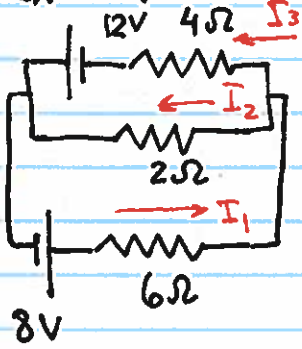
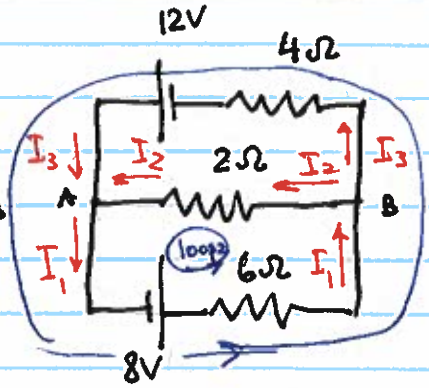
What if a complex circuit with multiple batteries cannot be simplified as a single loop?

Kirchhoff's Rules



same as



loop 1

Kirchhoff's rule #1

At any junction, the sum of currents flowing in is equal to the sum of currents flowing out $I_1 = I_2 + I_3$

Kirchhoff's rule #2

Sum of all potential differences across all elements around any closed loop must be zero

$V_A - V_B = 12V + 4\Omega \cdot I_3$
$= 2\Omega \cdot I_2$
$= +8V - 6\Omega I_1$

or

loop 1: $8V - 6\Omega \cdot I_1 - 4\Omega \cdot I_3 + 12V = 0$
$20V - 6\Omega \cdot I_1 - 4\Omega \cdot I_3 = 0$

loop 2: $8V - 6\Omega \cdot I_1 - 2\Omega \cdot I_2 = 0$

Three equations to find three currents

$$\begin{cases} I_1 = I_2 + I_3 \\ 20V - 6\Omega \cdot I_1 - 4\Omega \cdot I_3 = 0 \\ 8V - 6\Omega I_1 - 2\Omega I_2 = 0 \end{cases}$$

$I_1 = \frac{18}{11} A \quad I_2 = -\frac{10}{11} A \quad I_3 = \frac{28}{11} A$

Actually, the current through 2Ω resistor is in the opposite direction.