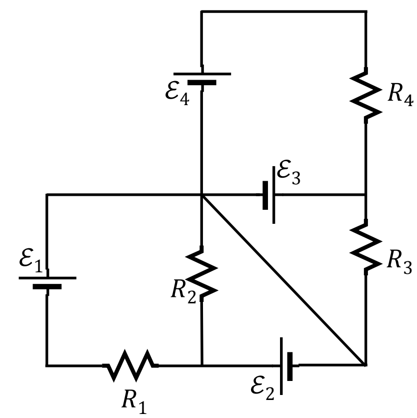
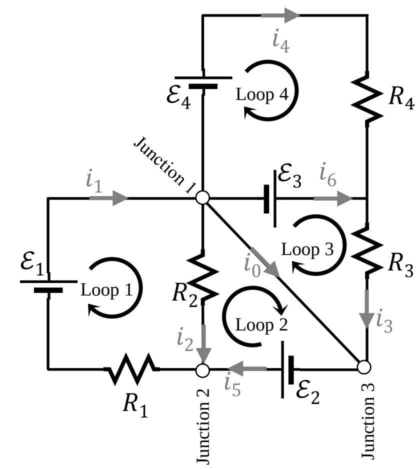
KVL Procedure

Consider the circuit shown at right.



1. Count the number of branches. You could think of this as counting the number of *unique* pipes for water to flow in the circuit.
   a. Junctions with three or more pipes indicate the beginning or end of a branch.
   b. A branch (or pipe) that turns 90° is still the same branch.
   c. Generally one must include branches with no circuit elements (resistors, batteries, capacitors, switches, etc). In the example at right, the diagonal branch is an example of a branch with no circuit elements.
   d. The circuit at right has 7 branches.
2. Label currents in each branch (i_1, i_2, i_3, ...etc).
   a. I sometimes use i_0 for special branches. In the circuit at right I might use i_0 for the diagonal branch with no circuit elements.
   b. Try to be consistent in the directions you choose.
      i. I like to choose away from the plus terminal of a battery.
      ii. Dom usually chooses to the right or down.



3. Count the number of *interior* loops.
   a. I call a loop interior if the loop has no branches inside of it.
   b. The circuit in our example has 4 loops.
   c. Notice each loop is labeled with a direction.
      i. I usually like my loop directions to be directed out of the plus terminal of a battery if possible.
      ii. Dom usually tends to go clockwise.
4. Determine the number of linearly independent junction equations.
   a. (#of Branches) – (# of Loops) = (#of Junction Equations)
   b. The circuit at right requires 7 – 4 = 3 junction equations.
   c. For each junction the sum of input currents should equal the sum of the output currents.
   d. The junctions chosen are arbitrary.
5. Determine the loop equations.
   a. The sum of *voltage gains* around a loop should equal zero (consequence of energy conservation).
   b. Pick a spot to start on each loop and follow the chosen loop direction.
   c. *Add* voltage gained across a battery if exiting on the *plus* terminal (subtract if exiting on the *minus* terminal).
   d. *Subtract* iR when passing by a resistor *if loop direction matches current direction drawn*. Add iR if loop direction is opposite current direction drawn.
   e. These rules reflect that (1) batteries are used to *add* voltage to a circuit while (2) resistors tend to *decrease* the voltage available to other circuit elements. It is for these reasons we often call the potential difference across a resistor a voltage *drop*.
6. Do algebra to determine unknowns.
   a. A problem typically involves the same number of unknowns as the number of branches.
   b. Usually the currents are the unknowns.
   c. On occasion, one of the currents is known while a resistance or battery voltage is unknown.
7. Interpret the results.
   a. It is common to inaccurately predict the direction of a current…this is NOT a problem!
   b. If you get a negative value for a current, the direction current flows in real life is opposite the direction you chose to draw it!