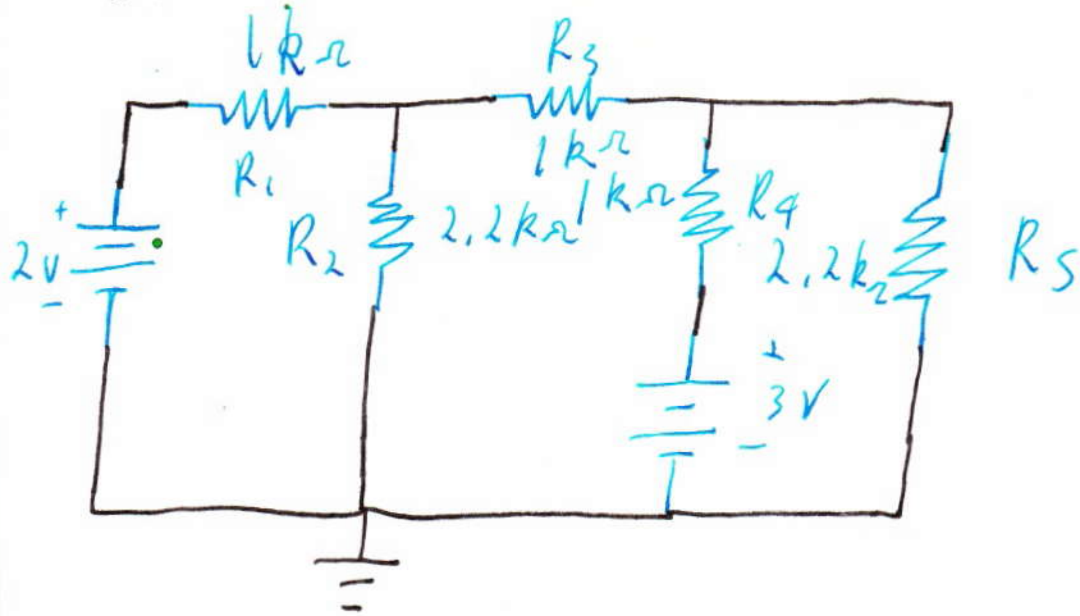
Hw # 8 CPE 1140 Bruce Liu

7) Using the superposition method, calculate the current through R_5.

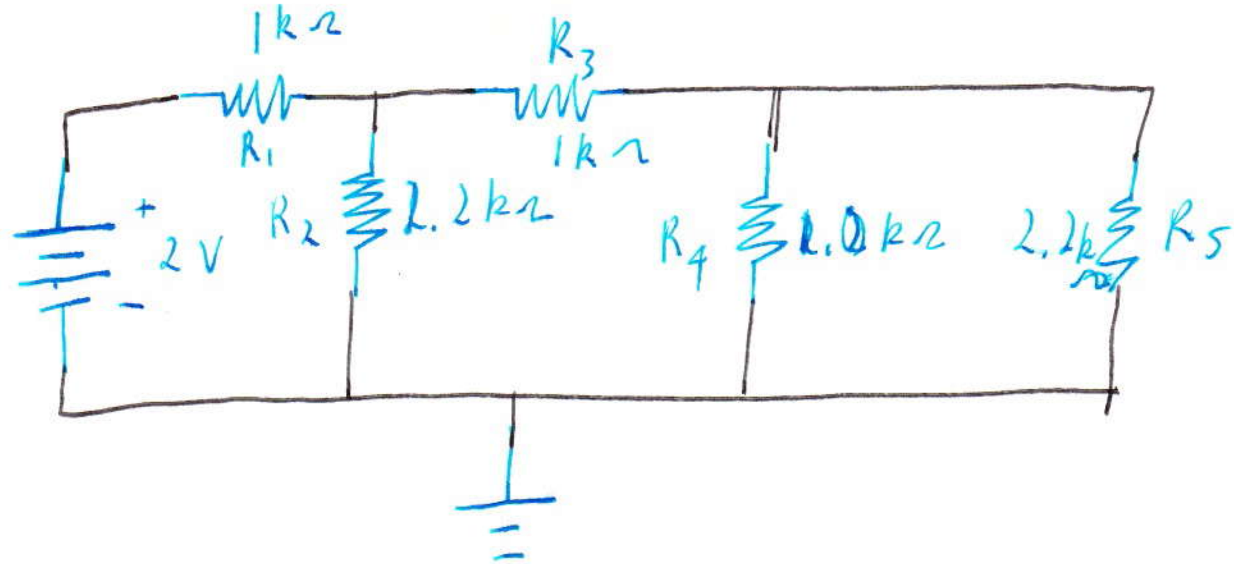


Step 1 make circuits independent of each source. Short all other voltage sources and break current sources.

Superposition circuit 1. 2v source

first objective Thevenin circuit

For inital current



R_{Th} combineing resitors

$$\frac{10^3 \times 2.2 \cancel{\times 10^3}}{3.2 \cancel{\times 10^3}} = R_{4 \parallel 5} = 687.5\,\Omega$$

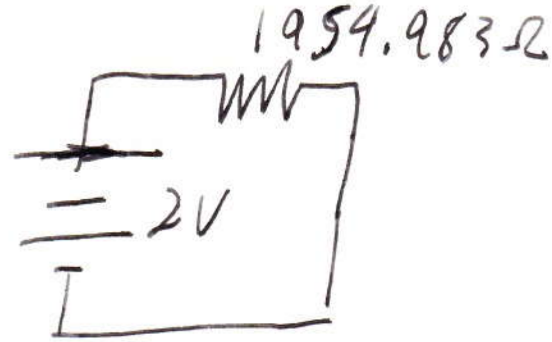
$$R_{4\parallel 5} + R_3 = 687.5 + 1000 = 1687.5\,\Omega$$

$$R_{3+4\parallel 5} = 1687.5\,\Omega$$

$$R_2 \parallel R_{3+4\parallel 5} = \frac{1687.5 \times 2.2 \times 10^3}{3887.5} = 954.98$$

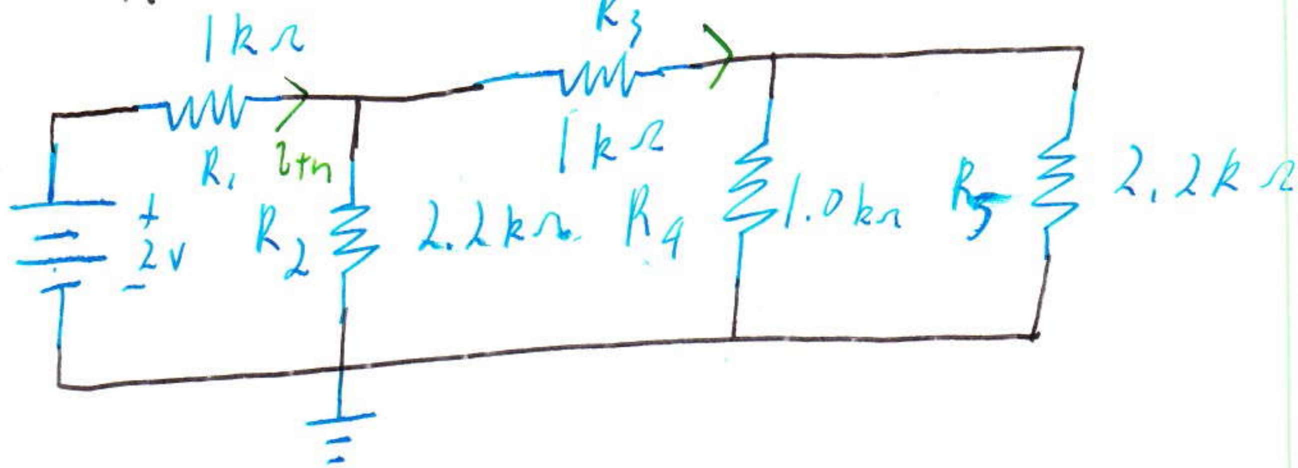
$$R_{th} = R_1 + R_{2\|(3+4)\|5} = 1954.983\ \Omega$$

$$R_{Th} = 1954.983\ \Omega$$



$$V = iR$$

$$\frac{V_{th}}{R_{th}} = i \qquad i_{th} = 1.023\ mA$$



objective is i_{R_5}

current divider

$$\frac{R_{other}}{\Sigma R}\, i_s = i_{Target}$$

$R_{3+(4\|5)} = 1687.5\ \Omega$

$R_2 = 2.2 \times 10^3\ \Omega$

$$i_{R_3} = \frac{2.2 \cancel{\times 10^3}}{3887.5}\ 1.023 \cancel{\times 10^{-3}}$$

$0.579\ mA = i_{R_3}$

Current divider again

$$\frac{R_{other}}{\Sigma R}\, i_{Source} = i_{Target}$$

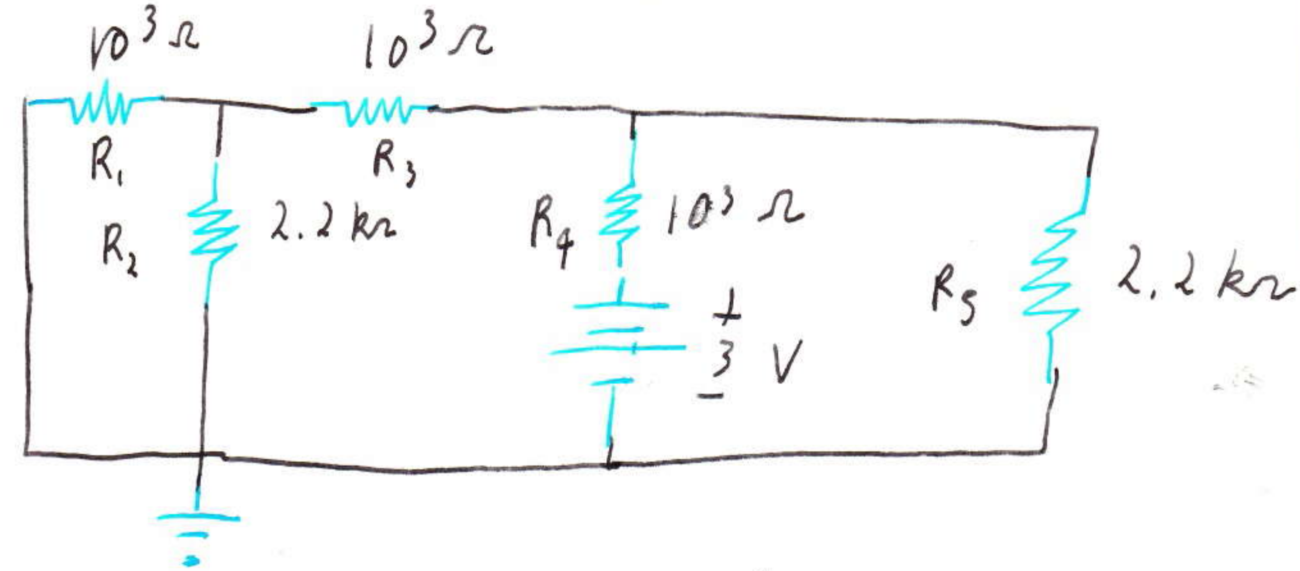
$$\frac{\cancel{10^3}}{3.2 \cancel{\times 10^3}}$$ 0.579×10^{-3}

1.809×10^{-4}

~~0.180×10^{-1}~~

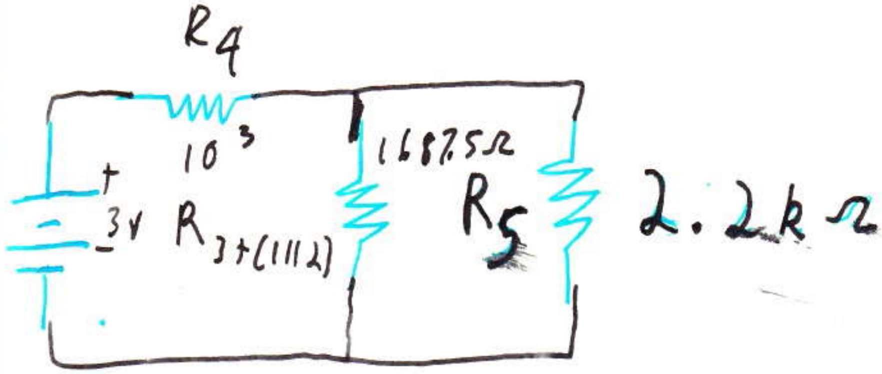
$0.180 \text{ mA} = i_{RS} \quad V_S = 2$

Superposition circuit 2 $V = 3v$



$$R_{1\|2} = \frac{2.2 \times 10^3 \cancel{\times 10^3}}{3.2 \cancel{\times 10^3}} \qquad R_{(1\|2)+3} = 1687.5\,\Omega$$

$$R_{1\|2} = 687.5\,\Omega$$



$$R_{(3+(1\|2))\|5} = \frac{1.687.5 \times 2.2 \times 10^3}{1687.5 + 2.2 \times 10^3}$$

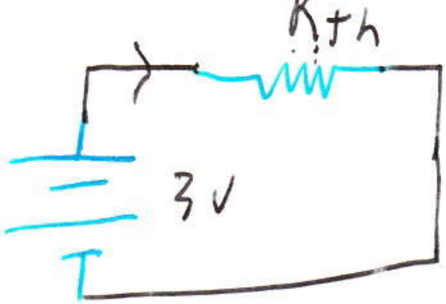
$$R_{(3+(1\|2))\|5} = \frac{3712.5 \times 10^3}{3887.5}$$

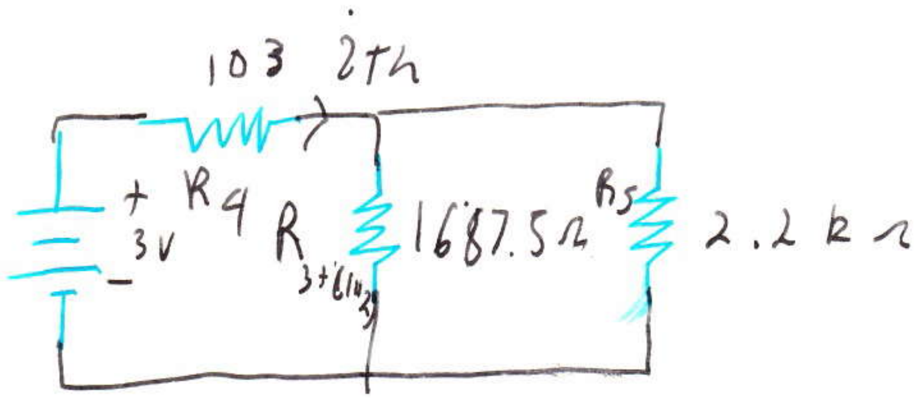
$$R_{3+(1\|2))\|5} = 954.983\ \Omega$$

$$R_{Th} = 1954.983 = R_{4+(3+(1\|2))\|5}$$

$$\frac{V_{Th}}{R_{Th}} = i_{Th}$$

$$i_5 = 1.534\ mA$$





current divider

$$\frac{R_{other}}{\Sigma R} i_S = i_{Target}$$

$$\frac{1687.5}{3887.5} 1.534\ mA$$

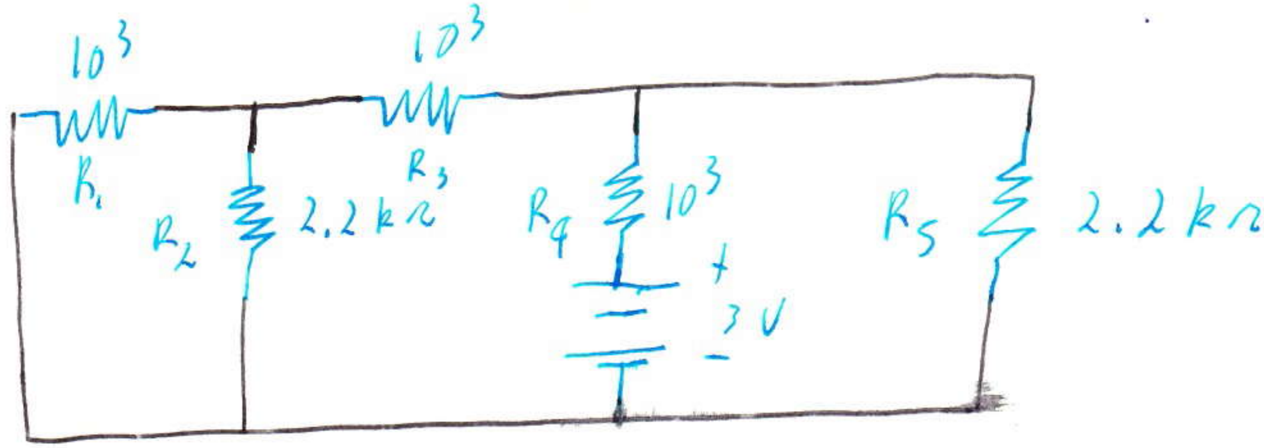
$$i_{R_S\ V_{5-3}} = 0.665\ mA$$

$$i_{R_{5}-V_{s}=2} + i_{R_{5}-V_{s}=3} = i_{R_{5}}$$

$$i_{R_5} = 0.579 \times 10^{-3} + 0.665 \times 10^{-3} \ mA$$

$$\boxed{i_{R_5} = 1.244 \ mA}$$

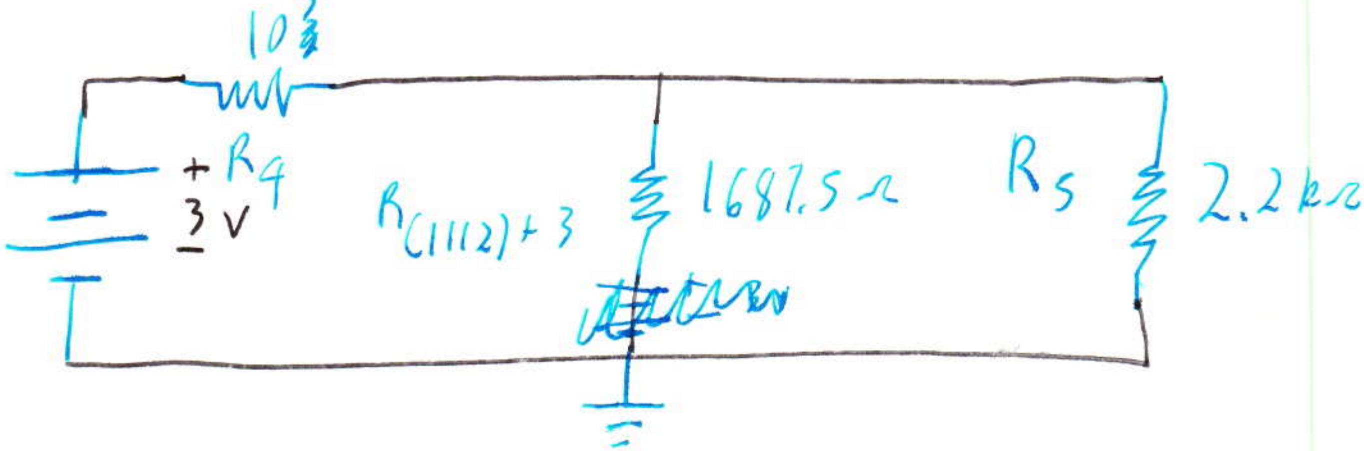
Superposition circuit 2 V = 3V



$$R_{1\|2} = \frac{2.2 \times 10^3 \cancel{\times 10^3}}{3.2 \cancel{\times 10^3}}$$

$$R_{1\|2} = 687.5\ \Omega$$

$$R_{(1\|2)+3} = 1687.5\ \Omega$$



$$i_{RS-V_S=2} + i_{RS-V_S=3} = i_{RS}$$

$$i_{RS} = 0.665 \times 10^{-3} + 0.579 \times 10^{-3}\ A$$

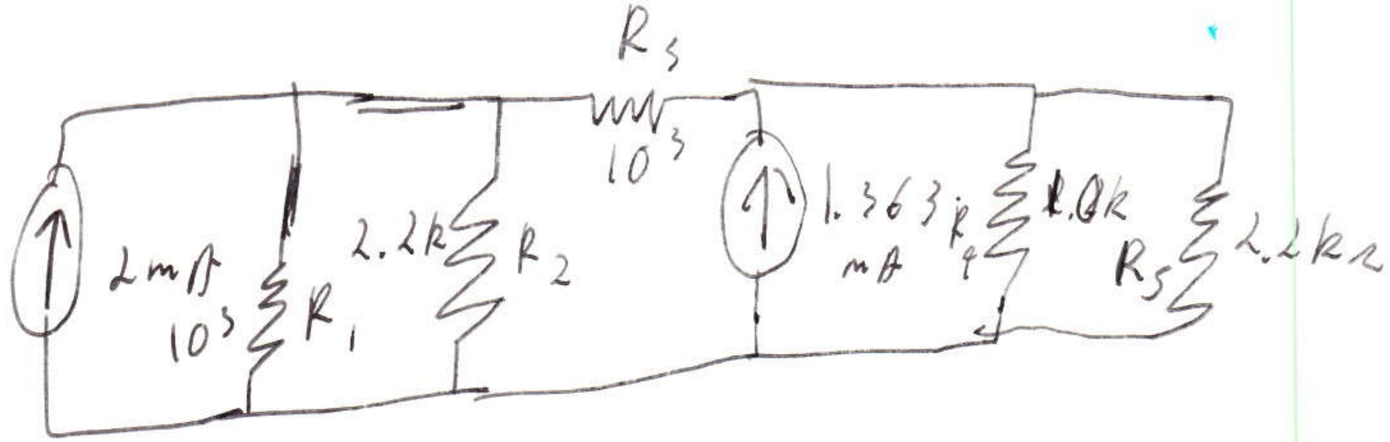
7 alternate)

attempting source transformation

$V = iR$

$\frac{V}{R} = i = \frac{2}{10^3}$ $\qquad$ $\frac{V}{R} = \frac{3}{2.2 \times 10^{+3}}$

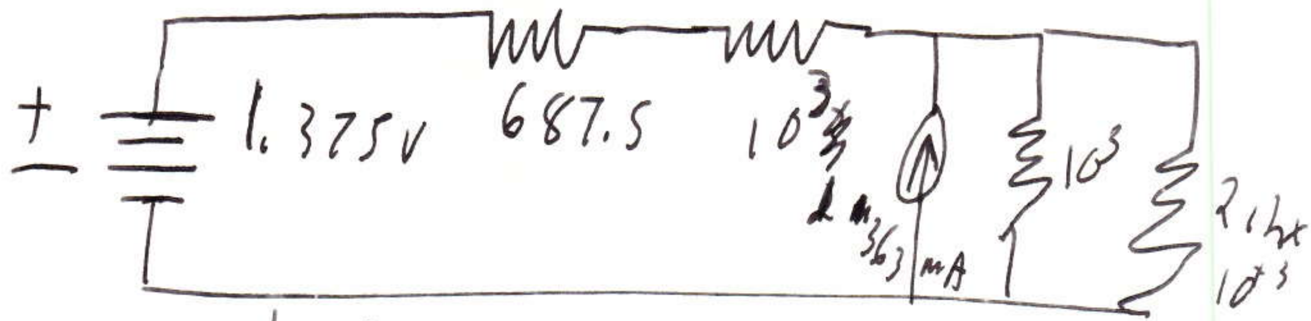
$i = 2\,mA$ $\qquad$ $i = 1.363\,mA$



$R_{1\|2} = 687.5$

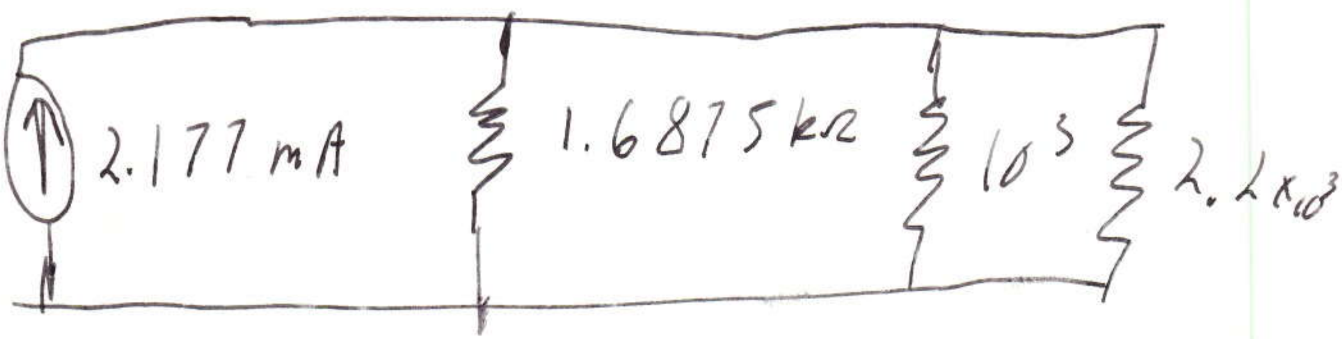
~~RT11~~ $\frac{V}{R} = i$ $\qquad$ $V = iR$

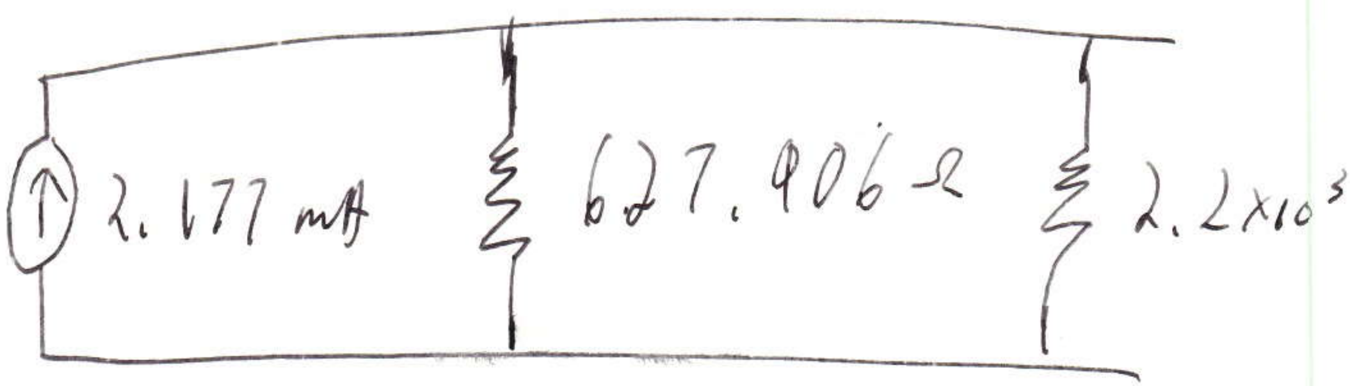
$V = 1.375\,V$



$$\frac{1.375}{1687.5} = i$$

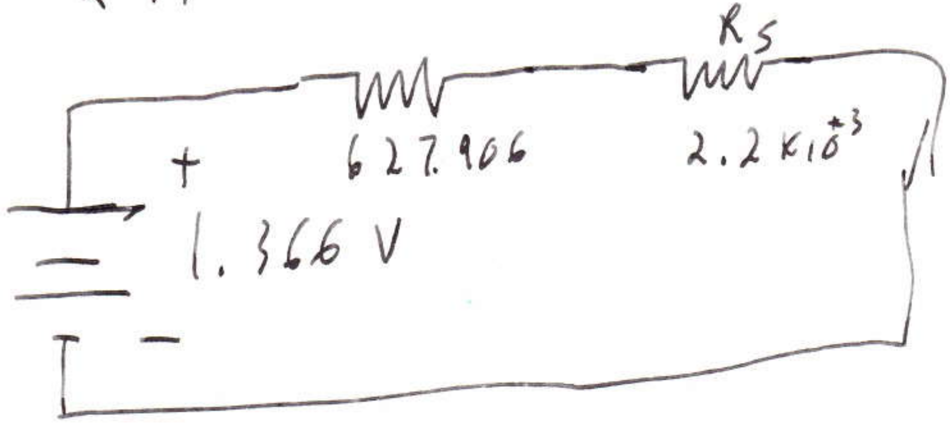
8.148×10^{-4}

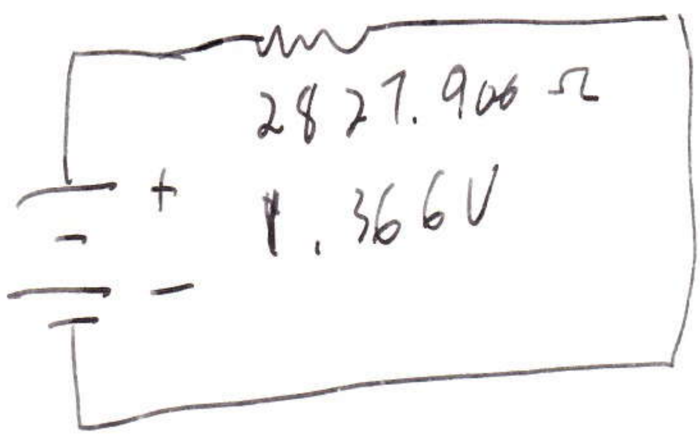




$V = iR$

$2.177 \times 10^{-3} \times 627.906 = 1.366\,V$

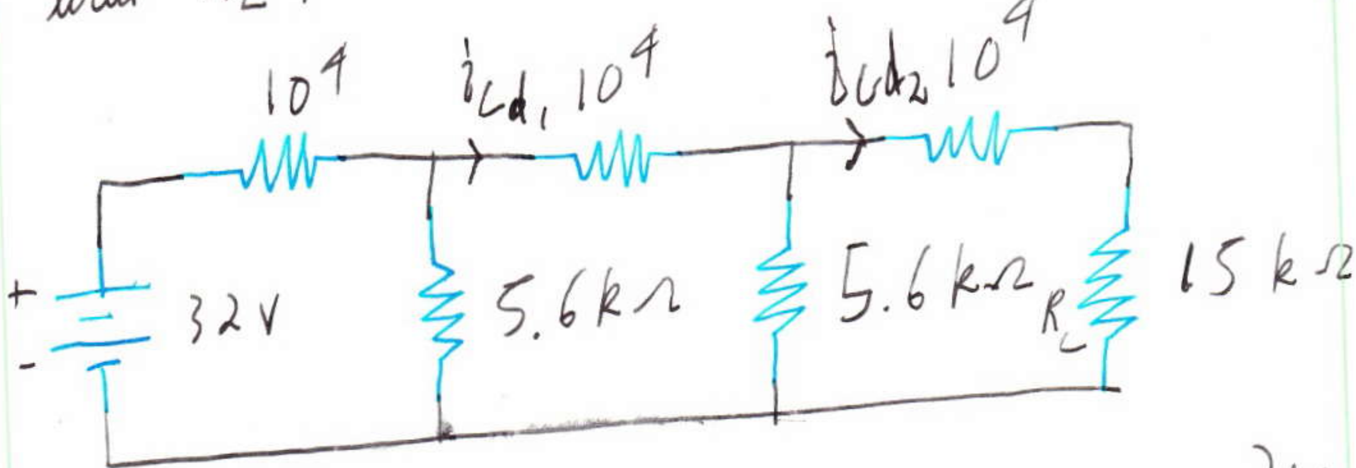




$i_{R_S} = 4.830 \times 10^{-4}$

$\boxed{i_{R_S} = 0.483\ mA}$

19) Using Thevenin's theorem, determine the current through the load R_L.



$$\left(\left(\left(10^4 + 15\times10^3\right) \| 5.6k\Omega\right) + 10^4\right) \| 5.6k\Omega$$

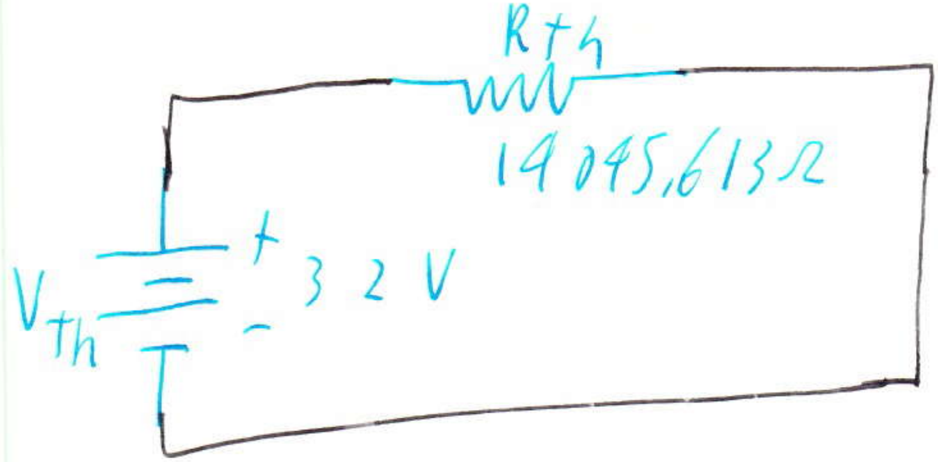
$$+ 10^4$$

$$25000 \| 5.6k\Omega = 4575.163\Omega$$

$$4575.163 + 10^4 = 14575.163\Omega$$

$$14575.163 \| 5.6\times10^3 = 4045.613\Omega$$

$$4045.613 + 10^4 = 14045.613\Omega$$



$$V = iR$$

$$\frac{V_{th}}{R_{th}} = i_{th}$$

$$\frac{32}{14045.613} = 2,278 \text{ mA} = i_{Th}$$

current divider

$$i_T = \frac{R_{other}}{\Sigma R} i_g$$

$$\frac{5.6k}{5.6k + 14575.163} \times 2.278 \, mA$$

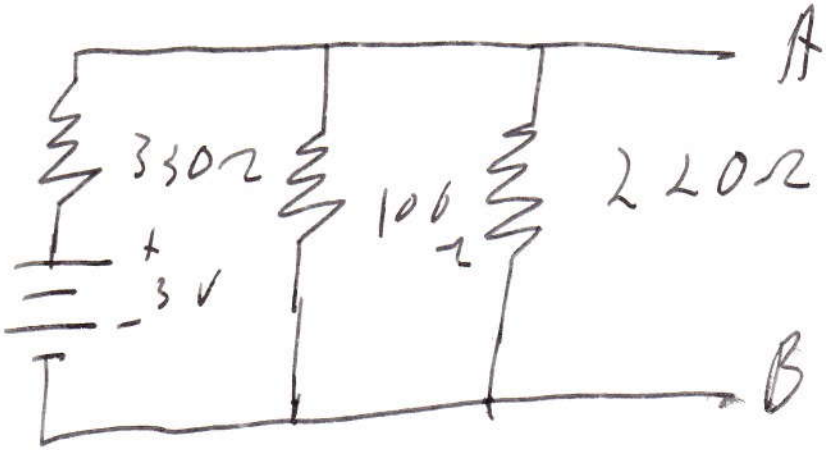
$$6.314 \times 10^{-4} \, A = i_{cd_1}$$

$$i_{cd_2} = \frac{5.6k}{5.6k + 25000} \times 6.314 \times 10^{-4}$$

$$i_{cd_2} = 1.155 \times 10^{-4}$$

$$\boxed{i_{R_L} = 0.115 \, mA}$$

311) apply Norton's theorem to the circuit



$V = iR$

$\frac{V}{R} = i$

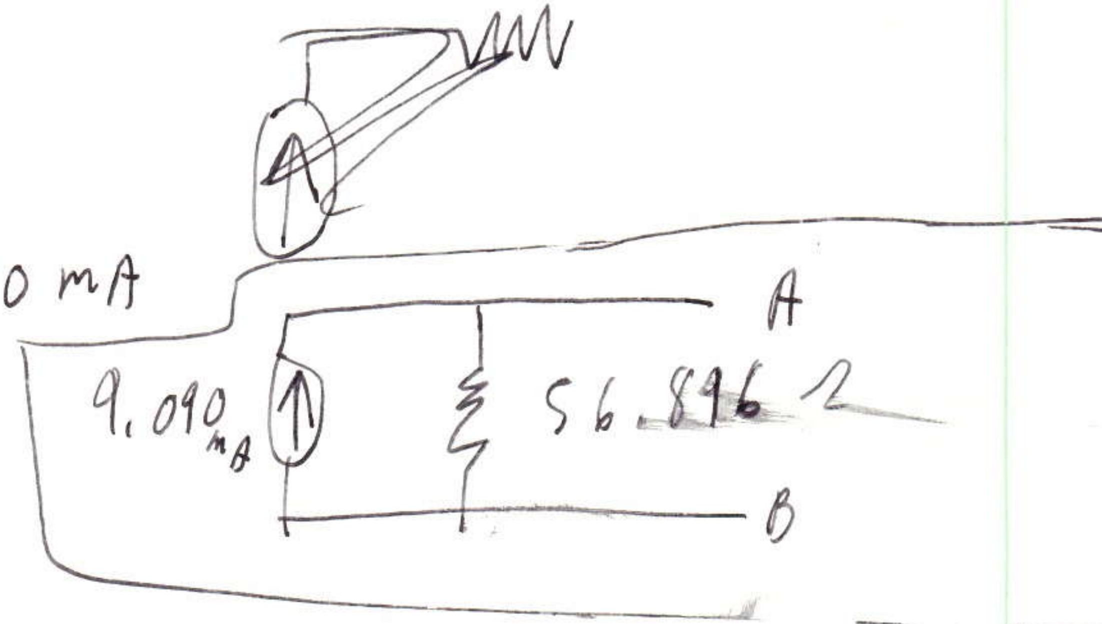
$\frac{3}{330}$

$\frac{1}{110} = i$

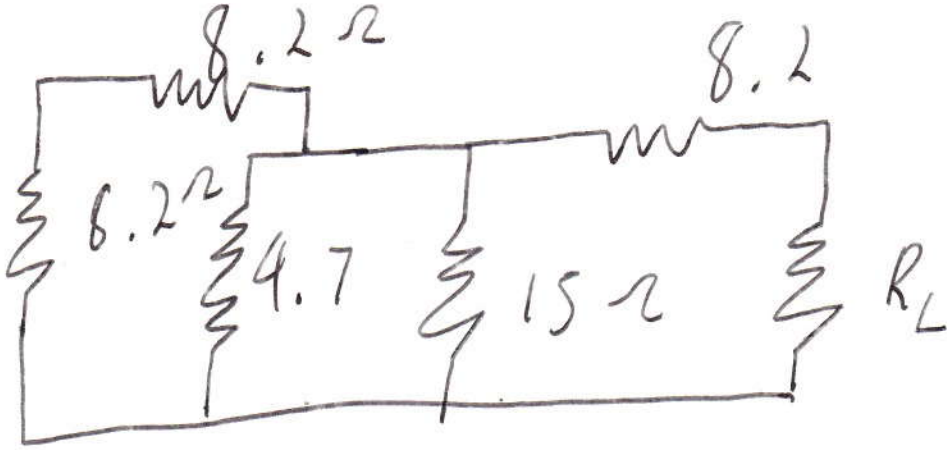
$i = 9.090 \text{ mA}$

$$\frac{1}{\frac{1}{330} + \frac{1}{100} + \frac{1}{220}} = R_{\parallel}$$

$R_{\parallel} = 56.896\ \Omega$



33) Determine R_L for maximum power.

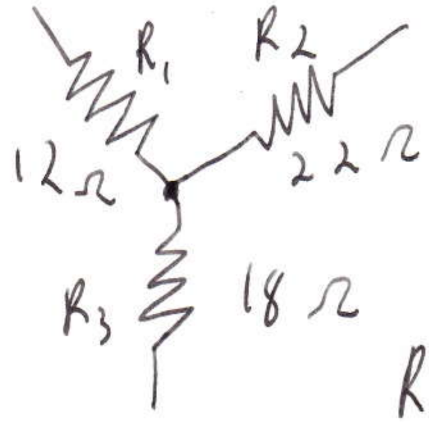


$$(16.4 \parallel 4.7 \parallel 15) + 8.2$$

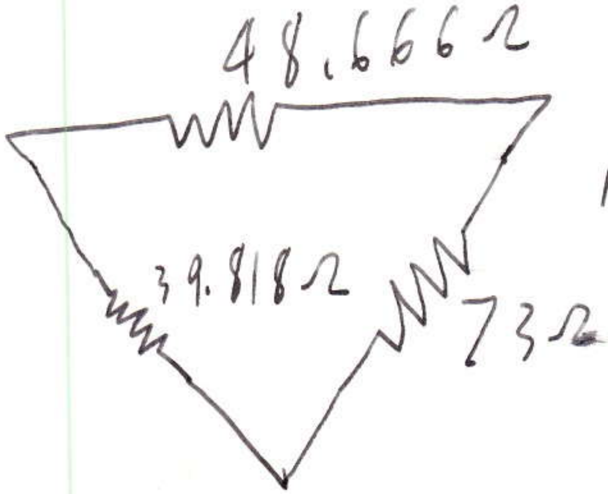
$$2.937\,\Omega + 8.2 = 11.137\,\Omega$$

For max power transfer R_L = R internal, so $\boxed{11.137\,\Omega = R_L}$

37) a)



$$\frac{R_1 R_2 + R_2 R_3 + R_1 R_3}{R_{opposite}}$$



numerator = 876 Ω

$$\frac{876}{22} = 39.818\ \Omega$$

$$\frac{876}{18} = 48.666\ \Omega$$

$$\frac{876}{12} = 73\ \Omega$$

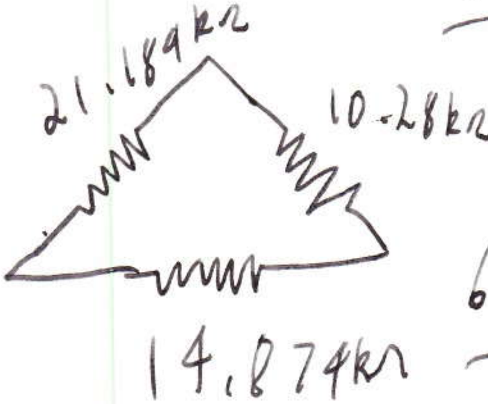
b)

$$\frac{R_1 R_3 + R_2 R_3 + R_2 R_1}{R_{opposite}}$$

numerator $6.8k \times 4.7k + 3.3k \times 4.7k + 3.3k \times 6.8k$

numerator $= 6.991 \times 10^7 \, \Omega$

$$\frac{6.991 \times 10^7}{6.8k} = 10.280 \, k\Omega$$



$$\frac{6.991 \times 10^7}{3.3k} = 21.184 \, k\Omega$$

$$\frac{6.991 \times 10^7}{4.7k} = 14.874 \, k\Omega$$