Help

There are a few basic rules that allow us to solve for voltages and currents within a circuit comprised with batteries, switches, and resistors.

Current always flows in a loop. In Figure 3.3 when the switch is pressed, current flows out of the + side of battery, across the switch, through the light and back to the – side of the battery. When there is no loop, no current can flow. In Figure 3.3 when the switch is off, the loop is broken, and no current will flow.

Kirchhoff's Voltage Law (KVL). The sum of the voltages around the loop is zero.For a battery, we label the + and – sides exactly the way the battery is labeled. For a resistor, we label the current arrow and the voltage + – like the left side of Figure 3.1. The important step is the direction of the current arrow must match the polarity of the corresponding voltage. It is common practice to draw arrows in the direction the currents actually flow, so the voltages will be positive. However, sometimes we don't know which way the current will flow, so we can just guess. If we happen to guess wrong, both the current and voltage will calculate to be negative and the correct behavior will still be obtained. We can think of the switch as a resistor of either 0 or infinity resistance, so it too can be labeled with a current arrow and a voltage polarity. Figure 3.4 shows the light circuit redrawn to show voltages and currents. As we are going around a circle and pass from + to –, we add that voltage. However, if we pass across an element from – to + we subtract that voltage.

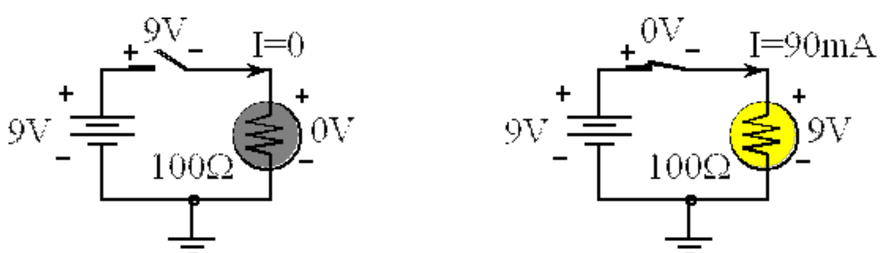

Figure 3.4. The voltages around a loop will sum to zero (KVL).

Kirchhoff's Current Law (KCL). The sum of the currents into a node equal the sum of the currents leaving a node as shown in Figure 3.5. To solve circuits using KCL and KVL, the current arrow across a resistor goes from the + voltage to the – voltage. Conversely, the current arrow across a battery goes from the – voltage to the + voltage. This is the same thing as saying current comes out of the battery's + terminal and into the battery's – terminal. At Node A, there is one incoming current and one outgoing current. This is a simple but important fact that $I1 = I2$. At Node B, there is one incoming current and two outgoing currents. Therefore, $I3 = I4+I5$. There are two currents into NodeC and two currents out of NodeC; thus, $I6+I7 = I8+I9$.

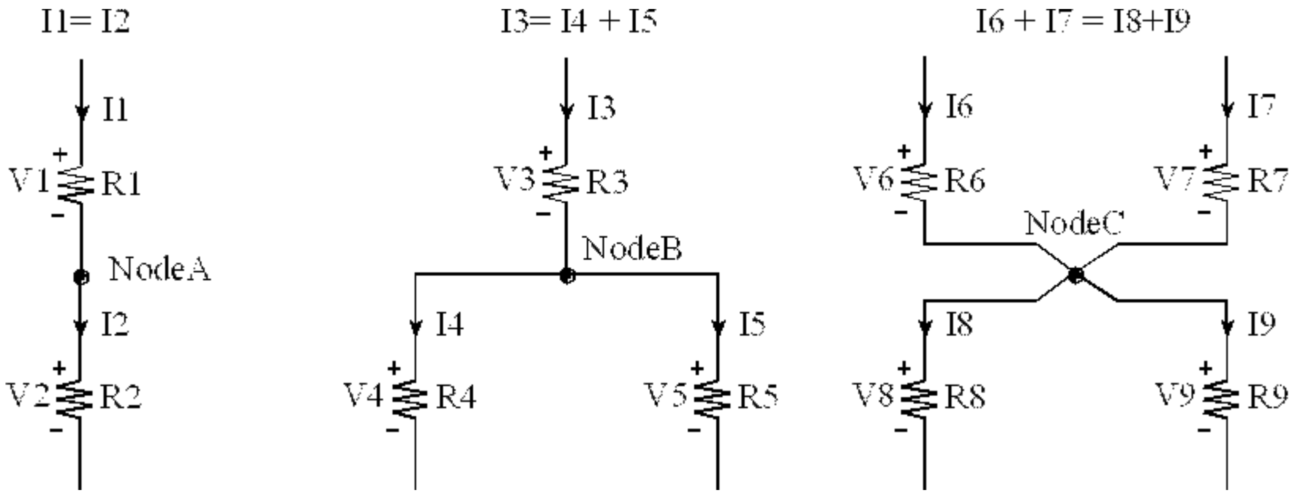

Figure 3.5. The sum of the currents into a node will equal the sum of the currents leaving (KCL).

Observation: If at all possible, draw the circuit so current flows down across the resistors and switches. As a secondary rule have currents go left to right across resistors and switches.

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