# Reading & Remarks

Charles K. Alexander and Matthew N. O. Sadiku, *Fundamentals of Electric Circuits 5th Edition*, McGrawHill, 2015.

- Chapter 4

Remarks:

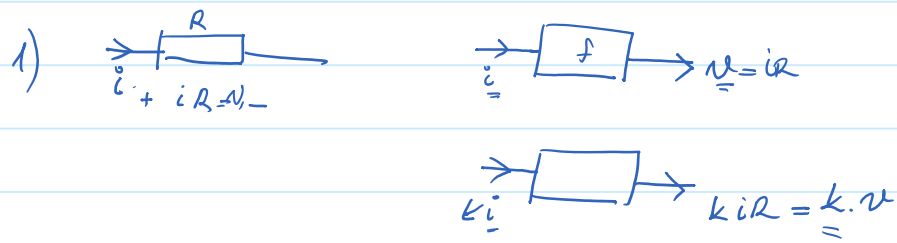
- Quiz - 1 ✓
- Homework - 2 ✓

# Linearity

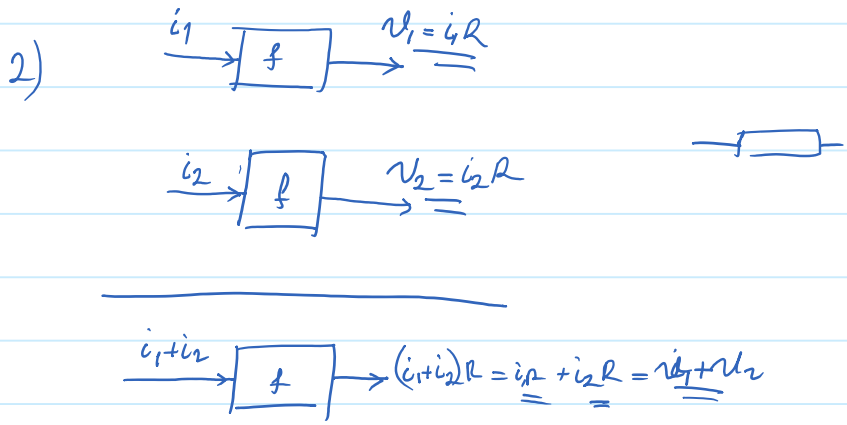
1. Homogeneity
2. Additivity

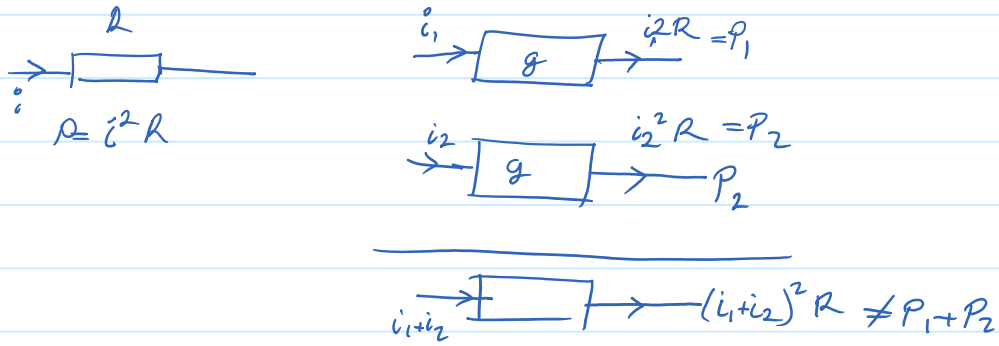
A resistor is linear. Relation between input current and output power is not linear.

1)



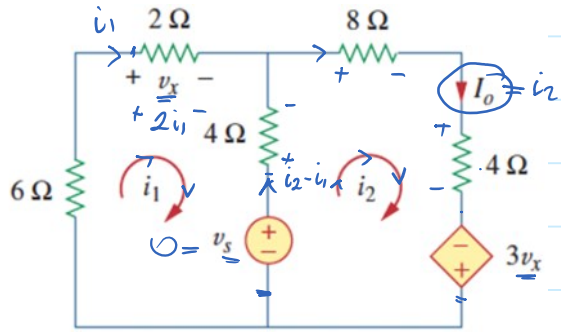

2)



# Exercise

For the circuit below, find $I_0$ when $v_s$ = 12V and $v_s$ = 24V




$$-v_s - 6i_1 - 2i_1 - 4(i_1 - i_2) = 0$$

$$v_s - 4(i_2 - i_1) - 8i_2 - 4i_2 + 6i_1 = 0$$

5/ $-12i_1 + 4i_2 = 12 = v_s$

6/ $10i_1 - 16i_2 = -12 = -v_s$

$-60i_1 + 20i_2 = 60$

$60i_1 - 96i_2 = -72$

$-76i_2 = -12$

$i_2 = \frac{-12}{-76} = \frac{6}{38} = \frac{3}{19}$

$V_s = 24$

$-76i_2 = -24$

$i_2 = \frac{12}{38} = \frac{6}{19}$

$V_s = 0 \rightarrow i_2 = 0$

$V_s = 12V$

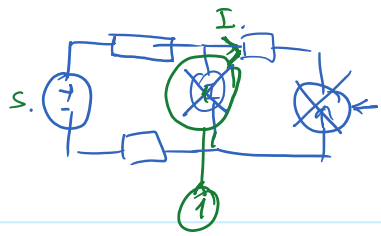
$\times 2$

$\times 2$

$$I_o = i_2 = \frac{12}{76}\text{A}$$

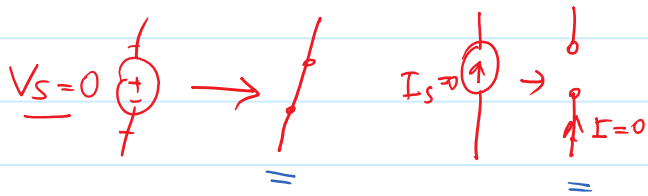
$$I_o = i_2 = \frac{24}{76}\text{A}$$

# Superposition

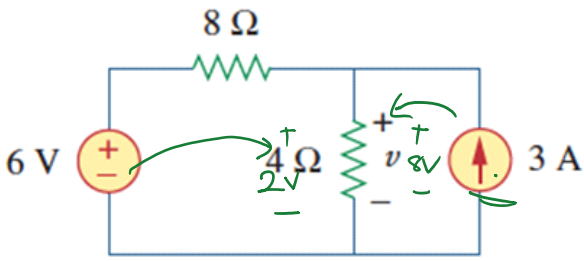



$I_1 + I_2 + I_3 = I$

1) Turn off all independent sources
   -> replace voltage source with 0V ( short circuit )
   -> replace current source with 0A ( open circuit )
   Find the output (voltage or current) due to that active source
2) Repeat step 1 for all independent sources
3) Find the total contribution by adding algebraically all the contributions due to independent sources

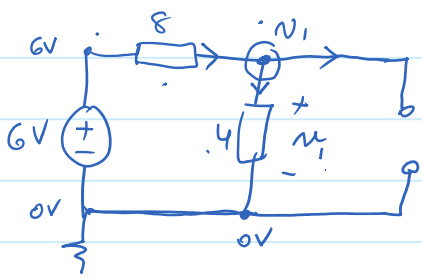


# Exercise

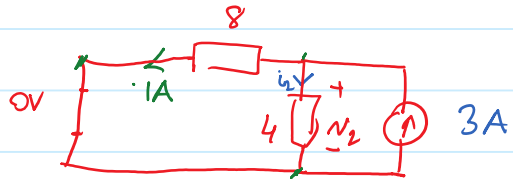



$v = v_1 + v_2$

$= 2 + 8 = 10V$




$v_1 = \frac{6}{8+4} \cdot 4 = 2V$




$i_2 = \frac{3}{8+4} \cdot 8 = 2A$

$v_2 = i_2 \cdot 4 = 2 \cdot 4 = 8V$

$$v = v_1 + v_2 = 2 + 8 = 10 \text{ V}$$

# Exercise

1 5 _ _ _ 1234 1/3

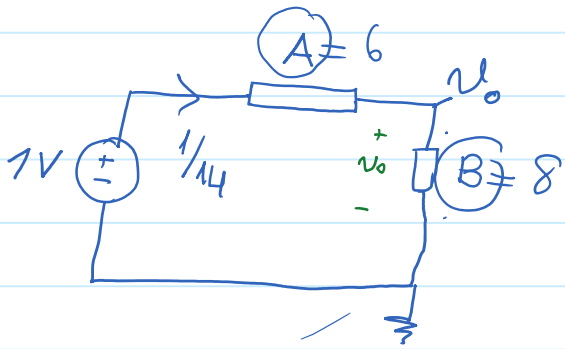
1pts **Q1*** last four digits of your student ID

Example: 21 → 1 2 3 4 → 1+2+3 = A=6, 3+4+1 = B=8

Answer: 68

* if not correct no credits

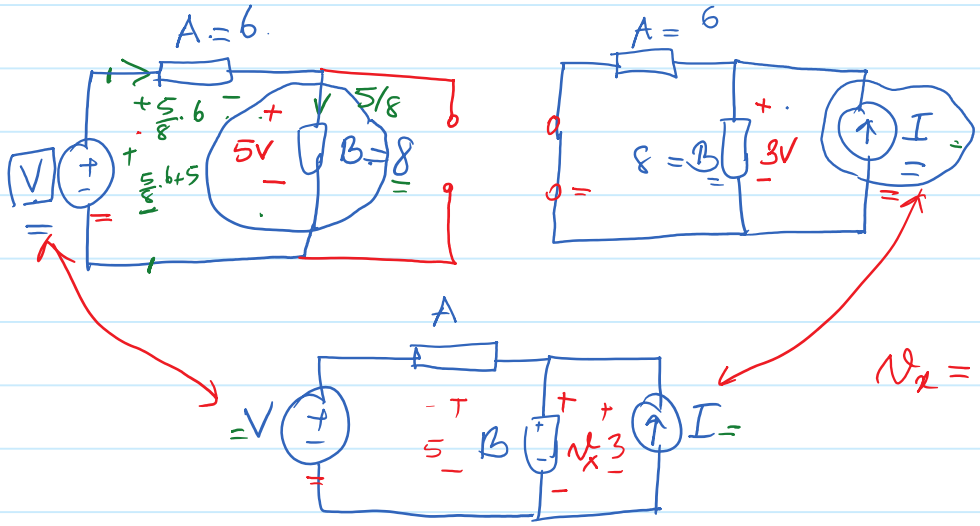
1pts **Q2.**




$v_o = ?$

$8 \cdot \frac{1}{14} = \frac{8}{14}$ (1)

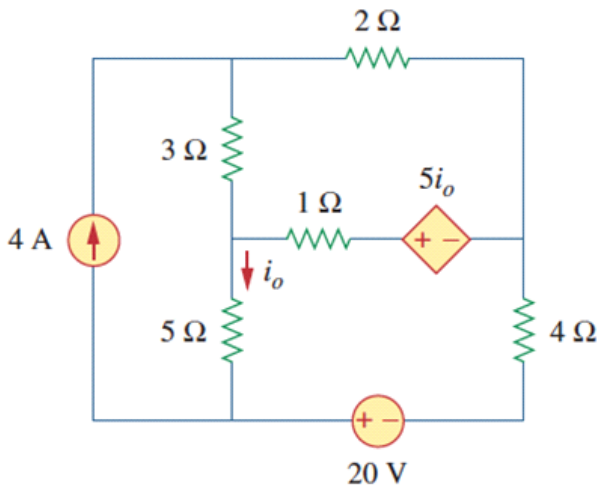
1pts **Q3.**




Hint: Use superposition.

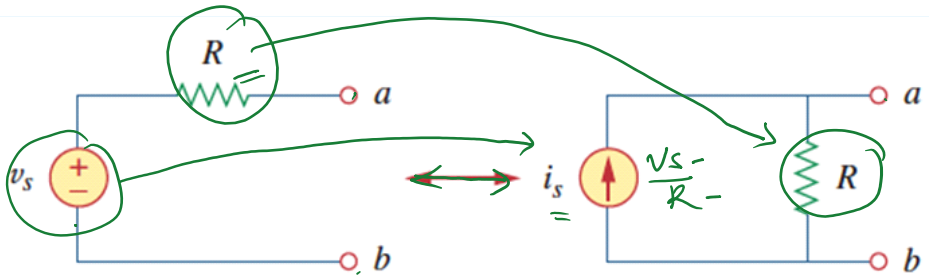
$v_x = 5+3 = 8$

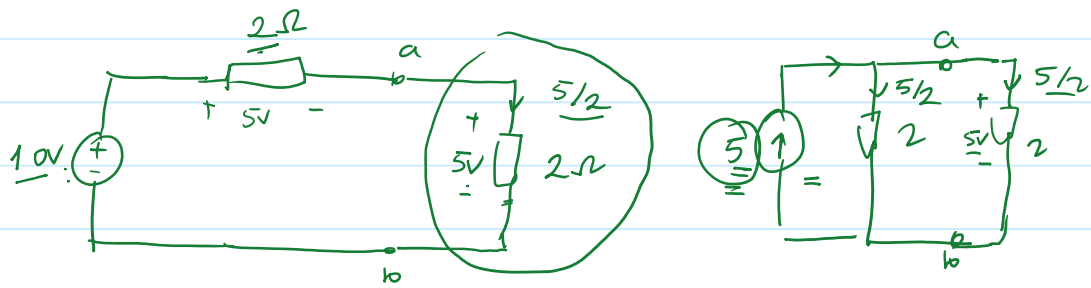
# Exercise



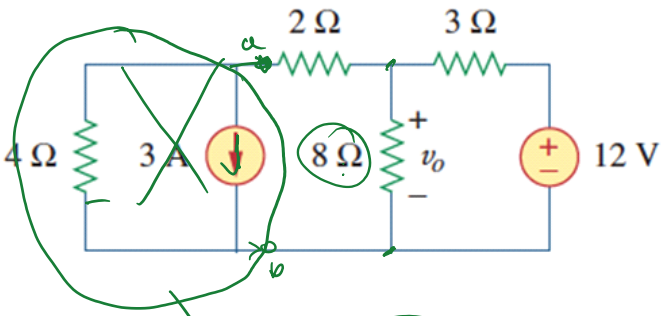

$$i_o = -\frac{8}{17} = -0.4706 \text{ A}$$

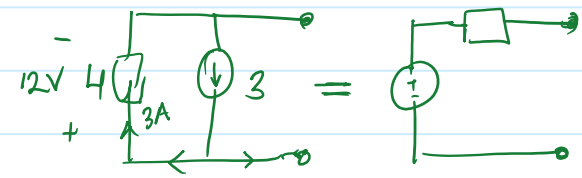
# Source Transformation

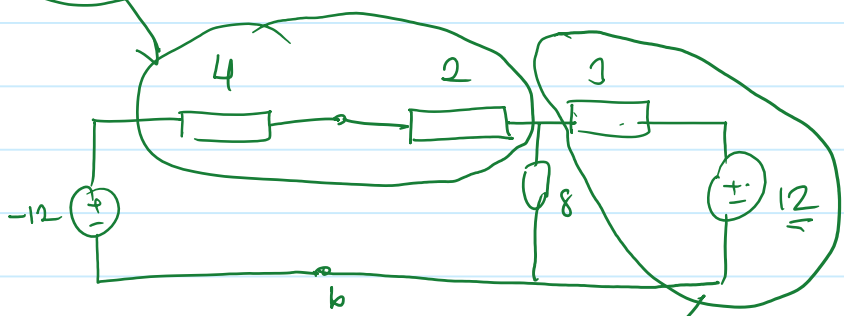


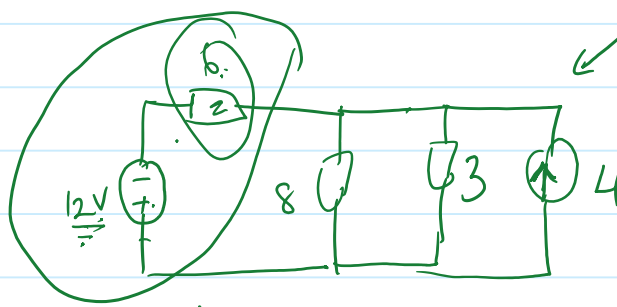



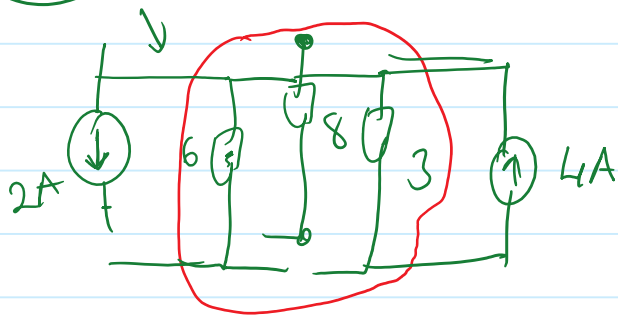
# Exercise



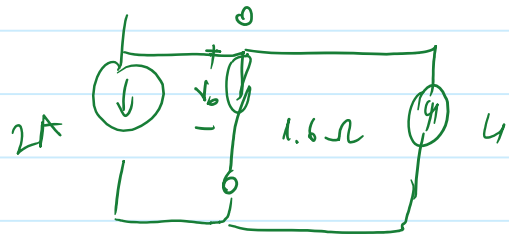



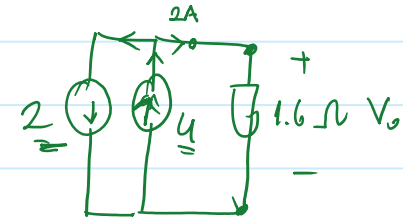



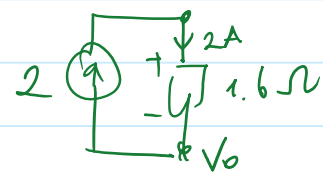




$$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{8} + \frac{1}{3}$$

$$R_{eq} = 1.6\ \Omega$$

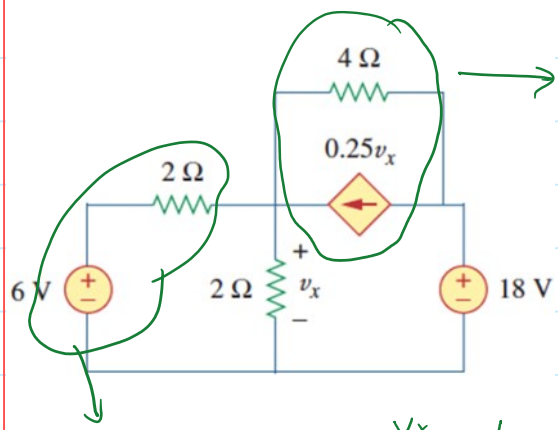


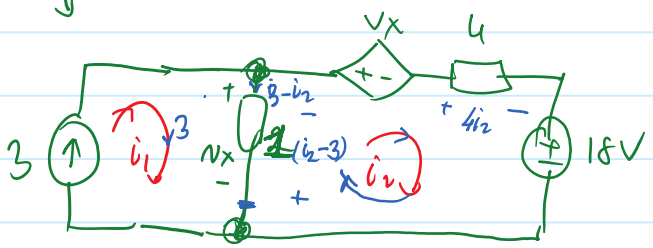




$1.6 \cdot 2A = 3.2V$

# Exercise








$$V_x = (3 - i_2) = 3 - \left(\frac{-9}{2}\right) = \frac{15}{2}$$

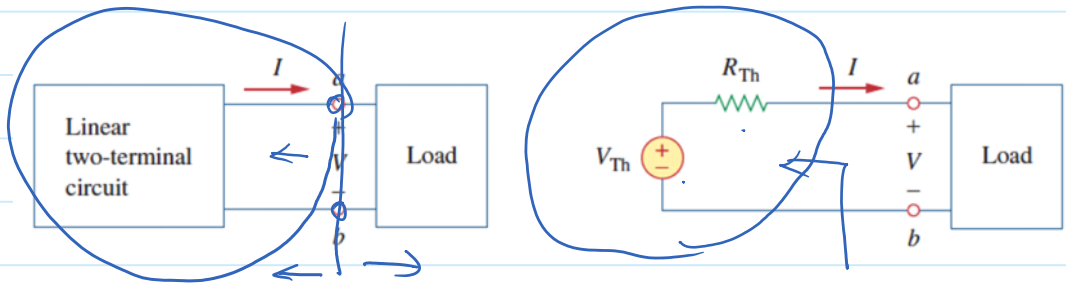
$i_1 = 3A$

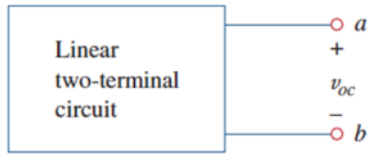
$$-(i_2 - 3)1 - V_x - 4i_2 - 18 = 0$$

$$-i_2 + 3 - 3 + i_2 - 4i_2 - 18 = 0$$

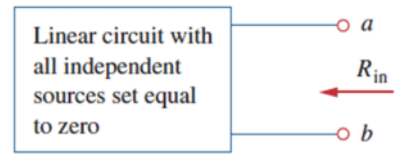
$$i_2 = -\frac{18}{4} = -\frac{9}{2}$$

# Thevenin's Theorem



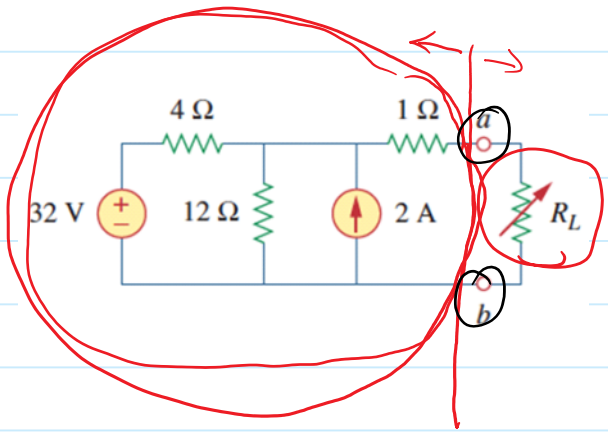



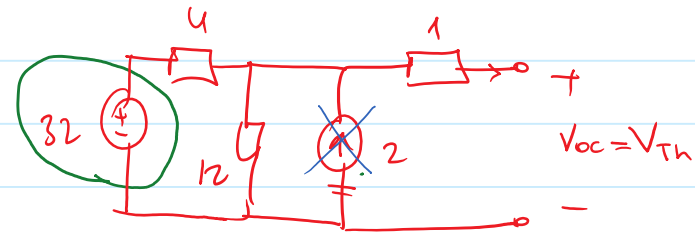

$V_{Th} = v_{oc}$

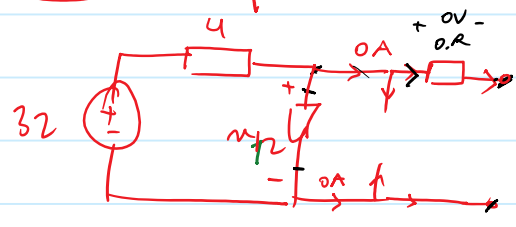



$R_{Th} = R_{in}$

# Exercise

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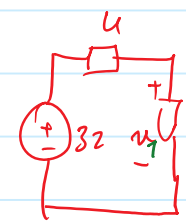
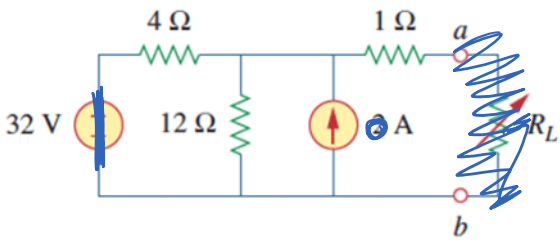
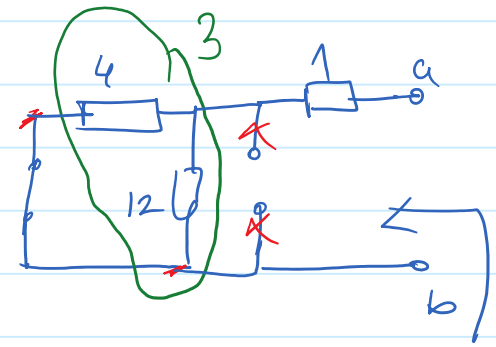
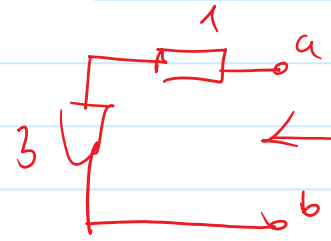



$v_1 = \frac{32}{16_4} \cdot 12^3 = 24V$

$V_{oc} = 24V = V_T$ $\quad R_{Th}$

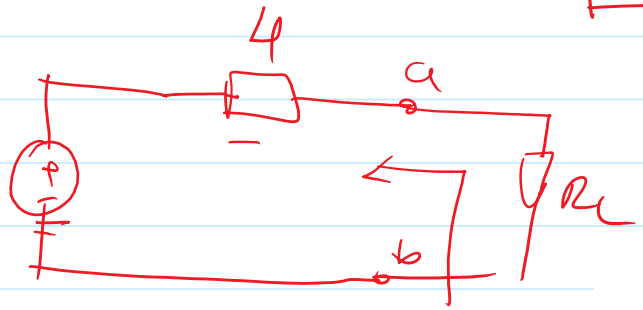


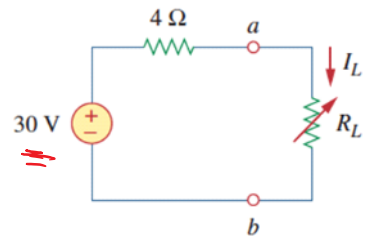




$R_{Th} = R_{eq}$

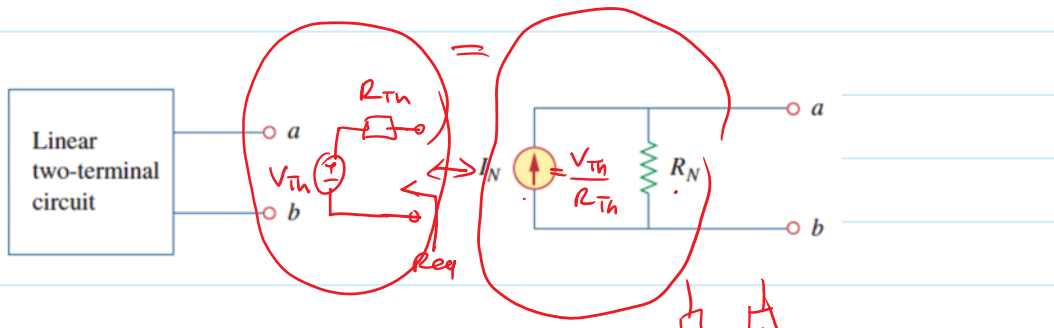
$R_{eq} = 4 = R_{Th}$




$30 = 24 + 6$

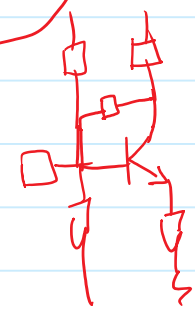


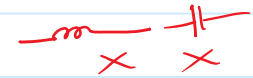
# Norton's Theorem

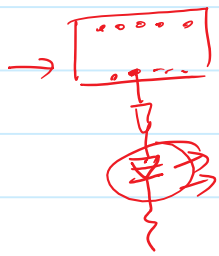


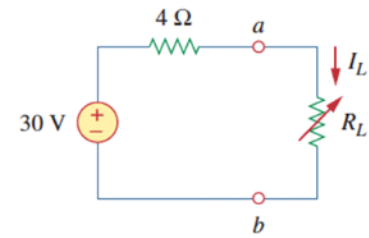

$$R_N = R_{\text{Th}}$$

$$I_N = \frac{V_{\text{Th}}}{R_{\text{Th}}}$$








4 Ω
a
$I_L$
30 V
$R_L$
b