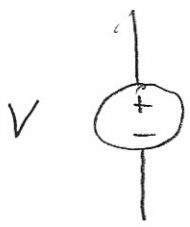
Ideal Voltage Sources

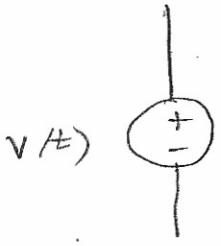
An ideal voltage source is one that would have no internal resistance. We denote such a source by



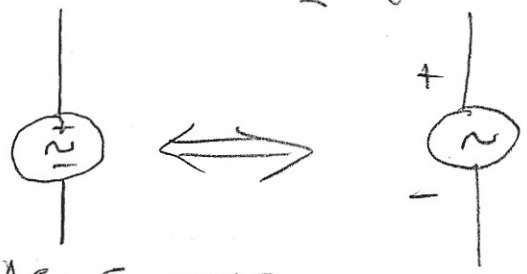
constant dc

old method

How do you know the lowest resistance you can use with a dc battery?

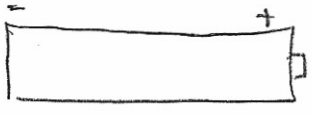


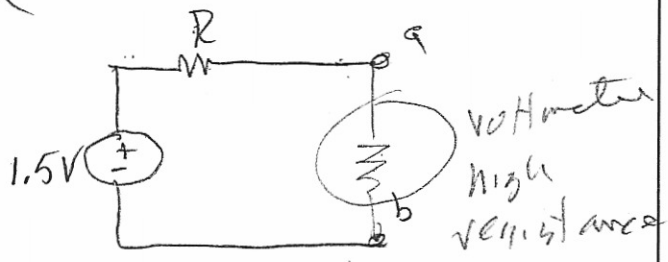
time varying



AC source

A "fresh" battery, say a size D, AA, AAA would have very low internal resistance



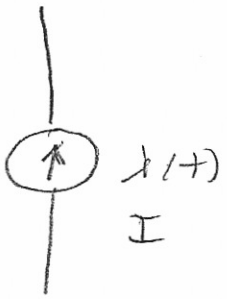


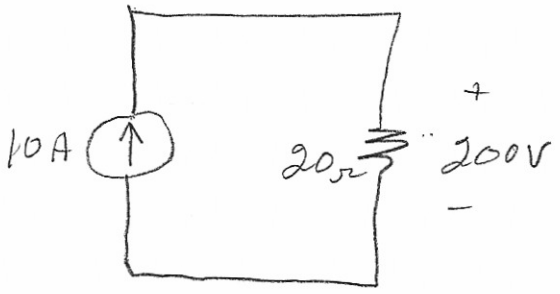
R goes up as the battery ages.

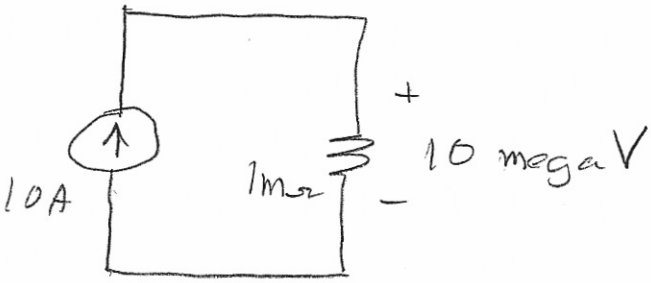
An ideal voltage source can put out

Ideal Current Sources

These are harder to come by.

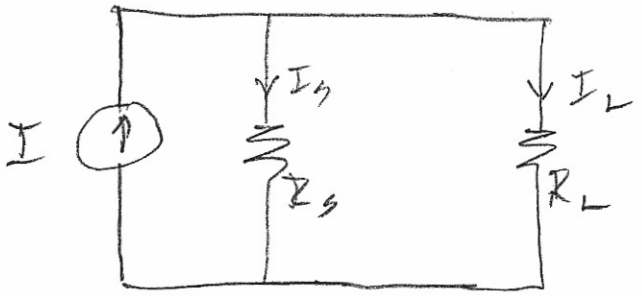






Won't happen in reality.

What happens;

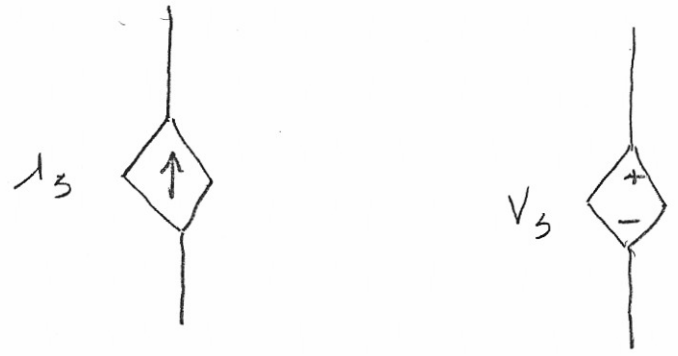


$$I_L = \frac{I \times R_S}{R_L + R_S} = \frac{I}{\frac{R_L}{R_S} + 1}$$

If $R_S \to \infty$, then $I_L = I$

Dependent (controlled) Sources

These become important in electronics.

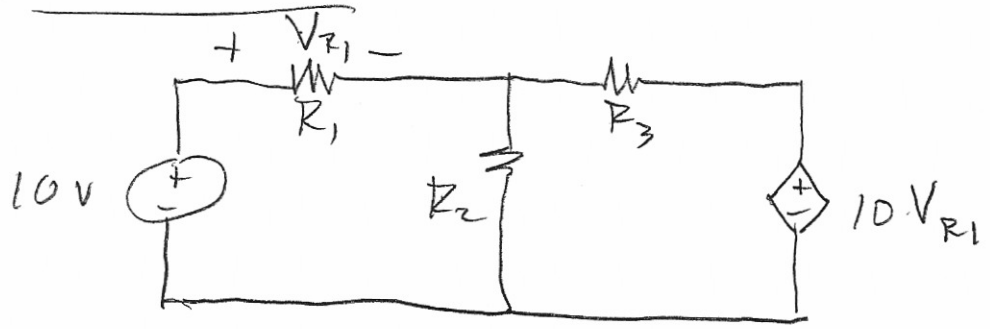


(always a diamond)

* The current source can be controlled by either a voltage or current somewhere else in the circuit.

The voltage source can be controlled by a current or voltage somewhere else in the circuit.

To illustrate:



As cathedrales

- Voltage controlled voltage source — VCVS — $V_s = k_1 V_x$
- Current controlled voltage — CCVS — $V_s = k_2 i_x$
- Current controlled current source — CCCS — $I_s = k_3 i_x$
- Voltage controlled current source — VCCS — $I_s = k_3 V_x$

Some Definitions

- Branch
- Node
- Loop
- Mesh

$b = l + n - 1$ independent

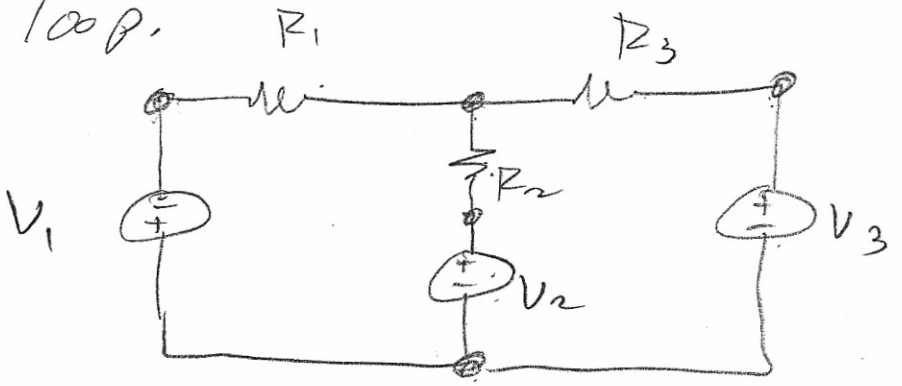
Branch: A branch represents a single element such as a voltage source or resistor. (represents a two terminal element)

Node: A point of connection between two or more branches.

Loop: Any closed path of a circuit. (cannot cross a node more than once)

mesh

A loop is independent if it contains at least one branch which is not a part of any other independent loop.



How many independent loops?

How many nodes?

How many branches?

$$b = l + n - 1$$

(l is independent loops)

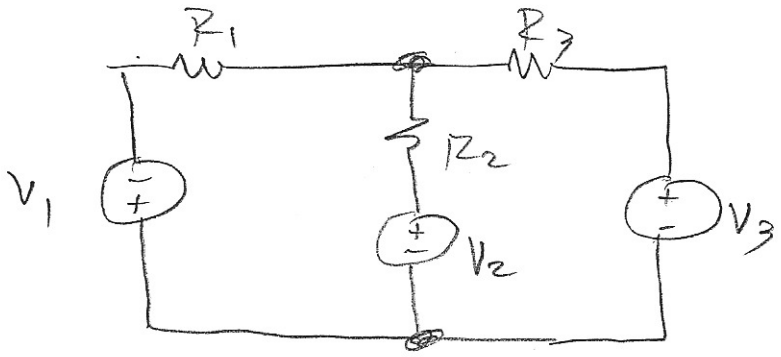
Above: $l = 2$, $n = 5$

$$b = 2 + 5 - 1 = 6$$

Later, when we do nodal analysis, I use essential node

If a part of a circuit has two or more elements in series we can usually treat this a a single branch.

Above;



$l = 2$, # $n = 2$

$b = l + n - 1 = 2 + 2 - 1 = 3$

Kirchhoff's Laws

Three basic laws allow us to solve circuits.

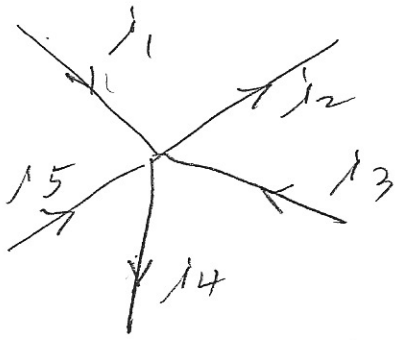
- KCL
- KVL
- Ohm's Law

KCL:

Sum of currents (algebraic) entering a node = 0

Sum of currents (algebraic) leaving a node = 0

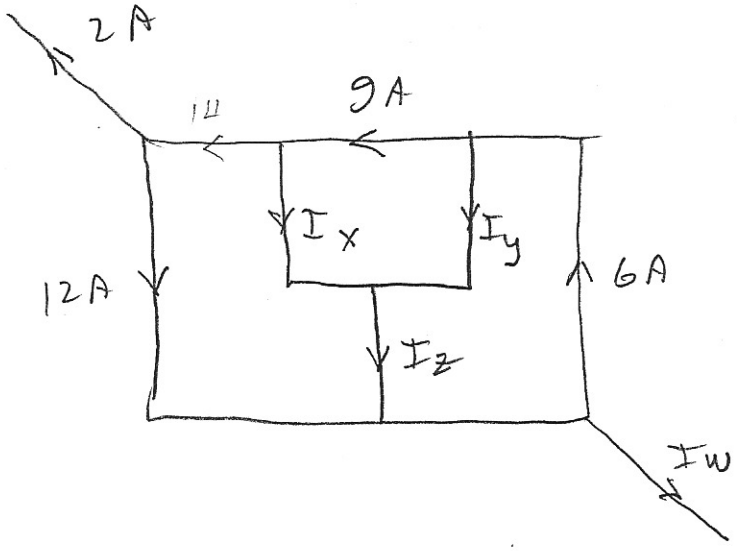
Sum of currents entering a node equal sum of currents leaving a node.



$\sum_{\text{entering}} = 0$ $\quad i_1 + i_3 + i_5 - i_2 - i_4 = 0$

$\sum_{\text{leaving}} = 0$ $\quad i_2 + i_4 - i_1 - i_3 - i_5 = 0$

$\sum_{\text{entering}} = \sum_{\text{leaving}}$ $\quad i_2 + i_4 = i_1 + i_3 + i_5$



Find I_x, I_y, I_z, I_w

KVL

$$\sum_{m=1}^{m=N} V_m = 0$$

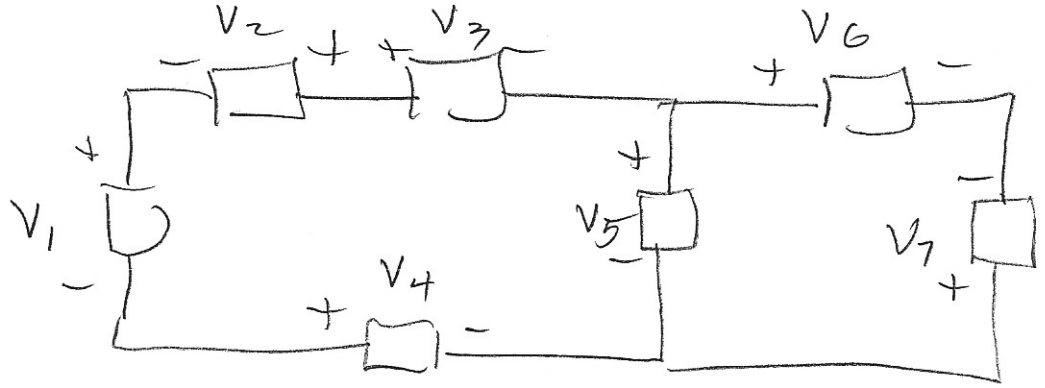
Sum of all voltage rises around a closed path = 0.

Sum of all voltage drops around a closed path = 0.

How do we define a voltage rise?

How do we define a voltage drop.

Consider



Write KVL around paths