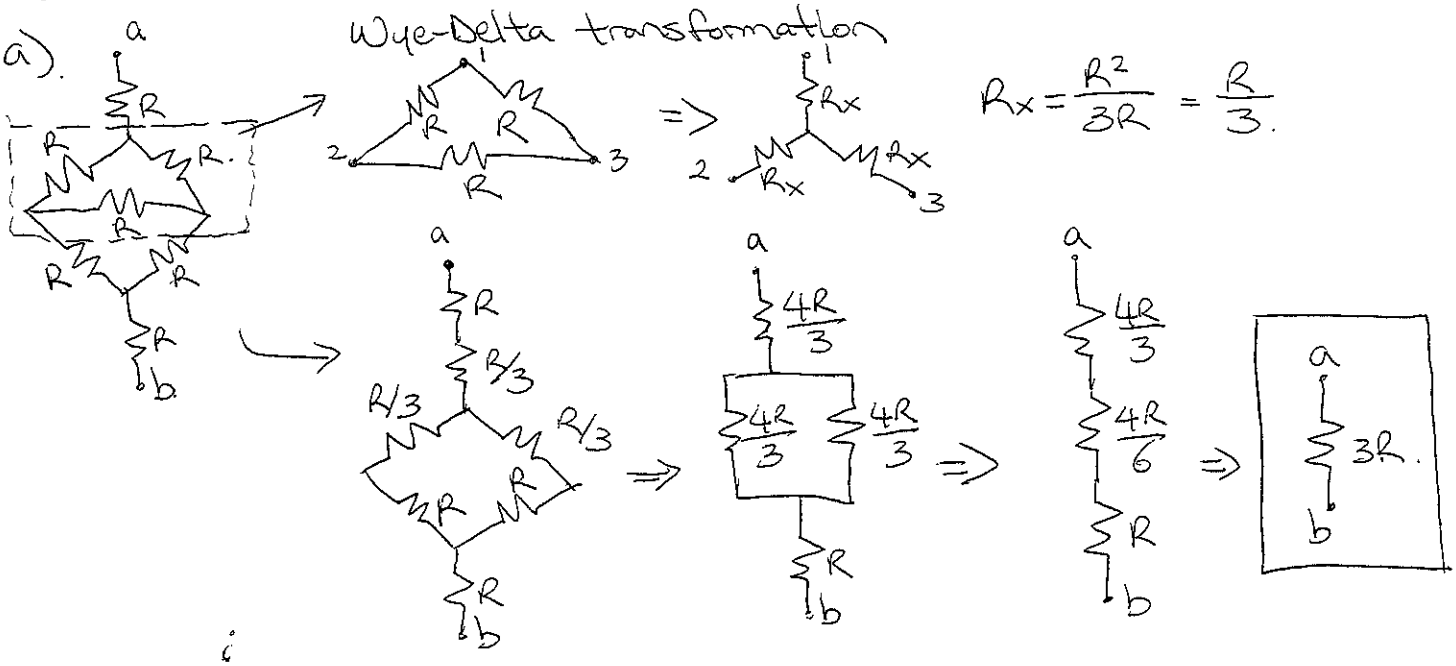
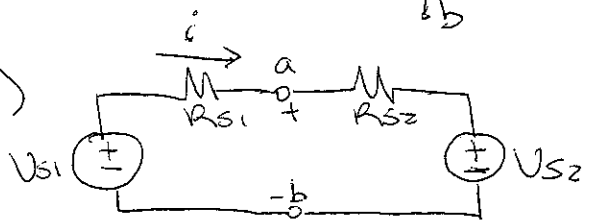
Problem 1

a) Wye-Delta transformation



b)



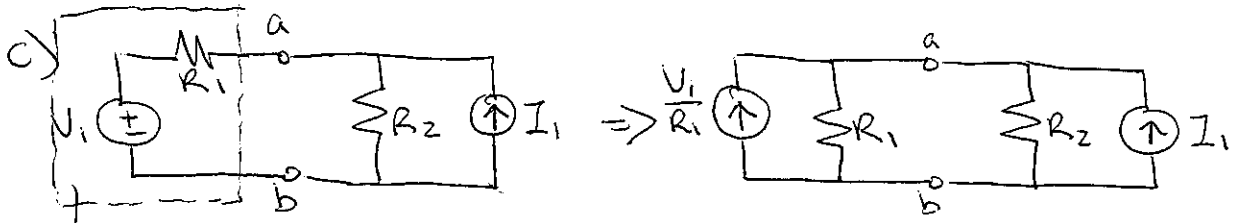
KVL: $-V_{S1} + i(R_{S1} + R_{S2}) + V_{S2} = 0$

$$i = \frac{V_{S1} - V_{S2}}{R_{S1} + R_{S2}} = \frac{1V - 4V}{2k\Omega + 1k\Omega} = \frac{-3V}{3k\Omega} = \boxed{-1mA}$$

KVL w/ V_{AB}: $-V_{S1} + iR_{S1} + V_{AB} = 0$

$$V_{AB} = V_{S1} - iR_{S1} = 1V - (-1mA)(2k\Omega) = 1V + 2V = \boxed{3V}$$

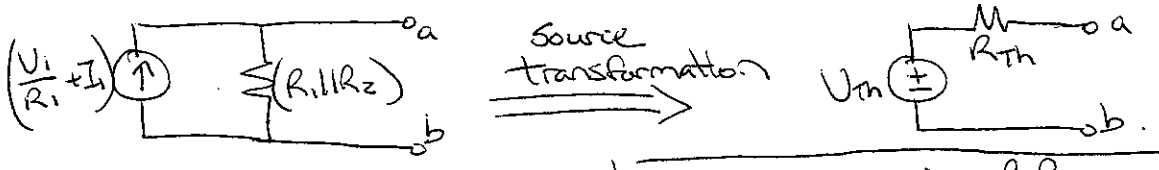
c)



Norton equivalent source: $\frac{V_1}{R_1}$ ↑ R_1

Resistors are in parallel → can be combined

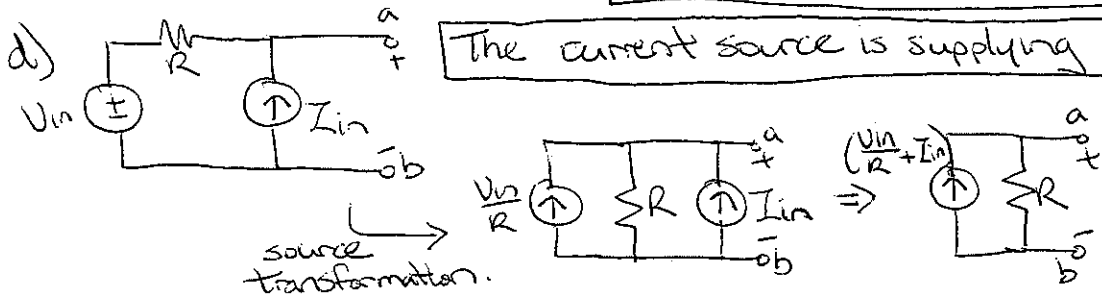
Current sources are in parallel → can be combined



$V_{Th} = \left(\frac{V_1}{R_1} + I_1\right)(R_1 \| R_2) \Rightarrow \boxed{V_{Th} = \left(\frac{V_1}{R_1} + I_1\right)\left(\frac{R_1 R_2}{R_1 + R_2}\right)}$

$R_{Th} = R_1 \| R_2 \Rightarrow \boxed{R_{Th} = \frac{R_1 R_2}{R_1 + R_2}}$

d)



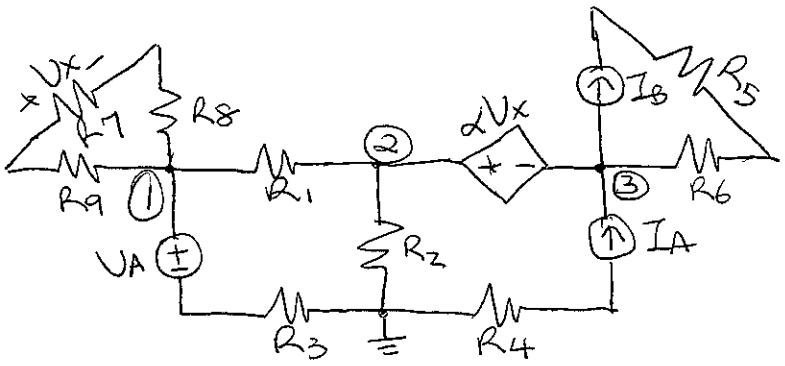
The current source is supplying power.

$V_{ab} = \left(\frac{V_{in}}{R} + I_{in}\right) \cdot R$

$= \left(\frac{1V}{1\Omega} + 1A\right) \cdot 1\Omega = 2V$

$\boxed{P = (V_{ab})(-I_{in}) = -2W,\ P < 0}$

Problem 2



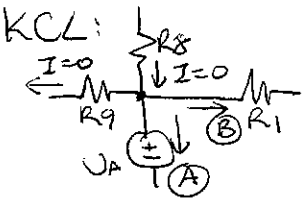
(a) Node (1):

- KVL shows no current flows in the triangle

$I R_7 + I R_8 + I R_9 = 0$

$I(R_7 + R_8 + R_9) = 0 \Rightarrow I = 0$

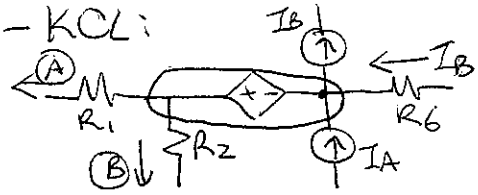
- KCL:



$$\underbrace{\frac{V_1 - V_A}{R_3}}_{A} + \underbrace{\frac{V_1 - V_2}{R_1}}_{B} = 0 \Rightarrow \underline{EQ1}$$

(b) Node (2) & (3):

- Nodes (2) & (3) form a supernode b/c only a voltage source in between
- KCL:



I_B loops back

$$\underbrace{\frac{V_2 - V_1}{R_1}}_{A} + \underbrace{\frac{V_2}{R_2}}_{B} + \underbrace{I_B - I_B}_{\text{cancel}} - I_A = 0 \Rightarrow \underline{EQ2}$$

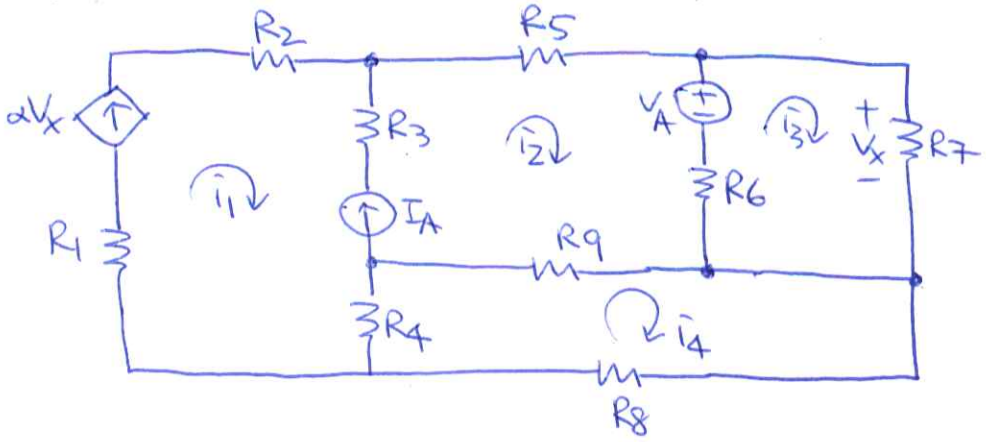
System of equations:

EQ1: $\frac{V_1 - V_A}{R_3} + \frac{V_1 - V_2}{R_1} = 0 \Rightarrow \boxed{\left(\frac{1}{R_1} + \frac{1}{R_3}\right)V_1 + \left(\frac{-1}{R_1}\right)V_2 = \frac{V_A}{R_3}}$

EQ2: $\frac{V_2 - V_1}{R_1} + \frac{V_2}{R_2} - I_A = 0 \Rightarrow \boxed{\left(\frac{-1}{R_1}\right)V_1 + \left(\frac{1}{R_1} + \frac{1}{R_2}\right)V_2 = I_A}$

Current through R_7 is 0, so $V_x = 0$, so $\alpha V_x = 0$, so $\boxed{V_3 = V_2}$

• Q3



$i_1 = \alpha V_x$

$I_A = i_2 - i_1$

$(i_4 - i_1)R_4 + (i_4 - i_2)R_9 + i_4 R_8 = 0$

$-V_A + i_3 R_7 + (i_3 - i_2)R_6 = 0$

$V_x = i_3 R_7$

total 5 unknowns: i_1, V_x, i_2, i_3, i_4

total 5 equations

∴ fulfills requirement

$i_1 = \alpha V_x$

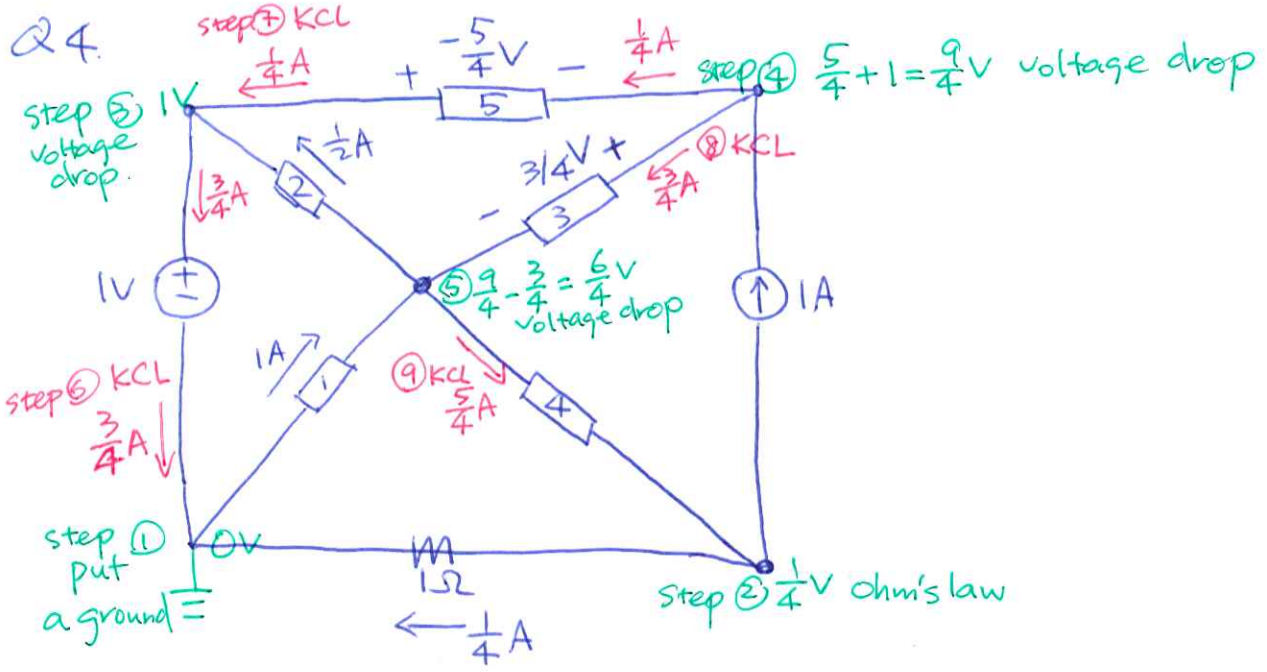
$-i_1 + i_2 = I_A$

$-R_4 i_1 - R_9 i_2 + (R_4 + R_8 + R_9) i_4 = 0$

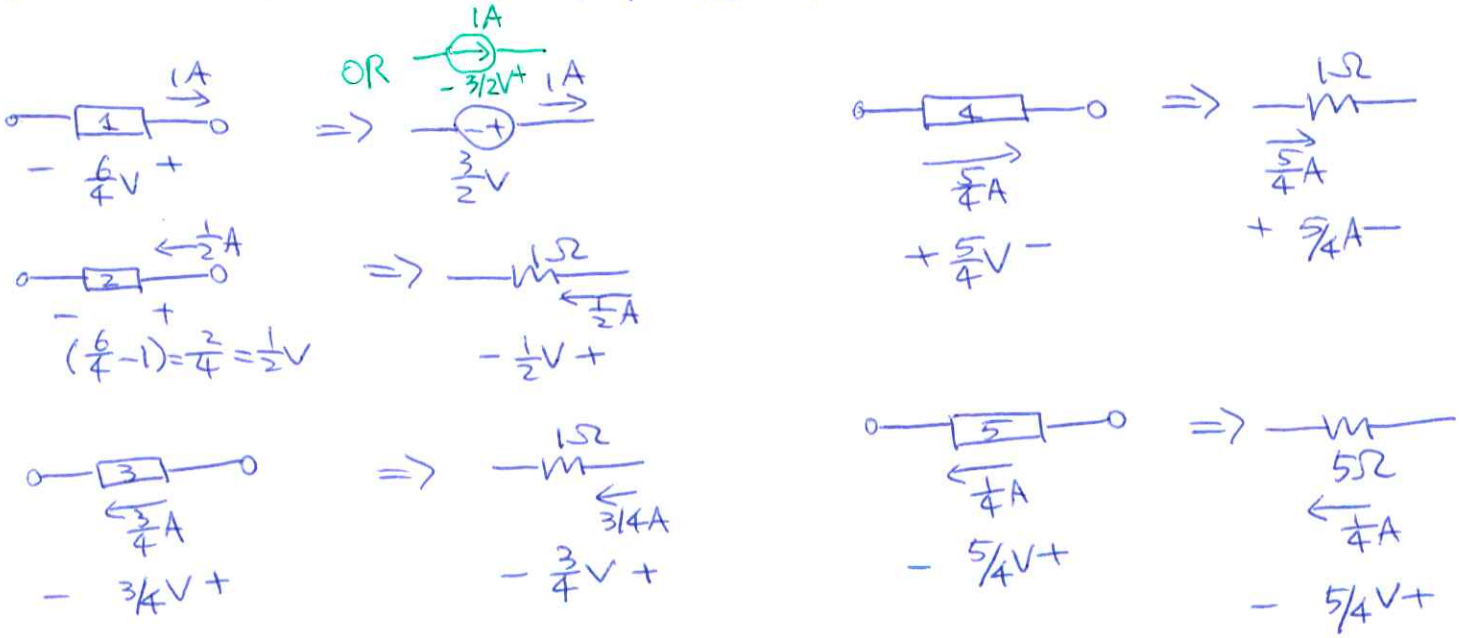
$-R_6 i_2 + (R_6 + R_7) i_3 = V_A$

$R_7 i_3 = V_x$

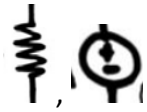
Q4.



unknow element	Symbol	Power Mag. (W)	consuming or providing
1	$\frac{3}{2}$V or 1A	$\lvert 1\cdot(0-\frac{6}{4})\rvert=\frac{3}{2}$	providing
2	1Ω	$\frac{1}{2}\cdot\frac{1}{2}=\frac{1}{4}$	Consuming
3	1Ω	$\frac{3}{4}\cdot\frac{3}{4}=\frac{9}{16}$	Consuming
4	1Ω	$\frac{5}{4}\cdot\frac{5}{4}=\frac{25}{16}$	Consuming
5	5Ω	$\frac{1}{4}\cdot\frac{5}{4}=\frac{5}{16}$	Consuming



Q4 rubric

Each correct symbol, e.g.  worth 2 points. In total there should be 5 symbols.

Each correct symbol value with correct unit, e.g., 1.5V, 1 ohm , worth 1 point. In total there should be 5 values with correct unit.

Each correct power magnitude worth 1 point. In total there should be 5 power magnitudes.

Each correct consuming or providing power, worth 1 point. In total there should be 4 consuming and 1 providing.