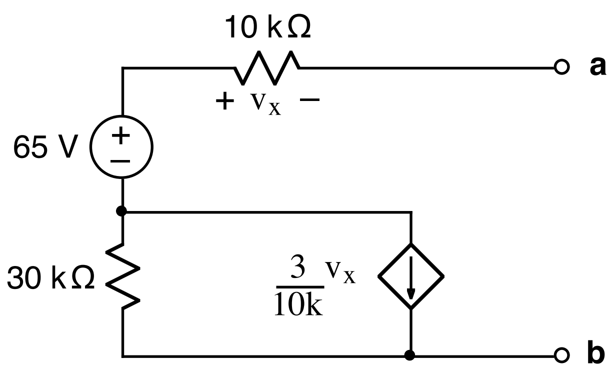
Ex:



a) Find the Thevenin equivalent of the above circuit relative to terminals **a** and **b**.

b) If we attach R_L to terminals **a** and **b**, find the value of R_L that will absorb maximum power.

c) Calculate the value of that maximum power absorbed by R_L.

Sol'n: a) $v_{Th} = v_{a,b}$ open circuit

With nothing across **a** and **b**, no current flows in the 10 kΩ resistor, and $v_x = 0V$.

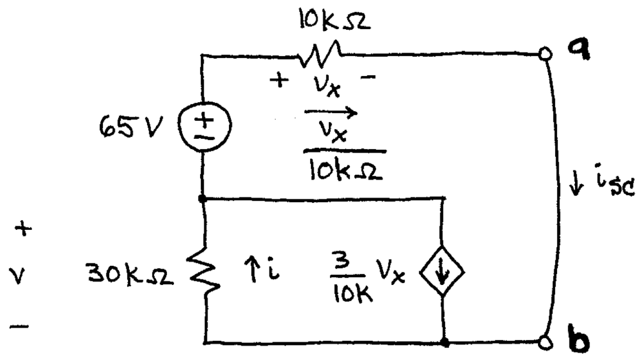
With $v_x = 0$, the dependent source has zero current and disappears.

We are left with the 65 V source and the two resistors in series. Since no current flows in the circuit, the voltage drop across the 30 kΩ resistor is zero volts.

$$\therefore v_{Th} = 65\,V$$

To find R_{Th}, we use $R_{Th} = \dfrac{v_{Th}}{i_{sc}}$

where i_{sc} = current thru short from **a** to **b**.



If we sum currents at the node on the left side, we have

$$i = \frac{v_x}{10k\Omega} + \frac{3}{10k\Omega} v_x = \frac{4}{10k\Omega} v_x$$

This allows us to write the voltage, v, across the $30\,k\Omega$ and the dependent source in terms of v_x:

$$v = -i \cdot 30k\Omega = -\frac{4}{10k\Omega} v_x \cdot 30k\Omega$$

Now we can replace the dependent source with an equivalent R:

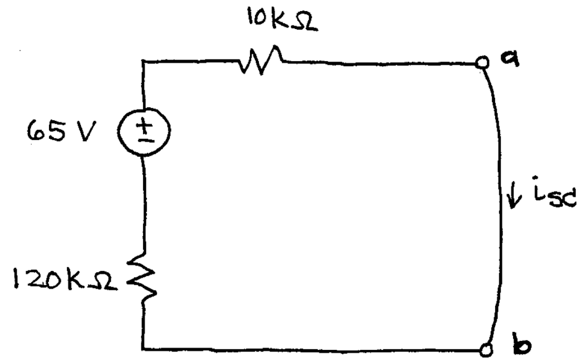
$$R_{eq} = \frac{v}{\frac{3}{10k} v_x} = \frac{-\frac{4}{\cancel{10k\Omega}} \cancel{v_x} \cdot 30k\Omega}{\frac{3}{\cancel{10k}} \cancel{v_x}} = -40k\Omega$$

This R_{eq} in parallel with the $30k\Omega$ gives

$$30k\Omega \| R_{eq} = 30k\Omega \| -40k\Omega = 10k\Omega \cdot 3 \| -4$$

$$30\,k\Omega \,\|\, R_{eq} = 10\,k\Omega \cdot \frac{-12}{-1} = 120\,k\Omega$$

New circuit model:

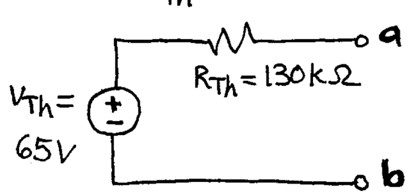


$$i_{sc} = \frac{65\,V}{10\,k\Omega + 120\,k\Omega} = \frac{65\,V}{130\,k\Omega} = \frac{1}{2}\,mA$$

$$\therefore\ R_{Th} = \frac{v_{Th}}{i_{sc}} = \frac{65\,V}{\frac{1}{2}\,mA} = 130\,k\Omega$$

Note: The method we used to find R_{eq} actually works all the time, and we have the above circuit, (without the short across **a** and **b**), as the equivalent of the original circuit.

With the equivalent circuit, we see that $V_{Th} = 65\,V$ and $R_{Th} = 10\,k\Omega + 120\,k\Omega$.



b) $R_L = R_{Th} = 130\,k\Omega$ for max pwr xfer

c) $$P_{max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{(65V)^2}{4 \cdot 130k\Omega} = \frac{65}{4 \cdot 2}\ mW$$

$$P_{max} = \frac{65}{8}\ mW = 8.125\ mW$$