Assignment Currents and Voltages in a Circuit
Assigning polarity of voltage drops and directions of currents.

First, from Ohm's Law, we know that the node voltage is higher at the node at which current with a positive magnitude enters a resistor. The difference in the force (voltage) applied across a resistor drive the current through the resistor.
node A \quad R \quad node B

$V_A$ is the node voltage at node A

$V_B$ is the node voltage at node B

if $V_A > V_B$, then current with a positive magnitude will flow from node A to node B.
The voltage drop across resistor $R$ is the difference between the voltage at node A minus the voltage at node B. The positive polarity of the voltage drop is the side of the resistor that positive current enters the resistor.
\[ V_R = V_A - V_B = IR \]

Node A + \( V_R \) - node B

\[ V_A \]

\[ I \geq 0 \text{mA} \]

Ohm's Law relates the amount of force (the voltage drop) to the current flowing through a resistor.
If you do not know the direction of the current, the voltage dropped across a resistor, or which node voltage is larger, we can arbitrarily assign direction of current and polarity of the voltage drop. If you apply Ohm’s Law correctly, the math will take care of any labels that should have been the opposite of your choice.
Ohm's law always assumes that current enters a resistor on the positive side of voltage drop and exits the resistor on the negative side of the voltage drop. If your choices for current flow and voltage drop do not match this, then you must include a negative sign with the product of current times resistance to obtain the correct sign for the voltage drop.
Suppose you chose

\[ V_R = R I_R \]

then Ohm's Law is

\[ V_R = -R I_R \]

\[ V_R = -R I_R \]

\[ V_R = R I_K \]
Rules for Current and Voltage Sources

a) The current flows out of the end of the current source that has the arrow.

\[ I = 2 \text{mA} \]

\[ V_I^- \rightarrow V_I^+ \]

\[ I = -5 \text{mA} \]

\[ +V_I^- \rightarrow -V_I^+ \]

We label the polarity of the voltage drop across a current source as if it is generating power (opposite of a resistor).
b) If a voltage source is generating power, which is not always the case, the positive current flows out of the anode (the end with the larger straight line).

\[ -3V + I_r \]

\[ \begin{array}{c}
\text{cathode} \\
\uparrow \\
3V \\
\downarrow \\
\text{anode}
\end{array} \]

The polarity of the voltage drop across the voltage source is always + on the anode and negative on the cathode.