KIRCHOFF'S RULES

In simple circuits we can analyze the circuit by using Ohm's Law and the rules for series and parallel combination of resistors. However, for more complex circuits, you won't be able to do this. You will need to use a set of rules called Kirchoff's Rules.
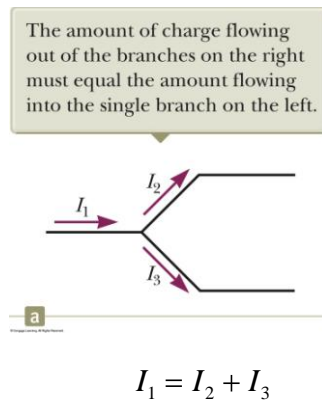
1. **Junction Rule** – The sum of the currents entering a junction must equal the sum of the currents leaving that junction.
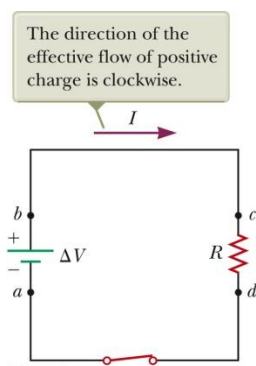
$$\sum I_{in} = \sum I_{out}$$

2. **Loop Rule** – The sum of the potential differences across all elements around any closed circuit loop must be zero.

$$\sum \Delta V_{closed\ loop} = 0$$

a) The *Junction Rule* is based on conservation of electric charge.

$$I_1 = I_2 + I_3$$

b) The *Loop Rule* is based on conservation of energy.

$$\Delta U_{closed\ path} = 0$$
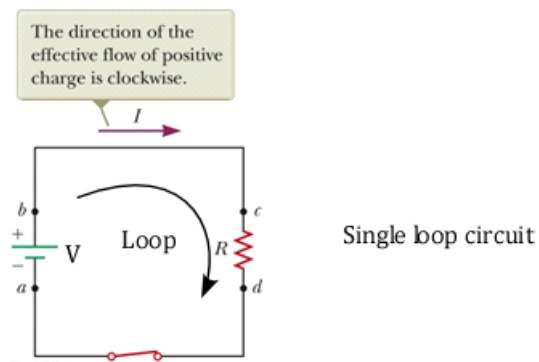$$\Delta U_{bat} + \Delta U_R = 0$$
$$q\Delta V_{bat} + q\Delta V_R = 0$$
$$\Delta V_{bat} + \Delta V_R = 0$$

In general, for any closed loop:

$$\sum \Delta V_{closed\ loop} = 0$$

Sign Convention for the Loop Rule

The direction of the effective flow of positive charge is clockwise.

Single loop circuit

1. Assume a direction for current in each branch of circuit.
2. Indicate direction in which loop rule will be applied.
3. ΔV_R = -IR if resistor is crossed in _same_ direction of current.
4. ΔV_R = +IR if resistor is crossed in _opposite_ direction of current.
5. ΔV_{bat} = +V if battery is crossed from − to + terminal.
6. ΔV_{bat} = -V if battery is crossed from + to − terminal.