19. Let \( i_1 \) be the current in \( R_1 \) and take it to be positive if it is to the right. Let \( i_2 \) be the current in \( R_2 \) and take it to be positive if it is upward.

(a) When the loop rule is applied to the lower loop, the result is

\[ \varepsilon_2 - i_1 R_1 = 0 \]

The equation yields

\[ i_1 = \frac{\varepsilon_2}{R_1} = \frac{5.0 \text{ V}}{100 \Omega} = 0.050 \text{ A}. \]

(b) When it is applied to the upper loop, the result is

\[ \varepsilon_1 - \varepsilon_2 - \varepsilon_3 - i_2 R_2 = 0. \]

The equation yields

\[ i_2 = \frac{\varepsilon_1 - \varepsilon_2 - \varepsilon_3}{R_2} = \frac{6.0 \text{ V} - 5.0 \text{ V} - 4.0 \text{ V}}{50 \Omega} = -0.060 \text{ A}, \]

or \( |i_2| = 0.060 \text{ A} \). The negative sign indicates that the current in \( R_2 \) is actually downward.

(c) If \( V_b \) is the potential at point \( b \), then the potential at point \( a \) is \( V_a = V_b + \varepsilon_3 + \varepsilon_2 \), so \( V_a - V_b = \varepsilon_3 + \varepsilon_2 = 4.0 \text{ V} + 5.0 \text{ V} = 9.0 \text{ V} \).