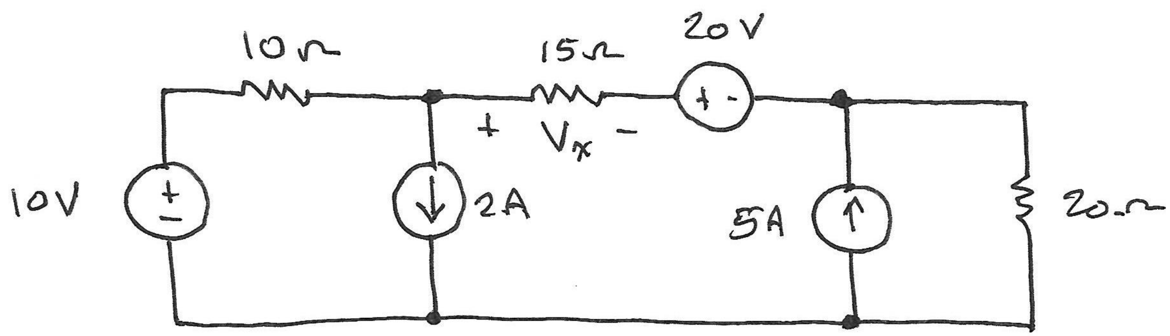
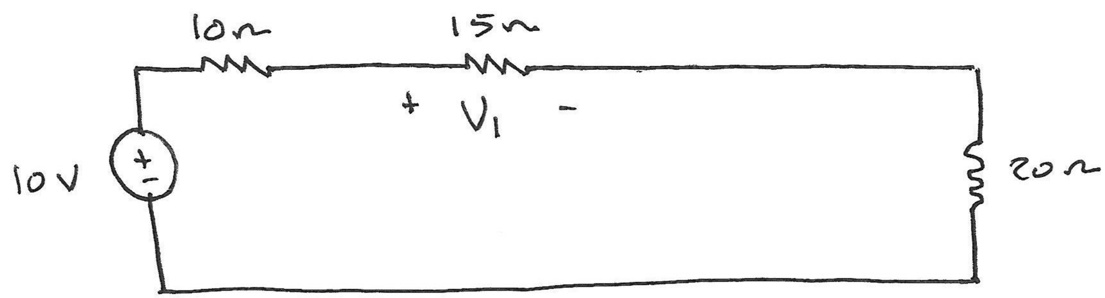
Superposition Example 1



Determine the value of V_x using superpositio

Circuit 1:

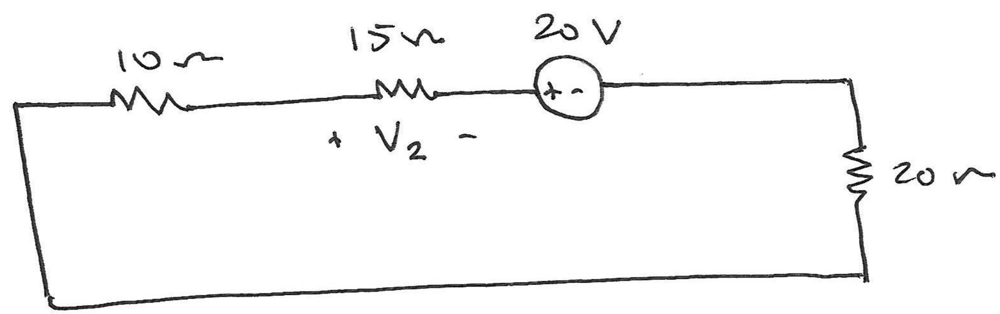


$$V_1 = \frac{15\Omega}{10\Omega + 15\Omega + 20\Omega} \cdot 10$$

$$= \frac{15}{45} \cdot 10$$

$$= \frac{10}{3} \text{ V}$$

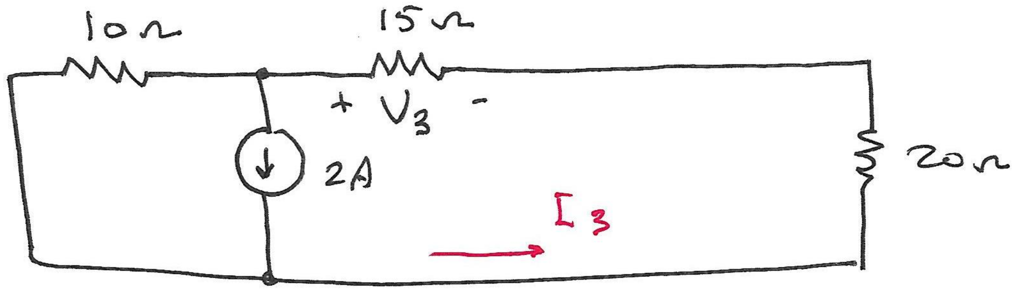
Circuit 2:



$$V_2 = -\frac{15\Omega}{45\Omega} \cdot 20\text{V}$$

$$= -\frac{20}{3} \text{ V}$$

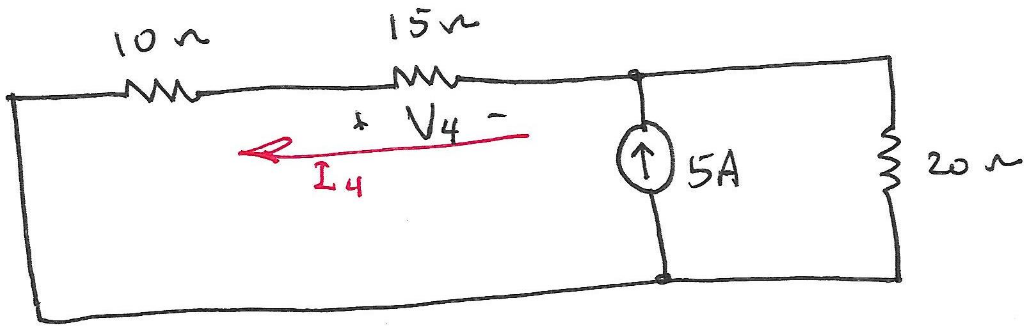
Circuit 3:



$$I_3 = \frac{10\,\Omega}{10\,\Omega + 35\,\Omega} \cdot 2A = \frac{10}{45} \cdot 2\,A = \frac{2}{9} \cdot 2\,A = \frac{4}{9}\,A$$

$$V_3 = -(15\,\Omega)\,I_3 = -\frac{60}{9}\,V = -\frac{20}{3}\,V$$

Circuit 4:

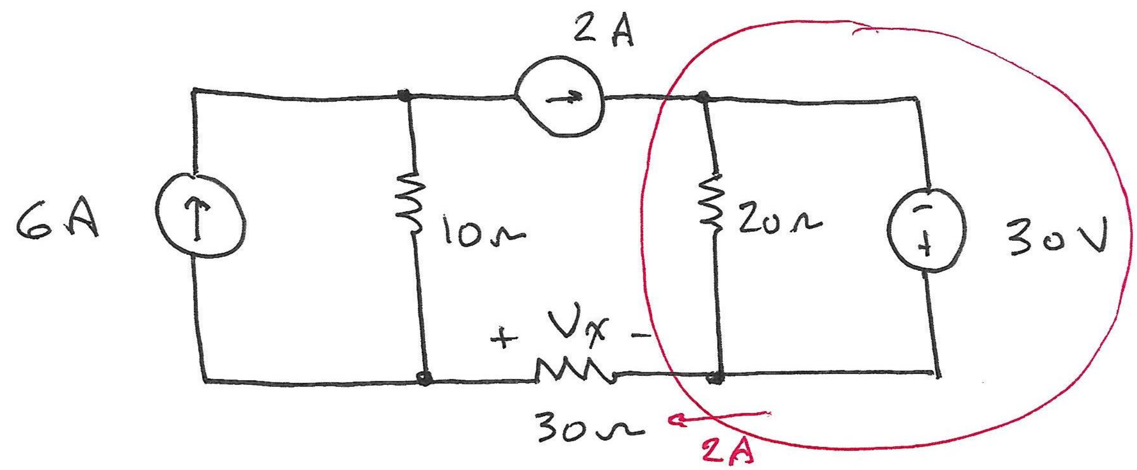


$$I_4 = \frac{20\,\Omega}{45\,\Omega} \cdot 5\,A = \frac{20}{9}\,A$$

$$V_4 = -(15\,\Omega)(I_4) = -\frac{300}{9} = -\frac{100}{3}\,V$$

$$V_x = V_1 + V_2 + V_3 + V_4 = \frac{10}{3} - \frac{20}{3} - \frac{20}{3} - \frac{100}{3} = -\frac{130}{3}\,V$$

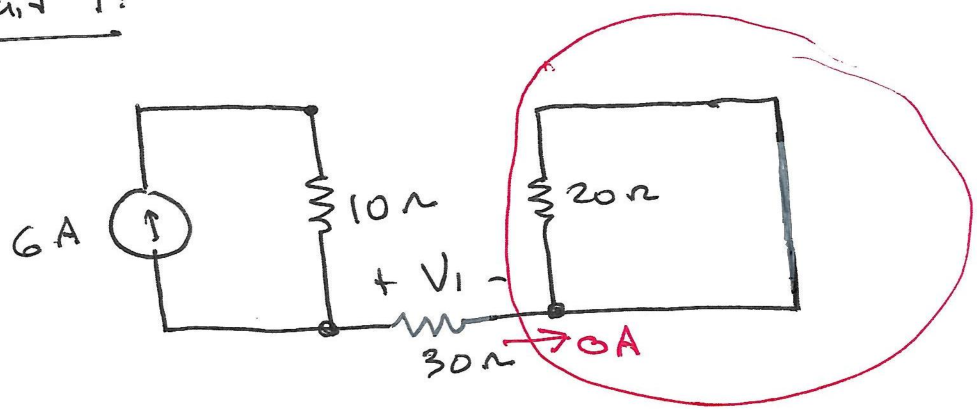
Superposition Example 2:



$V_x = -(30\Omega)(2$

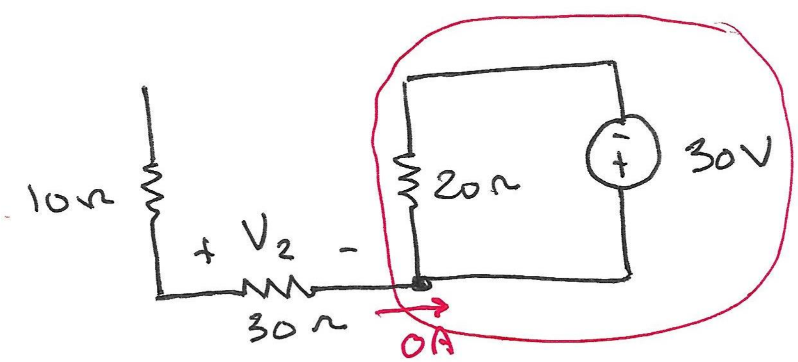
$= -60V$

Circuit 1:



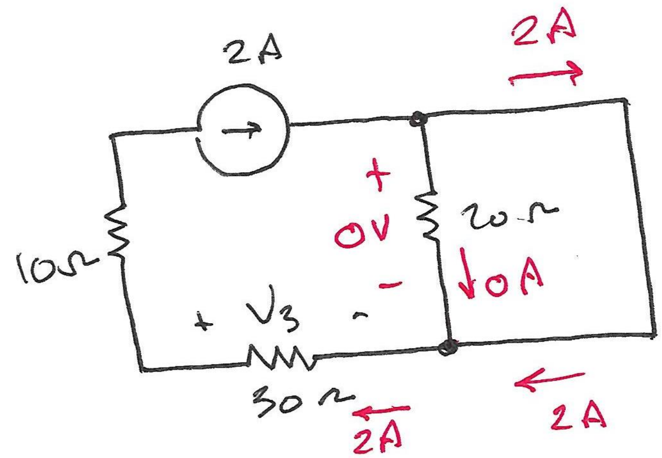
$V_1 = 0$

Circuit 2:



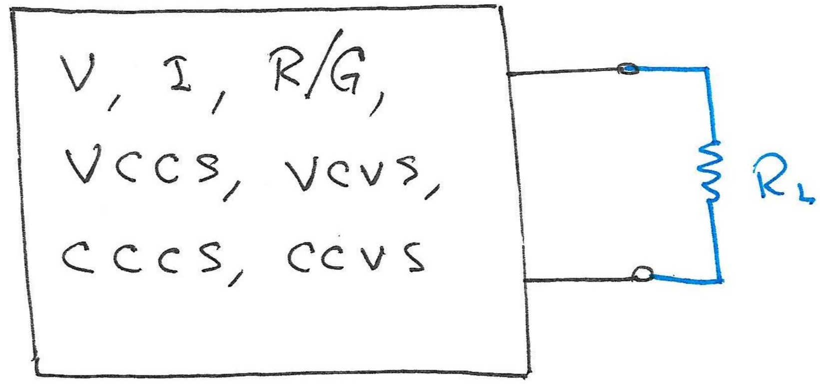
$V_2 = 0$

Circuit 3:

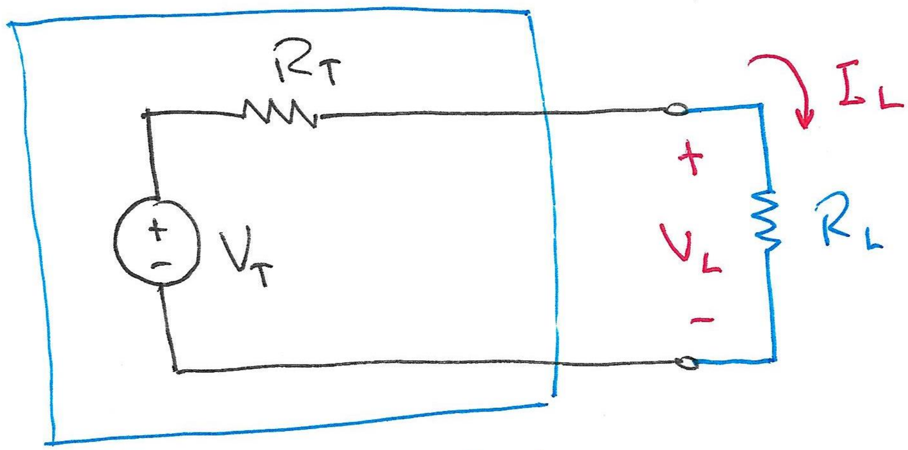


$$V_3 = -(30\Omega)(2A)$$

$$= -60\,V$$



What value of R_L will absorb maximum power?



Thévenin equivalent circuit of the box.

R_L is called the load resistor.

$$I_L = \frac{V_T}{R_T + R_L}$$

$$V_L = \frac{R_L}{R_T + R_L} V_T$$

$$P_L = V_L I_L = \frac{R_L V_T^2}{(R_T + R_L)^2}$$

$$P_L = \frac{R_L V_T^2}{(R_T + R_L)^2}$$

What value of R_L makes P_L a maximum?

$$\frac{dP_L}{dR_L} = \frac{(R_T + R_L)^2 V_T^2 - 2 R_L V_T^2 (R_T + R_L)}{(R_T + R_L)^4}$$

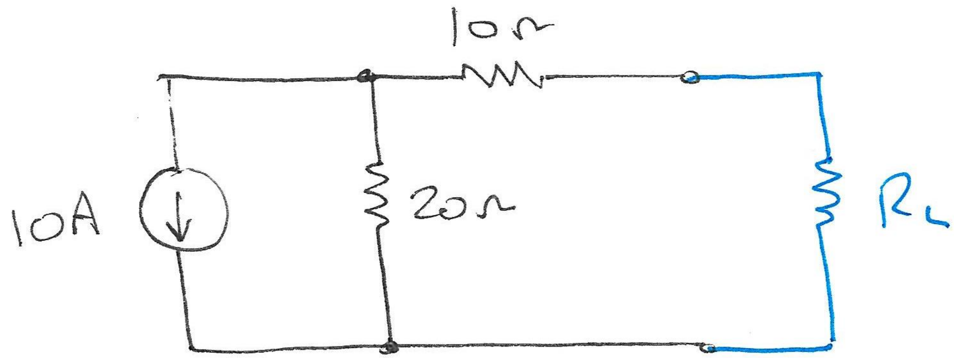
Set $\frac{dP_L}{dR_2} = 0$ and solve for R_L.

$$(R_T + R_L)^{\cancel{2}} \cancel{V_T^2} - 2 R_L \cancel{V_T^2} (\cancel{R_T + R_L}) = 0$$

$$R_T + R_L - 2 R_L = 0$$

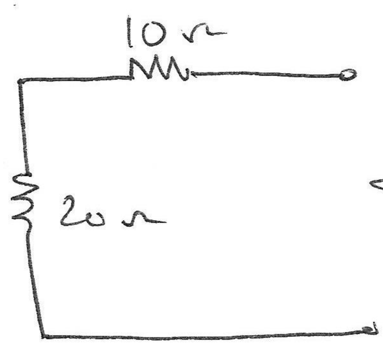
$R_L = R_T$ for maximum power delivered to the load.

$$\boxed{\begin{array}{c} \text{Maximum Power Transfer Theorem} \\ \text{Choose } R_L = R_T = R_N \text{ for} \\ \text{maximum power delivered to the load} \end{array}}$$



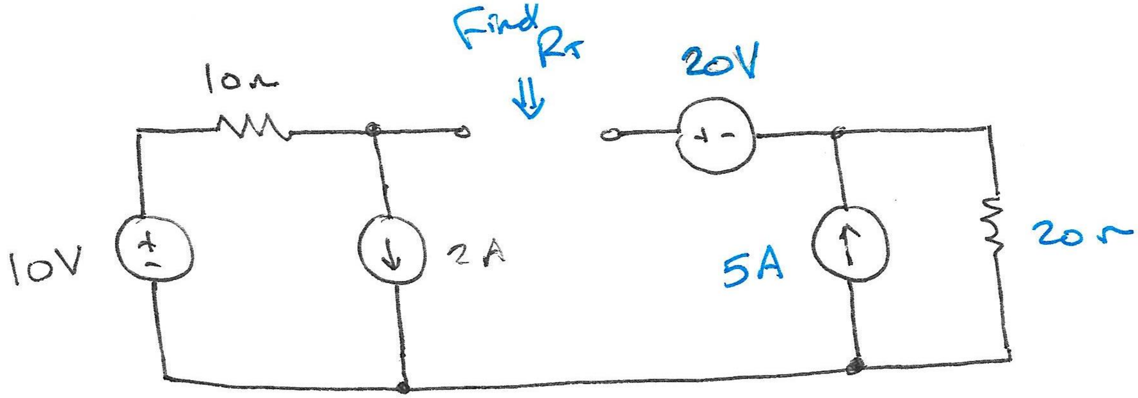
Choose R_L to absorb maximum power.

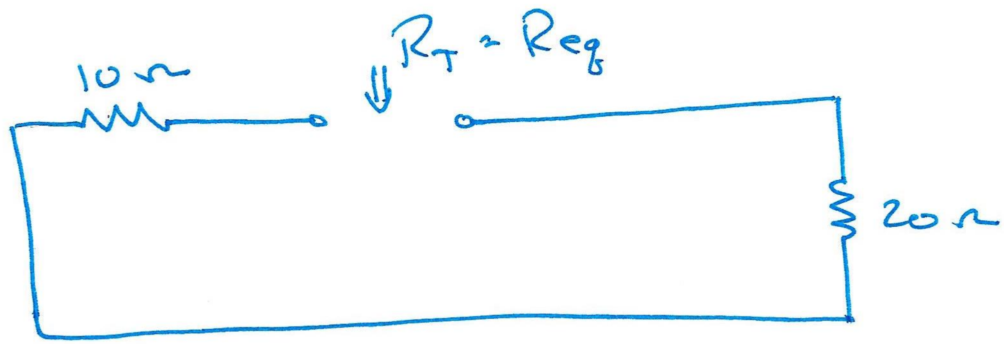
To find R_T or R_N, turn off the 10A source and calculate the equivalent resistance w.r.t. the output terminals.



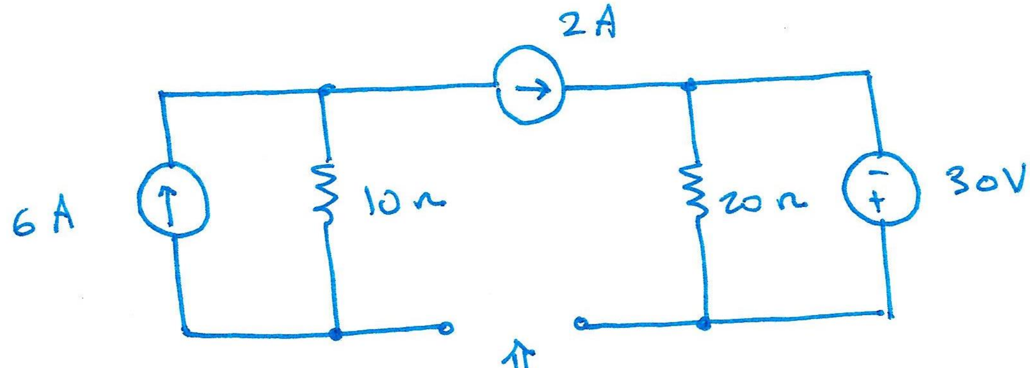
$\Leftarrow R_{eq} = 30\Omega$

$R_T = R_N = R_{eq}$



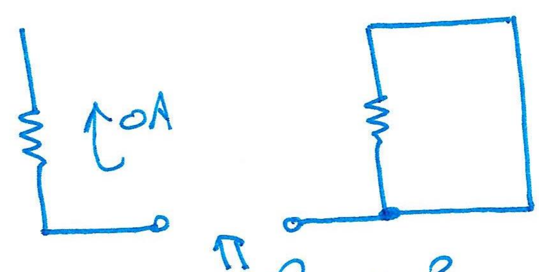


$$R_T = 10\Omega + 20\Omega = 30\Omega$$



Find R_T

Turn off all independent sources:



$R_{eq} = ?$

$= \infty$

$$\ddot{x} + 2\dot{x} + 3x = 0$$

Can we build a circuit that will solve this Ordinary Differential Equation (ODE)?