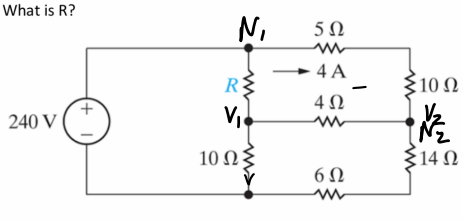
Question 1 (5 points)

What is R?



$V=IR \Rightarrow I=\frac{V}{R}$

Solving for V_2

$4A=\frac{240V-V_2}{(5+10)\Omega}$

$60=240V-V_2$

$V_2=180V$

Solving for V_1

$-4+\frac{V_2-V_1}{4}+\frac{V_2}{(14+6)}=0$

$-4+\frac{180-V_1}{4}+\frac{180}{20}=0$

$\frac{180-V_1}{4}=-5$

$180-V_1=-20$

$V_1=200V$

Solving for R

$\frac{V_1-240}{R}+\frac{V_1}{10}+\frac{V_1-V_2}{4}=0$

$\frac{200-240}{R}+\frac{200}{10}+\frac{200-180}{4}=0$

$\frac{-40}{R}+20+5=0$

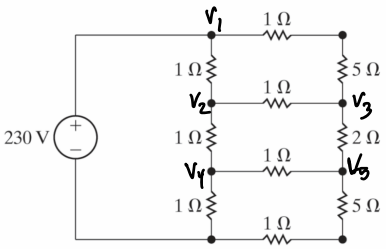
$\frac{-40}{R}=-25$

$R=\frac{-40}{-25}$

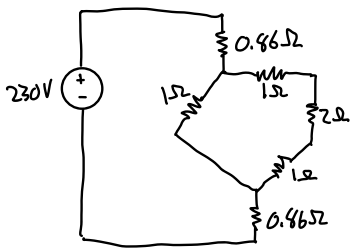
$R=1.6\,\Omega$

Question 2 (15 points)

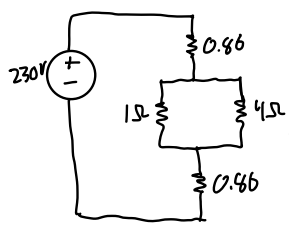
a) What is the equivalent resistance connected to the 230V battery?
b) Use Node-voltage method to find power dissipated in 2 Ohm resistor.
c) Find power supplied by 230 V



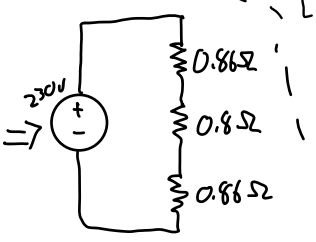
a) $1\,\Omega \,||\, (1+5)\Omega = 0.86\Omega$



$1\Omega+2\Omega+1\Omega=4\Omega$



$1\Omega \,||\, 4\Omega = 0.8$



$R_{eq}=0.86\Omega+0.8\Omega+0.86\Omega$

$R_{eq}=2.52\Omega$

b) ① $V_1=230$

② $\frac{V_2-230}{1}+\frac{V_2-V_3}{1}+\frac{V_2-V_4}{1}=0$

$3V_2-V_3-V_4=230$

③ $\frac{V_3-230}{6}+\frac{V_3-V_2}{1}+\frac{V_3-V_5}{2}=0$

$V_3-230+6V_3-6V_2+3V_3-3V_5=0$

$-6V_2+10V_3-3V_5=230$

④ $\frac{V_4-V_2}{1}+\frac{V_4}{1}+\frac{V_4-V_5}{1}=0$

$-V_2+3V_4-V_5=0$

⑤ $\frac{V_5-V_4}{1}+\frac{V_5}{6}+\frac{V_5-V_3}{2}=0$

$6V_5-6V_4+V_5+3V_5-3V_3=0$

$-3V_3-6V_4+10V_5=0$

$$\begin{bmatrix} 3 & -1 & -1 & 0 & 230 \\ -6 & 10 & 0 & -3 & 230 \\ -1 & 0 & 3 & -1 & 0 \\ 0 & -3 & -6 & 10 & 0 \end{bmatrix}$$

Solving matrix

$V_1=230V$, $V_2=150V$, $V_3=140V$

$V_4=60V$, $V_5=90V$

$i_{2\Omega}=\frac{V_3-V_5}{2}=\frac{140-90}{2}=25A$

$P=I^2R$

$P_{2\Omega}=(25)^2(2)$

$P_{2\Omega}=1250W$

#2 c) $i = \frac{V_1 - V_2}{1} + \frac{V_1 - V_3}{6} = \frac{230-150}{1} + \frac{230-140}{6} = 95A$

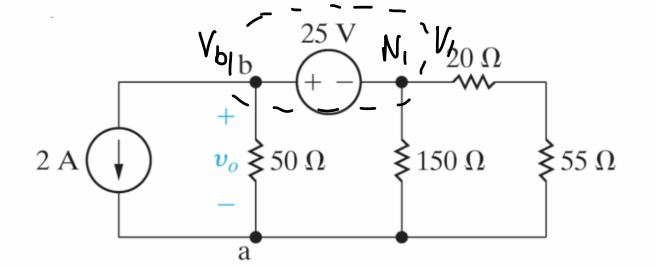
$P = IV \Rightarrow P = (95)(230) = 21850W$

$\boxed{P = 21{,}850W}$

Question 3 (15 points)

a) Identify the super node.

b) Use node-voltage method to find V_o.



a) the super node encompasses the 25V source between nodes b and N_1. (I circled it)

b) ① $V_b - V_1 = 25$ (constraint super Node)

② $\frac{V_1}{150} + \frac{V_1}{20+55} + 2 + \frac{V_b}{50} = 0$

$V_1 + 2V_1 + 300 + 3V_b = 0$

$3V_1 + 3V_b = 300$

$V_1 + V_b = 100$

Solve w/ matrix

$\begin{bmatrix} -1 & 1 & 25 \\ 1 & 1 & 100 \end{bmatrix} \Rightarrow$ $V_1 = 37.5V$, $V_2 = 62.5V$

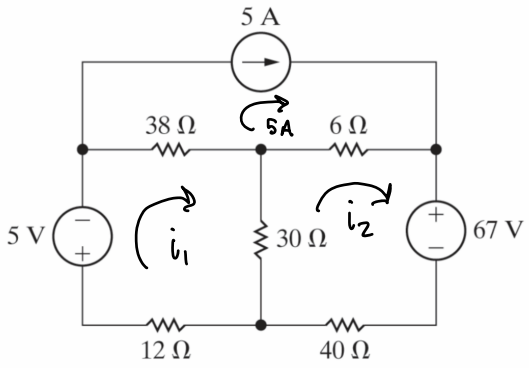
Given the circuit V_o would be equivalent to V_b

So: $V_o = V_b = 37.5V$

$\boxed{V_o = 37.5V}$

Question 4 (15 points)

a) Use mesh-current method to find out how much power the 5A source delivers.
b) Find total power delivered to the circuit by the current and voltage sources.
c) Find total power dissipated in the circuit by the resistors.



loop 1: $5V + 38(i_1 - 5) + 30(i_1 - i_2) + 12i_1 = 0$

$38i_1 + 30i_1 + 12i_1 - 30i_2 - 185 = 0$

$80i_1 - 30i_2 = 185$

loop 2: $67 + 40i_2 + 6(i_2 - 5) + 30(i_2 - i_1) = 0$

$-30i_1 + 40i_2 + 6i_2 + 30i_2 + 37 = 0$

$-30i_1 + 76i_2 = -37$

Solving w/ matrix:

$$\begin{bmatrix} 80 & -30 & | & 185 \\ -30 & 76 & | & -37 \end{bmatrix}$$

$i_1 = 2.5A \quad i_2 = 0.5A$

a) $V_{5A} = 38(2.5 - 5) + 6(0.5 - 5) = -122V$

$P = IV = (5)(-122V) = -610W$!

$P_{5A} = 610W$

b) $P_{67V} = 0.5(67) = 33.5W$

$P_{5V} = 2.5(5) = 12.5W$

$P_{5A} = 610W$

c) $P_R = I^2R$

$P_{38\Omega} = (2.5)^2 38 = 237.5W$

$P_{30\Omega} = (2.5 - 0.5)^2(30) = 120W$

$P_{6\Omega} = (5 - 0.5)^2(6) = 121.5W$

$P_{40\Omega} = (0.5)^2(40) = 10W$

$P_{12\Omega} = (2.5)^2(12) = 75W$

$P_{resistors} = 237.5 + 120 + 121.5 + 10 + 75 = 564W$

$P_{resistors} = 564W$