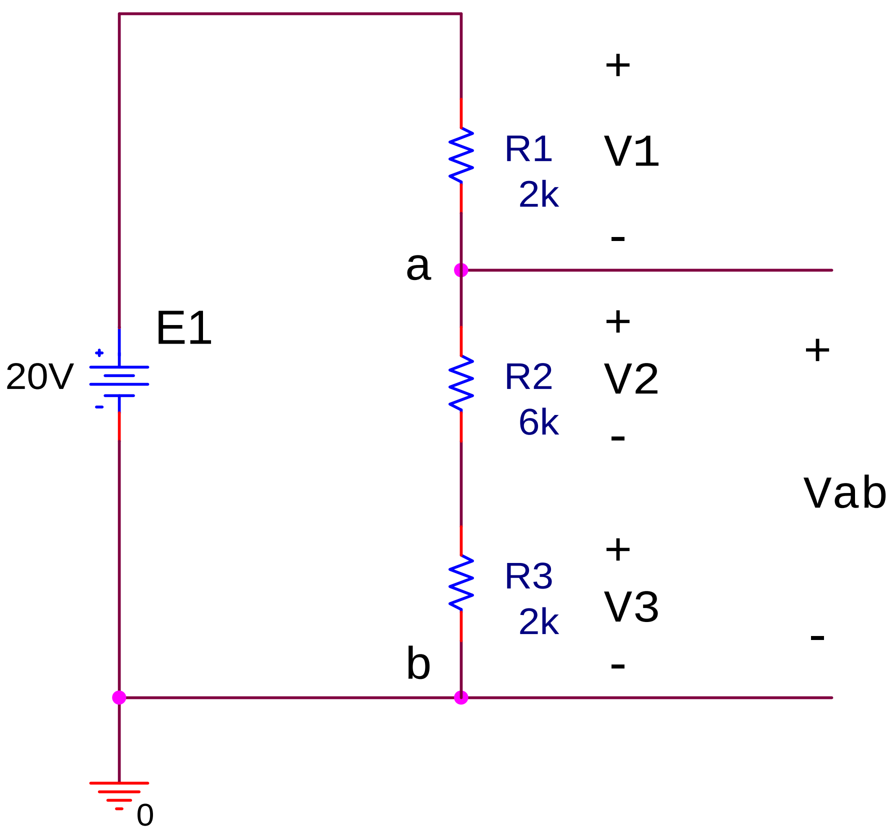
Voltage Divider Rule

- The voltage across resistive elements in a series circuit will divide as the magnitude of resistance levels
  - Series: Same "I"
  - More "R" => More "V"

Voltage Divider Rule

- Example – Find V_1, V_2, V_3, V_{ab}



$$I_1 = \frac{20V}{R_T} = \frac{20V}{10\,k\Omega} = 2\,mA$$

Leaving E1

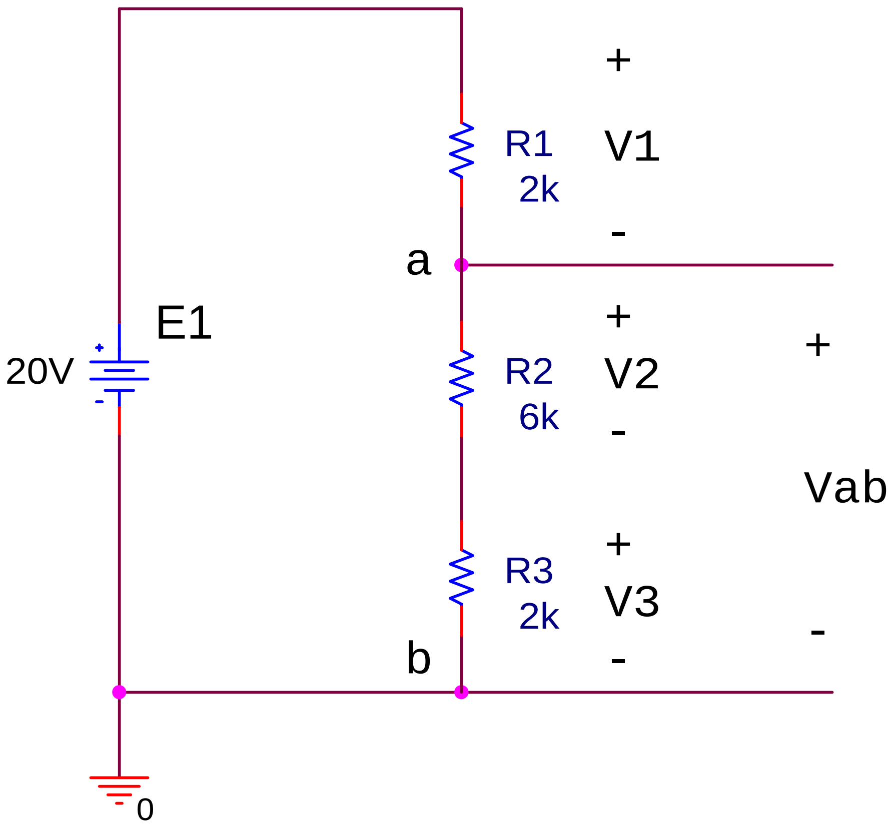
$$V_1 = V_3 = 2\,mA \cdot 2\,k\Omega = 4\,V$$

$$V_2 = 2\,mA \cdot 6\,k\Omega = 12\,V$$

$$V_{ab} = V_2 + V_3 = 16\,V$$

Voltage Divider Rule

- Example – Find V1, V2, V3, Vab



$$V_1 = \frac{R_1}{R_T} \cdot E_1 = \frac{2\,\mathrm{k}\Omega}{10\,\mathrm{k}\Omega} \cdot 20\,\mathrm{V}$$

$$= 4\,\mathrm{V}$$

$$V_2 = \frac{R_2}{R_T} \cdot E_1 = \frac{6\,\mathrm{k}\Omega}{10\,\mathrm{k}\Omega} \cdot 20\,\mathrm{V}$$

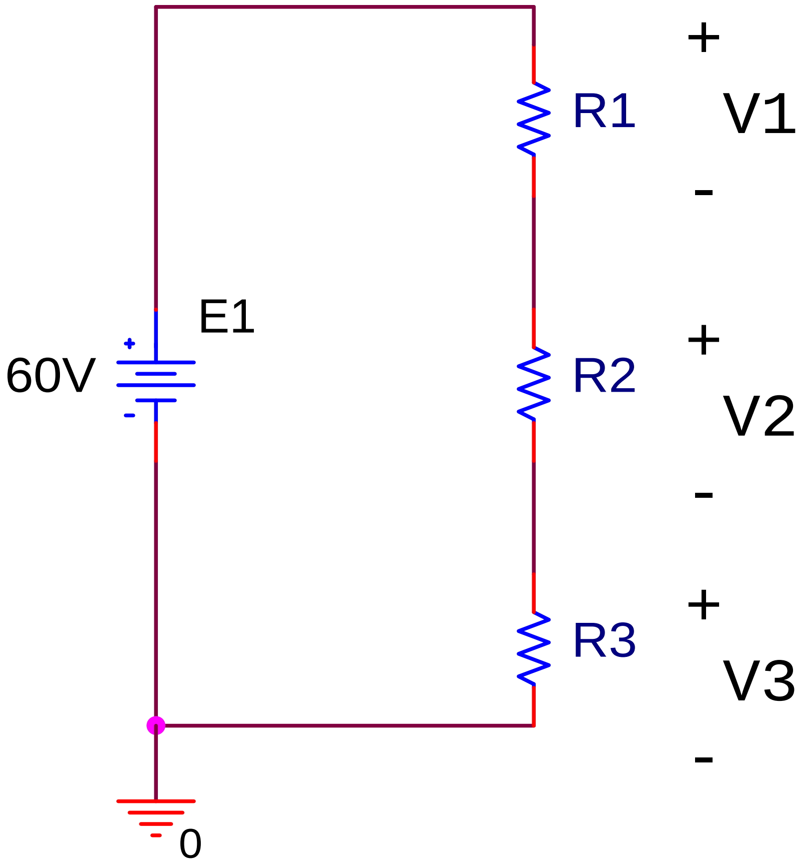
$$= 12\,\mathrm{V}$$

$$V_{ab} = \frac{R_{ab}}{R_T} \cdot E_1 = \frac{8\,\mathrm{k}\Omega}{10\,\mathrm{k}\Omega} \cdot 20\,\mathrm{V}$$

$$= 16\,\mathrm{V}$$

Breakout #1

- Find V_1, V_2, and V_3 given:

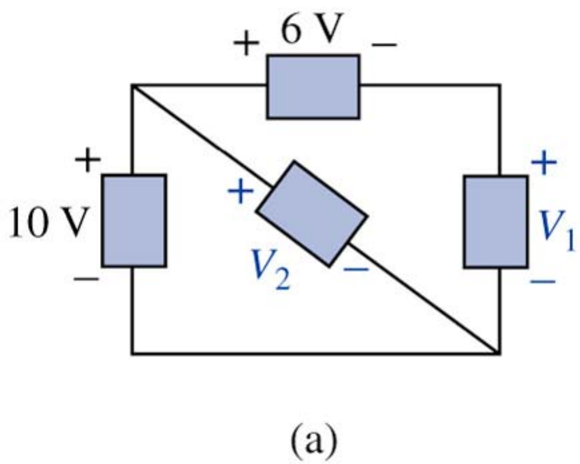


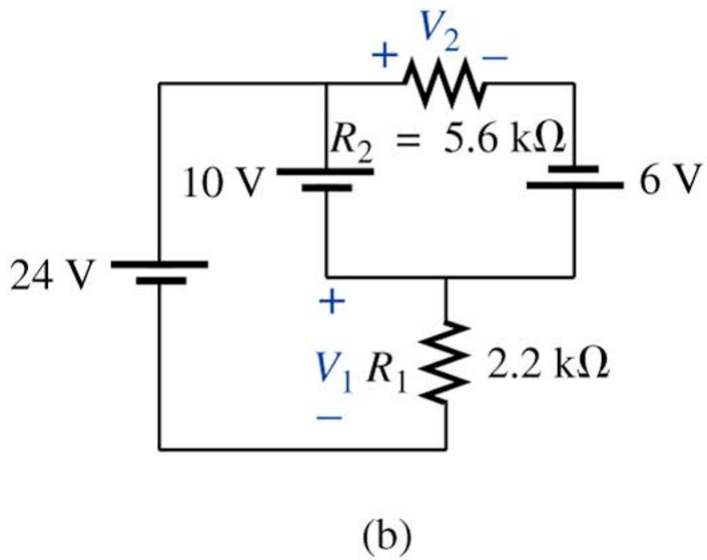
$$R_1 = 2 \cdot R_3$$

$$R_2 = 7 \cdot R_3$$

Breakout #2 - KVL

- Find V1 and V2 in the circuits shown below

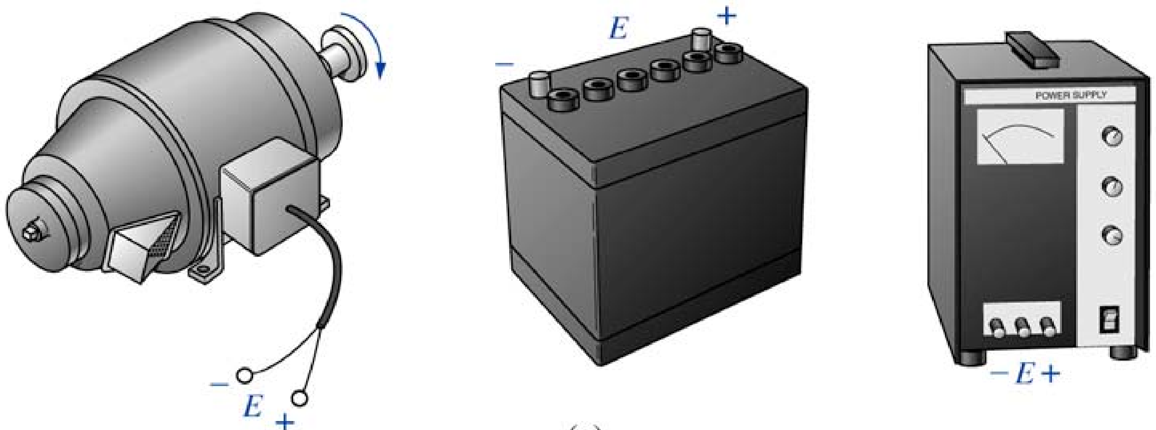




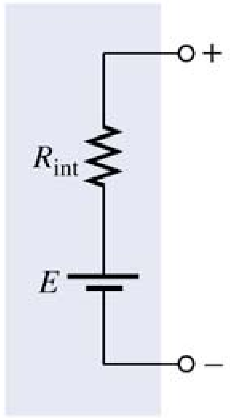
Practical (non-ideal) Voltage Sources

- The ideal voltage source has no internal resistance and thus delivers an output voltage of “E” volts with no load or under full load.
- Every practical voltage source (generator, battery, or laboratory supply) has some *internal equivalent* resistance.
- The voltage drop across the internal equivalent resistance lowers the source output voltage when a load is connected.

Practical (non-ideal) Voltage Sources



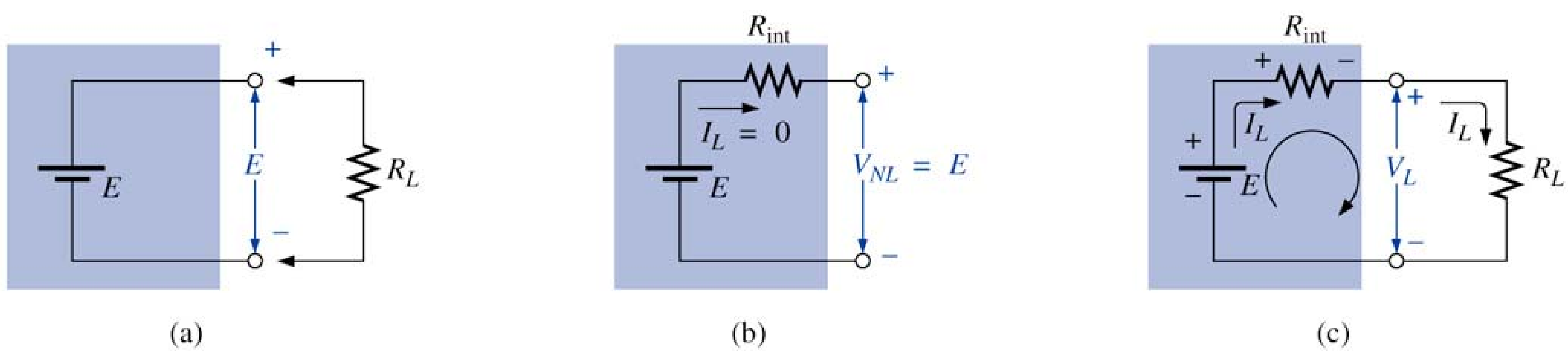
(a)



(b)

Practical (non-ideal) Voltage Sources

IDEAL Source | Practical Source | Practical Source w/Load



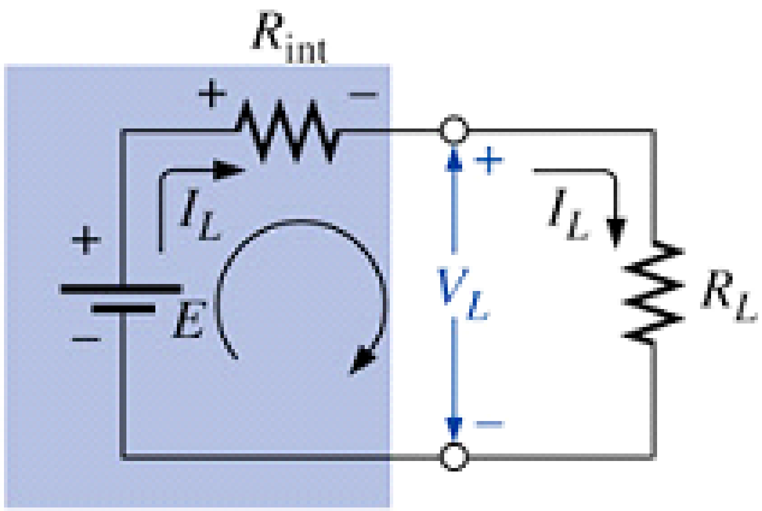
$$V_L = E$$

$$V_{NL} = E$$

$$V_L = E \cdot \frac{R_L}{R_L + R_{int}}$$

$$E - V_{Rint} - V_L = 0$$

Practical Voltage Sources – Finding R_{int}



$$R_{int} = \frac{E - V_L}{I_L}$$

But

$$E = V_{NL} \text{ and } \frac{V_L}{I_L} = R_L$$

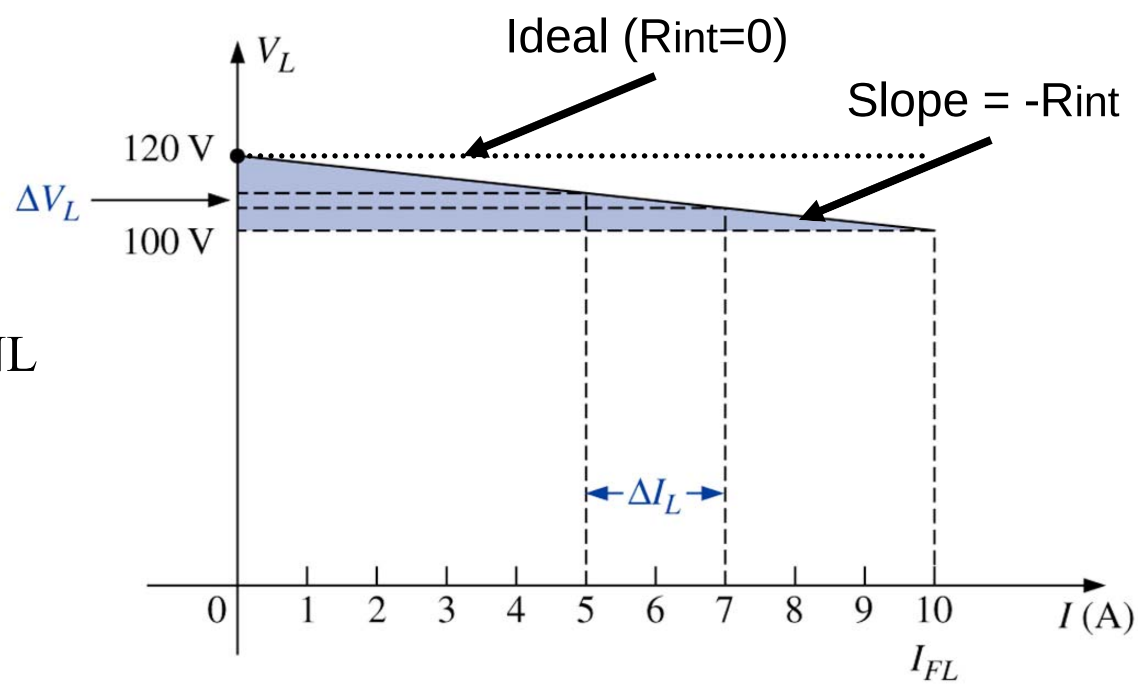
$$\therefore R_{int} = \frac{V_{NL}}{I_L} - R_L$$

Practical Voltage Sources – Regulation

$$E - V_{Rint} - V_L = 0$$

Rearranging:

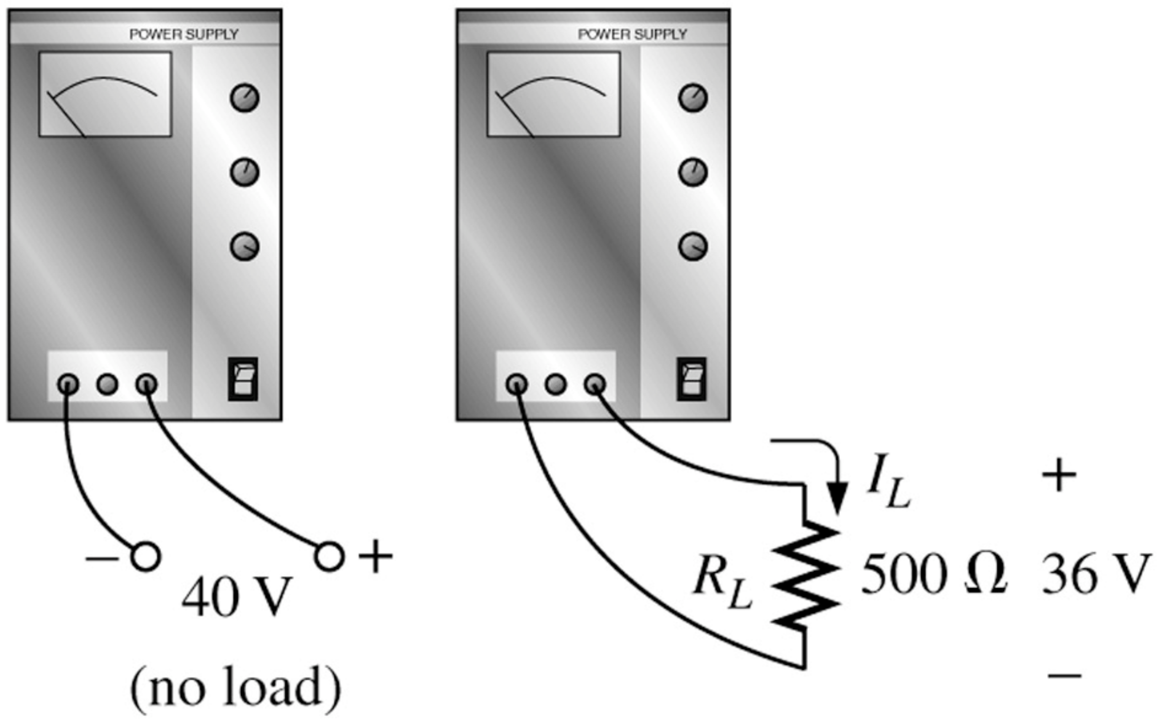
$$\underset{Y}{V_L} = \underset{m}{-R_{int}} \cdot \underset{X}{I_L} + \underset{b}{V_{NL}}$$



$$\therefore R_{int} = \left| \frac{\Delta V_L}{\Delta I_L} \right|$$

Breakout #3 – Rint

- Find the internal resistance of the source, Rint



(a) (b)