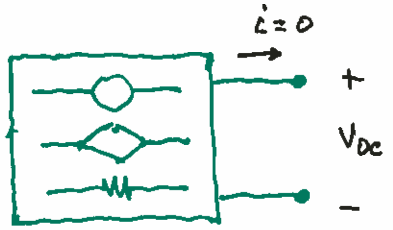
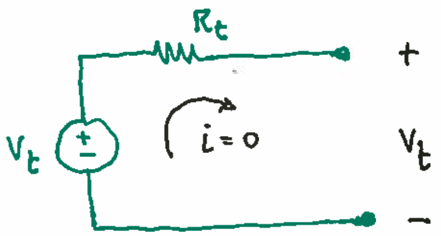
The voltage-current characteristics are identical at the two terminals. Thursday, February 11 2016

V_t and R_t are found by considering two operating extremes.

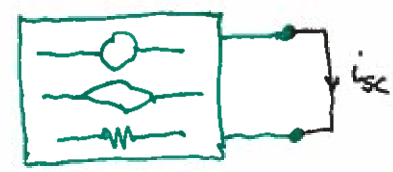
Open-circuit

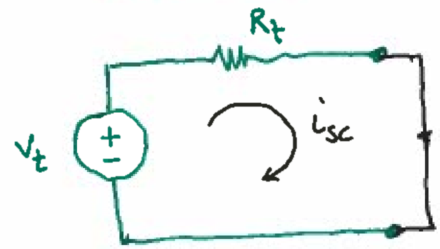




giving $\boxed{V_t = V_{oc}}$

Short-circuit





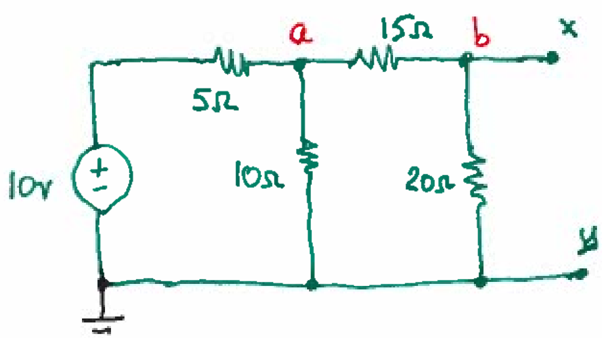
$i_{sc} = \dfrac{V_{oc}}{R_t}$

giving $i_{sc} = \dfrac{V_t}{R_t} = \dfrac{V_{oc}}{R_t}$

and $\boxed{R_t = V_{oc}/i_{sc}}$

Determining a Thevenin equivalent is two separate analysis problems:
Find V_t, find R_t.

Example: Find the Thevenin equivalent at terminals x, y.



Find V_t, where $V_t = V_{oc}$. Using node-voltage method, open-circuit voltage will be V_b.

Node a: $\dfrac{V_a - 10}{5} + \dfrac{V_a}{10} + \dfrac{V_a - V_b}{15} = 0$

$(\times 30) \quad 6V_a - 60 + 3V_a + 2V_a - 2V_b = 0$

or $\quad 11V_a - 2V_b = 60 \qquad (1)$

Node b: $\quad \dfrac{V_b - V_a}{15} + \dfrac{V_b}{20} = 0$

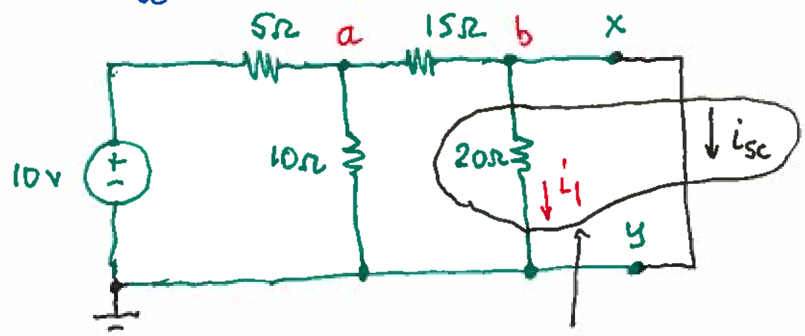
$(\times 60) \quad 4V_b - 4V_a + 3V_b = 0$

or $\quad -4V_a + 7V_b = 0 \qquad (2)$

Solving (1) and (2), $\quad V_a = 6.087\,v$
$\quad V_b = 3.478\,v$

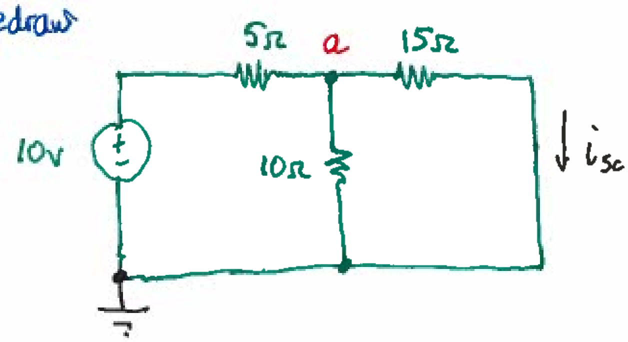
Thus, $\quad \boxed{V_t = V_b = V_{oc} = 3.478\,v}$

Now find i_{sc}



Notes:
- parallel combination of 20Ω and a short circuit! (Equivalent resistance short circuit = 0Ω)
- What's happened to V_b? Now connected directly to reference node. $V_b = 0$.
- $i_1 = 0$, since $V_b/20 = 0$. All current is in i_{sc}, none in 20Ω resistor.

Redraw



Node a: $\dfrac{V_a - 10}{5} + \dfrac{V_a}{10} + \dfrac{V_a}{15} = 0$ note this is i_{sc}

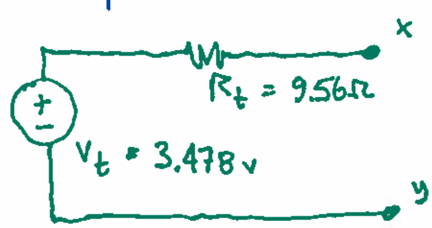
(x30) $6V_a - 60 + 3V_a + 2V_a = 0$

so $V_a = 60/11 \approx 5.455$ v.

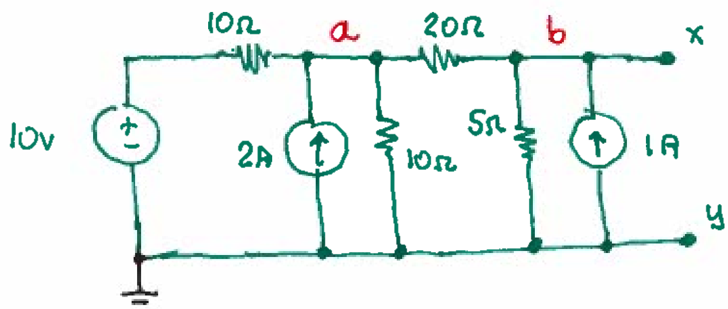
Therefore, $i_{sc} = \dfrac{V_a}{15} = 0.364$ A

and $R_t = \dfrac{V_{oc}}{i_{sc}} = \dfrac{3.478}{0.364} \approx 9.56\Omega$

The Thevenin equivalent circuit



Example 2: Find the Thevenin equivalent



Find V_t. Using node-voltage method, $V_t = V_b$

Node a: $\dfrac{V_a - 10}{10} - 2 + \dfrac{V_a}{10} + \dfrac{V_a - V_b}{20} = 0$

(x20) $2V_a - 20 - 40 + 2V_a + V_a - V_b = 0$

$5V_a - V_b = 60$ (1)