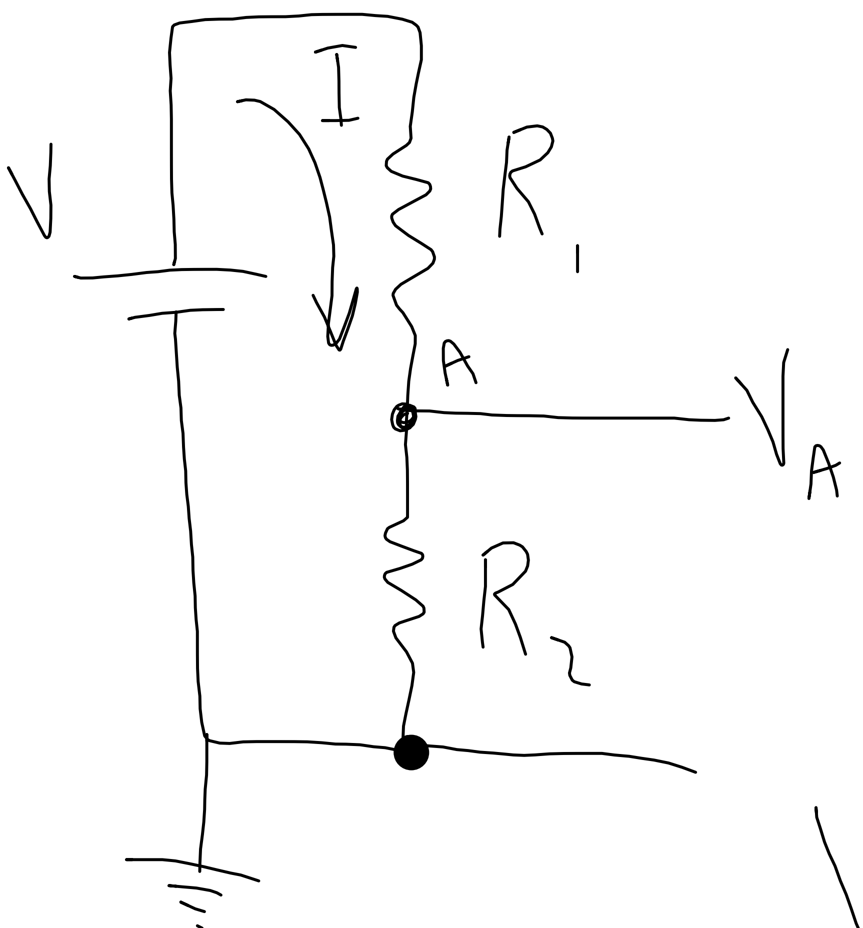
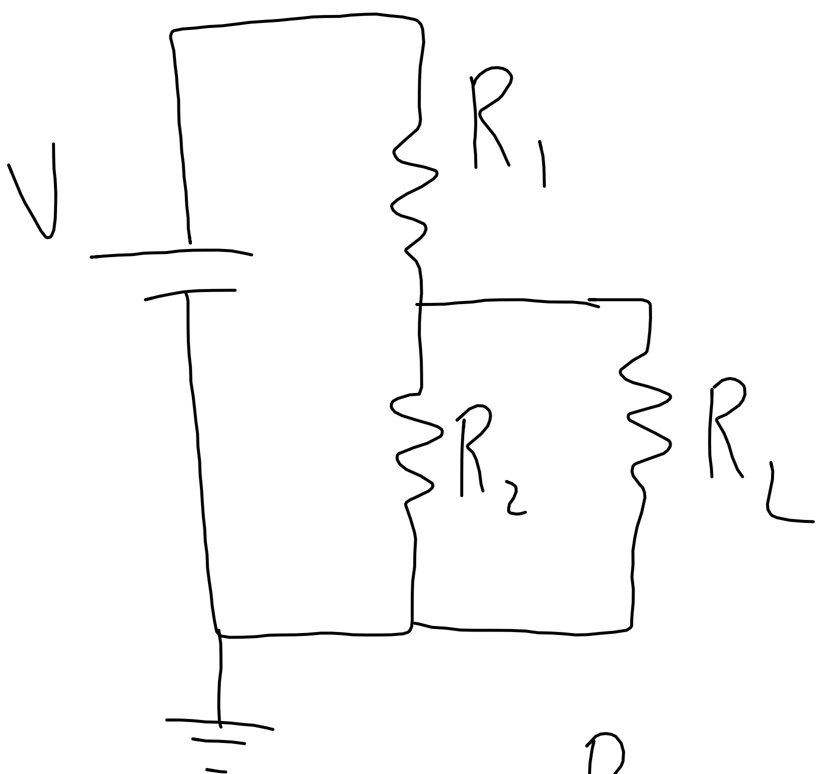
Voltage Divider



$$R_{eq} = R_1 + R_2 \qquad I = \frac{V}{R_1 + R_2}$$

$$V_A - 0 = I R_2$$

$$V_A = \frac{V}{R_1 + R_2} R_2 = V \left(\frac{R_2}{R_1 + R_2} \right)$$



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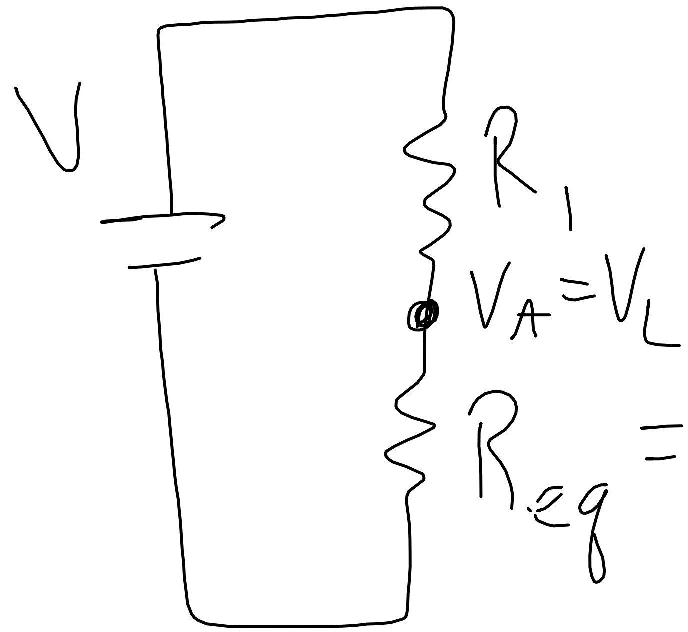
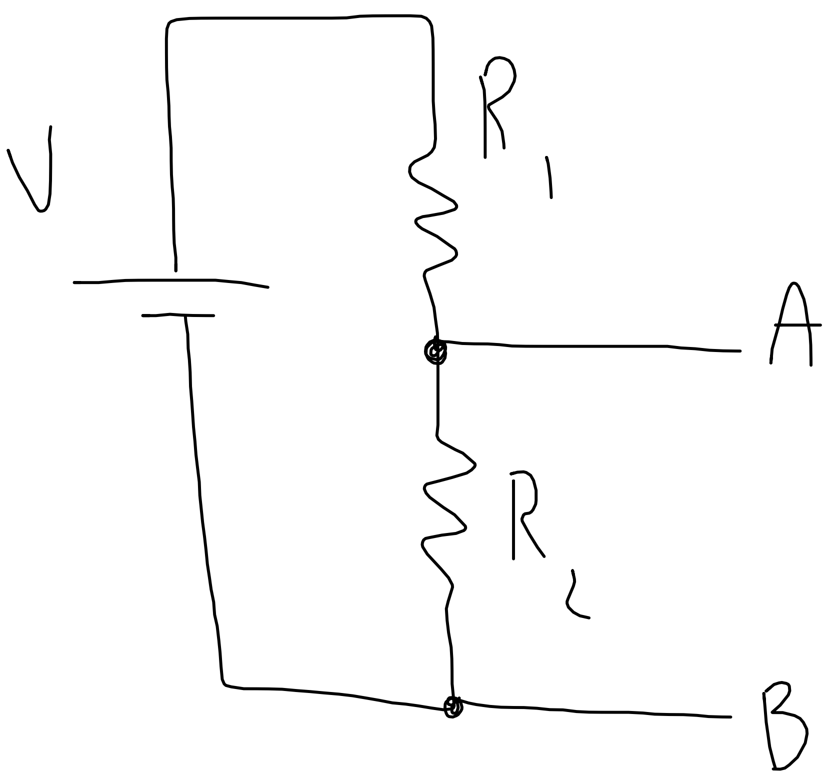


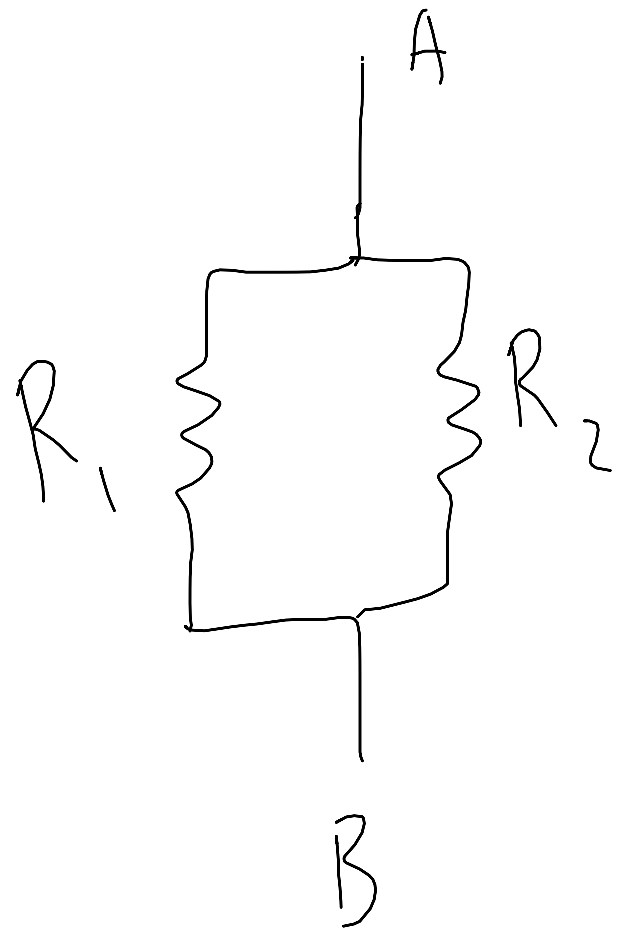
$$R_{eq} = \frac{R_2 R_L}{R_2 + R_L}$$

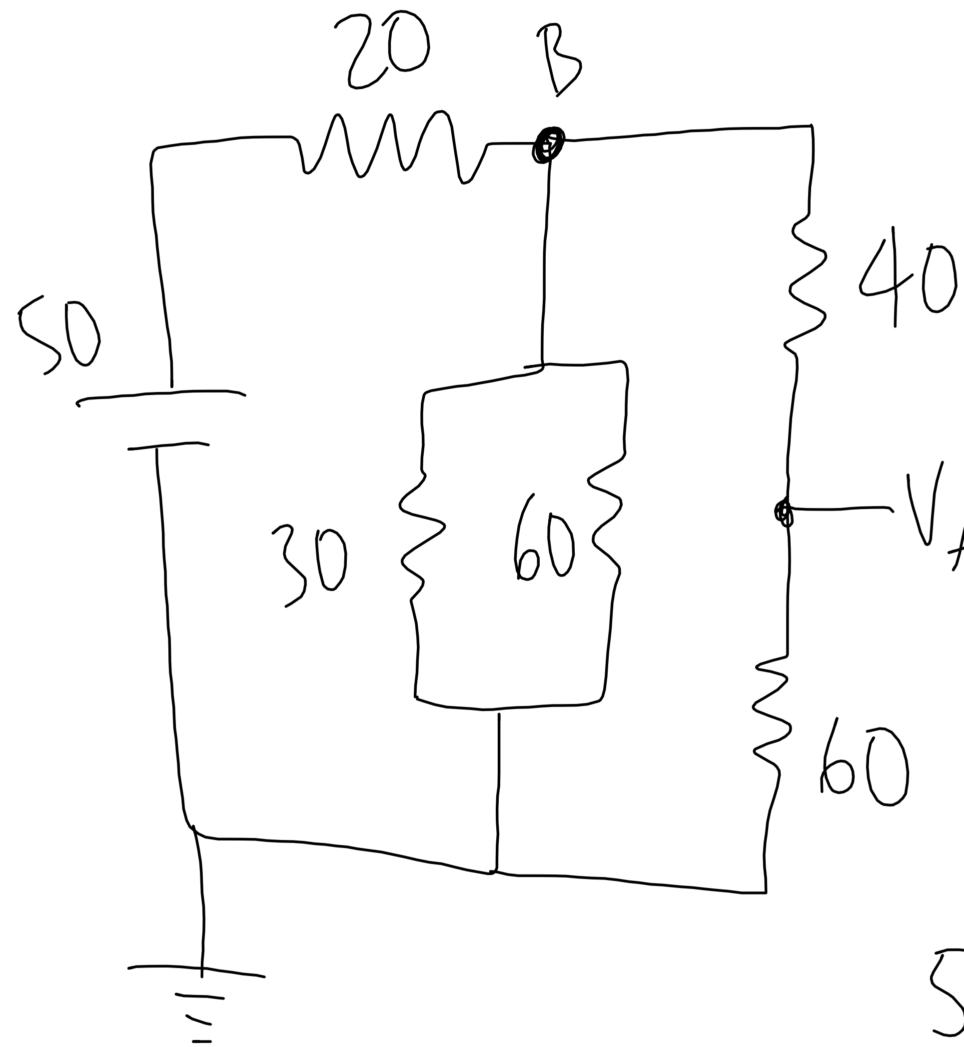
$$V_L = V \frac{R_{eq}}{R_1 + R_{eq}} = \frac{R_2 R_L / (R_2 + R_L)}{R_1 + \frac{R_2 R_L}{R_2 + R_L}}$$

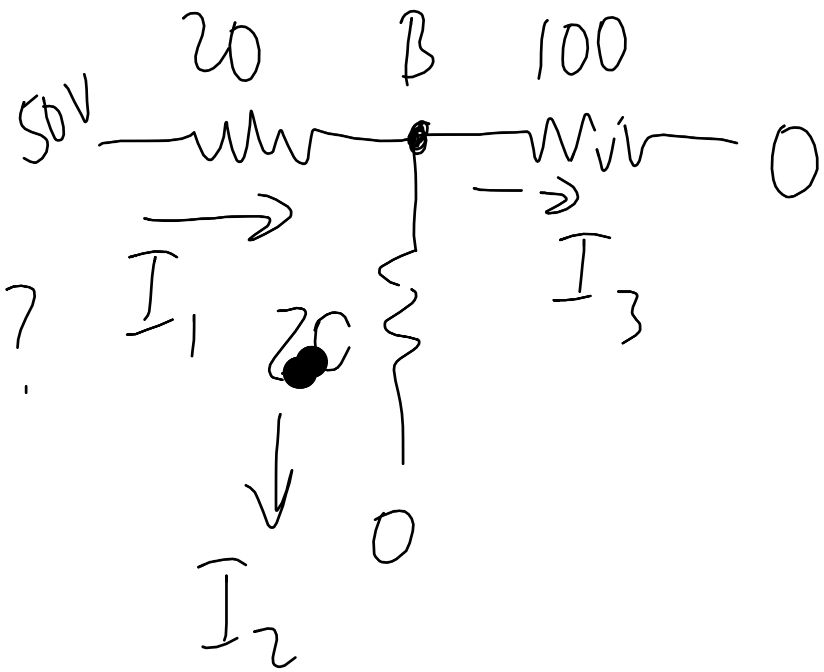
$$P_L = \frac{V_L^2}{R_L} \Rightarrow \text{Mathematica}$$

Take $\frac{dP_L}{dR_L} = 0 \Rightarrow R_L = \frac{R_1 R_2}{R_1 + R_2}$









$$50 - V_B = I_1 20$$

$$V_B = I_2 20$$

$$V_B = I_3 100$$

$$I_1 = I_2 + I_3$$

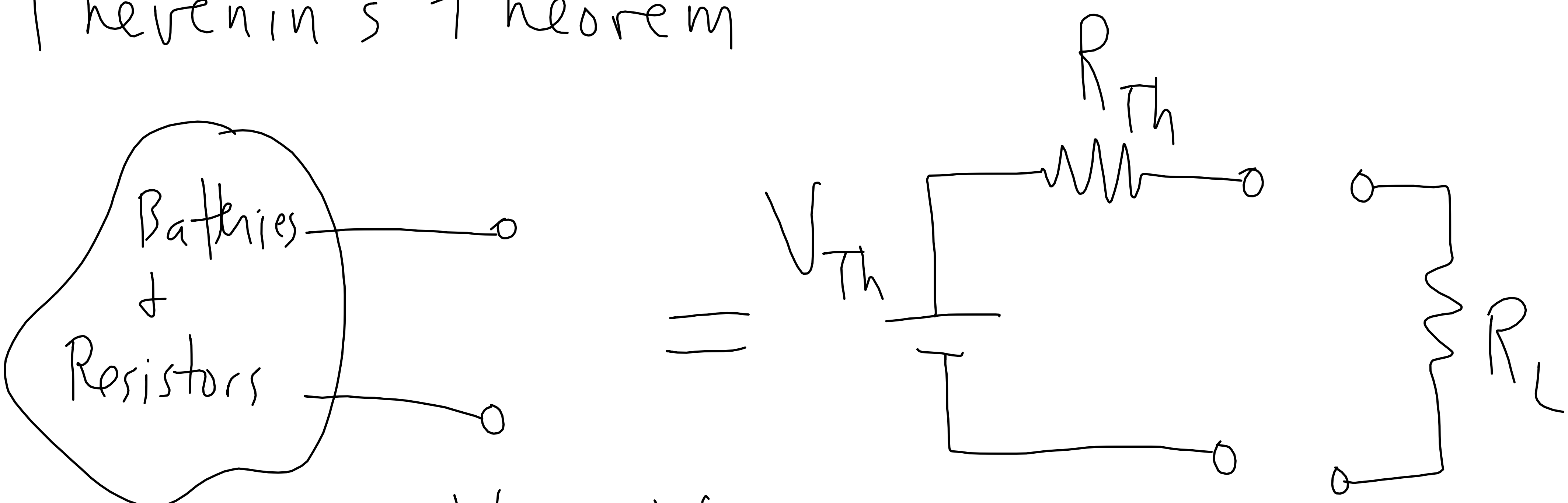
$$\frac{1}{R_{eq}} = \frac{1}{30} + \frac{1}{60} = \frac{3}{60}$$

Math: $V_B = 22.73$

$$V_A = .6 V_B = 13.64 \text{ V}$$

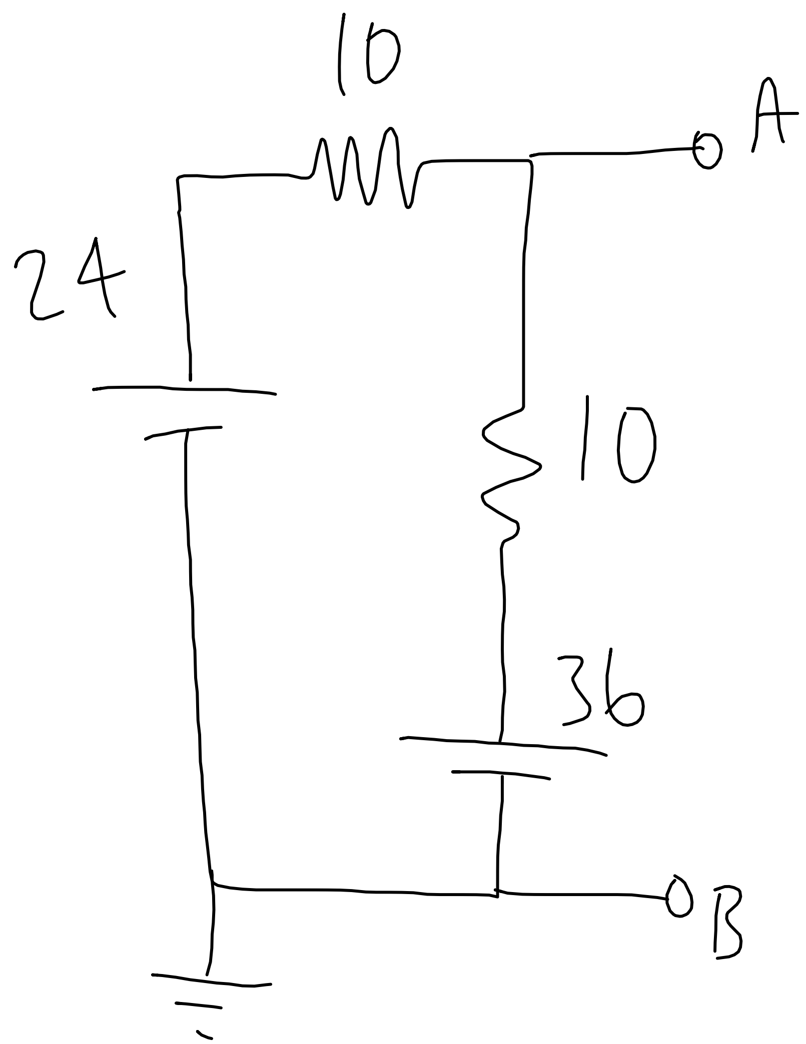
Attach load R_L between A & ground, & everything changes!

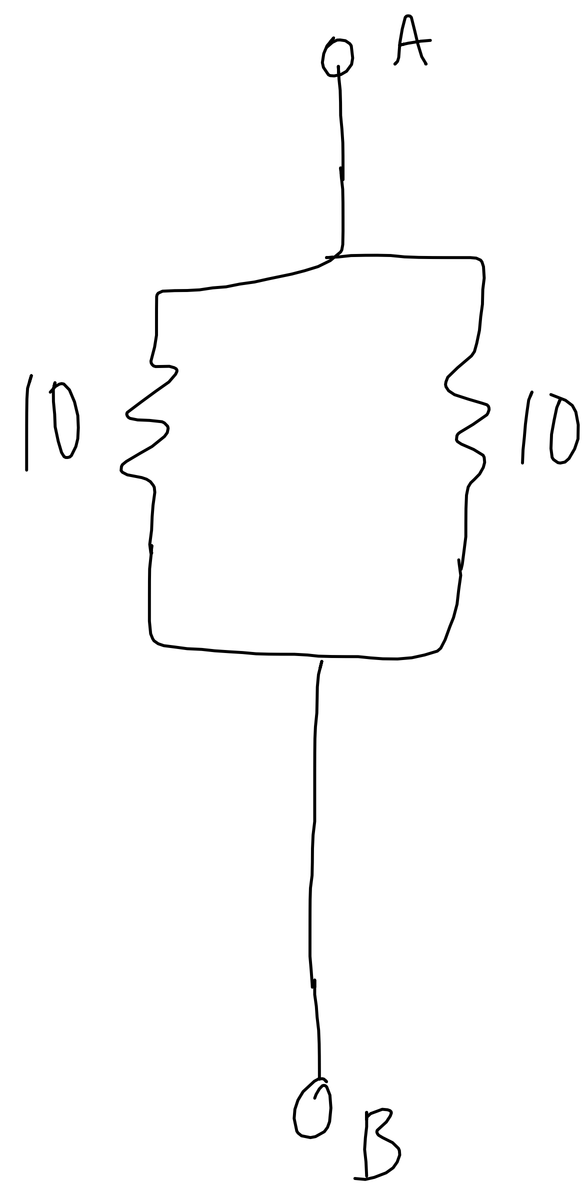
Thevenin's theorem



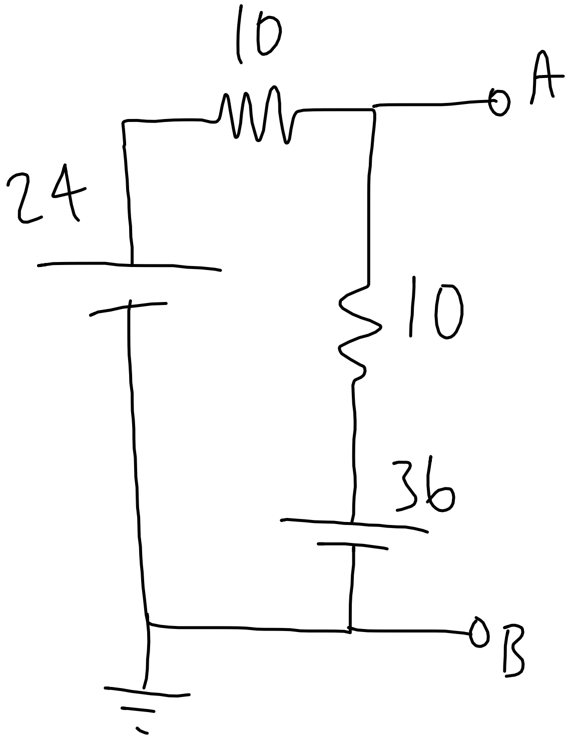
$V_{Th} = V_{\text{open circuit}}$

$R_{Th} = R$ that world sees looking in (with all batteries shorted)



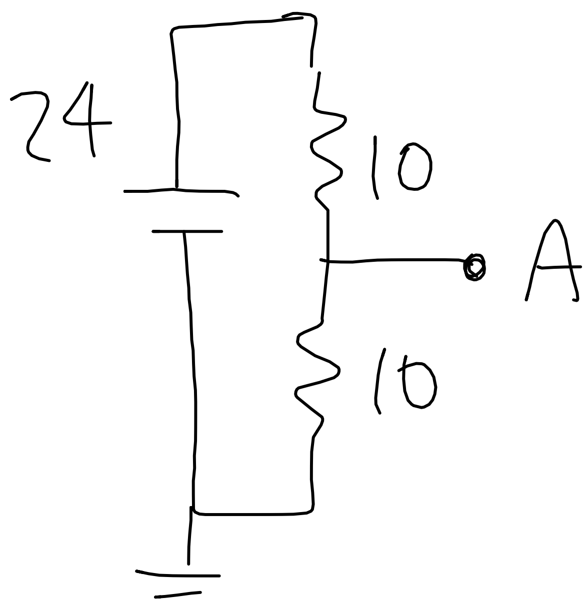


$R_{Th} = 5\,\Omega$



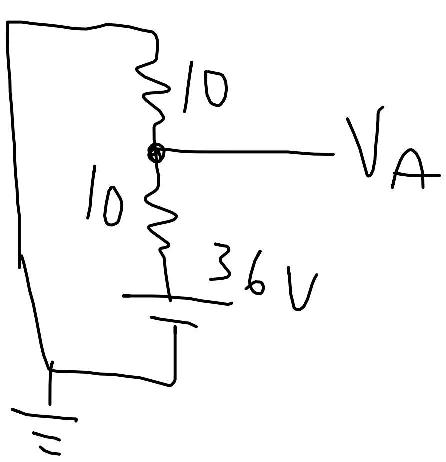
Use superposition to get V_A

1. Turn off 36V (short it)



$V_A = 12V$ (just from 24V source)

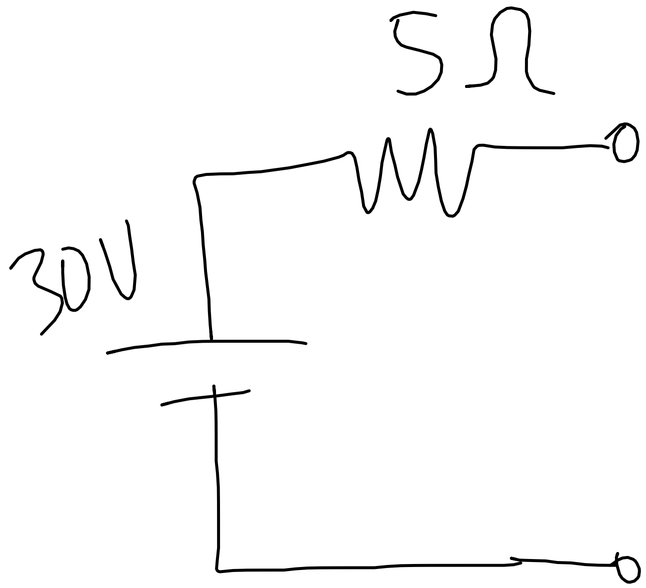
2. Turn off 24 V, turn on 36 V



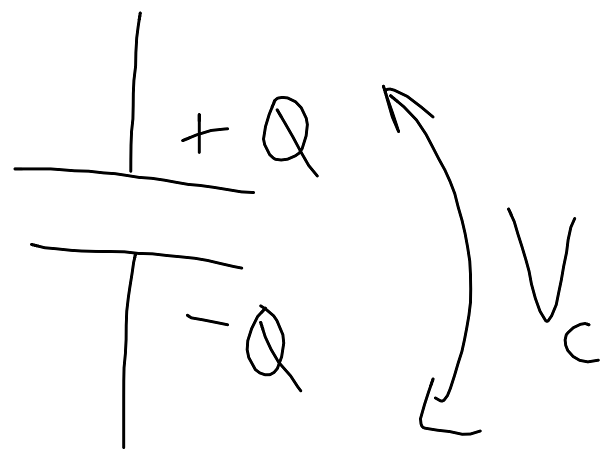
$V_A = 18$

Add them:

$V_A = 30V$



Capacitors



$$C = \frac{Q}{V_c}$$

$$\frac{dV_c}{dt} = \frac{1}{C}\frac{dQ}{dt} = \frac{I}{C} \qquad V_c = \frac{1}{C}\int I \, dt + \text{Const}$$

Suppose $I(t) = I_p \sin(\omega t)$ $\omega = 2\pi f$

$$V_c = \frac{1}{C} \int I_p \sin \omega t \, dt + \text{Const}$$

$$= \frac{-1}{\omega C} I_p \cos \omega t + \text{const}$$

$$= \frac{1}{\omega C} I_p \sin\left(\omega t - \pi/4\right) + \text{const}$$

!

If capacitor is ohmic...

$$R_c = \frac{V_c}{I_c} = \frac{-\frac{1}{\omega C} I_p \cos \omega t}{I_p \sin \omega t}$$

$$= -\frac{1}{\omega C} \tan \omega t \ ?$$

No phase info in this approach!