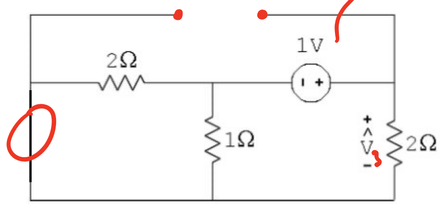
• Example #9-cont: Use superposition to determine $\hat{V}$ in this circuit

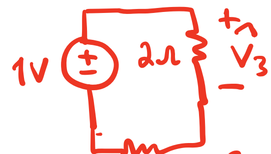
current source replaced by open-circuit

V_{s2}



$R_p = \frac{1 \cdot 2}{1+2} = \frac{2}{3}\,\Omega$

⇒



$R_p = 2/3\,\Omega$

Voltage division:

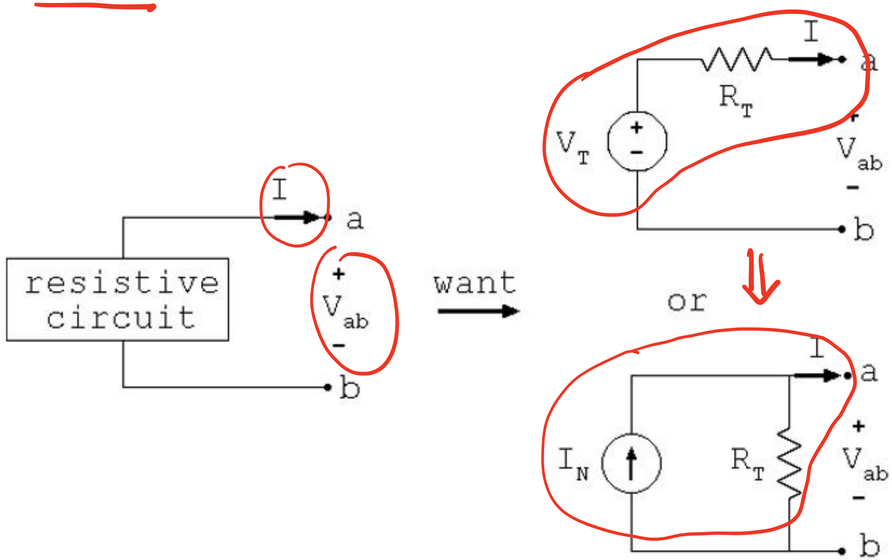
$$\hat{V}_3 = 1 \, \frac{2}{2 + 2/3} = \frac{3}{4}\,V$$

contribution from 1V source

$$\Rightarrow \hat{V} = \hat{V}_1 + \hat{V}_2 + \hat{V}_3 = \frac{1}{2} - 1 + \frac{3}{4} = \frac{1}{4}\,V$$

- Thevenin and Norton equivalent circuits

Can we model any resistive circuit using a simple circuit?

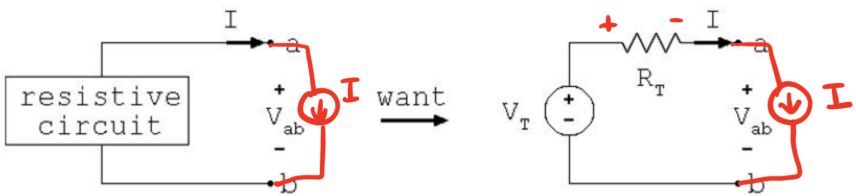


$I_N = \frac{V_T}{R_T} \Rightarrow R_T = \frac{V_T}{I_N}$

– Can we do this?

– How do we do this?

- Thevenin and Norton equivalent circuits



By superposition:

$$V_{ab} = K_1 V_{S1} + K_2 V_{S2} + \dots + \hat{K}_1 I_{S1} + \hat{K}_2 I_{S2} + \dots + A \cdot I$$

KVL: $-V_T + R_T \cdot I + V_{ab} = 0$

$$V_{ab} = V_T - R_T \cdot I$$

$$\Downarrow$$

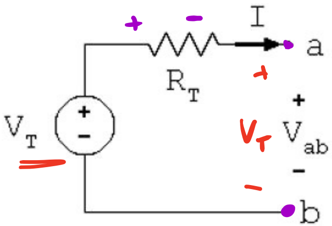
$$R_T = -A$$

V_T: Thevenin's voltage (if no independent sources, $V_T = 0$ and $I_N = 0$)

R_T: thevenin's resistance

I_N: Norton's current

- Thevenin and Norton equivalent circuits
  - How to get V_T?

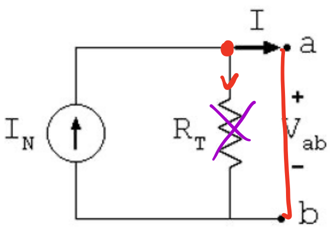


V_T - open circuit voltage

V_T $V_{ab} = V_T - R_T \underbrace{\cancel{I}}_{0}$

KVL: $-V_T + R_T \cdot I + V_{ab} = 0$

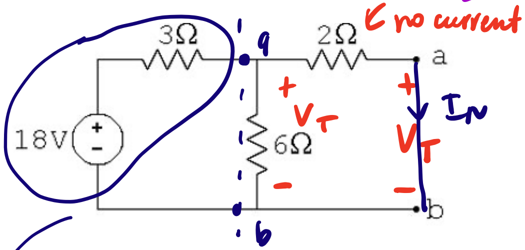
  - How to get I_N?



KCL: $I_N = \overbrace{\cancel{\frac{V_{ab}}{R_T}}}^{0} + I$

I_N: short-circuit current

• Example #10: Obtain V_T and I_N for the following circuit



Voltage division:

$$V_T = 18\left(\frac{6}{6+3}\right) = 12V$$

Find V_T - ?

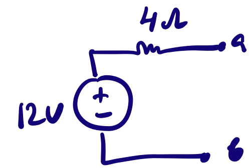
a) $-6V$

b) $6V$

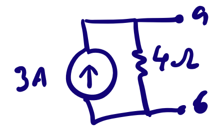
c) $-12V$

d) $12V$

e) I want my quiz to be 0 ☺



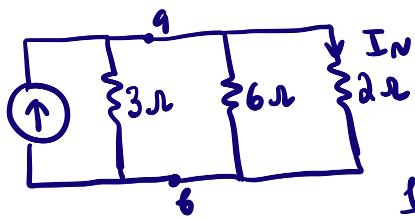
Thevenin's eq. circuit



Norton's eq. circuit

source transformation:

$$I = \frac{18}{3} = 6A$$



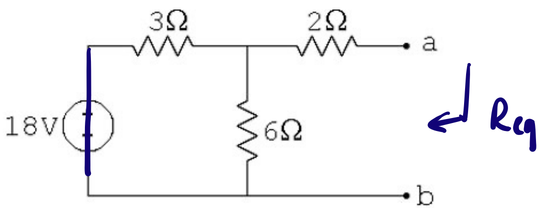
Current division:

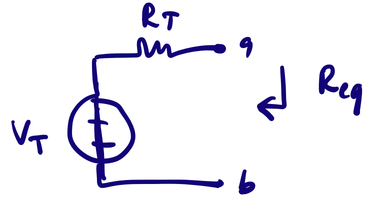
$$I_N = I\left(\frac{R_p}{2}\right) = 3A$$

$$\frac{1}{R_p} = \frac{1}{3} + \frac{1}{6} + \frac{1}{2} = 1\Omega$$

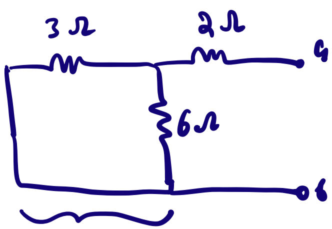
$$R_T = \frac{V_T}{I_N} = \frac{12}{3} = 4\Omega$$

- Example #10-cont: Obtain V_T and I_N for the following circuit
  - How to get R_T?

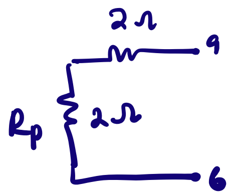




- Source supression: remove all <u>independent</u> sources:



$\rightarrow$

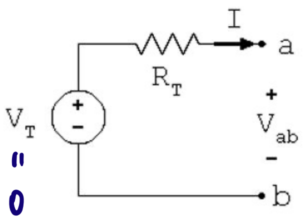


$\Rightarrow R_{eq} = 2 + 2 = 4\Omega = R_T$

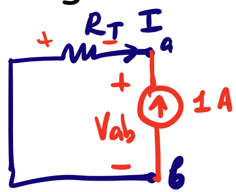
in ∥ ⇒

$$R_p = \frac{3 \cdot 6}{3+6} = \frac{18}{9} = 2\Omega$$

- Test signal method
  - What if can't simplify to a single resistor?



$\Rightarrow$



KVL:

$R_T \cdot I + V_{ab} = 0$

$R_T = -\frac{V_{ab}}{I}$ (1)

$I = -1\,A$

(1) $\frac{-V_{ab}}{-1} = V_{ab}$

⇓ we can get R_T by obtaining Vab, and it will be numerically equal to R_T.

Source suppression

↓

check if you can reduce to a single resistor

↙ yes ↓ done :)

↘ no ↓ inject 1 A into a terminal a ↓ obtain Vab

↳ $R_T = V_{ab}$ in Ω (not V) → done :)