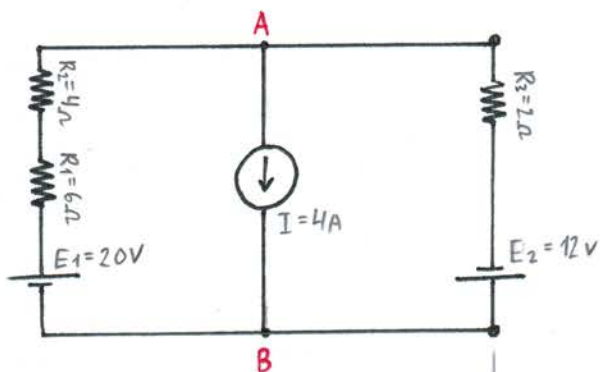


$$I_{R_L} = I_T \cdot \frac{R_{1,2}}{R_{1,2} + R_L} = 10 \cdot \frac{6}{6 + 14}$$

$$I_{R_L} = 3A$$

$$\begin{cases} I_T = I_1 + I_2 = 4 + 6 = 10A \\ R_{1,2} = R_1 \parallel R_2 = 8 \parallel 24 = 6\Omega \end{cases}$$

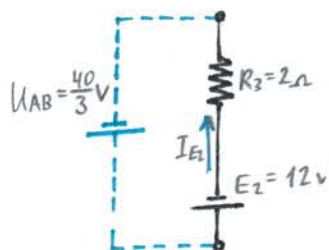
2



$$U_{AB} = \frac{\sum I_{sc}}{\sum G} = \frac{\frac{E_1}{R_1 + R_2} - I - \frac{E_2}{R_3}}{\frac{1}{R_1 + R_2} + 0 + \frac{1}{R_3}}$$

$$U_{AB} = \frac{\frac{20}{4+6} - 4 - \frac{12}{2}}{\frac{1}{4+6} + 0 + \frac{1}{2}} = \frac{-40}{3}$$

$$U_{AB} = 13.333V$$



$$I_{E_2} = \frac{U_{AB} - E_2}{R_3} = \frac{13.333 - 12}{2} =$$

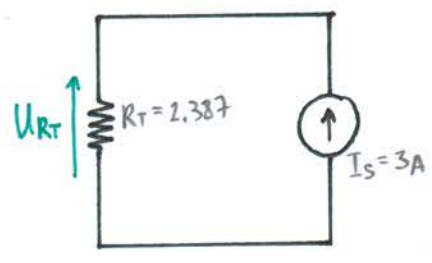
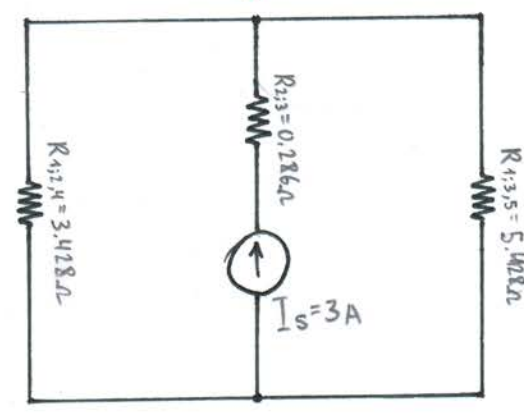
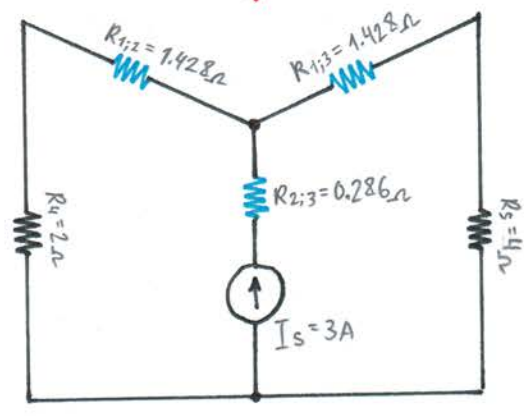
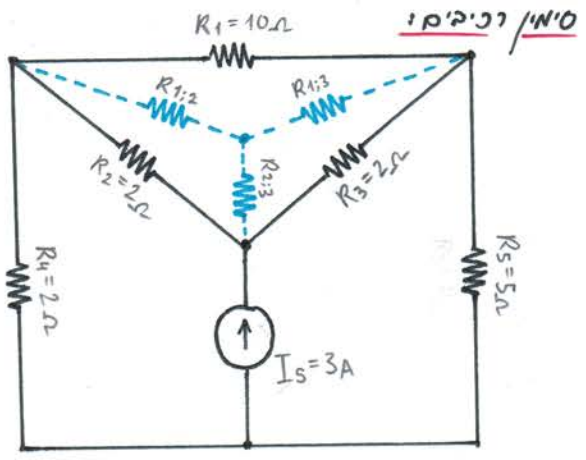
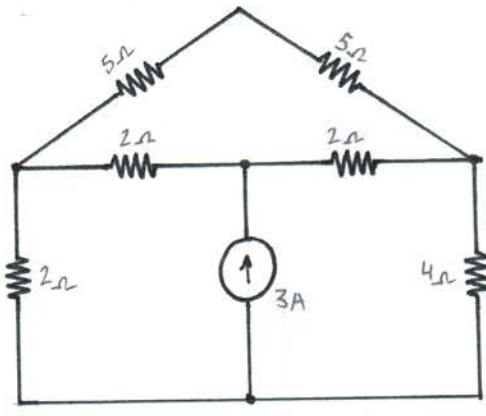
$$I_{E_2} = \frac{2}{3}A$$

$$P_{E_2} = E_2 \cdot I_{E_2} = 12 \cdot \frac{2}{3}$$

$$P_{E_2} = 8W$$

1

3



הצגת $\Delta(R_1, R_2, R_3)$ ← Y

$$S_{\Delta} = R_1 + R_2 + R_3 = 10 + 2 + 2$$

$$S_{\Delta} = 14$$

$$\begin{cases} R_{1,2} = \frac{R_1 R_2}{S_{\Delta}} = \frac{10 \cdot 2}{14} = \frac{10}{7} = 1.428\Omega \\ R_{1,3} = \frac{R_1 R_3}{S_{\Delta}} = \frac{10 \cdot 2}{14} = \frac{10}{7} = 1.428\Omega \\ R_{2,3} = \frac{R_2 R_3}{S_{\Delta}} = \frac{2 \cdot 2}{14} = \frac{2}{7} = 0.286\Omega \end{cases}$$

$$R_{1,2,4} = R_{1,2} + R_4 = 1.428 + 2 = \frac{24}{7} = 3.428\Omega$$

$$R_{1,3,5} = R_{1,3} + R_5 = 1.428 + 4 = \frac{38}{7} = 5.428\Omega$$

$$R_T = (R_{1,2,4} \parallel R_{1,3,5}) + R_{2,3}$$

$$R_T = (3.428 \parallel 5.428) + 0.286 = \frac{74}{31}$$

$$R_T = 2.387\Omega$$

$$U_{I_S} = U_{R_T} = I_S \cdot R_T = 3 \cdot 2.387 = \frac{222}{31}$$

$$U_{I_S} = 7.161V$$

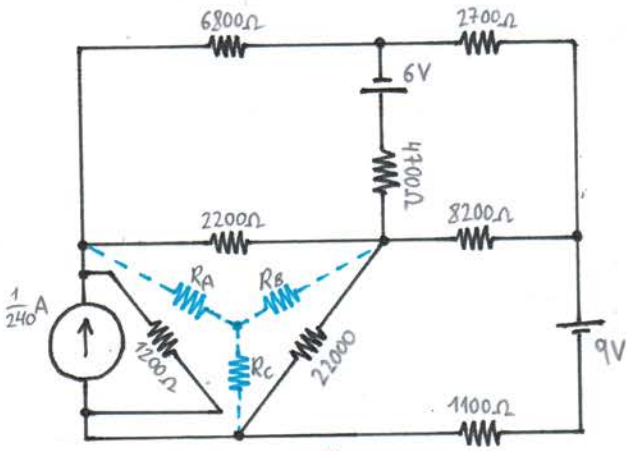
$$P_{I_S} = U_{I_S} \cdot I_S = 7.161 \cdot 3$$

$$P_{I_S} = 21.483W$$

* התשובה הסופית
התקבלה משם
המספרים הנ"ל

2

4



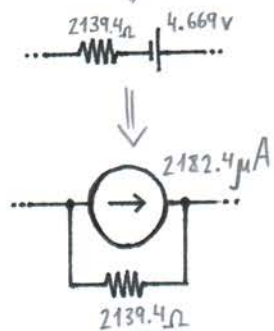
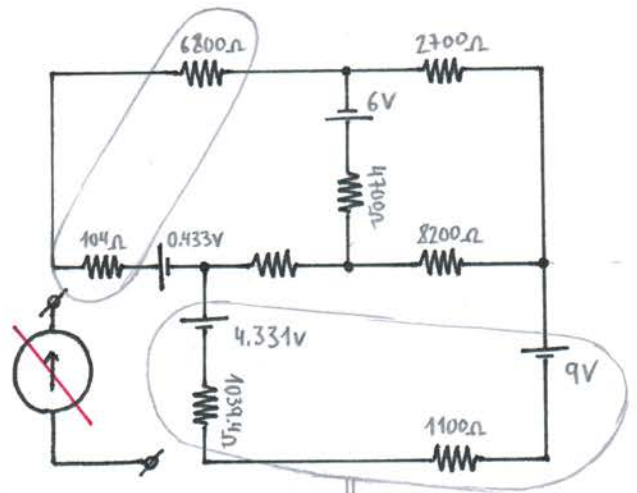
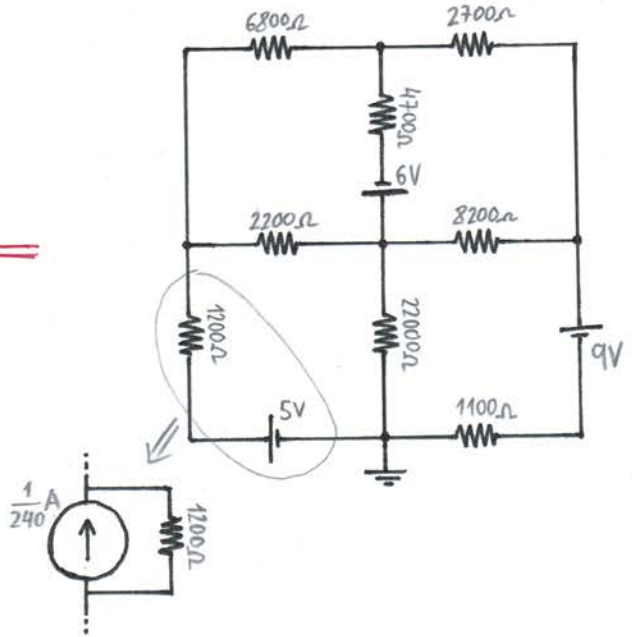
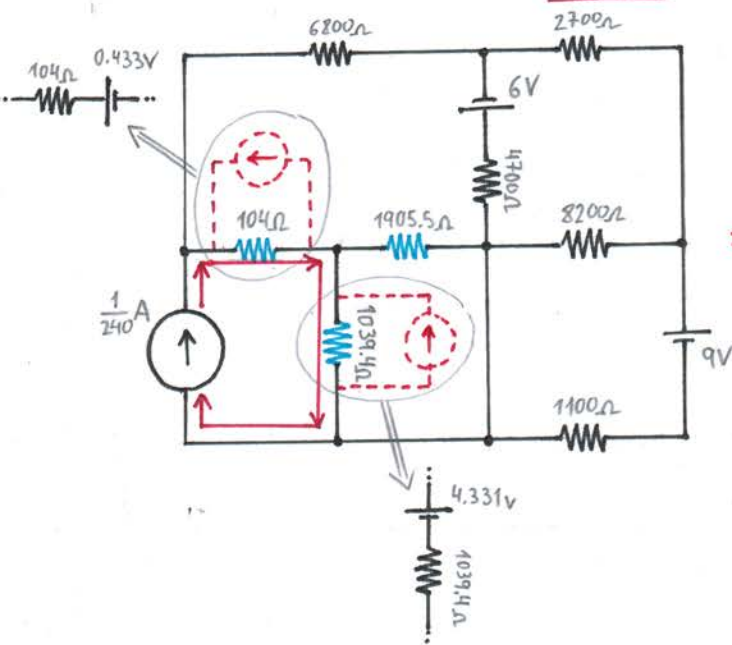
הצבת $\Delta \leftarrow Y$:

$$S\Delta = 2200 + 1200 + 22000$$

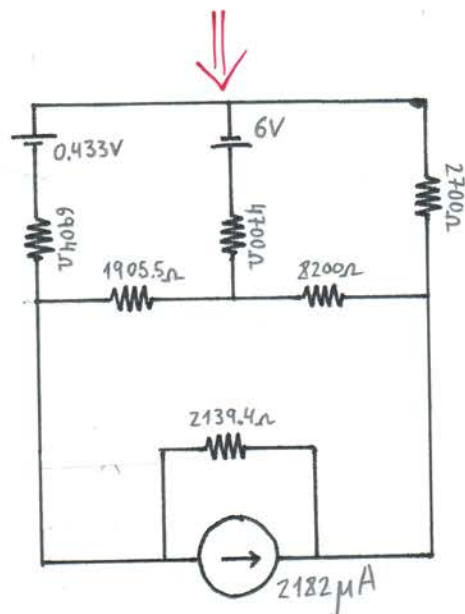
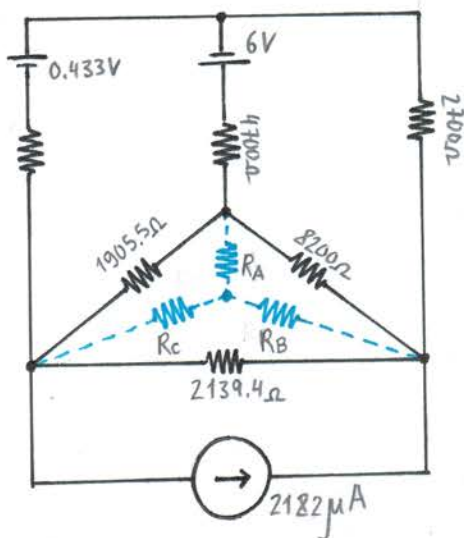
$$S\Delta = 25400$$

$$\begin{cases} R_A = \frac{1200 \cdot 2200}{S\Delta} = 104\Omega \\ R_B = \frac{2200 \cdot 22000}{S\Delta} = 1905.5\Omega \\ R_C = \frac{22000 \cdot 1200}{S\Delta} = 1039.4\Omega \end{cases}$$

הצבת מקורות:



3

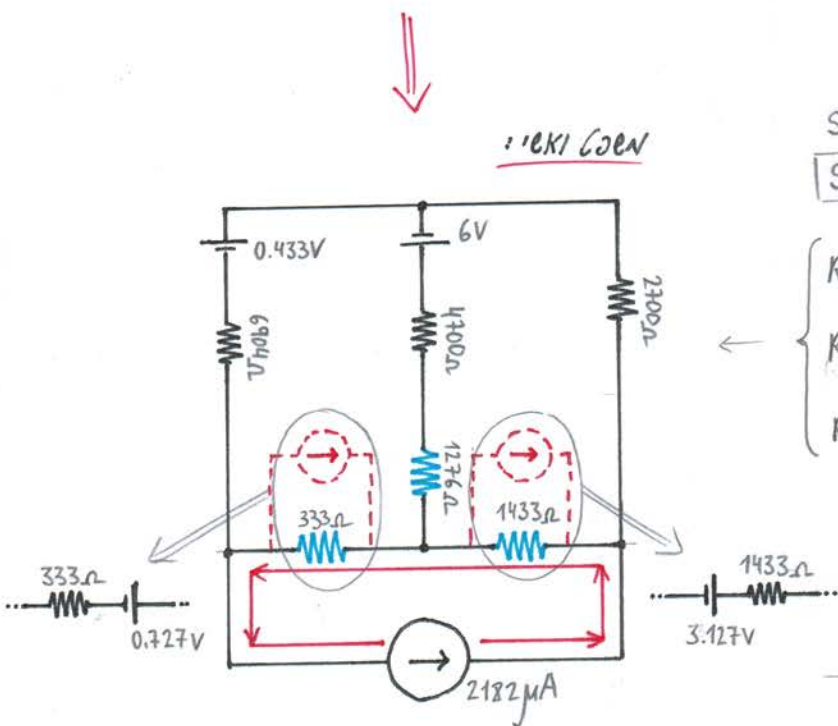


המרת $\Delta \leftarrow Y$:

$$S\Delta = 8200 + 2139.4 + 1905.5$$

$$S\Delta = 12244.9$$

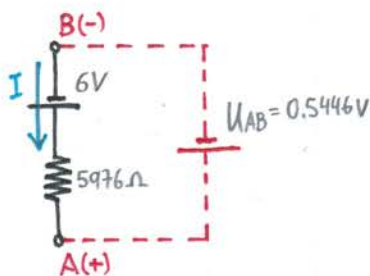
$$\begin{cases} R_A = \frac{1905.5 \cdot 8200}{S\Delta} = 1276\Omega \\ R_B = \frac{8200 \cdot 2139.4}{S\Delta} = 1433\Omega \\ R_C = \frac{2139.4 \cdot 1905.5}{S\Delta} = 333\Omega \end{cases}$$



המרת $Y \leftarrow \Delta$:

המרת $P_{(6V)} \ll I_{(6V)} \ll U_{AB}$:

$$U_{AB} = \frac{+ \frac{0.2935}{7237} + \frac{6}{5976} - \frac{3.127}{4133}}{(7237)^{-1} + (5976)^{-1} + (4133)^{-1}} = 0.5446V$$

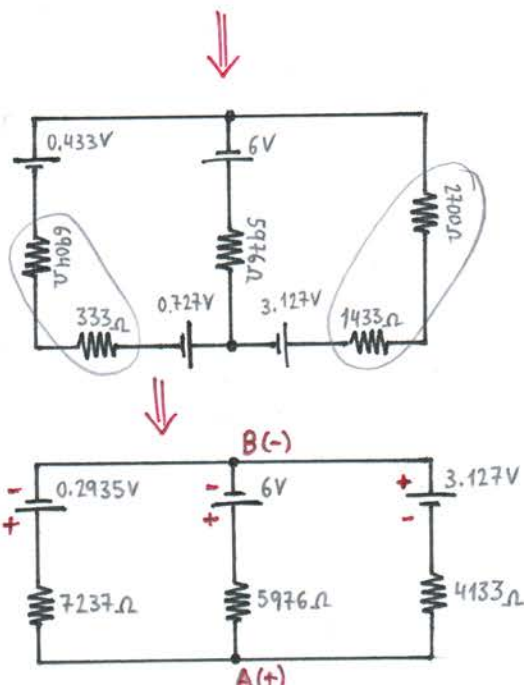


$$I = \frac{6 - U_{AB}}{5976} = \frac{6 - 0.5446}{5976}$$

$$I = 912.88\mu A$$

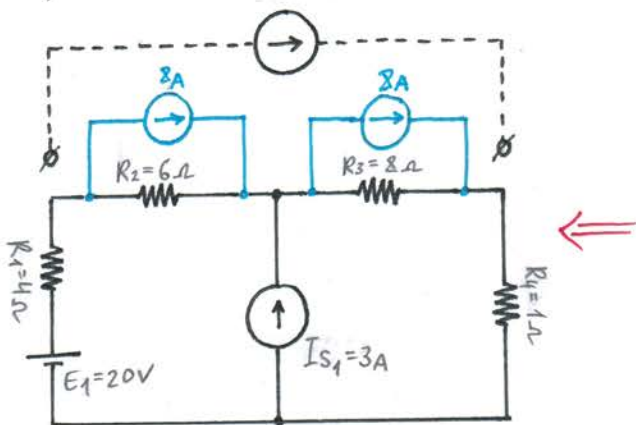
$$P = U \cdot I = 6 \cdot 912.88 \times 10^{-6}$$

$$P = 5.477mW \text{ ! } p_{\text{max}}$$

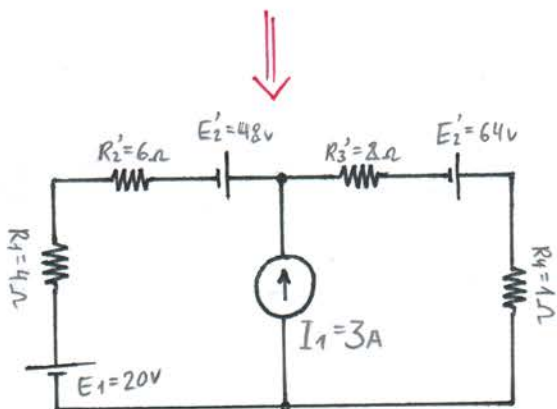
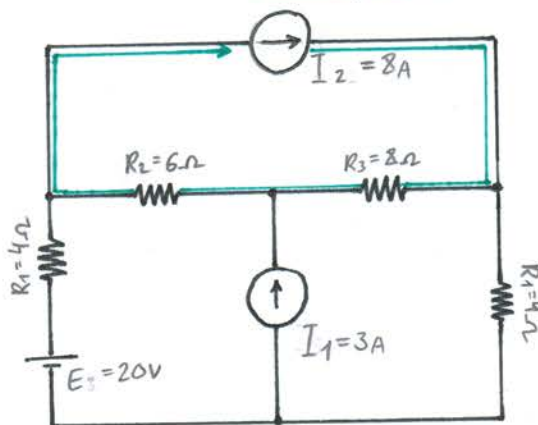


5

הכנסת משפט ואסי ע"י $I_2 = I_{\text{מסלול ירוק}}$:

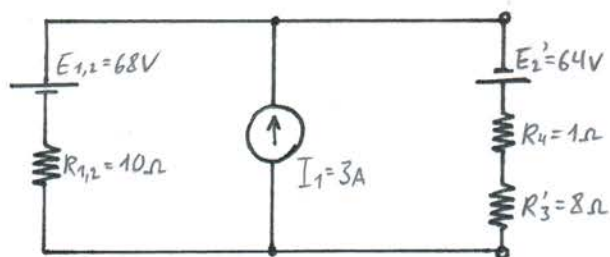


משפט מקור-סימון רכיבים:



$$R_{1,2} = R_1 + R_2' = 4 + 6 = 10\Omega$$

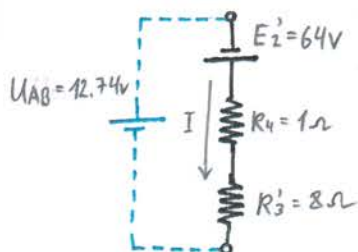
$$E_{1,2} = E_1 + E_2' = 20 + 48 = 68V$$



$$U_{AB} = \frac{\sum I_{sc}}{\sum G} = \frac{\frac{E_{1,2}}{R_{1,2}} + I_1 - \frac{E_2'}{R_3 + R_4}}{(R_{1,2})^{-1} + 0 + (R_3 + R_4)^{-1}}$$

$$U_{AB} = \frac{\frac{68}{10} + 3 - \frac{64}{8+1}}{10^{-1} + 0 + 9^{-1}}$$

$$U_{AB} = 12.738V$$

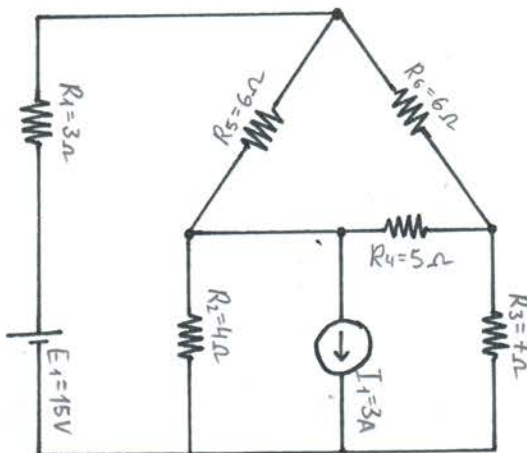
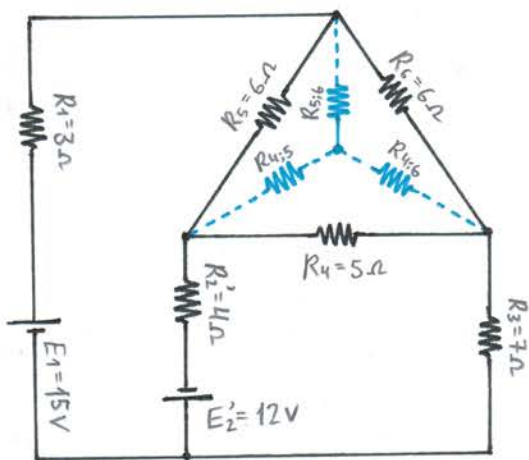


$$I_{R_4} = \frac{U_{AB} + E_2'}{R_3 + R_4} = \frac{12.738 + 64}{8 + 1} = 8.526A$$

$$P_{R_4} = I_{R_4}^2 \cdot R_4 = 8.526^2 \cdot 1$$

$$P_{R_4} = 72.698W$$

6



המרת $\Delta \leftarrow Y$:

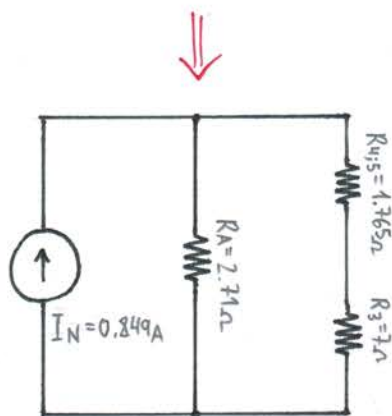
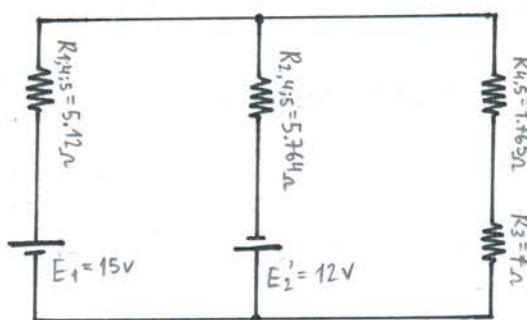
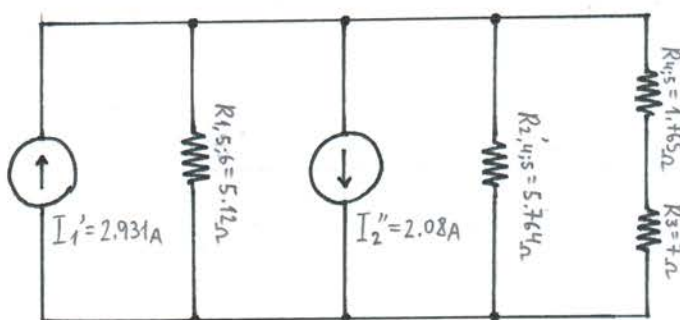
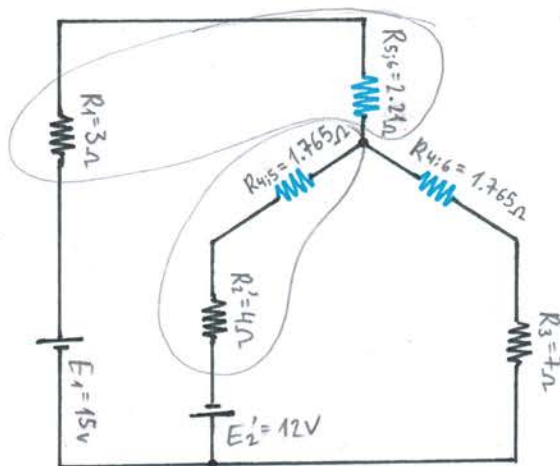
$$R_{4;5} = \frac{R_4 \cdot R_5}{R_4 + R_5 + R_6} = \frac{5 \cdot 6}{17} = 1.765\Omega$$

$$R_{5;6} = \frac{R_5 \cdot R_6}{R_4 + R_5 + R_6} = \frac{6 \cdot 6}{17} = 2.12\Omega$$

$$R_{4;6} = \frac{R_4 \cdot R_6}{R_4 + R_5 + R_6} = \frac{5 \cdot 6}{17} = 1.765\Omega$$

$$R_{1;5;6} = R_1 + R_{5;6} = 3 + 2.12 = 5.12\Omega$$

$$R_{2;4;5} = R_2' + R_{4;5} = 4 + 1.765 = 5.765\Omega$$



$$R_A = R_{1;5;6} \parallel R_{2;4;5}$$

$$R_A = 5.12 \parallel 5.76$$

$$R_A = 2.71\Omega$$

$$I_{R3} = I_N \cdot \frac{R_A}{R_A + (R_3 + R_{4;6})}$$

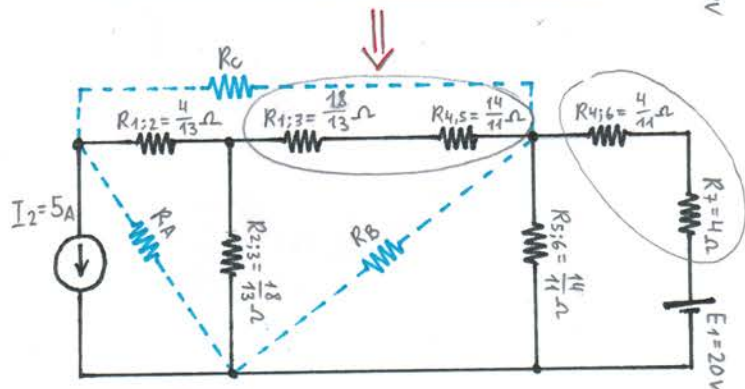
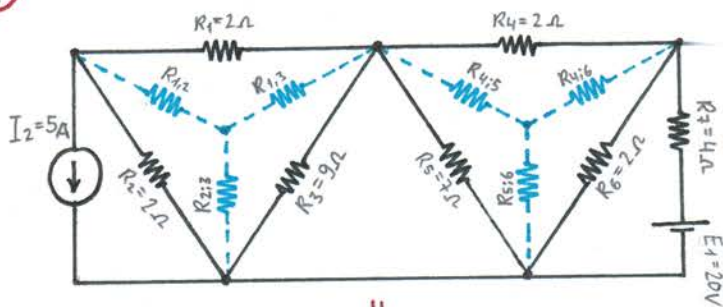
$$I_{R3} = 0.849 \cdot \frac{2.71}{2.71 + (7 + 1.765)}$$

$$I_{R3} = 0.2A$$

$$U_{R3} = I_{R3} \cdot R_3 = 0.2 \cdot 7$$

$$U_{R3} = 1.4V$$

7



$$R_{1,3,4,5} = R_{1,3} + R_{4,5} = \frac{18}{13} + \frac{14}{11} = \frac{380}{143} \Omega$$

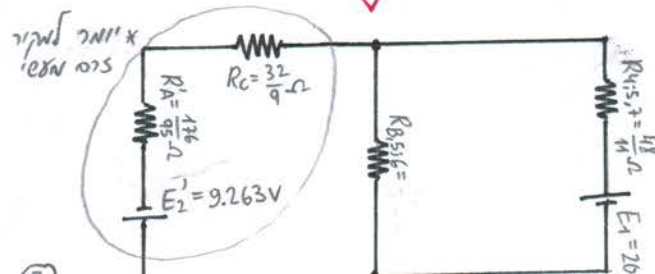
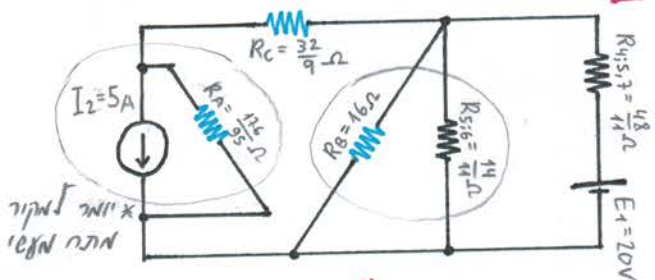
$$R_{4,6,7} = R_{4,6} + R_7 = \frac{4}{11} + 4 = \frac{48}{11} \Omega$$

הכנסת $\Delta \leftarrow Y$ ($R_{1,2}, R_{1,3,4,5}, R_{2,3}$)

$$Y'' = R_{1,2} \cdot R_{1,3,4,5} + R_{1,3,4,5} \cdot R_{2,3} + R_{2,3} \cdot R_{1,2}$$

$$Y'' = \frac{4}{13} \cdot \frac{380}{143} + \frac{380}{143} \cdot \frac{18}{13} + \frac{18}{13} \cdot \frac{4}{13} = \frac{64}{13}$$

$$\begin{cases} R_A = \frac{Y''}{R_{1,3,4,5}} = \frac{64/13}{380/143} = \frac{176}{95} \Omega \\ R_B = \frac{Y''}{R_{1,2}} = \frac{64/13}{4/13} = 16 \Omega \\ R_C = \frac{Y''}{R_{2,3}} = \frac{64/13}{18/13} = \frac{32}{9} \Omega \end{cases}$$



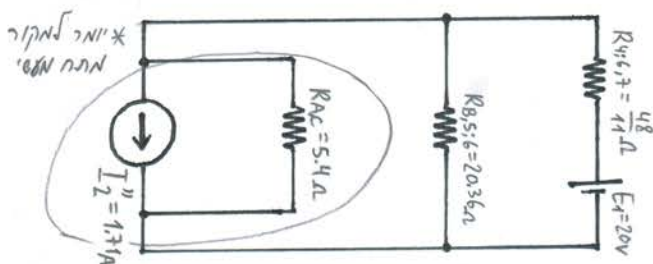
הכנסת $Y \leftarrow \Delta$ (R_1, R_2, R_3)

$$\begin{cases} R_{1,2} = \frac{R_1 R_2}{R_1 + R_2 + R_3} = \frac{2 \cdot 2}{2 + 2 + 9} = \frac{4}{13} \Omega \\ R_{1,3} = \frac{R_1 R_3}{R_1 + R_2 + R_3} = \frac{2 \cdot 9}{2 + 2 + 9} = \frac{18}{13} \Omega \\ R_{2,3} = \frac{R_2 R_3}{R_1 + R_2 + R_3} = \frac{2 \cdot 9}{2 + 2 + 9} = \frac{18}{13} \Omega \end{cases}$$

הכנסת $Y \leftarrow \Delta$ (R_4, R_5, R_6)

$$\begin{cases} R_{4,5} = \frac{R_4 R_5}{R_4 + R_5 + R_6} = \frac{2 \cdot 7}{2 + 2 + 7} = \frac{14}{11} \Omega \\ R_{5,6} = \frac{R_5 R_6}{R_4 + R_5 + R_6} = \frac{7 \cdot 2}{2 + 2 + 7} = \frac{14}{11} \Omega \\ R_{4,6} = \frac{R_4 R_6}{R_4 + R_5 + R_6} = \frac{2 \cdot 2}{2 + 2 + 7} = \frac{4}{11} \Omega \end{cases}$$

$$R_{A,C} = R_A + R_C = \frac{176}{95} + \frac{32}{9} = 5.4 \Omega$$



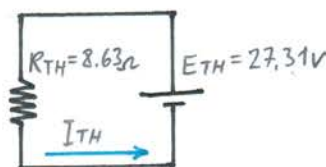
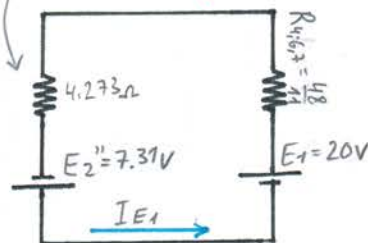
$$R_{A,C,B,S,6} = R_{A,C} \parallel R_{B,S,6} = 5.4 \parallel 20.363 = 4.273 \Omega$$

$$\begin{aligned} E_{TH} &= E_1 + E_2'' \\ E_{TH} &= 20 + 7.319 \\ E_{TH} &= 27.319 \text{ V} \end{aligned}$$

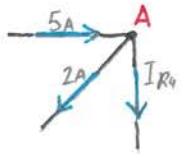
$$\begin{aligned} R_{TH} &= R_{A,C,B,S,6} + R_{4,6,7} \\ R_{TH} &= 4.273 + \frac{48}{11} \\ R_{TH} &= 8.636 \Omega \end{aligned}$$

$$\begin{aligned} I_{E1} &= I_{TH} = \frac{E_{TH}}{R_{TH}} = \frac{27.319}{8.636} \\ I_{E1} &= 3.163 \text{ A} \end{aligned}$$

$$P_{E1} = I_{E1} \cdot E_1 = 3.163 \cdot 20 = 86.413 \text{ W}$$



8



:A $\rightarrow$ N3 $\rightarrow$ [KCL] $\rightarrow$ 28

$$I_{R4} = 5 - 2$$

$$I_{R4} = 3A$$

$$P_{R4} = I_{R4}^2 \cdot R_4$$

$$P_{R4} = 3^2 \cdot 4$$

$$P_{R4} = 36W$$

