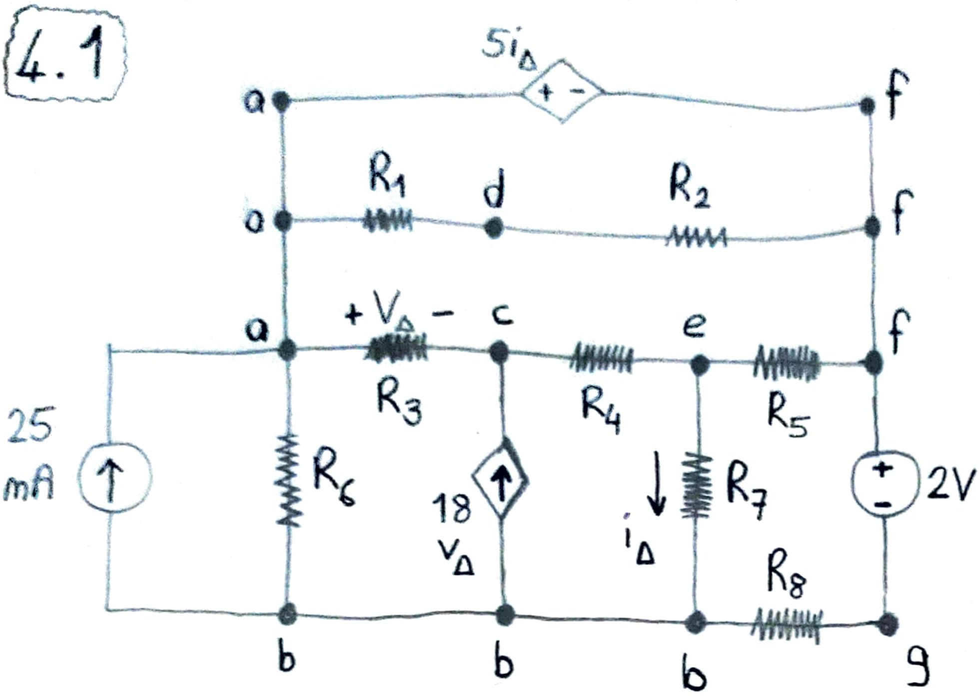
GEEKDAY

4.1



a) $a \overset{(2)}{\supset} b$, a—f, a—d, a—f, d—f, a—c, c—e, e—f, f—g, b—g, e—b ⇛ 12 branches

b) All above except one of the a—b branches which a path with 25mA curr. So there are 11 branches with unknown current.

c) $a \overset{(2)}{\supset} b$, a—c, c—e, e—f, c—b, e—b, $a \overset{(2)}{\supset} f$, b—f

→ 10 essential branches

d) Branches above except a—b branch with 25mA current source. 9 total.

e) a, b, c, d, e, f, g = 7 nodes

f) a, b, c, e, f = 5 essential nodes

g) (a-b), (a-b-c), (c-b-e), (e-b-g-f), (a-c-f-d), (a-d-f) = 6 meshes

4.2

a) Essential nodes are important to show current changes on branches but writing equations with essential branches is the deciding one on number of equations Because unknown current number on a circuit is equal to number of essential branches with unknown current, So we need at least 9 equations since there are 9 essential branch with unknown current on this circuit.

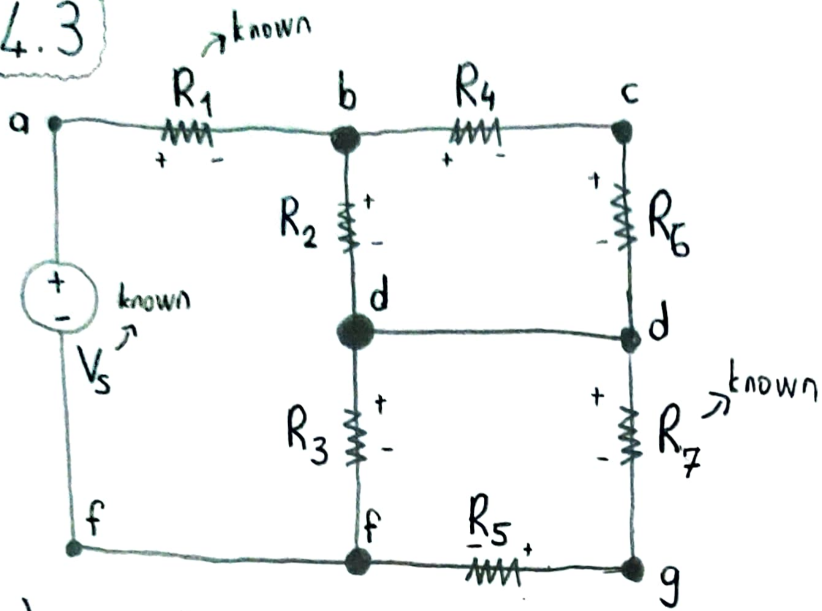
b) a, b, c, e, f nodes are essential ones. We can use them to derive equa-tions using KCL (Kirchhof's Current Law). The equations we will derive from a and b won't make difference since the current going through them are equal. So we can say 4 equations needed

c) $E-(N-1)$, this equation shows how many equations can be derived by using KVL (Kirchhof's Voltage Law). E is equal to number of essential branches and N is equal to essential nodes.
Since we say "must be derived" we can ignore essential branch with known current.
So $E=9$ and $N=5$, the answer is $(9-(5-1))=5$ equations.

d) Since there are 2 current sources we can say that they should be avoided because if we can't measure their voltage, we can't use KCL on that mesh

GEEKDAY

4.3



a) $i_{R_1}, i_{R_2}, i_{R_3}, i_{R_4}, i_{R_5}, i_{R_6}, i_{R_7}, i_{V_s} \Rightarrow 8$ current but...

$(i_{R_1} = i_{V_s}), (i_{R_4} = i_{R_6}), (i_{R_7} = i_{R_5}) \Rightarrow 8-3=5$ unknown current

b) $(N-1)$ gives number of equations can be written with KCL. N, is the number of essential nodes. since there are 3 essential nodes (b, d, f) on the circuit answer is $\Rightarrow (3-1) = 2$ equations.

c) for node b $\Rightarrow i_{R_1} = i_{R_2} + i_{R_4}$

for node d $\Rightarrow i_{R_2} + i_{R_6} = i_{R_3} + i_{R_7}$

d) $E-(N-1)$, $\left.\begin{array}{l} E = \text{essential branches} = 5 \\ N = \text{essential nodes} = 3 \end{array}\right\} 5-(3-1) = 3$ equations

e) $V_s = V_{R_1} + V_{R_2} + V_{R_3}$ or $V_s = i_{R_1} \cdot R_1 + i_{R_2} \cdot R_2 + i_3 \cdot R_3$

$V_{R_2} = V_{R_4} + V_{R_6}$

$V_{R_3} = V_{R_5} + V_{R_7}$

4.4

a) for node b $\Rightarrow 0 = -i_{R_1} + i_{R_2} + i_4$

for node d $\Rightarrow 0 = -i_{R_2} - i_{R_4} + i_{R_3} + i_{R_7}$

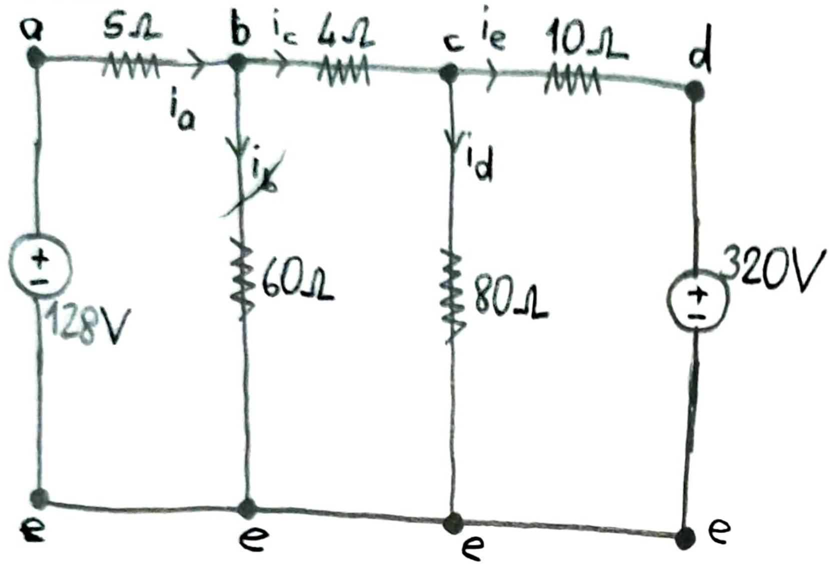
for node f $\Rightarrow 0 = i_{R_1} - i_{R_3} - i_{R_7}$

b) $-b = i_{R_1} - i_{R_2} - i_{R_4}$

$$
\begin{array}{r}
-d = i_{R_2} + i_{R_4} - i_{R_3} - i_{R_7} \\
+ \quad \\
\hline
-b-d = i_{R_1} - i_{R_3} - i_{R_7} = f \;//
\end{array}
$$

GEEKDAY

4.11



* essential nodes = b, c, e

* needed equation = N-1

$= 3-1$

$= 2$

* e node is referance

a) for node b $\Rightarrow \dfrac{V_b - 128}{5} + \dfrac{V_b}{60} + \dfrac{V_b - V_c}{4} = 0$

for node c $\Rightarrow \dfrac{V_c - V_b}{4} + \dfrac{V_c}{80} + \dfrac{V_c - 320}{10} = 0$

$$\left.\begin{aligned} b &\Rightarrow 28V_b - 15V_c = 1536 \\ c &\Rightarrow 29V_c - 20V_b = 2560 \end{aligned}\right\} \left.\begin{aligned} V_b &= 162V \\ V_c &= 200V \end{aligned}\right\}$$

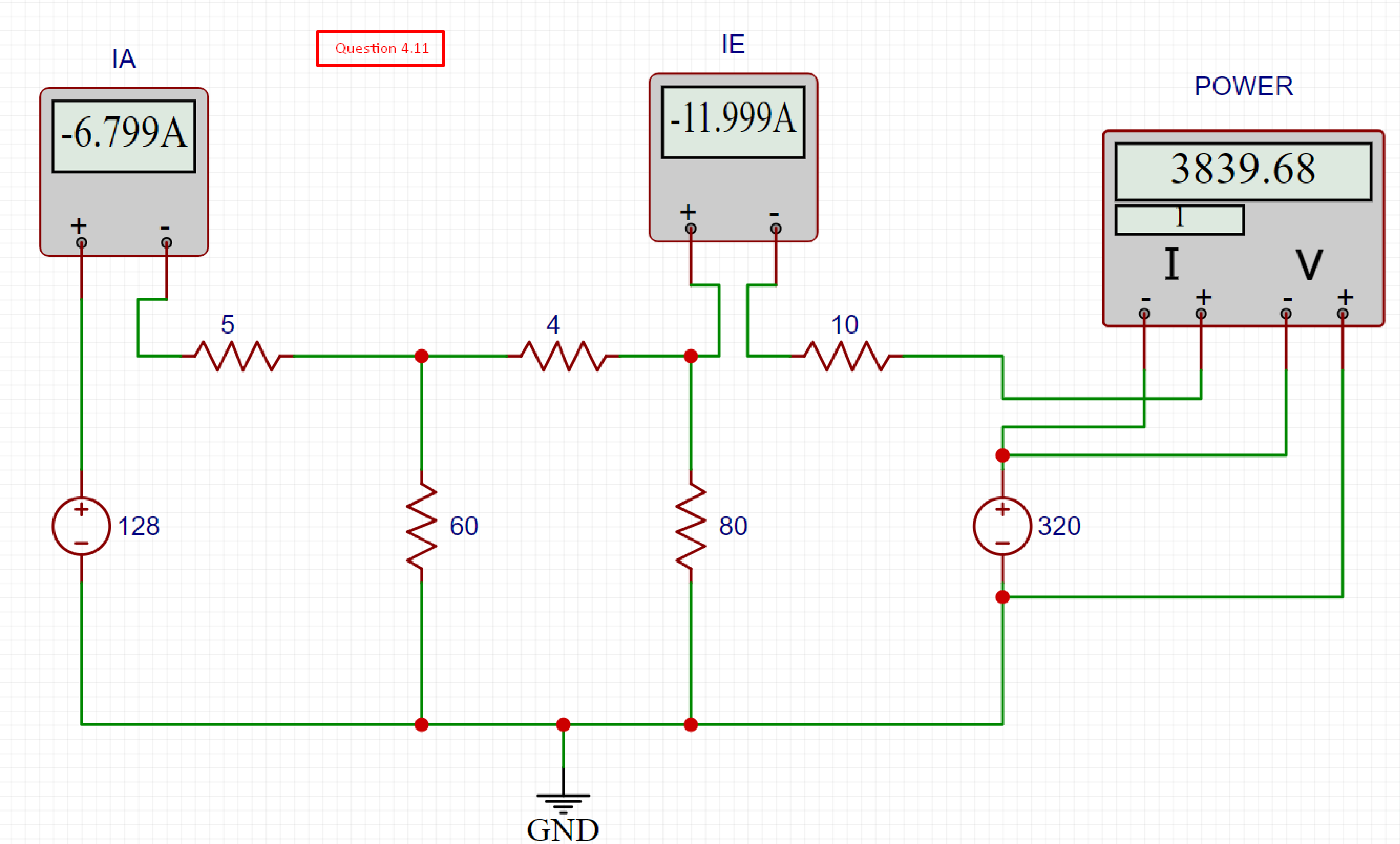
$i_a = \dfrac{128 - 162}{5} = -6.8A$

$i_e = \dfrac{200 - 320}{10} = -12A$

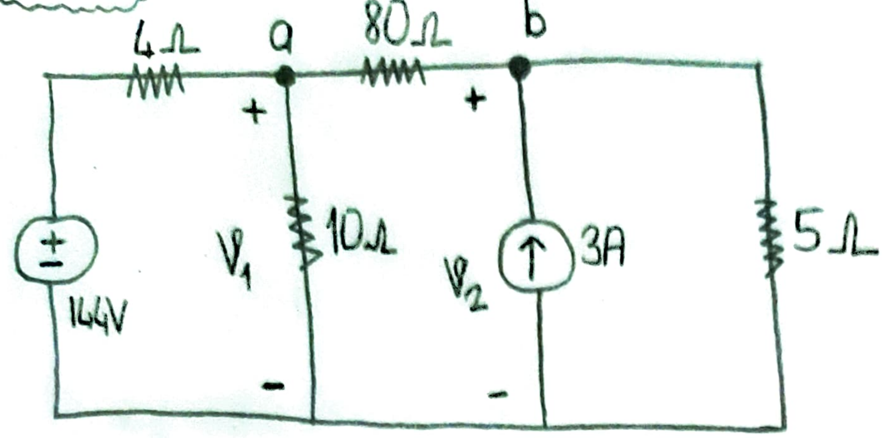
b) For 128V source $\Rightarrow p = V.i = 128.(-6.8) = -870.4W$ (absorbs)

for 320V source $\Rightarrow p = V.i = -320.(-12) = 3840W$

develops power


Question 4.11
IA
-6.799A
+
-
IE
-11.999A
+
-
POWER
3839.68
I
I
V
-
+
-
+
5
4
10
60
80
128
320
GND

4.12



* $\dfrac{V_1 - 144}{4} + \dfrac{V_1}{10} + \dfrac{V_1 - V_2}{80} = 0$ (for a)

* $20V_1 - 2880 + 8V_1 + V_1 - V_2 = 0$

* $V_2 = 29V_1 - 2880$ (1)

* $\dfrac{V_2 - V_1}{80} - 3 + \dfrac{V_2}{5} = 0$

* $V_2 - V_1 - 240 + 16V_2 = 0$

* $V_1 = 17V_2 - 240$ (2)

$V_1 = 17(29V_1 - 2880) - 240$

$V_1 = 493V_1 - 48960 - 240$

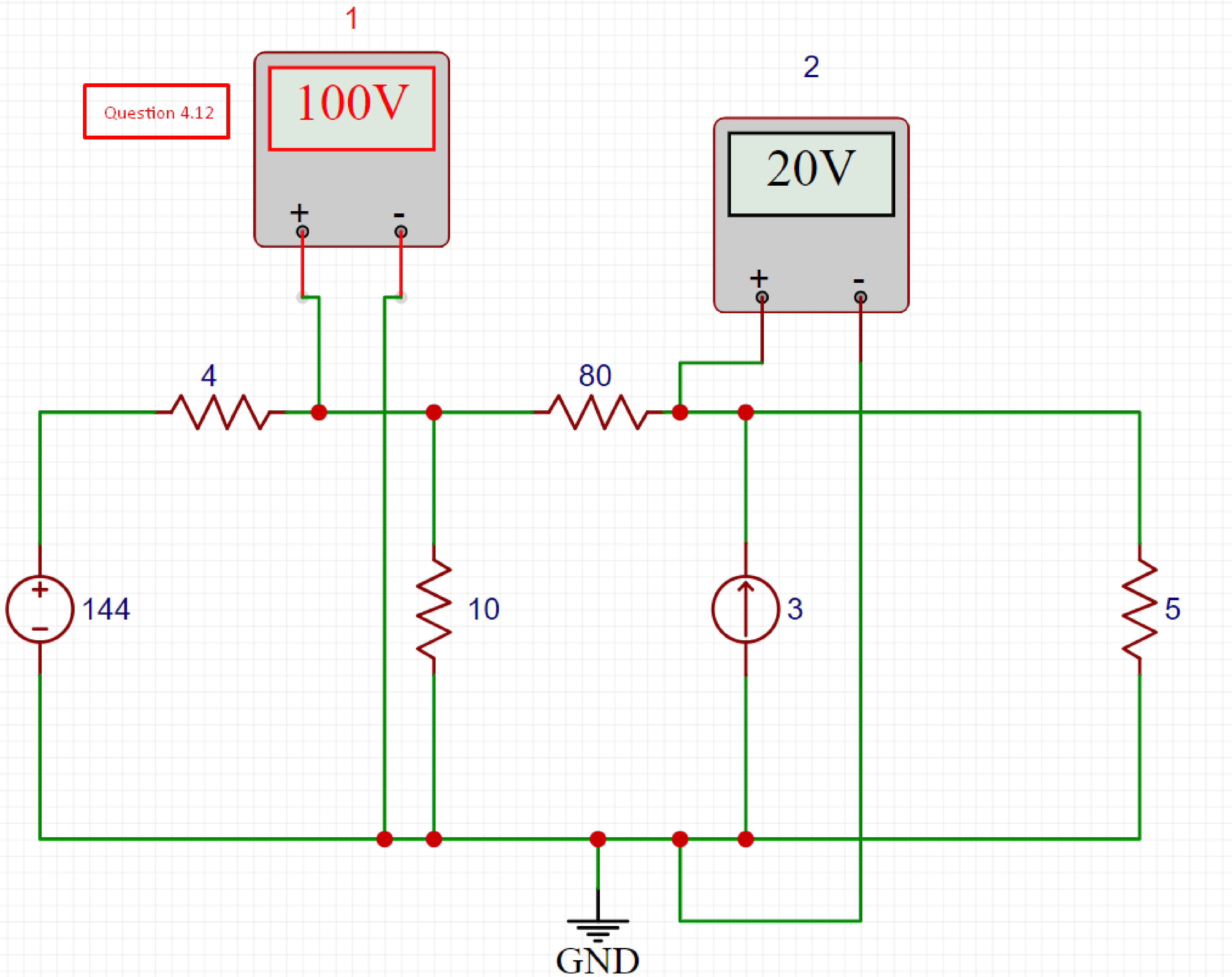
$492V_1 = 49200$

$V_1 = 100V$

* $V_2 = 29(100) - 2880$

$V_2 = 2900 - 2880$

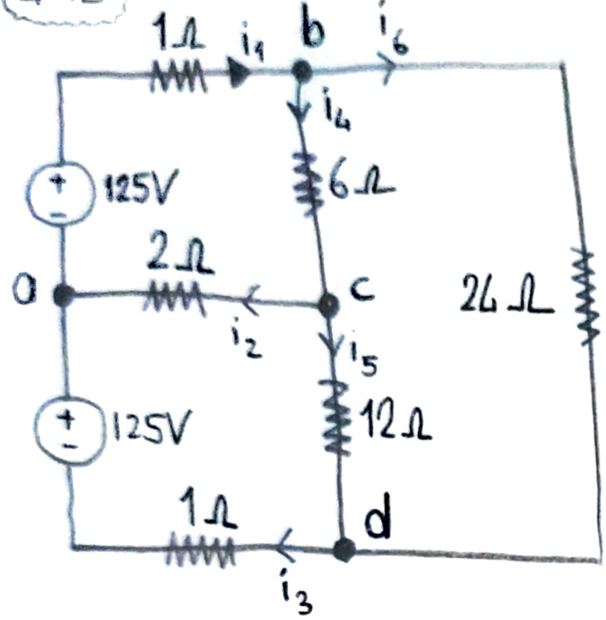
$V_2 = 20V$



Question 4.12
1
100V
+
-
2
20V
+
-
4
80
144
10
3
5
GND

GEEKDAY

4.15



a) for b $\Rightarrow \dfrac{V_b-125}{1}+\dfrac{V_b-V_d}{24}+\dfrac{V_b-V_c}{6}=0$

$\Rightarrow 24V_b-3000+V_b-V_d+4V_b-4V_c=0$

$\Rightarrow 29V_b-4V_c-V_d=3000 \quad \ldots (1)$

for c $\Rightarrow \dfrac{V_c}{2}+\dfrac{V_c-V_b}{6}+\dfrac{V_c-V_d}{12}=0$

$\Rightarrow 6V_c+2V_c-2V_b+V_c-V_d=0$

$\Rightarrow 2V_b-9V_c+V_d=0 \quad \ldots (2)$

for d $\Rightarrow \dfrac{V_d-125}{1}+\dfrac{V_d-V_c}{12}+\dfrac{V_d-V_b}{24}=0$

$\Rightarrow 24V_d-3000+2V_d-2V_c+V_d-V_b=0$

$\Rightarrow V_b+2V_c-27V_d=-3000 \quad \ldots (3)$

(1) ... $29V_b-4V_c-V_d=3000$

(2) ... $2V_b-9V_c+V_d=0$

+

$31V_b-13V_c=3000 \quad \ldots (x)$

(2) ... $54V_b-243V_c+27V_d=0$

(3) ... $V_b+2V_c-27V_d=-3000$

+

$55V_b-241V_c=-3000 \quad \ldots (y)$

$x+y = 86V_b-254V_c=0 \Rightarrow \dfrac{V_b \cdot 43}{127}=V_c$

$V_b = 101V$ (rounded)

$V_c = 11V$ (rounded) for easy calculation

$V_d = -107V$ (rounded)

$$i_1 = \frac{125 - V_b}{1} = \frac{125 - 101}{1} = 24A$$

$$i_2 = \frac{V_c}{2} = \frac{11}{2} = 5{,}5A$$

$$i_3 = \frac{V_d - (-125)}{1} = \frac{-107 + 125}{1} = 18V$$

$$i_4 = \frac{V_b - V_c}{6} = \frac{101 - 11}{6} = 15V$$

$$i_5 = \frac{V_c - V_d}{12} = \frac{11 - (-107)}{12} = \frac{118}{12} = 9{.}8V$$

$$i_6 = \frac{V_b - V_d}{24} = \frac{101 - (-107)}{24} = \frac{208}{24} = 8{.}7V$$

b) $p = V_1 . i_1 + V_3 . i_3$ (developed)

$$= 125 . 24 + 125 . 18$$

$$= 3000 + 2250$$

$$= 5250W$$

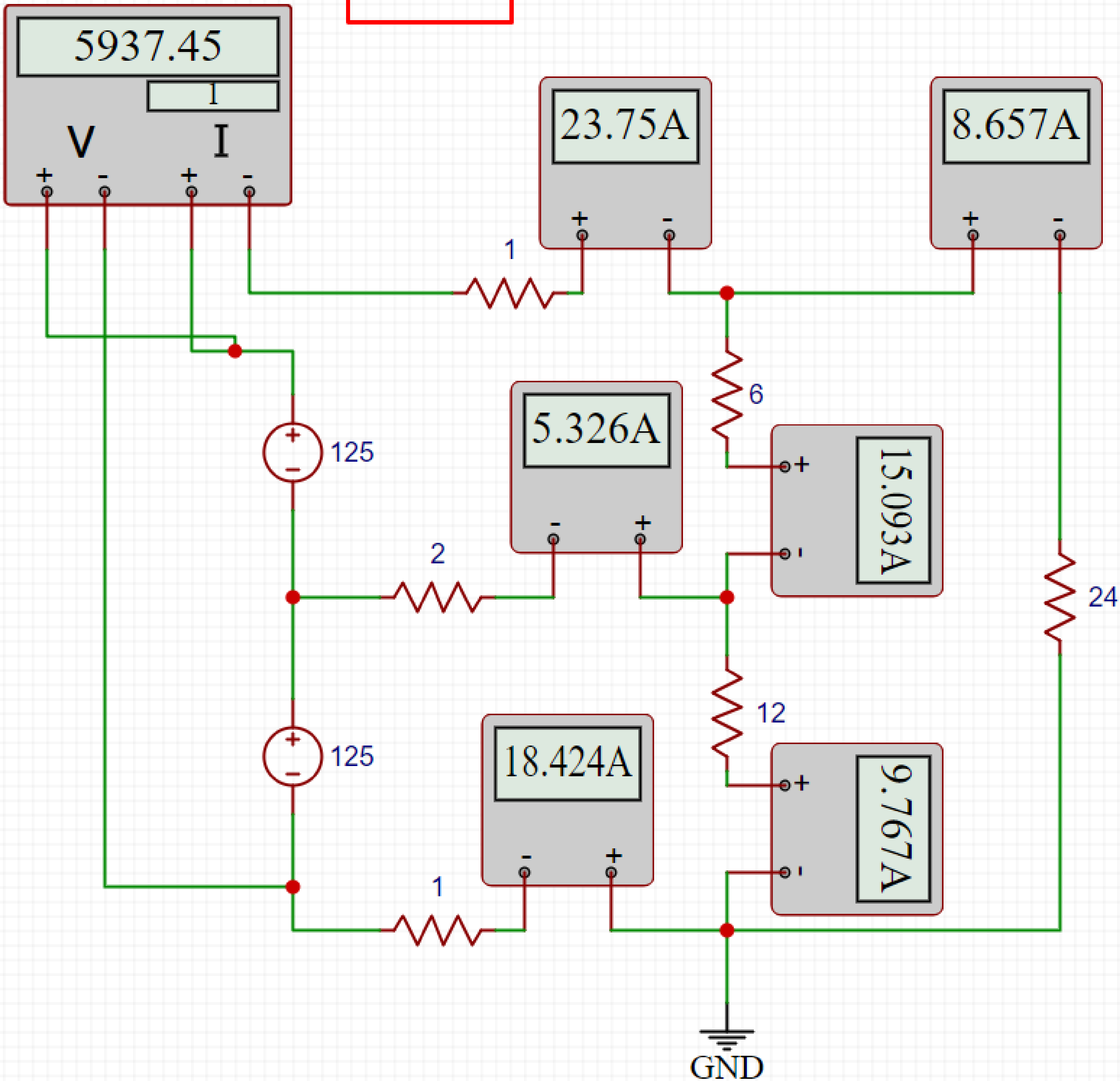
$$p = (R_1 . i_1) . i_1 + (R_2 . i_2) . i_2 + \dots + (R_6 . i_6) . i_6$$

$$= 24^2 + 11 . (5{,}5) + 18^2 + 90 . 15 + 118 . (9{,}8) + 208 . (8{,}7)$$

$$= 576 + 60{,}5 + 324 + 1350 + 1158 + 1802$$

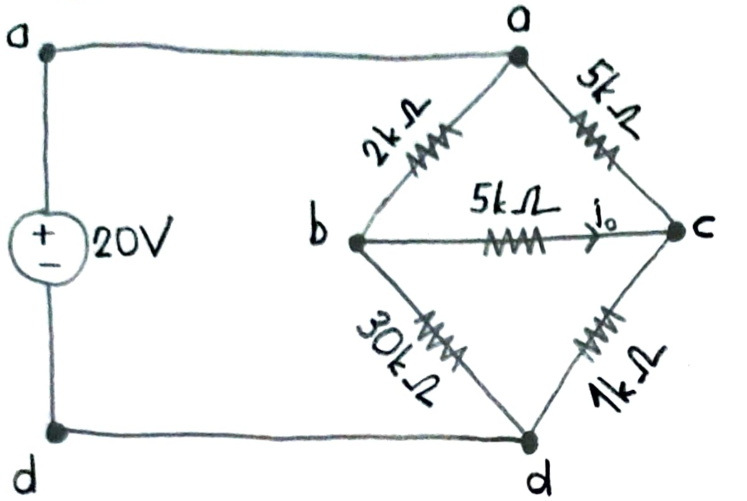
$$= 5250W$$

Question 4.15



GEEKDAY

4.24



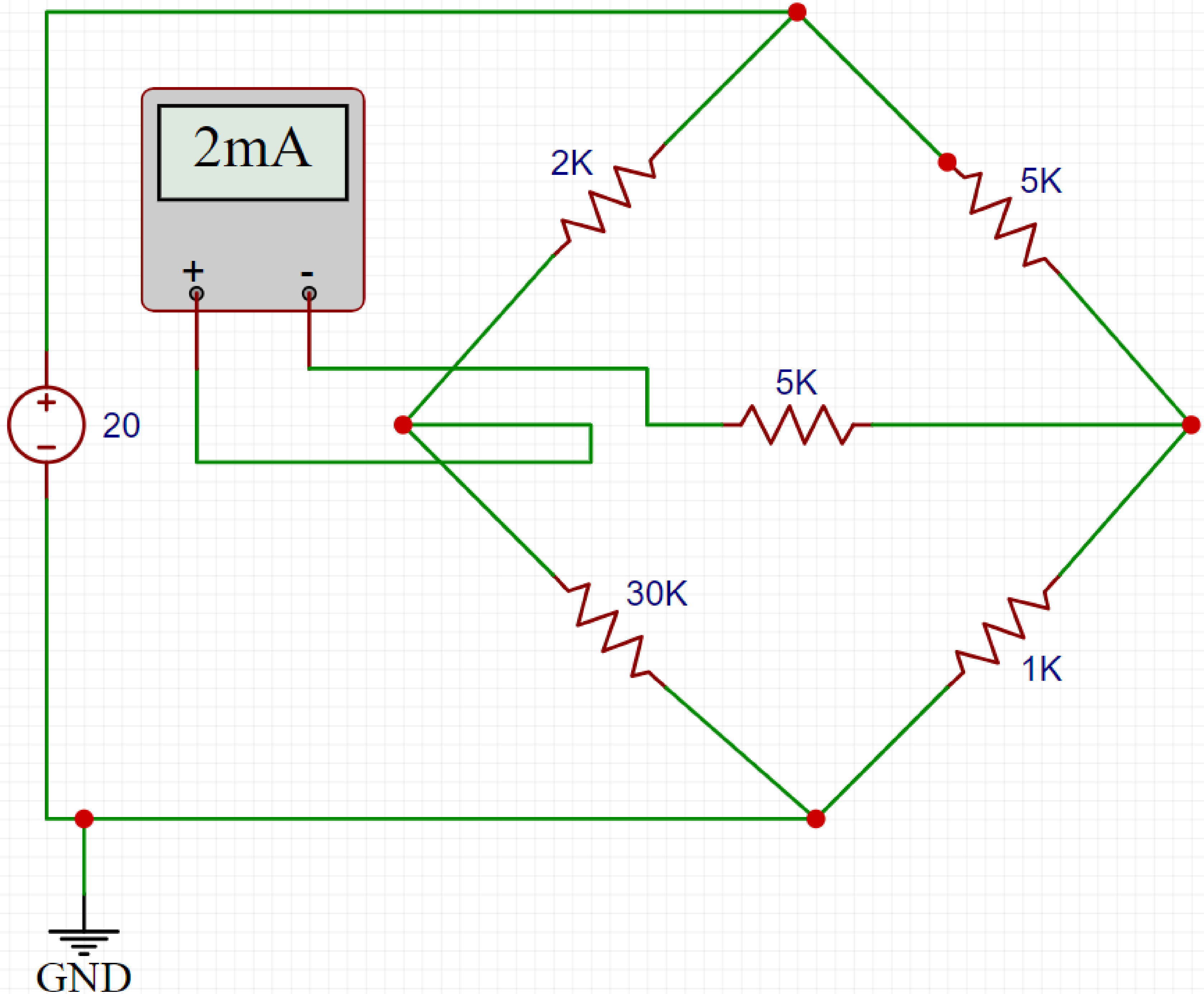
$$* \text{ for } b \Rightarrow \frac{V_b-20}{2k}+\frac{V_b-V_c}{5k}+\frac{V_b}{30k}=0 \Big\} \; 11V_b-3V_c=150 \quad (\times 7)$$

$$* \text{ for } c \Rightarrow \frac{V_c-20}{5k}+\frac{V_c-V_b}{5k}+\frac{V_c}{1k}=0 \Big\} \; 7V_c-V_b=20 \quad (\times 3)$$

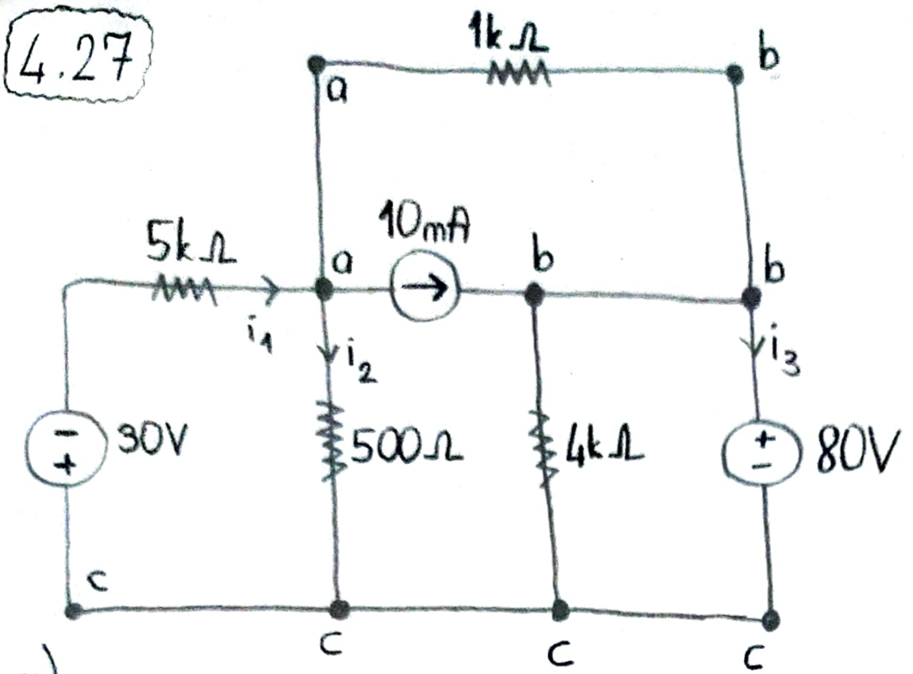
$$* \left.\begin{array}{l} 77V_b-21V_c=1050 \\ 21V_c-3V_b=60 \end{array}\right\} \; 74V_b=1110 \; \left\} \begin{array}{l} V_b=15V \\ V_c=5V \end{array}\right.$$

$$* \; i_o=\frac{V_b-V_c}{R}=\frac{15-5}{5k}=2mA$$

Question 4.24



4.27



a)

* for node a $\Rightarrow \frac{V_a+30}{5k} + \frac{V_a}{0{,}5k} + 0{,}01 + \frac{V_a-80}{1k} = 0 \quad (\times 5k)$

$$\Rightarrow 16V_a = 320 \,, \quad V_a = 20V$$

* $i_1 = -\frac{20+30}{5k} = -0{,}01A = -10mA$

* $i_2 = \frac{20}{0{,}5k} = 0{,}04A = 40mA$

* $i_3 = \frac{20-80}{1k} + 0{,}01 - \frac{80}{4k} = -0{,}07A = -70mA$

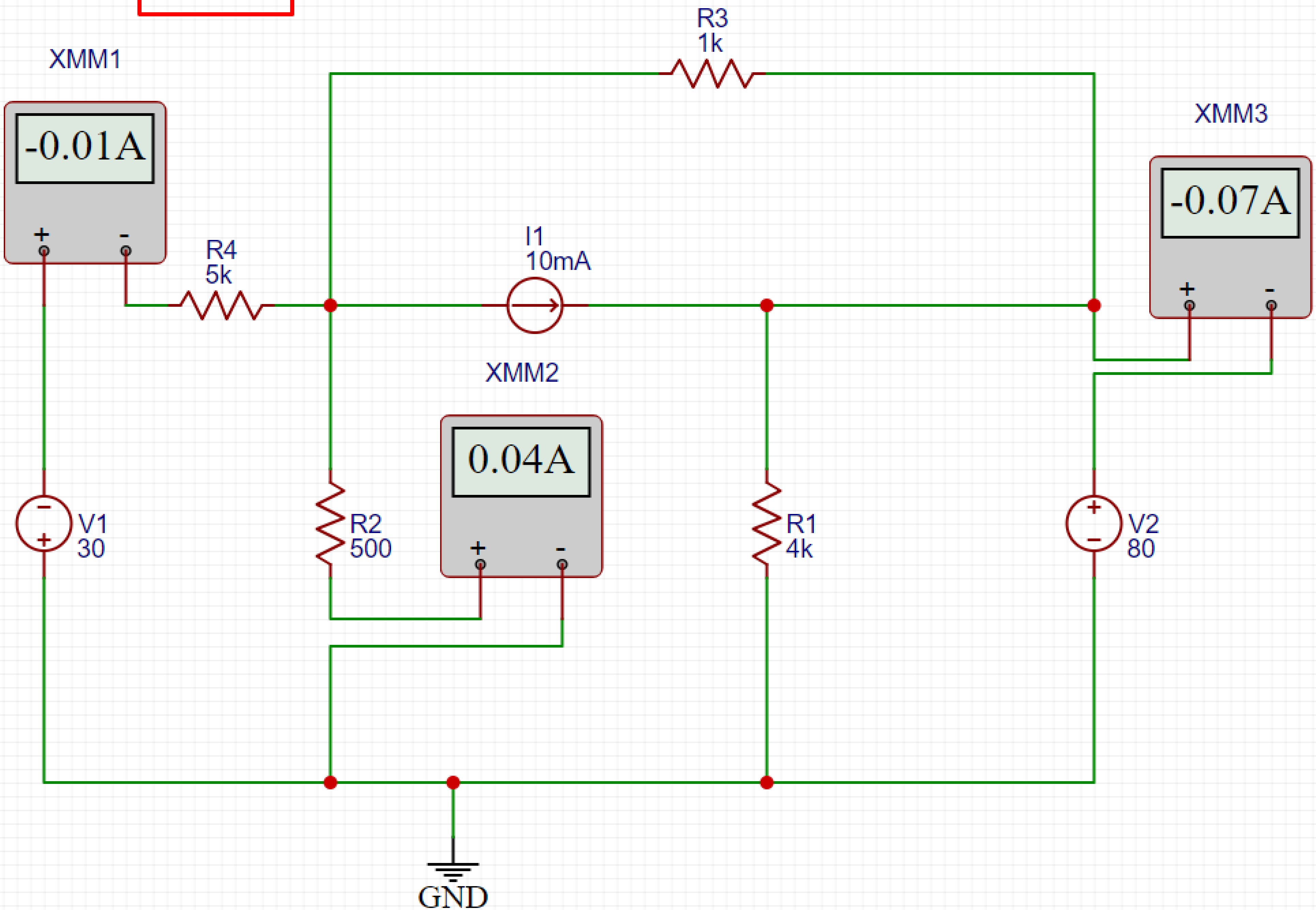
b) developed power $\Rightarrow p = 30V.(-i_1) + 80V.(-i_3) + 60V.(10mA)$

$$= 0{,}3 + 5{,}6 + 0{,}6$$
$$= 6{,}5W$$

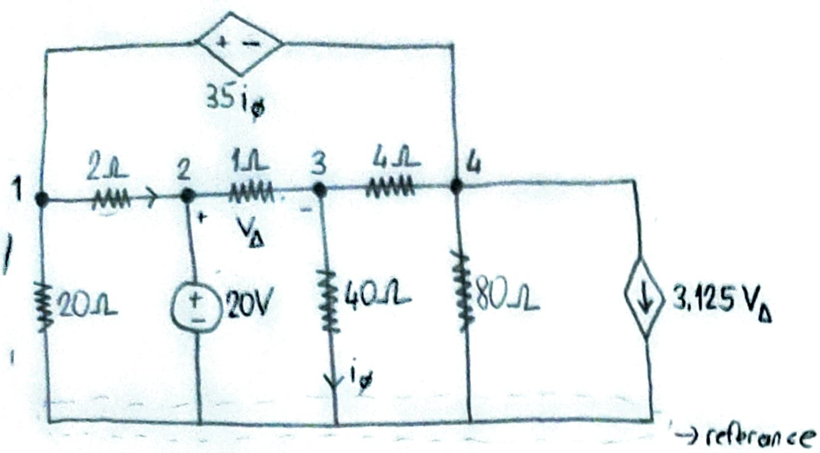
consumed power $\Rightarrow p = (i_1^2 . 5k) + (i_2^2 . 0{,}5k) + \left(\frac{80}{4k}\right)^2 . 4k + \left(\frac{60}{1k}\right)^2 . 1k$

$$= 6{,}5W$$

Question 4.27



4.30



* 1 and 4 nodes are supernode.
* $V_1 - V_4 = 35 i_\phi$ .... ①

* $V_2 = 20V$ .... ②
* $V_3 = 20 - V_\Delta$ .... ③

* node-voltage method for node 3

$$\rightarrow -\frac{V_\Delta}{1} + \frac{20 - V_\Delta}{40} + \frac{20 - V_\Delta - V_4}{4} = 0 \quad (\times 40)$$

$$\rightarrow -40V_\Delta + 20 - V_\Delta + 200 - 10V_\Delta - 10V_4 = 0$$

$$\rightarrow -51V_\Delta - 10V_4 + 220 = 0 \quad .... ④$$

* node-voltage method for nodes 1 and 4 (since they are supernodes)

$$\rightarrow \frac{V_1}{20} + \frac{V_1 - 20}{2} + \frac{V_4 - (20 - V_\Delta)}{4} + \frac{V_4}{80} + 3.125V_\Delta = 0 \quad (\times 80)$$

$$\rightarrow 4V_1 + 40V_1 - 800 + 20V_4 + 20V_\Delta - 400 + V_4 + 250V_\Delta = 0$$

$$\rightarrow 44V_1 + 21V_4 + 270V_\Delta = 1200 \quad .... ⑤$$

* i_ϕ equation on node 3

$$\rightarrow \frac{20 - V_\Delta}{40} = i_\phi \rightarrow (20 - V_\Delta).35 = 40(V_1 - V_4) \rightarrow 8V_1 - 8V_4 + 7V_\Delta = 140 \quad .... ⑥$$

* unknowns $\rightarrow V_\Delta, V_1, V_4$ equation $\rightarrow$ ④, ⑤, ⑥

$$x = \begin{bmatrix} 0 & -10 & -51 \\ 44 & 21 & 270 \\ 8 & -8 & 7 \end{bmatrix} \quad y = \begin{bmatrix} -220 \\ 1200 \\ 140 \end{bmatrix} \quad A = \begin{bmatrix} V_1 \\ V_4 \\ V_\Delta \end{bmatrix}$$

$V_\Delta = 10V$ $\quad V_4 = -29V$

$V_1 = -20.25V$ $\quad i_\phi = 0{,}25A$

* power developed by 20V

$\rightarrow p = V.i$ where $V = 20$

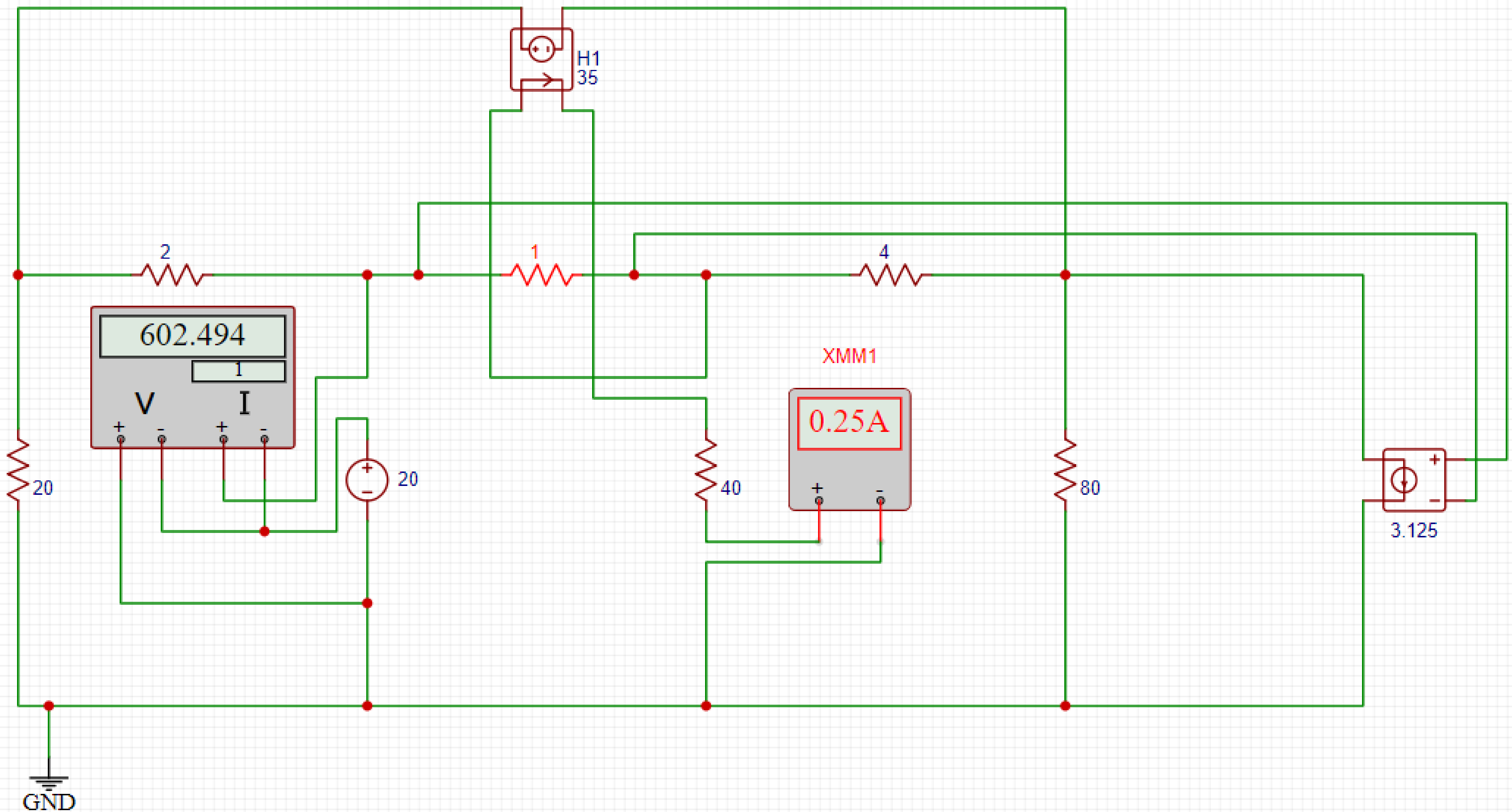
$$i = \frac{V_2 - V_1}{2} + \frac{V_\Delta}{1}$$

$$= \frac{20 + 20.25}{2} + 10$$

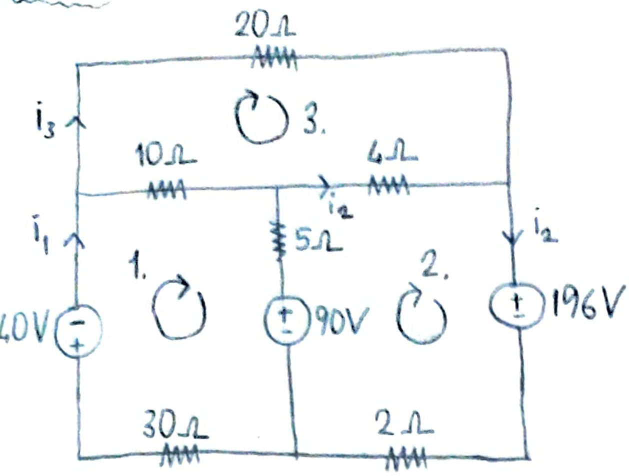
$$= 30.125A$$

$$\boxed{\rightarrow p = 20.(30.125) = 602.5W}$$

Question 4.30



4.36



a) 2748W developed

b) $P_{dev} = P_{dis}$

for mesh 1 (KVL)

$* \; -40 + 10(i_1 - i_3) + 5(i_1 - i_2) - 90 + 30i_1 = 0$

$-40 + 10i_1 - 10i_3 + 5i_1 - 5i_2 - 90 + 30i_1 = 0$

$45i_1 - 5i_2 - 10i_3 = 130$ ...... ①

for mesh 2 (KVL)

$* \; 90 + 5(i_2 - i_1) + 4(i_2 - i_3) - 196 + 2i_2 = 0$

$90 + 5i_2 - 5i_1 + 4i_2 - 4i_3 - 196 + 2i_2 = 0$

$-5i_1 + 11i_2 - 4i_3 = +106$ ..... ②

for mesh 3 (KVL)

$* \; 10(i_3 - i_1) + 20i_3 + 4(i_3 - i_2) = 0$

$10i_3 - 10i_1 + 20i_3 + 4i_3 - 4i_2 = 0$

$-10i_1 - 4i_2 + 34i_3 = 0$ .... ③

matris

$$\begin{bmatrix} 45 & -5 & -10 \\ -5 & 11 & -4 \\ -10 & -4 & +34 \end{bmatrix} = x \; , \; y = \begin{bmatrix} 130 \\ 106 \\ 0 \end{bmatrix} \; , \; A = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix}$$

$i_1 = 5A$

$i_2 = 13A$

$i_3 = 3A$

power

for -40V

$P = V_1 . i_1$ $\quad V_1 = -40V$

$i_1 = 5A$

$P = -40.5$

$= -200W$ (developed power)

for -90V

$P = V . i$ $\quad i = i_1 - i_2$

$= 5 - 13$

$= -8A$

$= -90.(-8)$

$= +720W$ (absorbs power)

for -192V

$P = V.i$ $\quad V = -192$

$i = 13A$

$= (-192).13$

$= -2548$ (developed power)

total developed

$200 + 2548 = 2748W$

total dissipated

$i_1^2 . 30 = 750W$

$(i_1 - i_3)^2 . 10 = 40W$

$(i_1 - i_2)^2 . 5 = 64.5 = 320W$

$(i_2 - i_3)^2 . 4 = 100.4 = 400W$

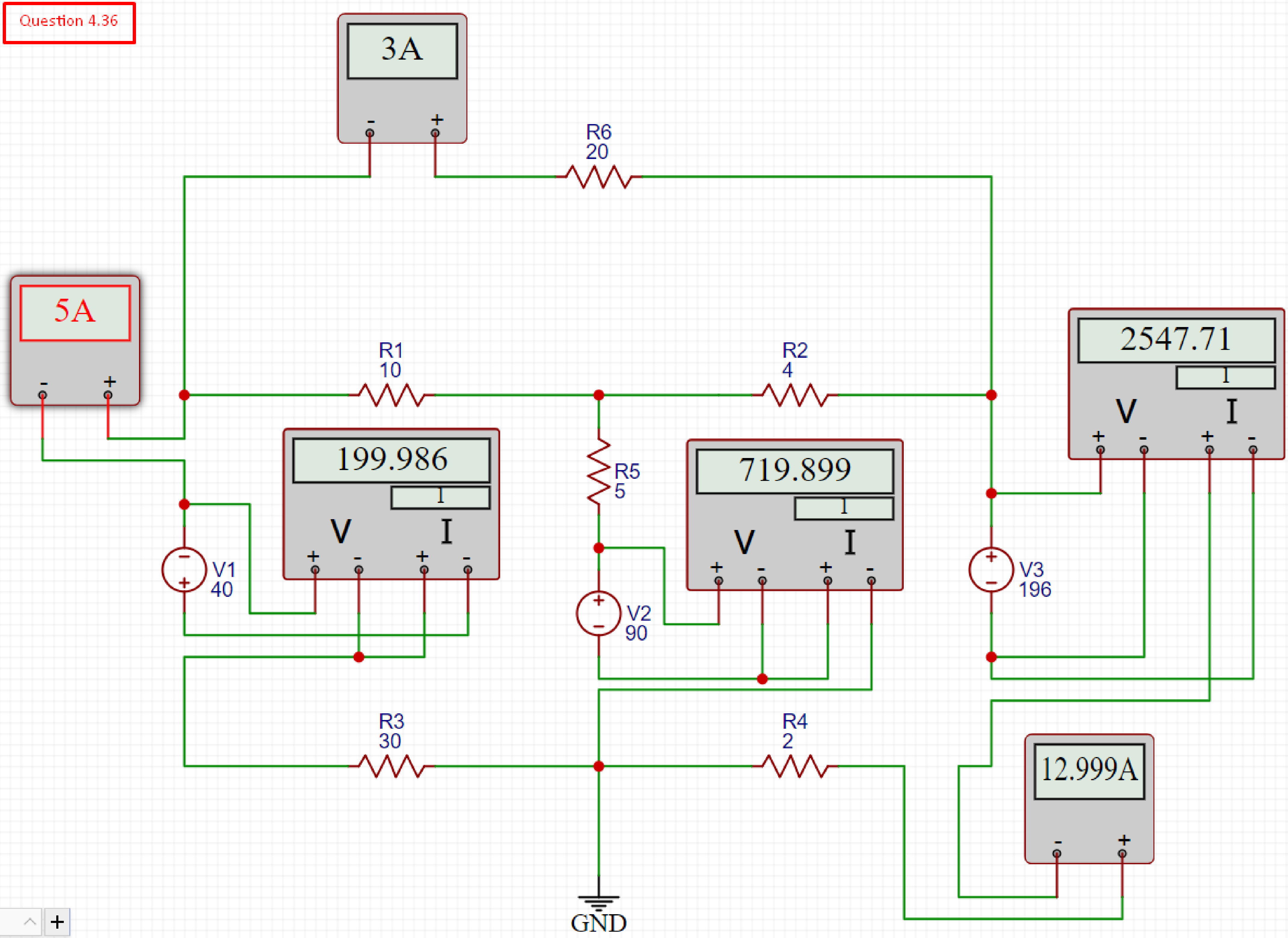
$i_3^2 . 20 = 9.20 = 180W$

$i_2^2 . 2 = 169.2 = 338W$

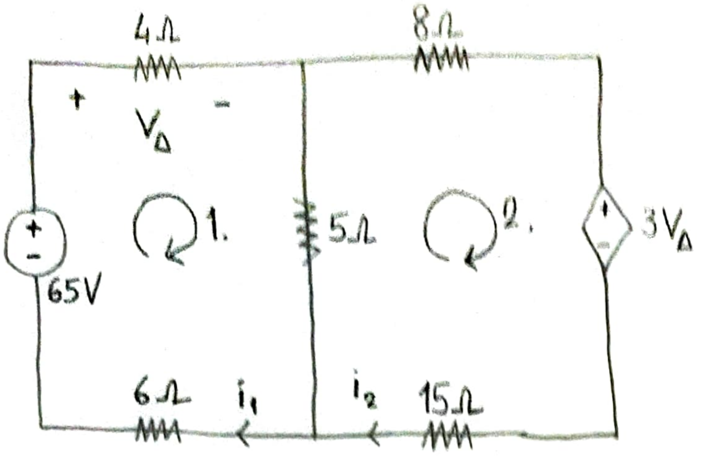
$90.(i_1 - i_2) = 90.8 = 720W$

2748W dissipated

Question 4.36



4.39



for mesh 1 (KVL)

$* \; 65 - V_\Delta + (i_1 - i_2).5 + 6i_1 = 0$

$65 - V_\Delta + 5i_1 - 5i_2 + 6i_1 = 0$

$11i_1 - 5i_2 - V_\Delta = -65 \; .... (1)$

for mesh 2 (KVL)

$* \; 5(i_2 - i_1) + 8i_2 - 3V_\Delta + 15i_2 = 0$

$5i_2 - 5i_1 + 8i_2 - 3V_\Delta + 15i_2 = 0$

$-5i_1 + 28i_2 - 3V_\Delta = 0 \; ..... (2)$

V_Δ equation

$-V_\Delta = R.i_1$

$-V_\Delta = 4.i_1$

equation (1) and (2)

$* \; 11i_1 - 5i_2 - V_\Delta = -65$

$11i_1 - 5i_2 + 4i_1 = -65$

$15i_1 - 5i_2 = -65 \; (x4)$

$60i_1 - 20i_2 = -260$

$5i_1 + 20i_2 = 0$

+

$65i_1 = -260$

$i_1 = -4A$

$* \; -5i_1 + 28i_2 - 3V_\Delta = 0$

$-5i_1 + 28i_2 + 12i_1 = 0$

$7i_1 + 28i_2 = 0$

$i_1 + 4i_2 = 0 \; (x5)$

$i_1 = -4A$

$i_2 = 1A$

power dissipated in the 15Ω resistor

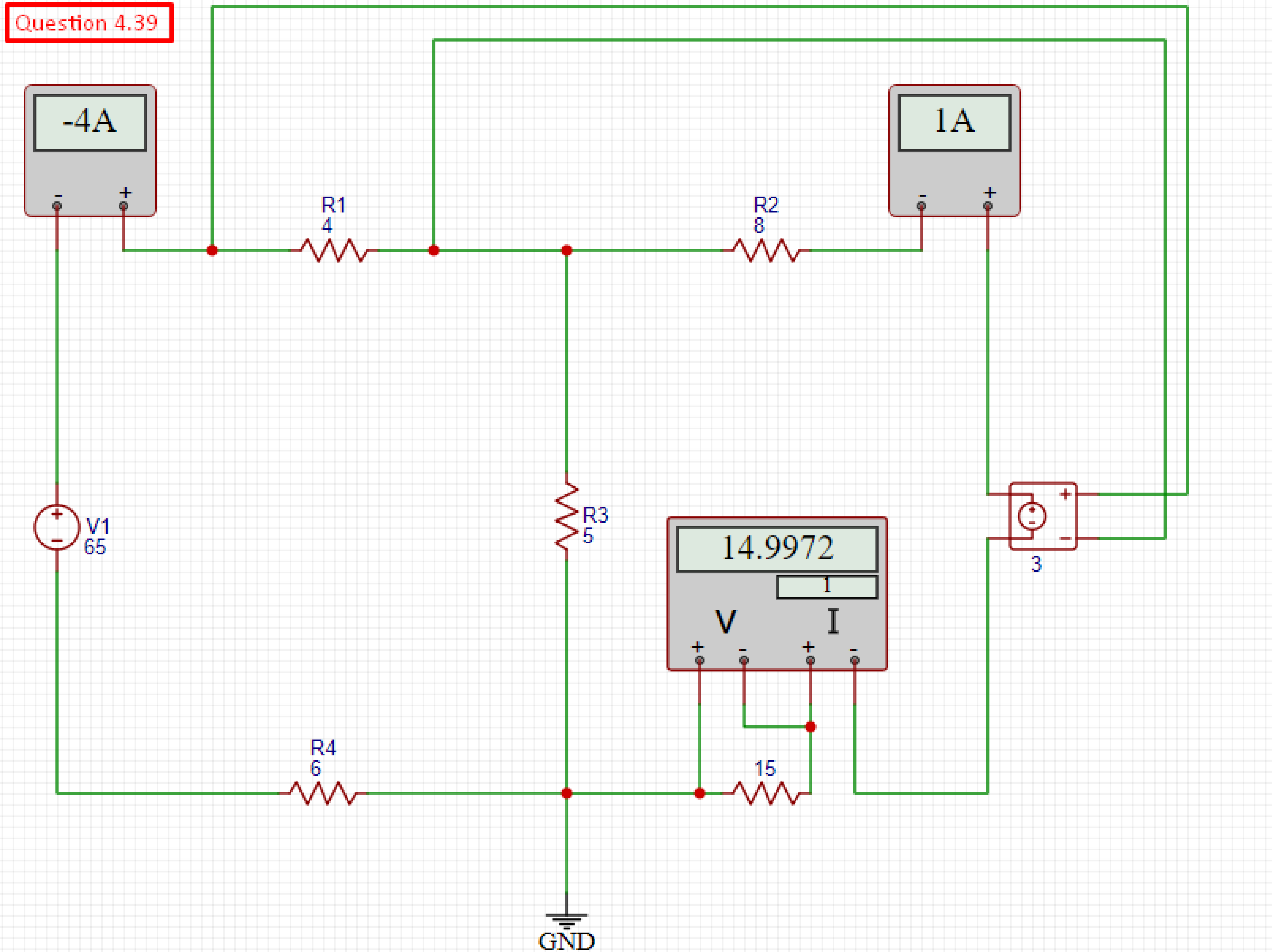
$p = V.i = i.R.i = i^2.R$

$= (1)^2.15$

$p = 15W$ dissipated

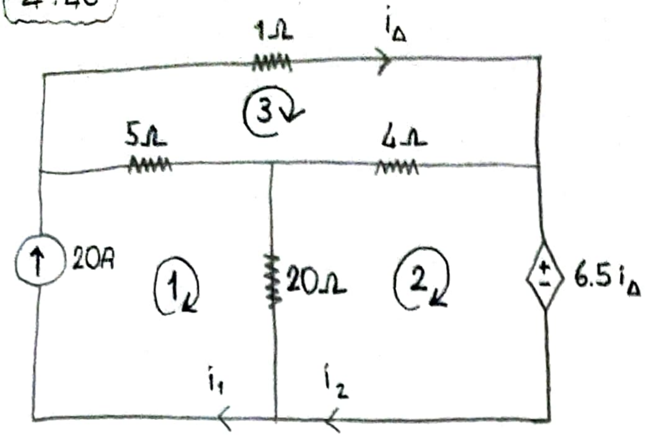
$R = 15\Omega$

$i = i_2 = 1A$



Question 4.39
-4A
1A
R1
4
R2
8
R3
5
V1
65
R4
6
15
3
14.9972
1
V
I
GND

4.46



for mesh 1

$i_1 = 20A$

for mesh 2

$* 20(i_2-20) + 4(i_2-i_\Delta) + 6.5i_\Delta = 0$

$20i_2 - 400 + 4i_2 + 2.5i_\Delta = 0$

$24i_2 + 2.5i_\Delta = 400$ ....(1)

for mesh 3

$* 5(i_\Delta - 20) + i_\Delta + 4(i_\Delta - i_2) = 0$

$5i_\Delta - 100 + i_\Delta + 4i_\Delta - 4i_2 = 0$

$-4i_2 + 10i_\Delta = 100$ ......(2)

equations (1) and (2)

$* 24i_2 + 2.5i_\Delta = 400$

$-4i_2 + 10i_\Delta = 100 \quad (\times 6)$

$* 24i_2 + 2.5i_\Delta = 400$

$-24i_2 + 60i_\Delta = 600$

$+$

$62.5i_\Delta = 1000$

$i_\Delta = 16A$

$i_1 = 20A$

$i_2 = 15A$

$i_\Delta = 16A$

total power developed in the circuit

for 20A (KVL)

$* -V + 5.4 + 20(20-i_2) = 0$

$-V + 20 + 400 - 20.15 = 0$

$-V + 420 - 300 = 0$

$V =$

$* p = V.i$

$= -120.20$

$\boxed{= -2400W \text{ developed}}$

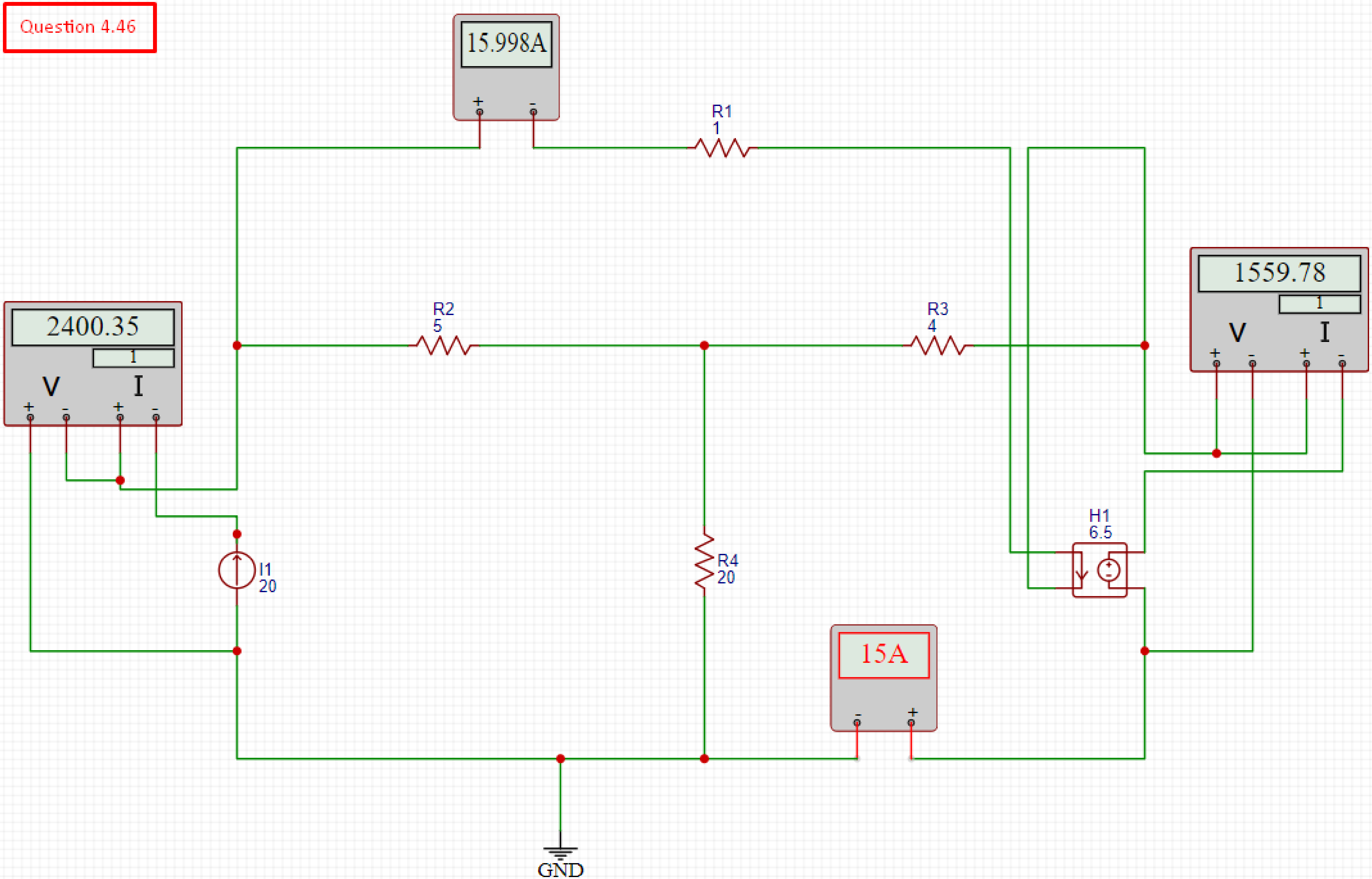
for $6.5i_\Delta$

$* p = V.i$ $\quad V = 6.5.16 = 104$

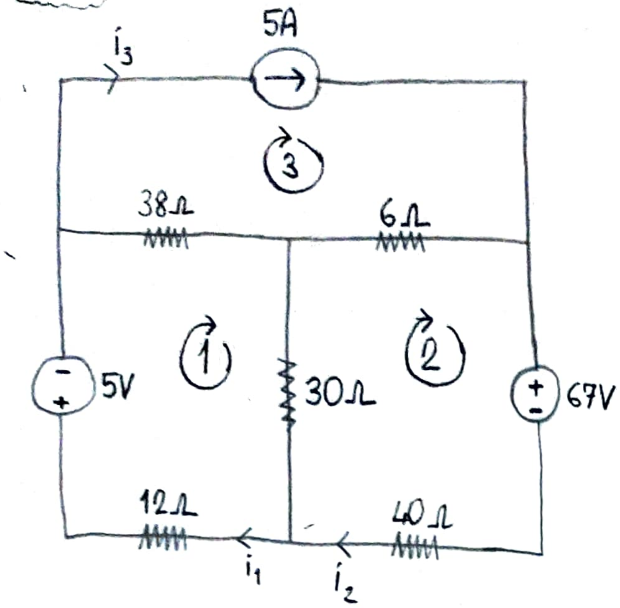
$p = 104.15$ $\quad i = 15A$

$= 1560W$ consumed

Question 4.46



4.47



For mesh 1

* $+5 + 38(i_1 - 5) + 30(i_1 - i_2) + 12i_1 = 0$

$+5 + 38i_1 - 190 + 30i_1 - 30i_2 + 12i_1 = 0$

$80i_1 - 30i_2 = 185$ ..... (1) $(\times 3)$

For mesh 2

* $30(i_2 - i_1) + 6(i_2 - 5) + 67 + 40i_2 = 0$

$30i_2 - 30i_1 + 6i_2 - 30 + 67 + 40i_2 = 0$

$-30i_1 + 76i_2 = -37$ ...... (2) $(\times 8)$

equation (1) and (2)

* $240i_1 - 90i_2 = 555$

$-240i_1 + 608i_2 = -296$

$+$

$518i_2 = 259$

$i_2 = 0{,}5A$

* $i_1 = 2{,}5A$

$i_2 = 0{,}5A$ //

voltage of 5A current source (KVL)

$-V_x + 6(5 - i_2) + 38(5 - i_1) = 0$

$-V_x + 6(4{,}5) + 38(2{,}5) = 0$

$V_x = 27 + 95$

$V_x = 122V$ //

a) $p = -V_x \cdot i$ $\qquad V_x = 122V$

$\qquad i = 5A$

$p = -122.5$

$= -610W$ (delivers)

b) $P_1 = 5.(2{,}5)$

$= 12{,}5W$ (absorbs)

$P_2 = 67.(0{,}5)$

$= 33{,}5\ W$ (absorbs)

$P_3 = -122{,}5$

$= -610W$ (delivers)

total power delivered to the circuit

c) $P_1 + P_2 + 38(2{,}5)^2 + 12(2{,}5)^2 + 30(2)^2 + 40(0{,}5)^2 + 6(4{,}5)^2$

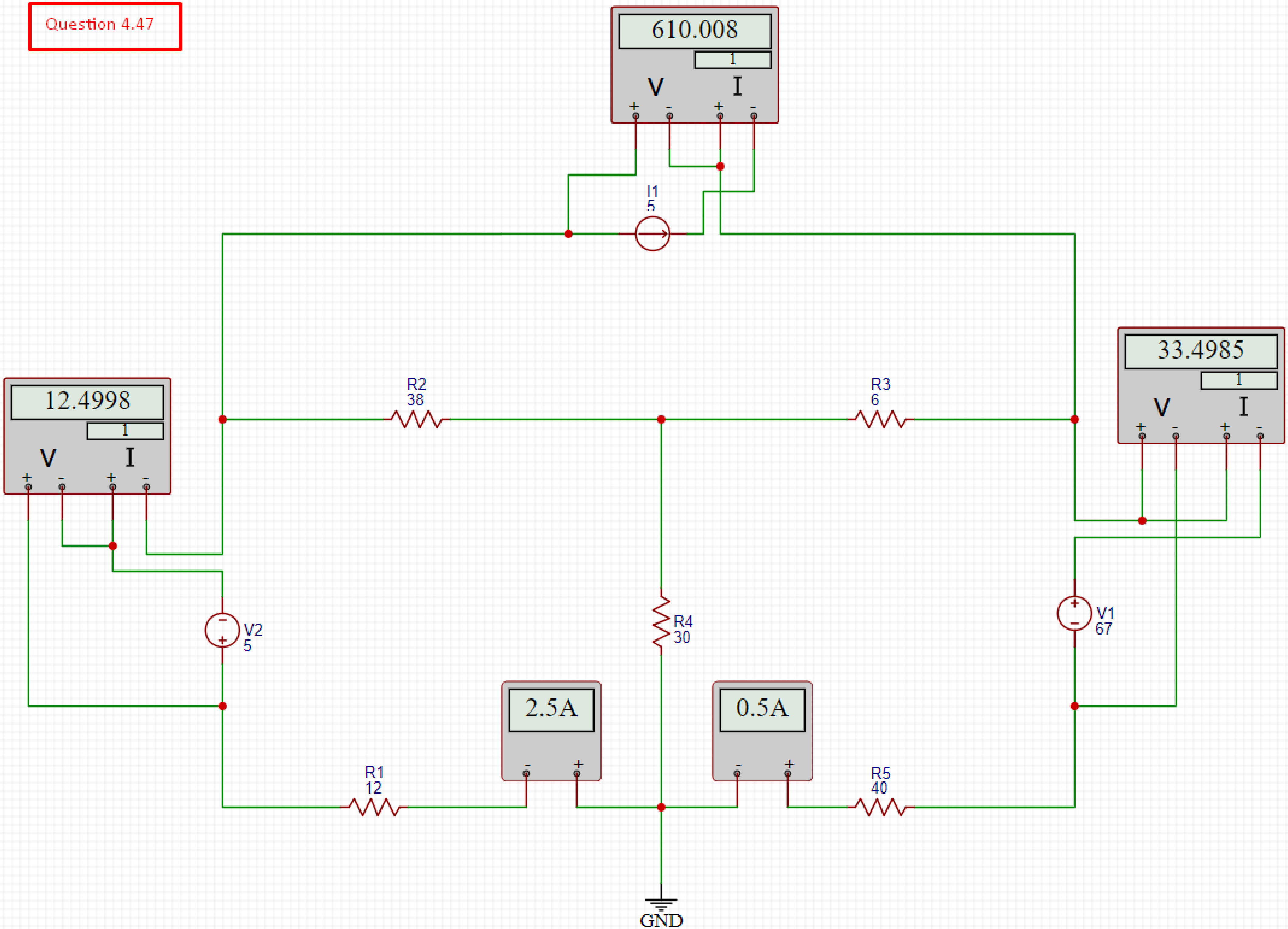
$\underbrace{(12{,}5) + (33{,}5) + (237.5) + 75 + 120 + 10 + 121{,}5}$ $= P_{dis}$

$P_{diss} = 610W$

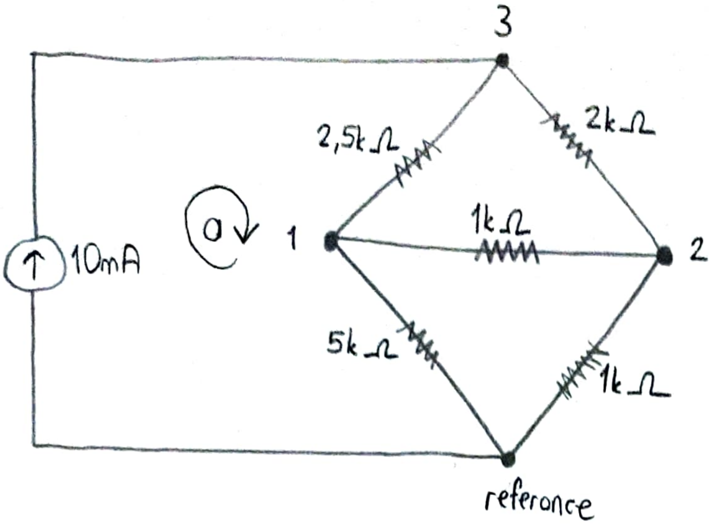
$) =$

$P_{dev} = 610W$

Question 4.47



4.54



a) I would recommend node-voltage method since it is easy to write equations rather than mesh-current method in this kind of questions.

b) for node 1 (KCL)

$$* \frac{V_1 - V_3}{2{,}5k} + \frac{V_1 - V_2}{1k} + \frac{V_1}{5k} = 0 \quad (\times 5k)$$

$$2V_1 - 2V_3 + 5V_1 - 5V_2 + V_1 = 0$$

$$8V_1 - 5V_2 - 2V_3 = 0 \quad \ldots\ldots (1)$$

for node 2 (KCL)

$$* \frac{V_2 - V_3}{2k} + \frac{V_2 - V_1}{1k} + \frac{V_2}{1k} = 0 \quad (\times 2k)$$

$$V_2 - V_3 + 2V_2 - 2V_1 + 2V_2 = 0$$

$$-2V_1 + 5V_2 - V_3 = 0 \quad \ldots\ldots (2)$$

for node 3

$$* -10mA + \frac{V_3 - V_1}{2{.}5k} + \frac{V_3 - V_2}{2k} = 0 \quad (\times 10k)$$

$$-100 + 4V_3 - 4V_1 + 5V_3 - 5V_2 = 0$$

$$-4V_1 - 5V_2 + 9V_3 = 100 \quad \ldots\ldots (3)$$

metris

$$\begin{bmatrix} 8 & -5 & -2 \\ -2 & +5 & -1 \\ -4 & -5 & +9 \end{bmatrix} = x, \quad y = \begin{bmatrix} 0 \\ 0 \\ 100 \end{bmatrix}, \quad A = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} \Rightarrow \begin{aligned} V_1 &= 10V \\ V_2 &= 8V \\ V_3 &= 20V \end{aligned}$$

power dissipated in 1k Ω

$$p = V.i \qquad V = V_1 - V_2 = 10 - 8 = 2V$$

$$p = 2.2mA \qquad i = \frac{V}{R} = \frac{2}{1k} = 2mW.$$

$$= 4mW$$

c) yes, I would change since I take the bottom node of the circuit as a referance. I would've need to write an equation for that but since I know the voltage values applying mesh-current method is a lot easier,

d) for mesh a

$$-V_a + (V_3 - V_1) + (V_1) = 0$$

$$V_a = (20 - 10) + (10)$$

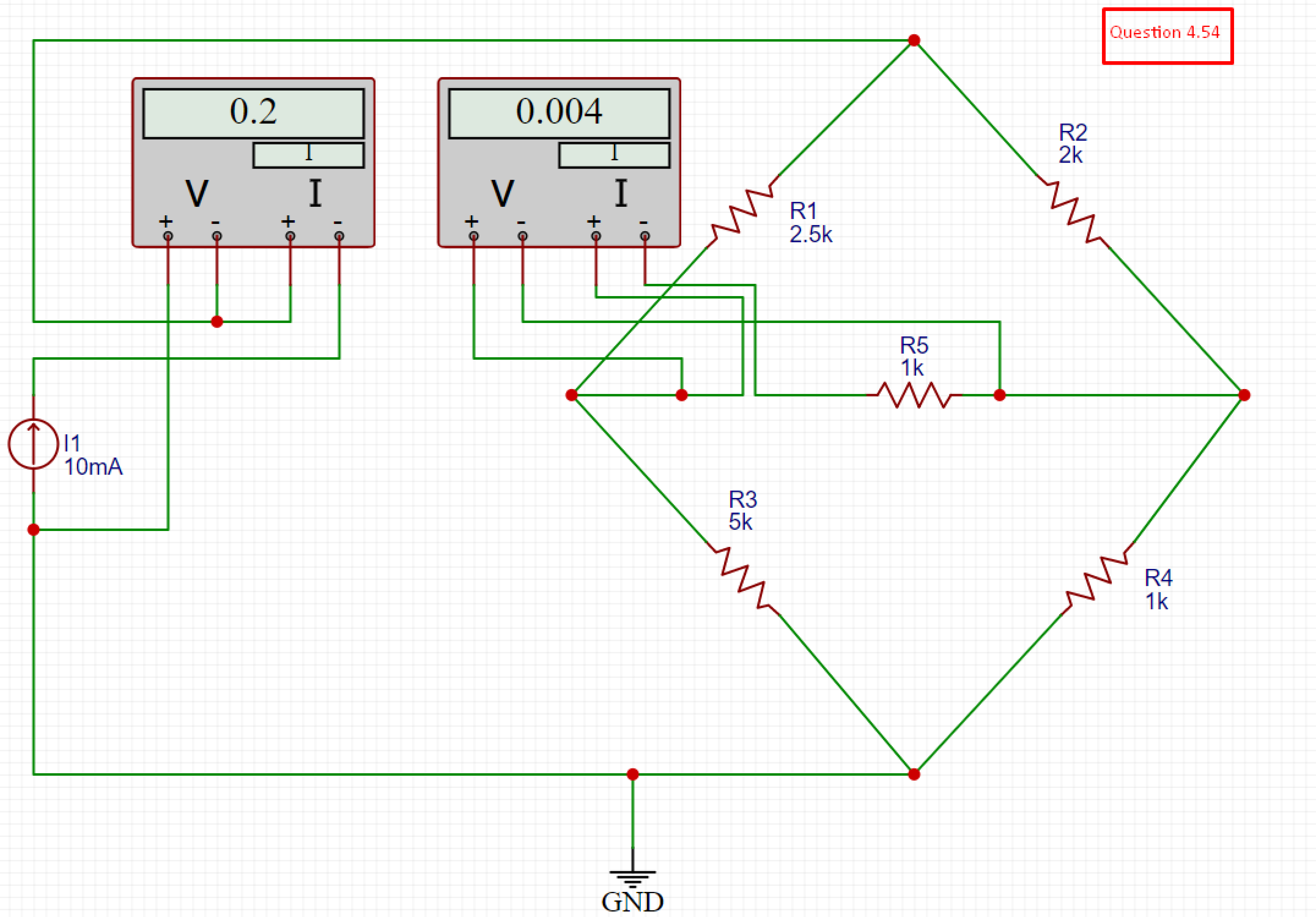
$$V_a = 20V$$

power delivered by 10mA current source

$$p = V.i \qquad V = 20$$

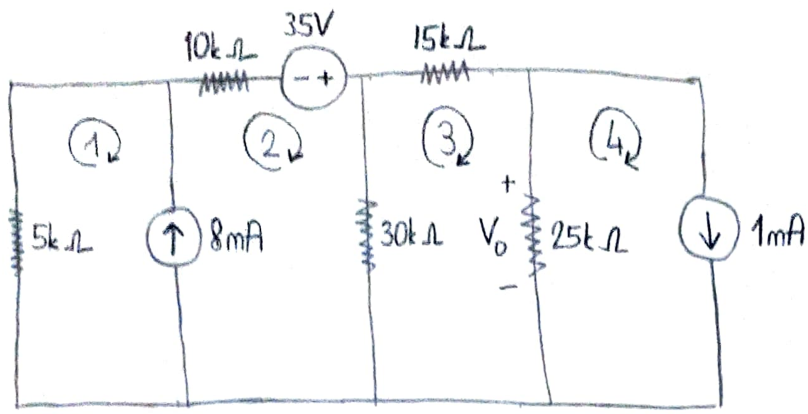
$$= 20.10mA \qquad i = 10mA$$

$$= 200mW = 0{,}2W$$



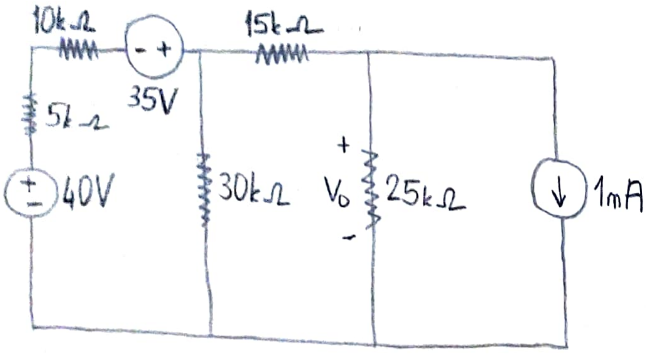
Question 4.54
0.2
V
I
+
-
+
-
0.004
V
I
+
-
+
-
R1
2.5k
R2
2k
R5
1k
R3
5k
R4
1k
I1
10mA
GND

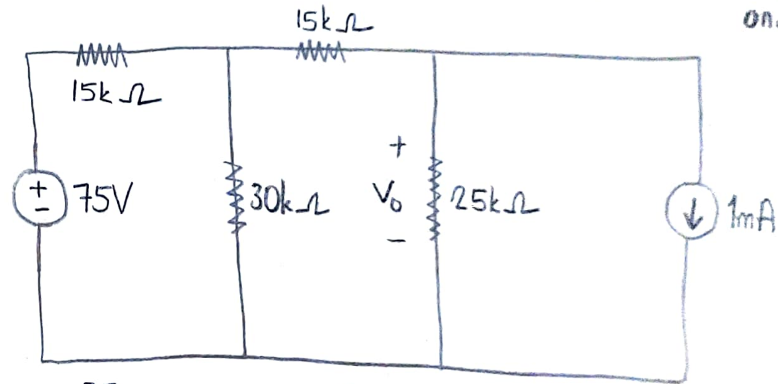
(4.59)



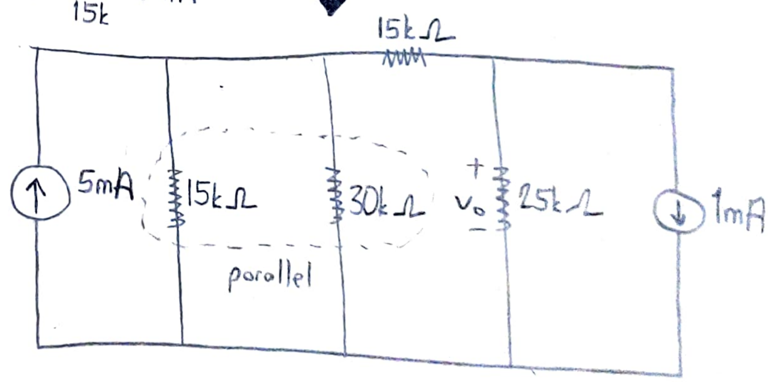
a)

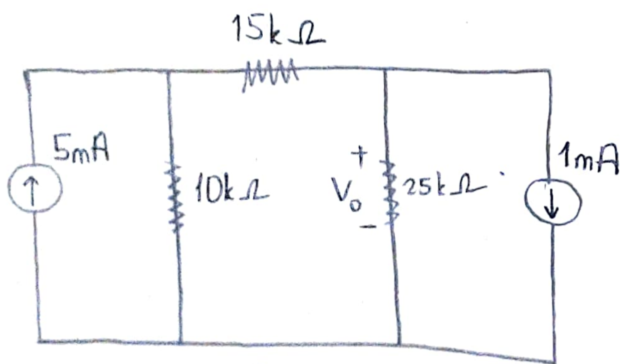
* We can transform 5kΩ resistor and and 8mA current source to a voltage source since they are parallel. And so on...

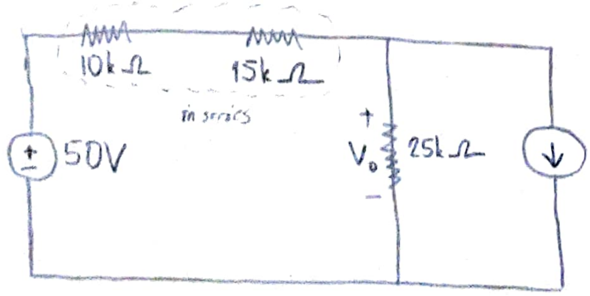


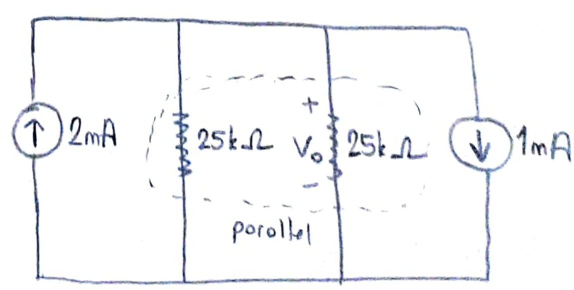


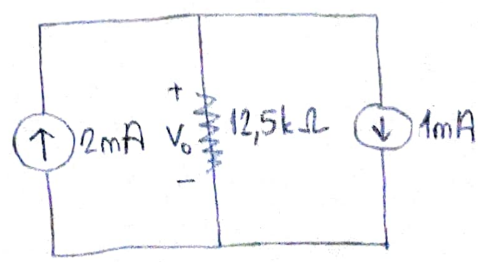
* $i = \frac{75}{15k} = 5mA$











$R = 12{,}5k\Omega$

$i = (2mA - 1mA)$
$= 1mA$

$V_o = R \cdot i$

$V_o = 12{,}5k \cdot 1mA$

$V_o = 12{,}5V$

GEEKDAY

b) for mesh 1-2 (super mesh)

$* \; 5k(i_1) + 10k(i_2) - 35 + 30k(i_2 - i_3) = 0$

$5k(i_1) + 40k(i_2) - 30k(i_3) = 35$

$1k(i_1) + 8k(i_2) - 6k(i_3) = 7 \; \ldots\ldots \; 1$

$* \; i_2 - i_1 = 8mA \; \ldots\ldots \; 2$

for mesh 3

$* \; 30k(i_3 - i_2) + 15k(i_3) + 25k(i_3 - 1mA) = 0$

$0 - 30k(i_2) + 70k(i_3) = 25 \; \ldots\ldots \; 3$

matris

$$\begin{bmatrix} 1k & 8k & -6k \\ -1k & 1k & 0 \\ 0 & -30k & 70k \end{bmatrix} = X \;,\; y = \begin{bmatrix} 7 \\ 8 \\ 25 \end{bmatrix} \;,\; A = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} \;,\; \begin{matrix} i_1 = -5{,}33mA \\ i_2 = 2{,}67mA \\ i_3 = 1{,}5mA \end{matrix}$$

answer

$* \; V_o = R.i$ $\qquad R = 25k\Omega$

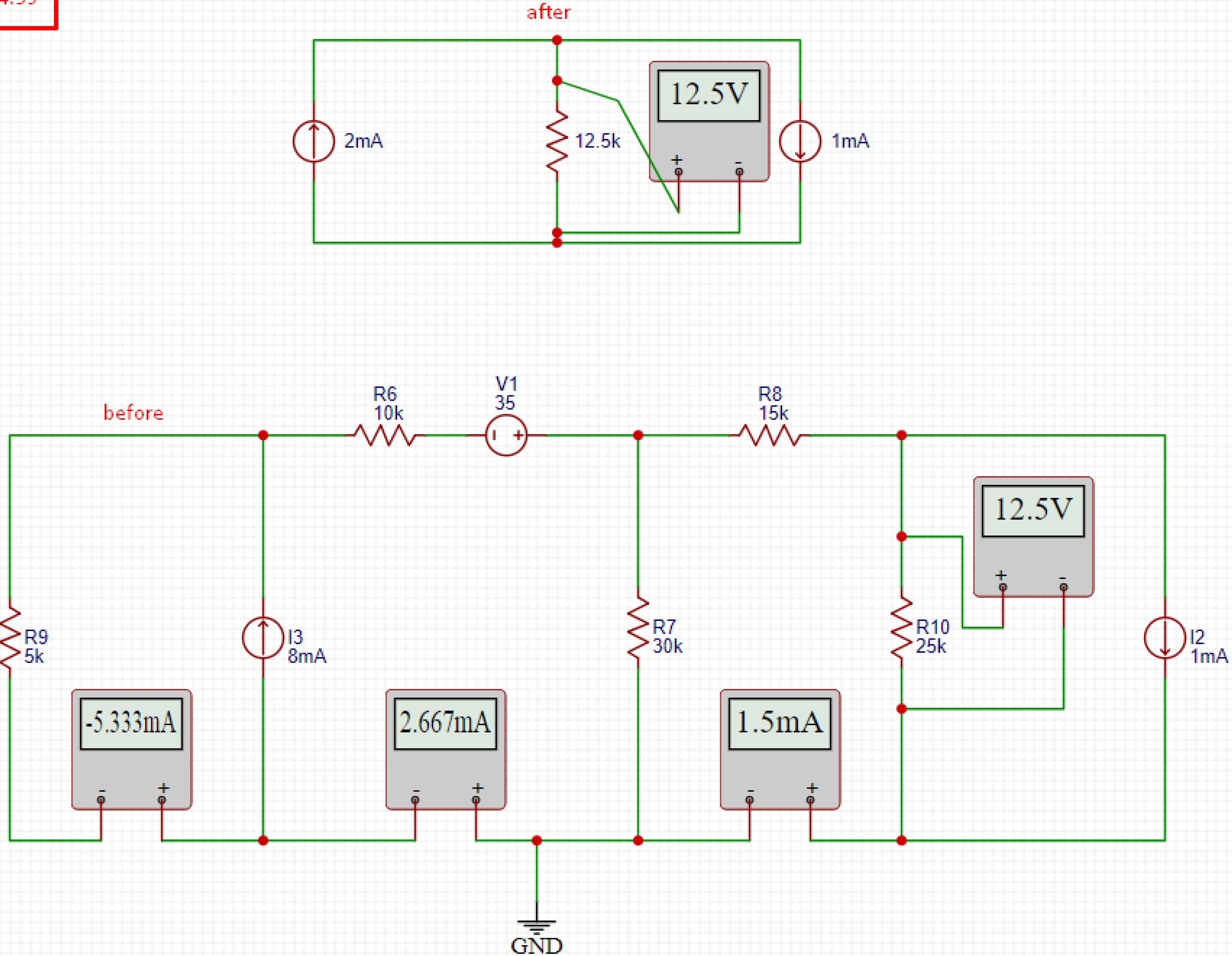
$V_o = 25k \cdot \frac{1}{2} mA$ $\qquad i = i_3 - 1mA$

$\boxed{V_o = 12{,}5V}$

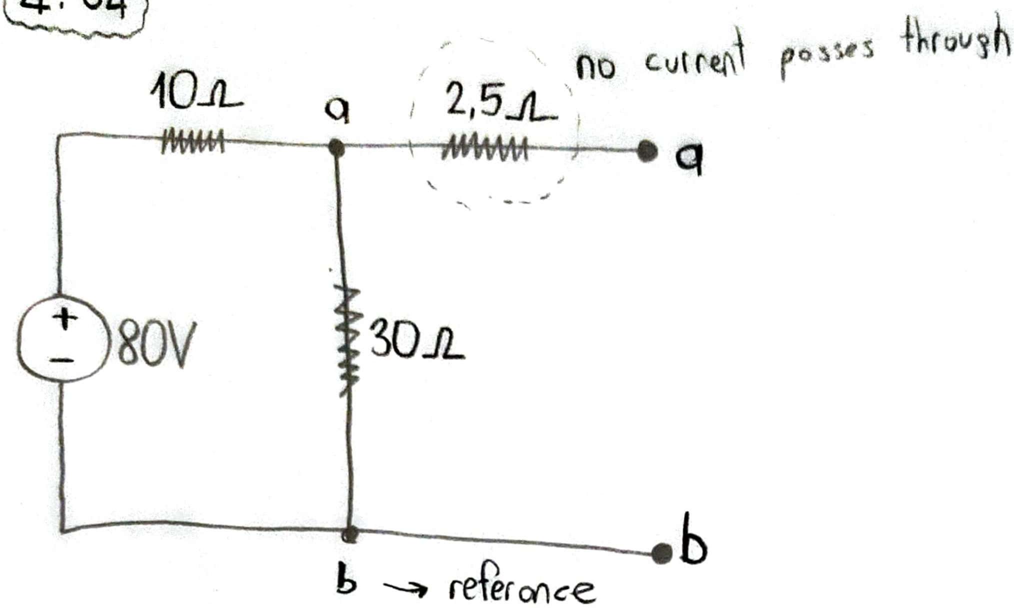
$= 1{,}5 - 1$

$= 0{,}5mA$

Question 4.59



4.64



for node a (KCL)

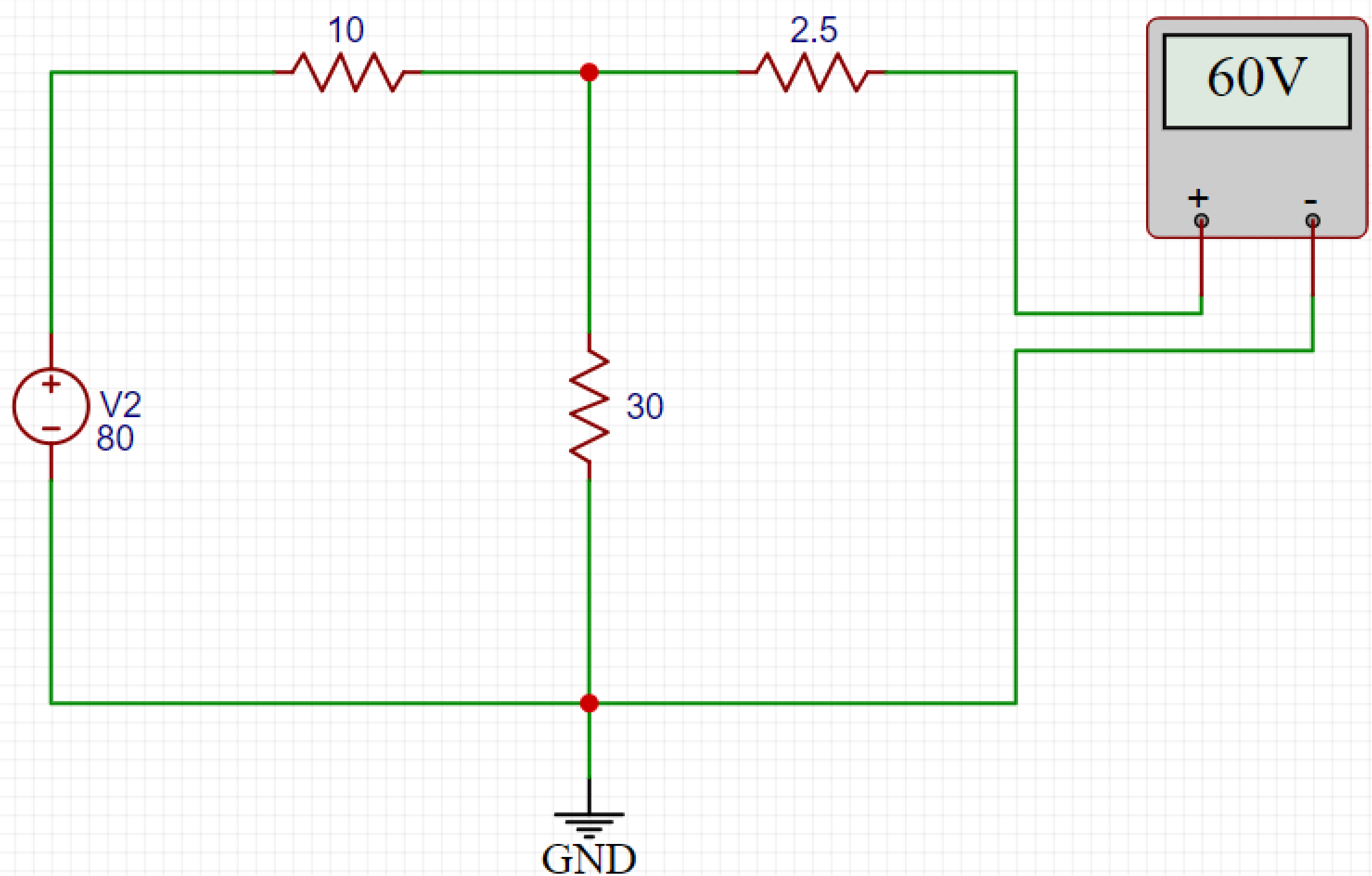
$$* \quad \frac{V_a - 80}{10} + \frac{V_a}{30} = 0 \quad (\times 30)$$

$$3V_a - 240 + V_a = 0$$

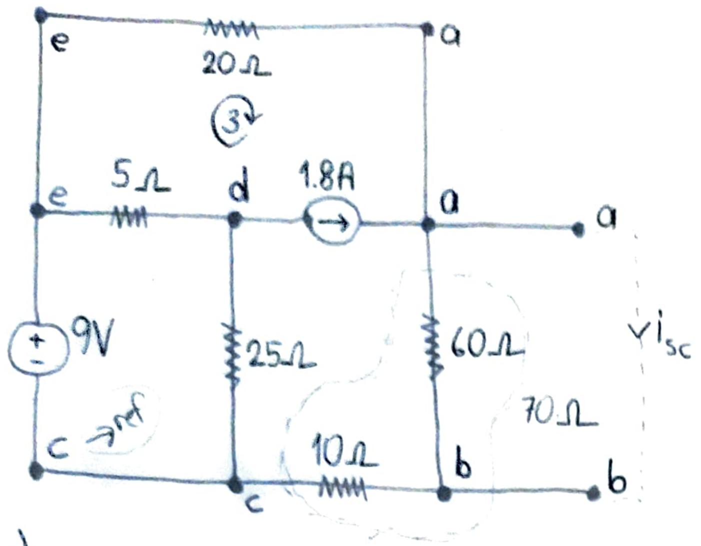
$$4V_a = 240$$

$$V_a = 60V$$

Question 4.64



4.78



a)

for node a (KCL)

$$* \quad \frac{V_a}{70} + \frac{V_a - 9}{20} - 1.8 = 0 \quad (\times 140)$$

$$2V_a + 7V_a - 63 - 252 = 0$$

$$9V_a = 315 \quad , \quad V_a = 35V$$

V_{Th}

$* \; V_{Th} = V_a - V_b$

$$* \begin{array}{cc} 70 & 35 \\ 10 & x \end{array} \Big\} \; x = 5V = V_b$$

$* \; V_{Th} = 35 - 5 = 30V$

i_{sc}

* no current flow through 60Ω.

for node a

$$\frac{V_a - 9}{20} + \frac{V_a}{10} - 1.8 = 0 \quad (\times 20)$$

$$V_a - 9 + 2V_a - 36 = 0$$

$$3V_a = 45$$

$$V_a = 15V$$

$$i_{sc} = \frac{V_a}{10} \qquad R_{Th} = \frac{V_{Th}}{i_{sc}}$$

$$i_{sc} = 1{,}5A \qquad R_{Th} = 20\Omega$$

b) after we remove independent sources 10Ω resistance and 20Ω resistance becomes connected in series. 60Ω resistance stays parallel to them. So R_{Th} is:

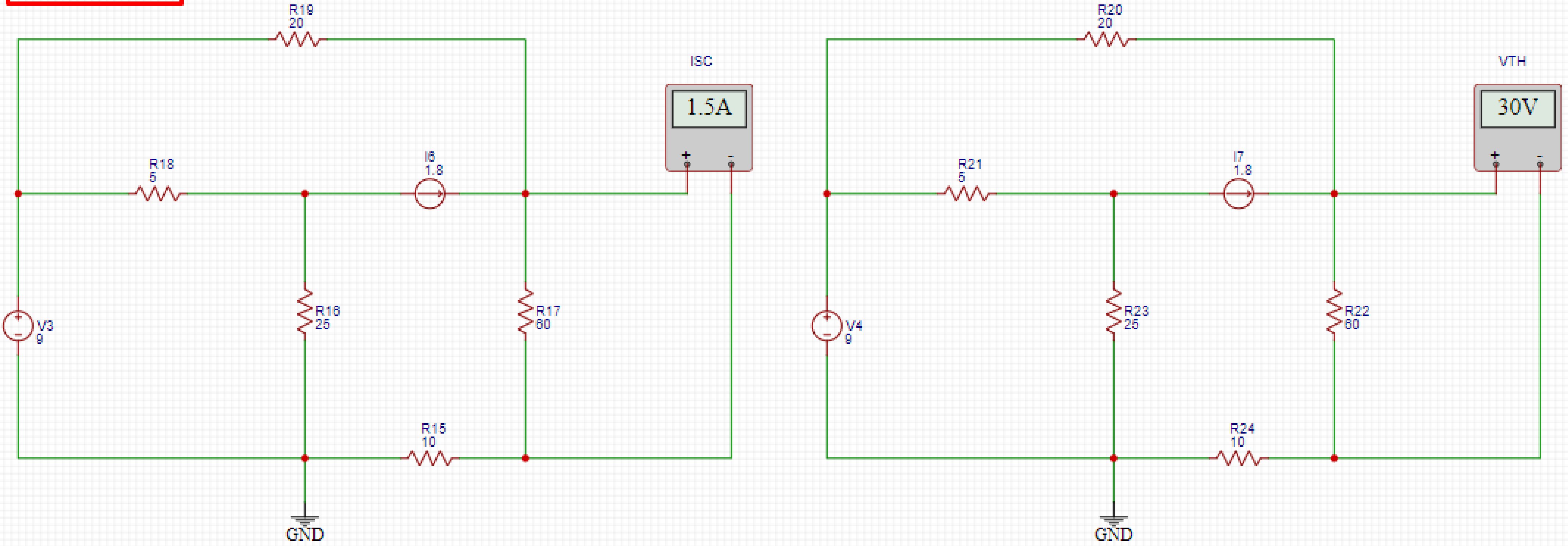
$$R_{Th} = (20 + 10 \,//\, 60)$$

$$= \frac{30.60}{30+60}$$

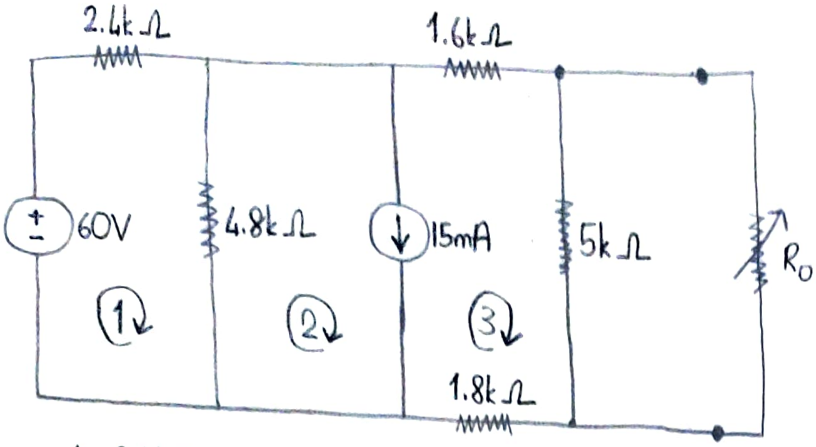
$$= \frac{30.60}{90} = 20\Omega$$

$$R_{Th} = 20\Omega$$

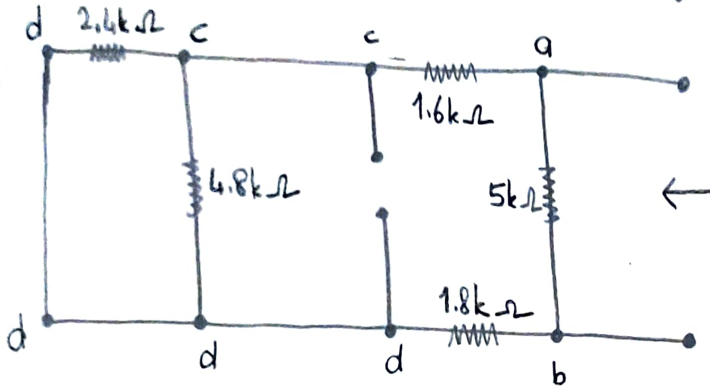
Question 4.78



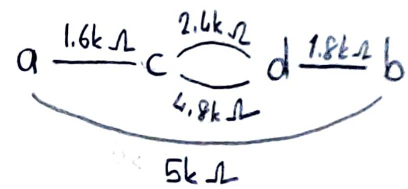
4.82

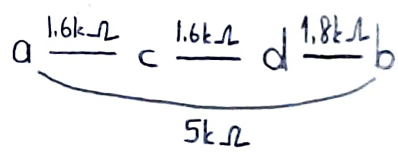


a)



* To get maximum value of R_o we need to get R_{Th}.





$\Rightarrow \frac{5k \cdot 5k}{10k} = 2{,}5$

$* R_{Th} = 2{,}5\,\Omega$

$P_{max} = 2.5k \cdot (1.6mA)^2$

$P_{max} = 6.4$ mW

b) for mesh 1

$* -60 + 2.4k(i_1) + 4.8k(i_1 - i_2) = 0$

$7{,}2k(i_1) - 4.8k(i_2) = 60 \ldots\ldots (1)$

for supermesh 2-3

$* 4.8k(i_2 - i_1) + 1.6k(i_3) + 5k(i_3) + 1.8k(i_3) = 0$

$-4.8k(i_1) + 4.8k(i_2) + 8.4k(i_3) = 0 \ldots\ldots (2)$

for 15mA source

$* i_2 - i_3 = 15mA = 0{,}015A$

matris

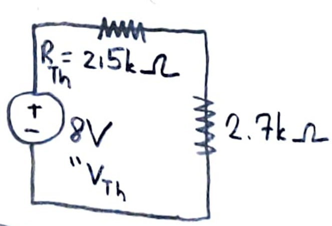
$$x = \begin{bmatrix} 7{,}2k & -4.8k & 0 \\ -4.8k & +4.8k & +8.4k \\ 0 & 1k & -1k \end{bmatrix},\ y = \begin{bmatrix} 60 \\ 0 \\ 15 \end{bmatrix},\ A = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} \Rightarrow \begin{matrix} i_1 = 19{,}4mA \\ i_2 = 16.6mA \\ i_3 = 1.6mA \end{matrix}$$

$V_{Th} = i_3 \cdot R$

$V_{Th} = 1.6mA \cdot 5k\Omega$

$V_{Th} = 8V$

c) Closest resister value $\rightarrow R_H = 2.7k\Omega$



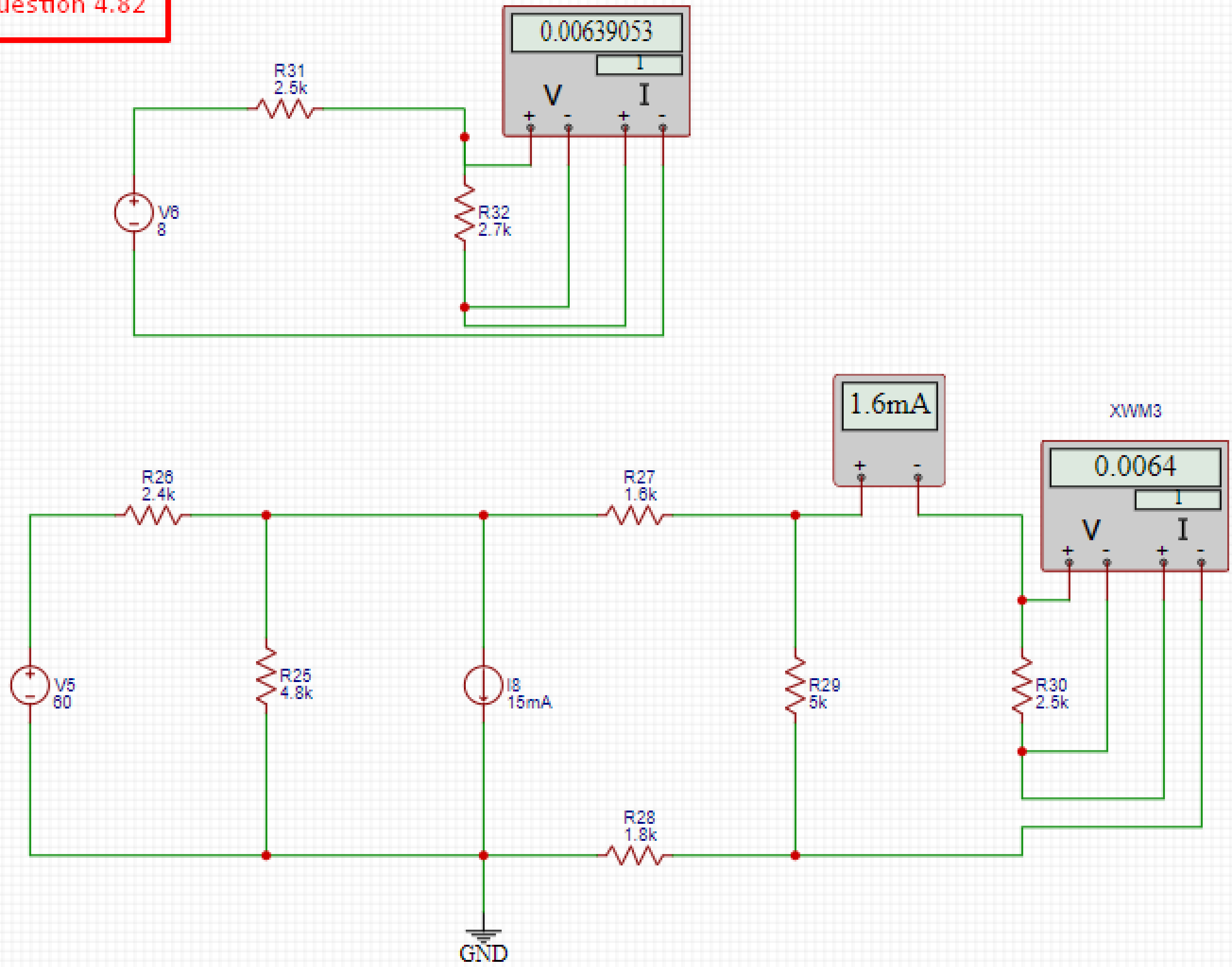
$* i_H = \frac{8V}{2.5k + 2.7k} = 1.54mA$

$* p = V \cdot i = R \cdot i^2$

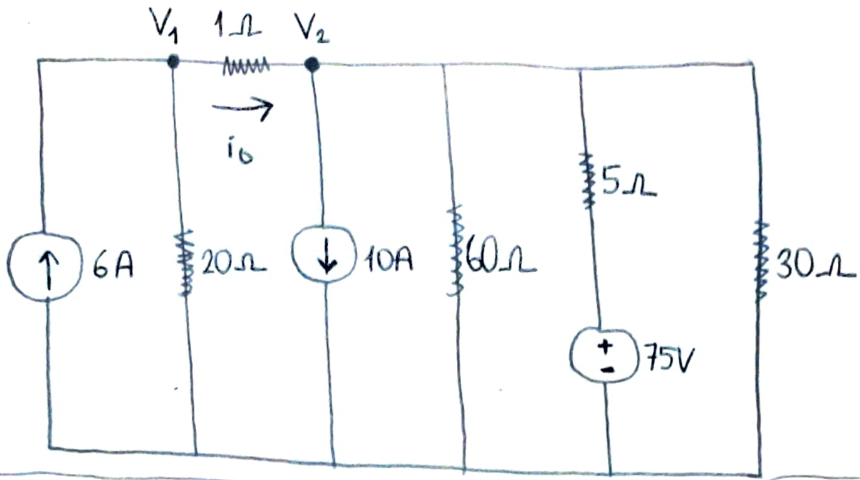
$= (2.7k) \cdot (1.54)^2$

$= 6.403$ mW

Question 4.82

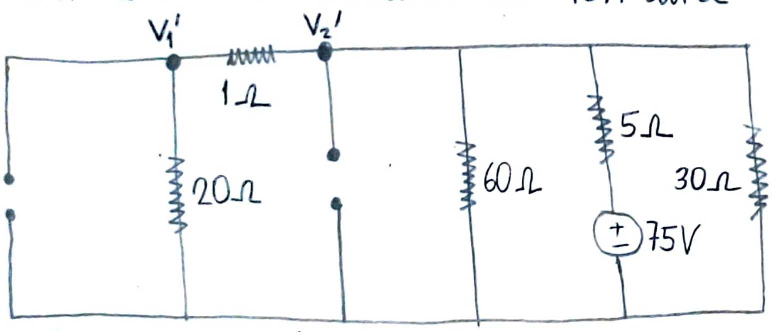


4.95



$$* \; i_0 = i_0' + i_0'' + i_0'''$$
$$= -2.4 + 1.6 + 4.8$$
$$* \; i_0 = 4A$$

* First I'll remove 6A source and 10A source



for node V_1'

$$* \; \frac{V_1'-V_2'}{1} + \frac{V_1'}{20} = 0$$

$$* \; 21V_1' - 20V_2' = 0 \ldots (1)$$

for node V_2'

$$* \; \frac{V_2'-V_1'}{1} + \frac{V_2'}{60} + \frac{V_2'-75}{5} + \frac{V_2'}{30} = 0$$

$$* \; 60V_2' - 60V_1' + V_2' + 12V_2' - 900 + 2V_2' = 0$$

$$* \; -60V_1' + 75V_2' = 900 \ldots (2)$$

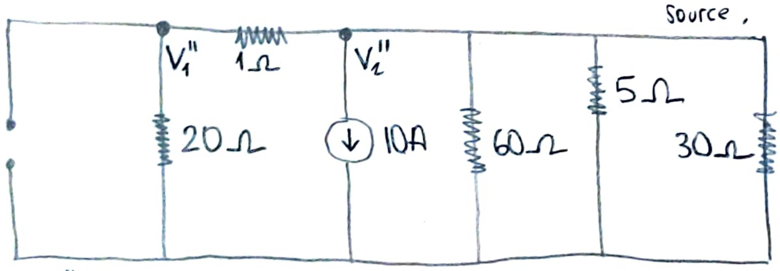
$* \; V_1' = 48V$

$V_2' = 50.4V$

$* \; i_0' = (V_1' - V_2')/R$

$= -2.4A$ //

* Second I'll remove 6A current source and 75V source,



for Node V_1''

$$* \; \frac{V_1''-V_2''}{1} + \frac{V_1''}{20} = 0 \Rightarrow 21V_1'' - 20V_2'' = 0 \ldots (1)$$

for node V_2''

$$* \; \frac{V_2''-V_1''}{1} + 10 + \frac{V_2''}{60} + \frac{V_2''}{5} + \frac{V_2''}{30} = 0$$

$$* \; 60V_2'' - 60V_1'' + 600 + V_2'' + 12V_2'' + 2V_2'' = 0$$

$$* \; -60V_1'' + 75V_2 = -600 \ldots (2)$$

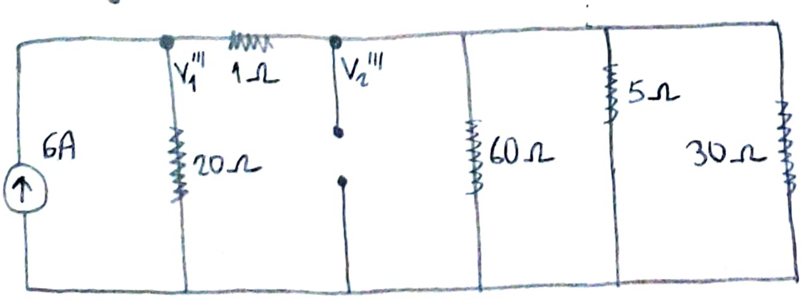
$* \; V_1'' = -32V$

$V_2'' = -33.6V$

$* \; i_0'' = (V_1'' - V_2'')/R$

$= 1.6A$ //

* Lastly I'll remove 10A source and 75V source



for node V_1'''

$$* \; \frac{V_1'''-V_2'''}{1} + \frac{V_1'''}{20} - 6 = 0 \quad (\times 20)$$

$$* \; 21V_1 - 20V_2 = 120 \ldots (1)$$

for node V_2'''

$$* \; \frac{V_2'''-V_1'''}{1} + \frac{V_2'''}{60} + \frac{V_2'''}{5} + \frac{V_2'''}{30} = 0 \quad (\times 60)$$

$$* \; -60V_1''' + 75V_2''' = 0 \ldots (2)$$

$* \; V_1''' = 24V$

$V_2''' = 19.2V$

$* \; i_0''' = (V_1''' - V_2''')/R$

$= 4.8A$ //

Question 4.95