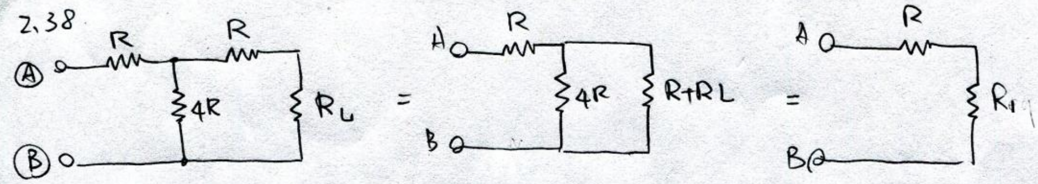
2.38

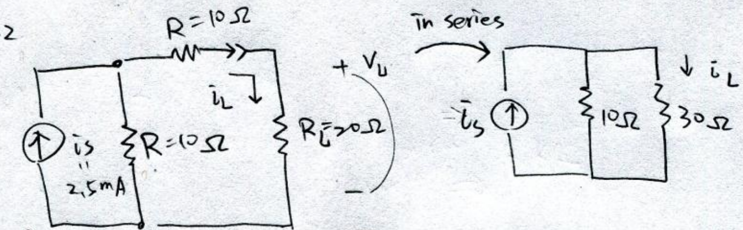


$$R_1 = \frac{1}{\frac{1}{4R} + \frac{1}{R+R_L}} = \frac{4R^2 + 4R \cdot R_L}{5R + R_L}$$

$$R_{AB}: \quad R + R_1 = R_L \quad \Rightarrow \quad \frac{9R^2 + 5RR_L}{5R + R_L} = R_L$$

$$R_L^2 = 9R^2 \quad R_L = 3R \quad \Rightarrow \quad R = \frac{R_L}{3}$$ ※

2.42

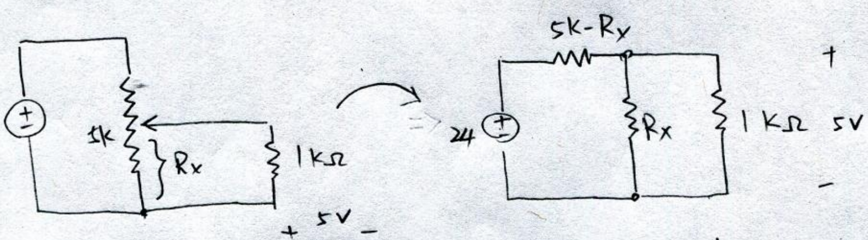


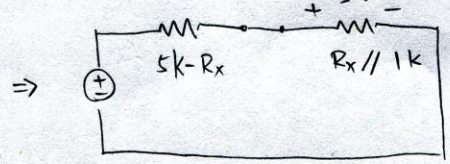
Using formula of current division

$$i_L = i_s \cdot \frac{1/30}{1/30 + 1/10} = 2.5 \cdot \frac{1}{4} = 0.625 \text{ (mA)}$$

Apply Ohm's of $R_L$ : $V_L = i_L \cdot R_L = 0.625 \cdot 20 = 12.5 \text{ (mV)}$ ※

2.44





$$R_x // 1k = \frac{1}{\frac{1}{R_x} + \frac{1}{1k}} = \frac{R_x}{1+R_x} \text{ (k}\Omega\text{)}$$

Apply formula of voltage division :

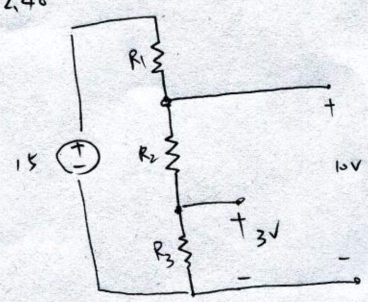
$$5 = 24 \cdot \frac{R_x/1+R_x}{R_x/1+R_x + 5 - R_x} = \frac{24 R_x}{R_x + 5 + 4R_x - R_x^2}$$ (continue) ↓

$$24R_x = 25R_x + 25 - 5R_x^2$$

$$5R_x^2 - R_x - 25 = 0 \qquad R_x = \frac{1 \pm \sqrt{501}}{10} = 2.338 \text{ or } \underline{-2.138} \times$$

$$\Rightarrow \underline{R_x = 2338\ \Omega} \ \divideontimes$$

2.48




Apply formula of voltage divider.

$$3 = 15 \cdot \frac{R_3}{R_1 + R_2 + R_3}$$

$$10 = 15 \cdot \frac{R_2 + R_3}{R_1 + R_2 + R_3}$$

$$\frac{R_3}{R_1 + R_2 + R_3} = \frac{3}{15}, \quad \frac{R_2 + R_3}{R_1 + R_2 + R_3} = \frac{10}{15}$$

we can choose $R_1 : R_2 : R_3 = 5 : 7 : 3$ to satisfy the output

ex: $R_1 = 5\,k\Omega$, $R_2 = 7\,k\Omega$, $R_3 = 3\,k\Omega$. or scale it with any number

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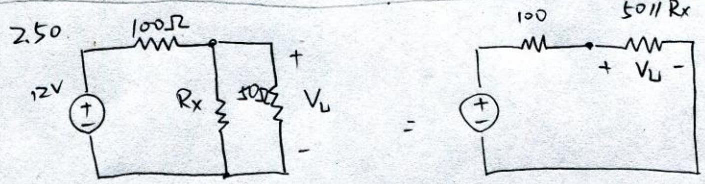
2.50




$$50 \parallel R_x = \frac{1}{1/50 + 1/R_x} = \frac{50R_x}{50 + R_x}$$

for $V_L = 2$ :

$$V_L = 12 \cdot \frac{50R_x/50+R_x}{100 + 50R_x/50+R_x} = 12 \cdot \frac{50R_x}{150R_x + 5000} = \frac{12R_x}{3R_x + 100}$$

$$12R_x = 3V_L R_x + 100V_L$$

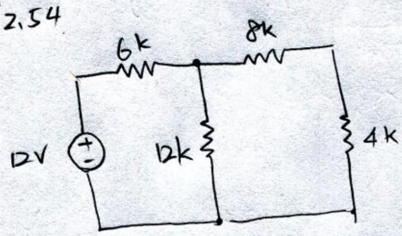
$$R_x = \frac{100V_L}{12 - 3V_L}$$

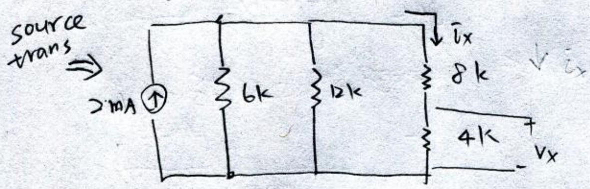
for $V_L = 2$. $R_x = 33.33$

for $V_L = 4$. $R_x = \infty$, (open wire)

for $V_L = 6$. impossible.

2.54

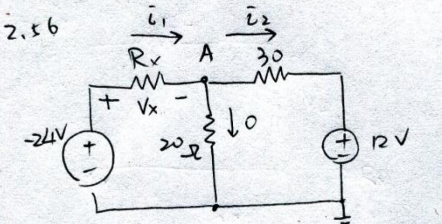



$$i_x = 2 \cdot \frac{1/12}{1/6 + 1/12 + 1/12} = 0.5\ (mA)$$ (use the formula of current divider)

$$V_x = i_x \cdot R_x = 0.5\times10^{-3} \times 4\times10^{3} = 2\ (V)$$ ※

2.56



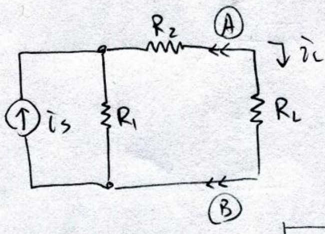

Use KCL @ A : $i_1 - i_2 - i_x = 0$ & $i_x = 0$ ⇒ $i_1 = i_2$

∴ $i_x = 0$ ⇒ $V_A = 0$

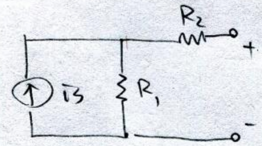
$$i_2 = \frac{0 - 12}{30} = -0.4$$

$$R_x = \frac{V_x}{i_1} = \frac{-24 - 0}{-0.4} = 60\ (V)$$ ※

3.36

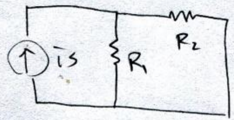



(a) open :




$V_T = i_s \cdot R_1$

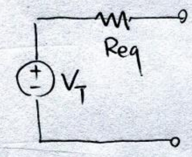
short :



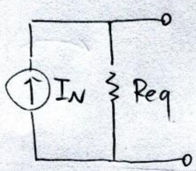

$I_N = i_s \cdot \frac{R_1}{R_1 + R_2}$

$R_{eq} = \frac{V_T}{I_N} = R_1 + R_2$

Thévnin :




Norton :




where $V_T = i_s \cdot R_1$

$R_{eq} = R_1 + R_2$

$I_N = \frac{i_s R_1}{R_1 + R_2}$

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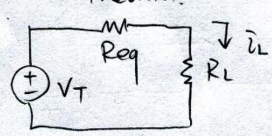
Students can also use source transformation and circuit reduction to find Thévnin equivalent

b) Use Thévnin.




where $V_T = i_s \cdot R_1$

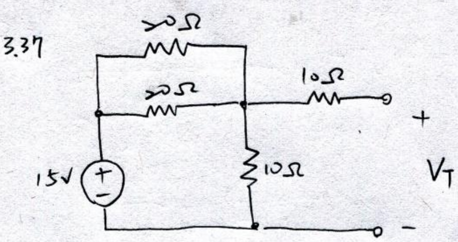
$R_{eq} = R_1 + R_2$

$$i_L = \frac{V_T}{R_{eq} + R_L} = \frac{i_s R_1}{R_1 + R_2 + R_L}$$

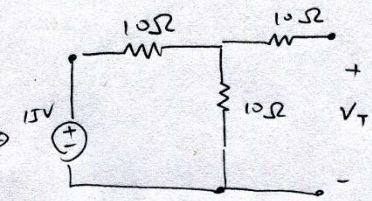
c) current division :

$$i_L = i_s \cdot \frac{1/R_2 + R_L}{1/R_1 + 1/R_2 + R_L} = i_s \cdot \frac{R_1}{R_1 + R_2 + R_L}$$ *

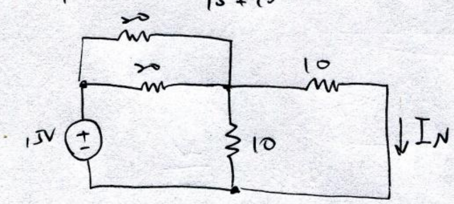
3.37




⇒




$V_T = 15 \cdot \frac{10}{10+10} = 7.5$ V

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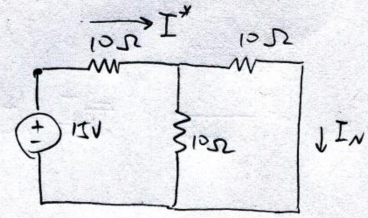


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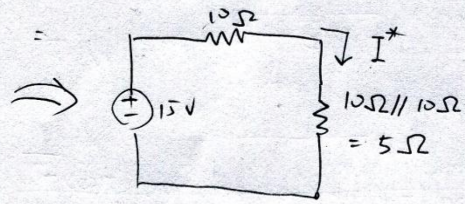
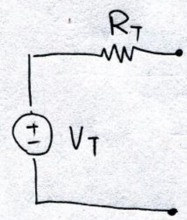


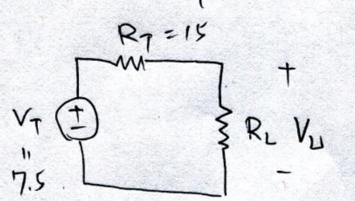

$I^* = \frac{15\text{ V}}{15\,\Omega} = 1$ (A)  $I_N = I^* \cdot \frac{1/10}{1/10 + 1/10} = 0.5$ (A)




Thévenin expression: $R_T = \frac{V_T}{I_N} = 15\,\Omega$

$V_T = 7.5$ V

circuit equivalent:

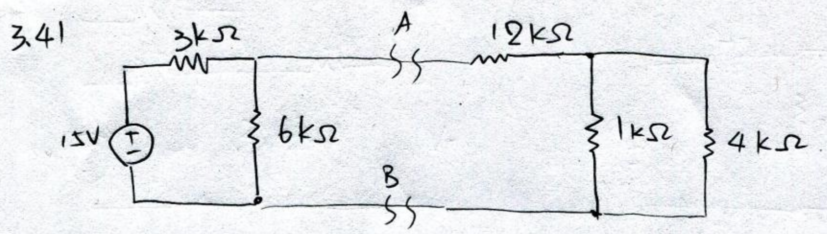



$R_L = 5\,\Omega$  $V_L = V_T \cdot \frac{5}{5+15} = 1.875$ (V)

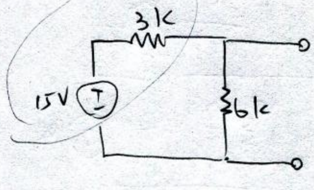
$R_L = 10\,\Omega$  $V_L = V_T \cdot \frac{10}{10+15} = 3$ (V)

$R_L = 50\,\Omega$  $V_L = V_T \cdot \frac{50}{50+15} = 5.77$ (V)

3.41

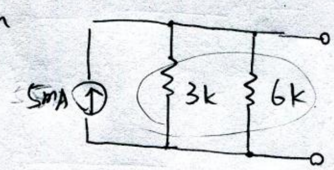



Thévenin of left :



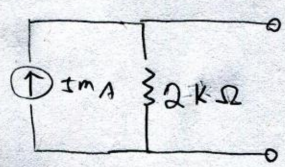

source transform

$$I = \frac{V}{R} = \frac{15}{3k} = 5\ mA$$



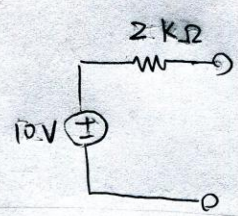

Resistors in parallel:

$$R_{eq} = \frac{1}{\frac{1}{3} + \frac{1}{6}} = 2$$

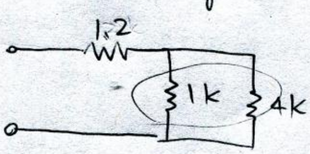



source transform

$V = IR = 10\ V$

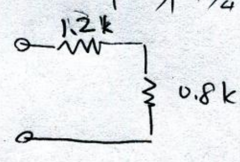



Thévin of right:

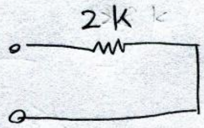



parallel

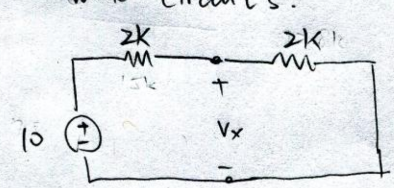
$$R_{eq} = \frac{1}{\frac{1}{1} + \frac{1}{4}} = 0.8$$




series




whole circuits:




$$V_x = 10 \cdot \frac{2}{2+2} = 5\ (V)$$ #