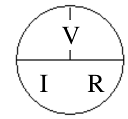
A. Stolp
1/10/12

## Ohm's law (resistors)

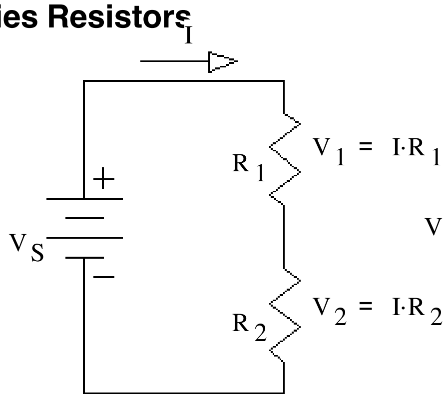
$$V = I \cdot R$$


$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$ definition of resistance and the unit "Ω"

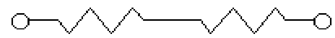



## Series Resistors




$$V_T = V_1 + V_2$$

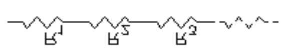
$$R_{eq} = \frac{V_T}{I} = \frac{V_1 + V_2}{I} = \frac{V_1}{I} + \frac{V_2}{I} = R_1 + R_2$$



$$R_{eq} = R_1 + R_2$$

Resistors are in series if and only if exactly the **same current** flows through each resistor.

## Voltage Divider



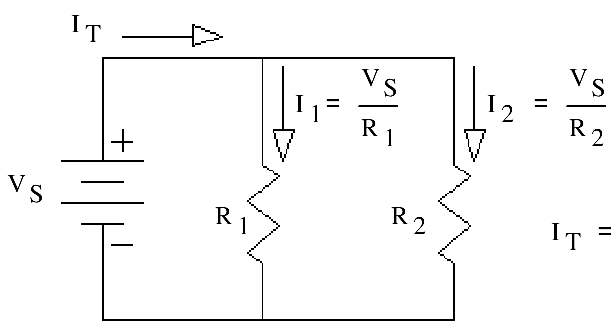
**series:** $R_{eq} = R_1 + R_2 + R_3 + \ldots$

Exactly the **same current** through each resistor

**Voltage divider:**

$$V_{Rn} = V_{total} \cdot \frac{R_n}{R_1 + R_2 + R_3 + \ldots}$$

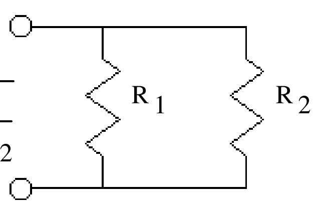
## Parallel Resistors




$$I_T = \frac{V_S}{R_1} + \frac{V_S}{R_2}$$

$$R_{eq} = \frac{V_S}{I_T} = \frac{V_S}{\frac{V_S}{R_1} + \frac{V_S}{R_1}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

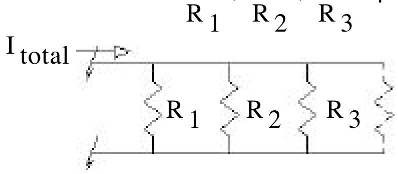
$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$




Resistors are in parallel if and only if the **same voltage** is across each resistor.

## Current Divider

**parallel:** $R_{eq} = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$

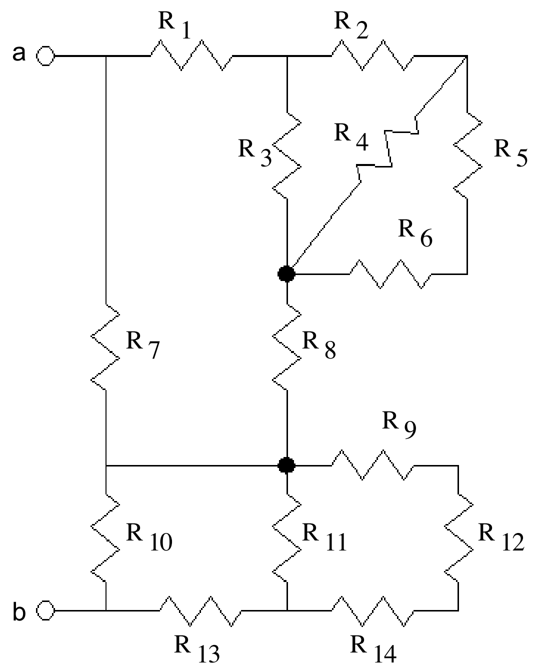



Exactly the **same voltage** across each resistor

**current divider:**

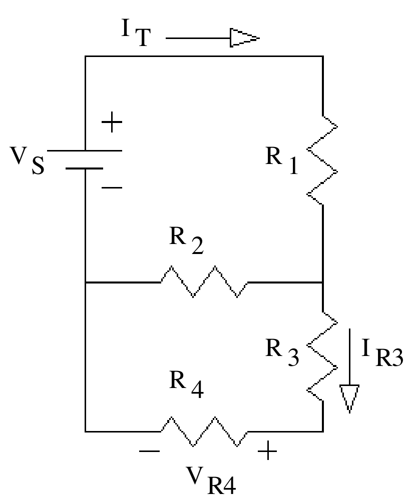
$$I_{Rn} = I_{total} \cdot \frac{\frac{1}{R_n}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

**Series and Parallel**




All resistor-only networks can be reduced to a single equivalent, but not always by means of series and parallel concepts.

**Dividers** May have to combine some resistors first to get series and parallel resistors to use with divider expressions.




$V_{R1}$ =

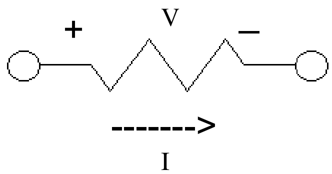
$V_{R2}$ =

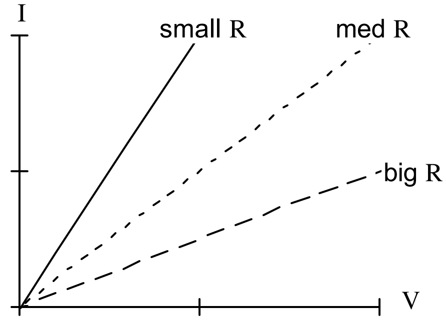
$V_{R4}$ =

$I_T$ =

$I_{R3}$ =

## Resistors




$$R = \frac{1}{\text{slope}} = \frac{\Delta V}{\Delta I}$$

## Power

flow $\frac{m^3}{sec}$ pressure $\frac{N}{m^3}$ flow x pressure: $\frac{m^3}{sec}\cdot\frac{N}{m^2} = \frac{m}{sec}\cdot\frac{N}{1} = \frac{N\cdot m}{sec} = \frac{Joule}{sec} = W$ = power

same for electricity power $P = I\cdot V$

Power dissipated by resistors: $P = V\cdot I = \frac{V^2}{R} = I^2\cdot R$

For the divider example on the last page:

$P_S = V_S\cdot I_T =$

$P_{R1} = \frac{{V_{R1}}^2}{R_1} =$

$P_{R2} =$

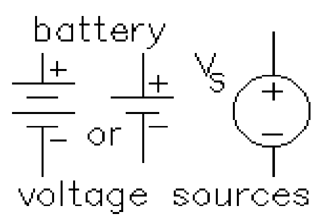
$P_{R3} = {I_{R1}}^2\cdot R_1 =$

$P_{R3} =$

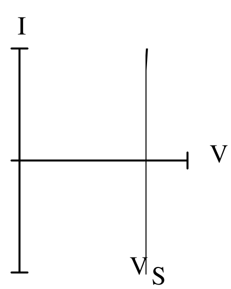
How much energy does $R_3$ dissipate in 36 seconds?

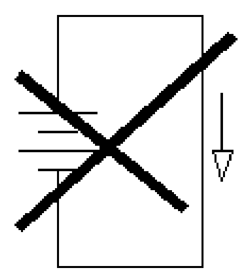
$P_{R4} =$

## Sources

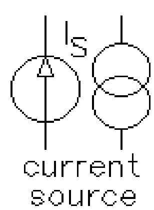



Battery Cell

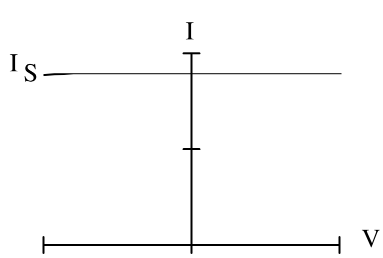


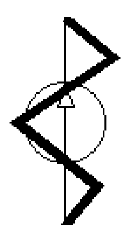



Doesn't make sense for ideal voltage sources and ideal wires

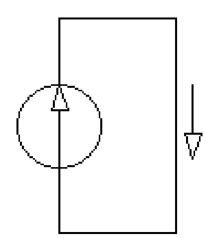



Less intuitive, less like sources we are used to seeing.



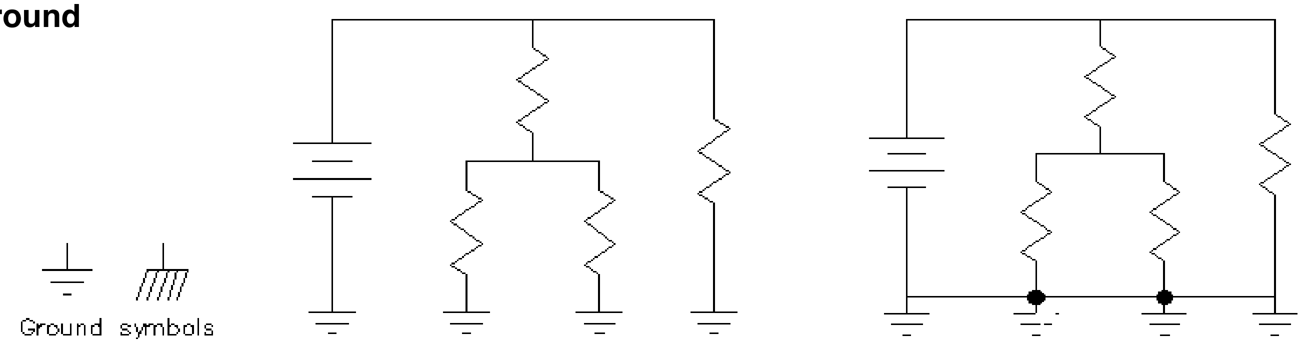



Doesn't make sense for ideal current sources



Must have a path for the current to flow

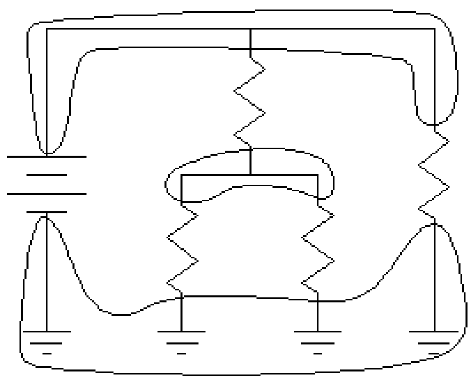
## Ground



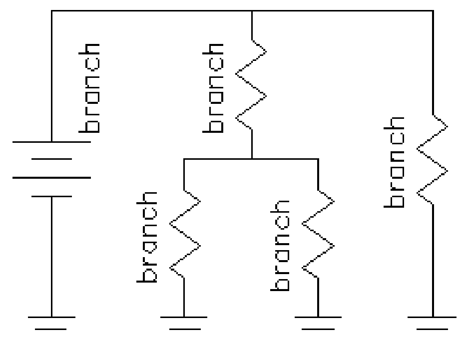

Ground is considered zero volts and is a reference for other voltages.

## Nodes & Branches

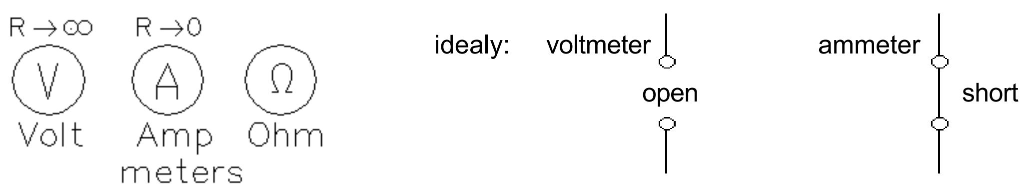
**Node** = all points connected by wire, all at same voltage (potential)



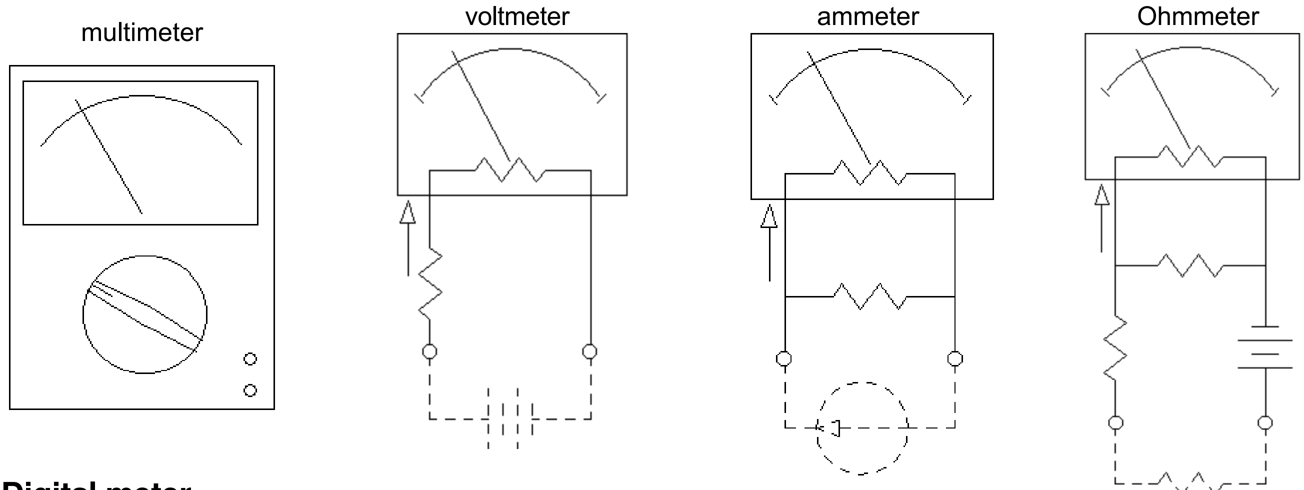

**Branch** = all parts with the same current




## Meters




## Analog meters




## Digital meter