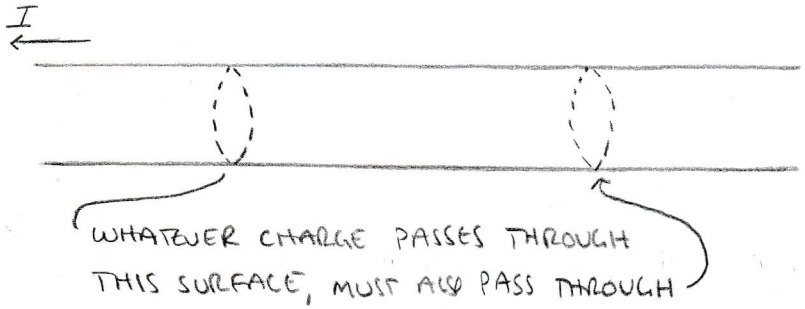
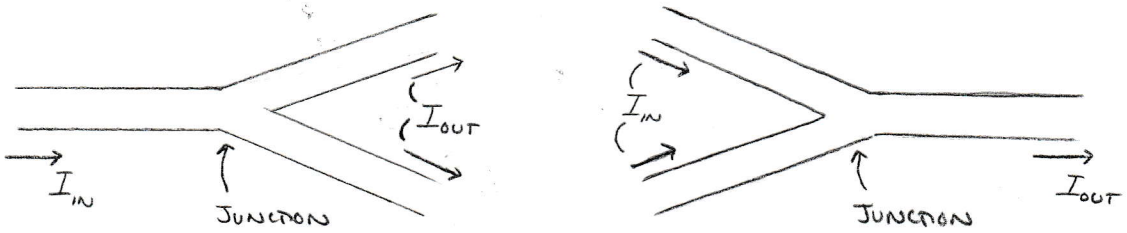
DRAWING #7: CONSERVATION OF CURRENT

CONSIDERING THAT CHARGE IS QUANTIZED, AND CANNOT BE CREATED OR DESTROYED, IT IS EASY TO SEE THAT CURRENT MUST BE THE SAME AT ALL POINTS IN A CURRENT-CARRYING WIRE:



THIS IS KNOWN AS THE LAW OF CONSERVATION OF CURRENT.

THIS LAW IS USEFUL FOR ANALYZING JUNCTIONS (A POINT WHERE A WIRE(S) BRANCH(ES)):



BECAUSE OF THE CONSERVATION OF CURRENT, WE CAN WRITE:

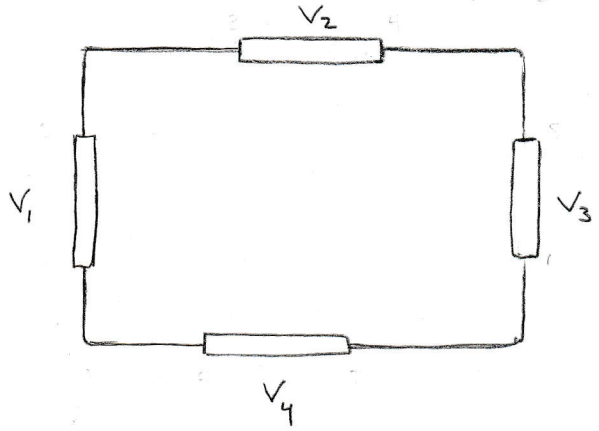
$$\sum I_{IN} = \sum I_{OUT}$$

THIS IS KNOWN AS KIRCHHOFF'S JUNCTION LAW.

DRAWING #1: KIRCHHOFF'S LOOP LAW

WE'VE NOW SEEN ELECTRICAL COMPONENTS THAT CAN BE USED TO INCREASE OR DECREASE THE POTENTIAL IN AN ELECTRICAL NETWORK (e.g., BATTERIES AND RESISTORS, RESPECTIVELY).

CONSIDER AN ELECTRICAL CIRCUIT WITH A NUMBER OF SUCH COMPONENTS:



RECALL FROM ELECTROSTATICS THAT THE WORK PER UNIT CHARGE, WHICH CAN BE WRITTEN AS A DIFFERENCE IN THE ELECTRIC POTENTIAL, AROUND ANY CLOSED LOOP IS ZERO:

$$W_{\substack{\text{CLOSED}\\\text{LOOP}}}(\text{UNIT}) = \oint_a^b \mathbf{E}\cdot d\mathbf{s} = -\left(\Phi(b) - \Phi(a)\right) = 0$$

THIS MEANS THAT THE SUM OF POTENTIAL DIFFERENCES (VOLTAGES) AROUND ANY ELECTRICAL CIRCUIT IS ZERO:

$$\boxed{V_{\text{CIRCUIT}} = \sum_i V_i = 0}$$

(IN TERMS OF ELECTRICAL CIRCUITS) THIS IS KNOWN AS KIRCHHOFF'S LOOP LAW.

NOTE: THIS LAW WILL BE USEFUL FOR ANALYZING COMPLEX, MULTI-COMPONENT ELECTRICAL CIRCUITS.