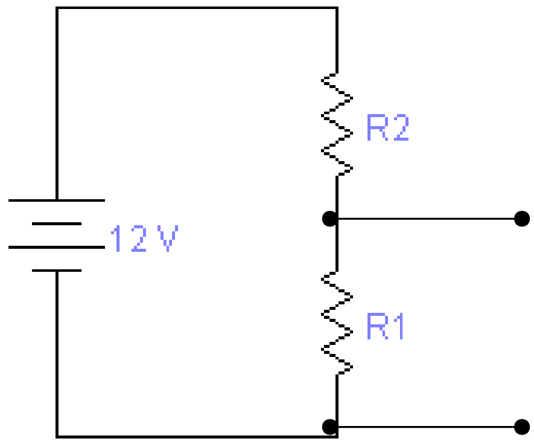
Class 3 2/16/08 Good Lab. Practice

- Make circuits neat
- Check the circuit before turning on power, and turn power if you need change circuit elements.
- Do not touch the circuit with bare hand when power is on.
- Make sure the grounding is good
- When using meters, start with large range first
- Do not short voltage source or open current source.

Example: voltage divider

If you want to use your car battery (12 V) to power your laptop computer which requires 3V power supplier, how would you do it.



$$v_1 = \frac{R_1}{R_{EQ}} \times 12$$

$$3 = \frac{R_1}{R_1 + R_2} \times 12$$

$$R_1 = \frac{R_2}{3}$$

Ammeter

- Ammeter:
  - measure current,
  - put in series,
  - The lower the internal resistance is, the better the meter is

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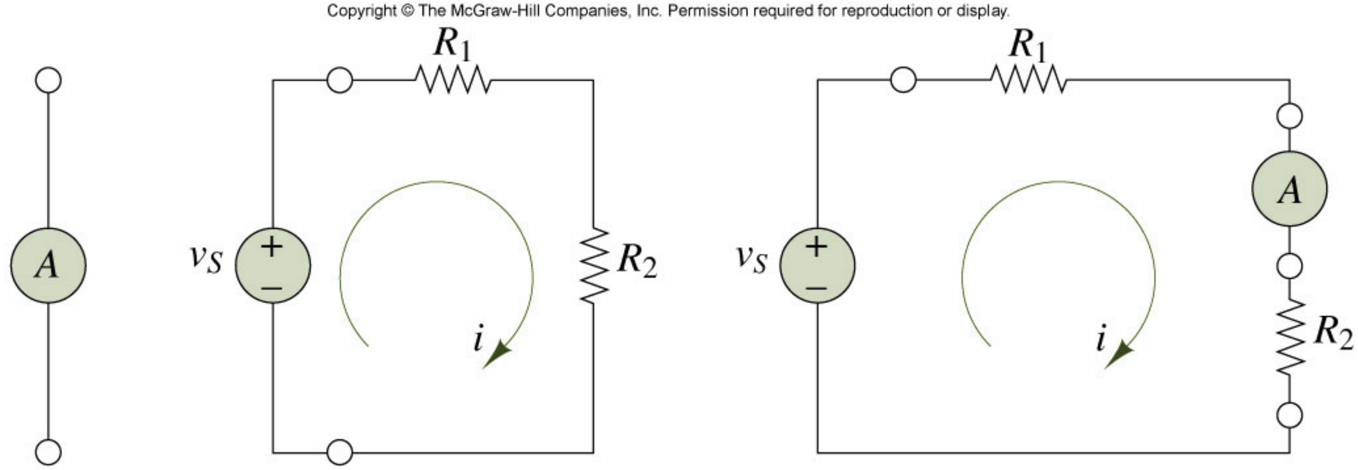

Symbol for ideal ammeter

A series circuit

Circuit for the measurement of the current i

Practical voltage sources

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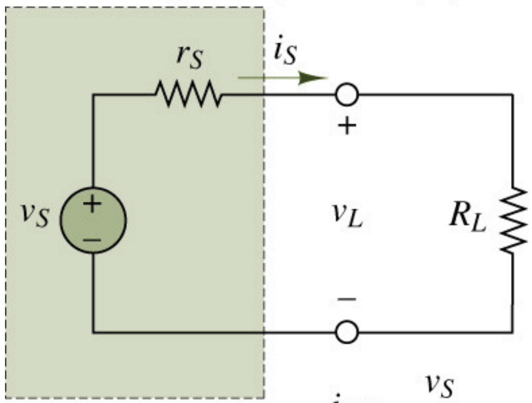
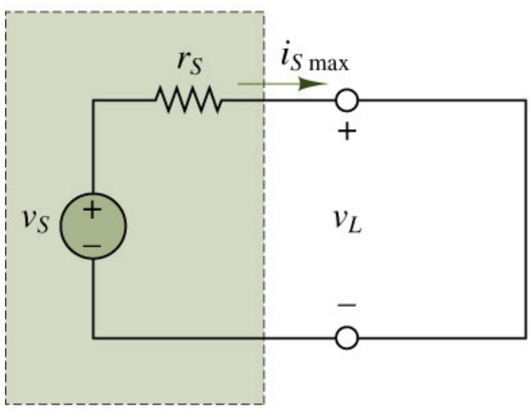


Practical voltage source

$$i_S = \frac{v_S}{r_S + R_L}$$

$$\lim_{R_L \to 0} i_S = \frac{v_S}{r_S}$$



The maximum (short circuit) current which can be supplied by a practical voltage source is

$$i_{S\,\max} = \frac{v_S}{r_S}$$

Ideal voltage source: $r_s=0$

$$i_S = \frac{v_S}{r_S + R_L}$$

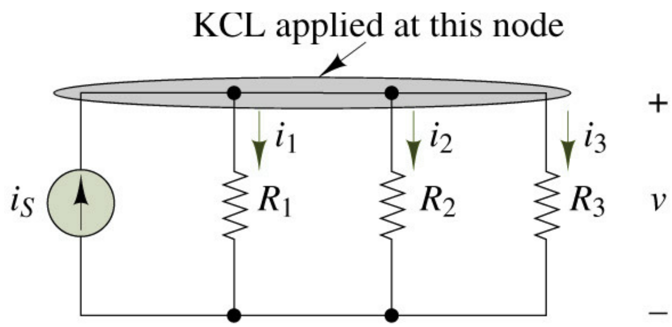
$$v_L = i_S R_L = \frac{R_L}{r_S + R_L} v_S$$

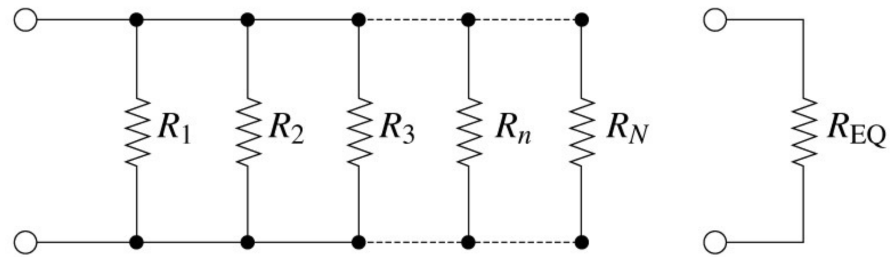
The output voltage is now depend on the R_L

Make $r_s << R_L$, so $v_L \approx v_S$, independent on R_L

Parallel Resistors and the Current Divider Rule

•Parallel Circuit: resistors share the same terminal → same voltage on each resistor.





$$\text{KVL}: \; v = v_1 = v_2 = v_3$$

$$\text{KCL}: \; i_S = i_1 + i_2 + i_3$$

$$i_1 = \frac{v}{R_1}; \; i_2 = \frac{v}{R_2}; \; i_3 = \frac{v}{R_3}$$

$$i_S = v\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$i_S = \frac{v}{R_{EQ}}$$

$$\frac{1}{R_{EQ}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

In general for N resistors in parallel:

$$\frac{1}{R_{EQ}} = \sum_{n=1}^{N} \frac{1}{R_n}, \quad v = v_1 = ... = \text{v}_\text{N}, \; i_S = \sum_{n=1}^{N} i_n$$

For parallel resistors: $R_{\text{EQ}} < (R_1, R_2, ...R_N)$

Current Divider: $i_1 = \frac{v}{R_1} = \frac{R_{EQ}}{R_1} i_S, \; i_2 = \frac{v}{R_2} = \frac{R_{EQ}}{R_2} i_S, \; i_3 = \frac{v}{R_3} = \frac{R_{EQ}}{R_3} i_S$

Large current though smaller R

Advantage of parallel circuit: a broken branch will not affect other branches

Voltmeter

- Voltmeter:
  - measure voltage,
  - put in parallel,
  - the higher the internal resistance is, the better the meter is.

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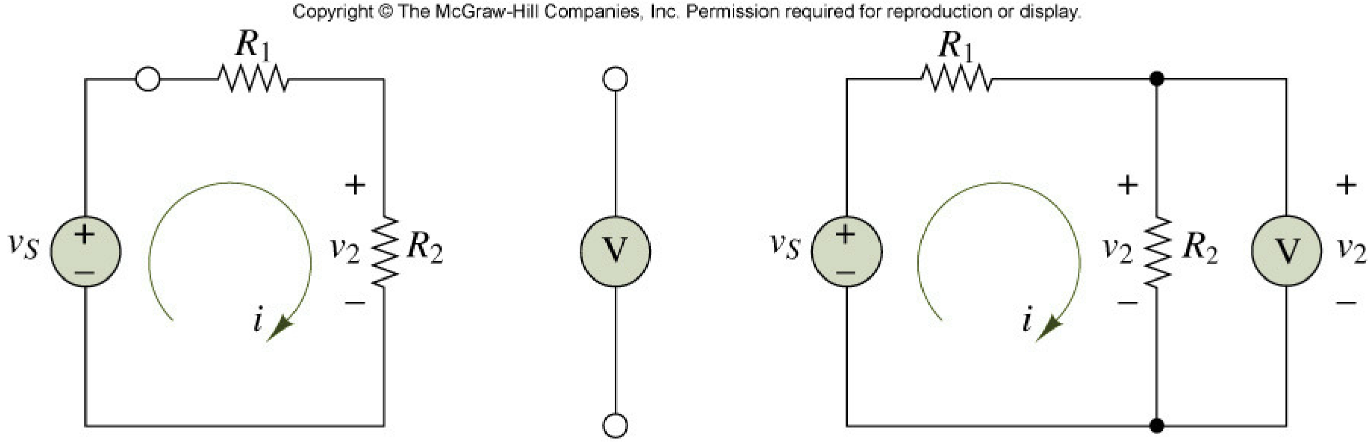

A series circuit | Ideal voltmeter | Circuit for the measurement of the voltage v_2

An example: parallel circuit

There is a circuit breaker in circuit that supplies power to your kitchen. The circuit break will be triggered if the total current exceeds 25 A. Can you turn on a 1500W toaster, a 1000W dishwasher, a 1000 W microwave oven, and 1000W refrigerator simultaneously?

$$i = i_{toaster} + i_{dishwasher} + i_{microwave} + i_{refrig.}$$

$$\begin{aligned} i &= \frac{P_{toaster}}{120} + \frac{P_{dishwasher}}{120} + \frac{P_{microwave}}{120} + \frac{P_{refrig}}{120} \\ &= \frac{1}{120} \times (1500 + 1000 + 1000 + 1000) = 37.5A \end{aligned}$$