Basic Electronics: Kirchhoff's Laws

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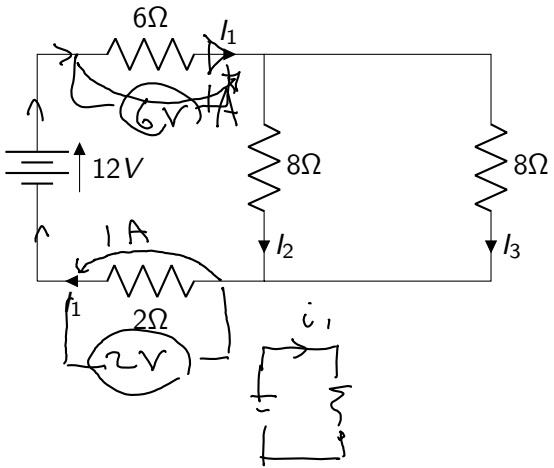
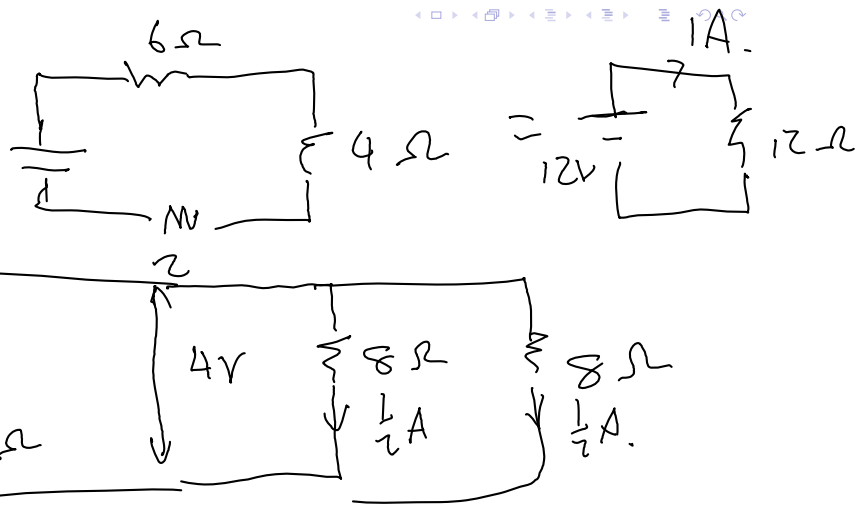
Recap

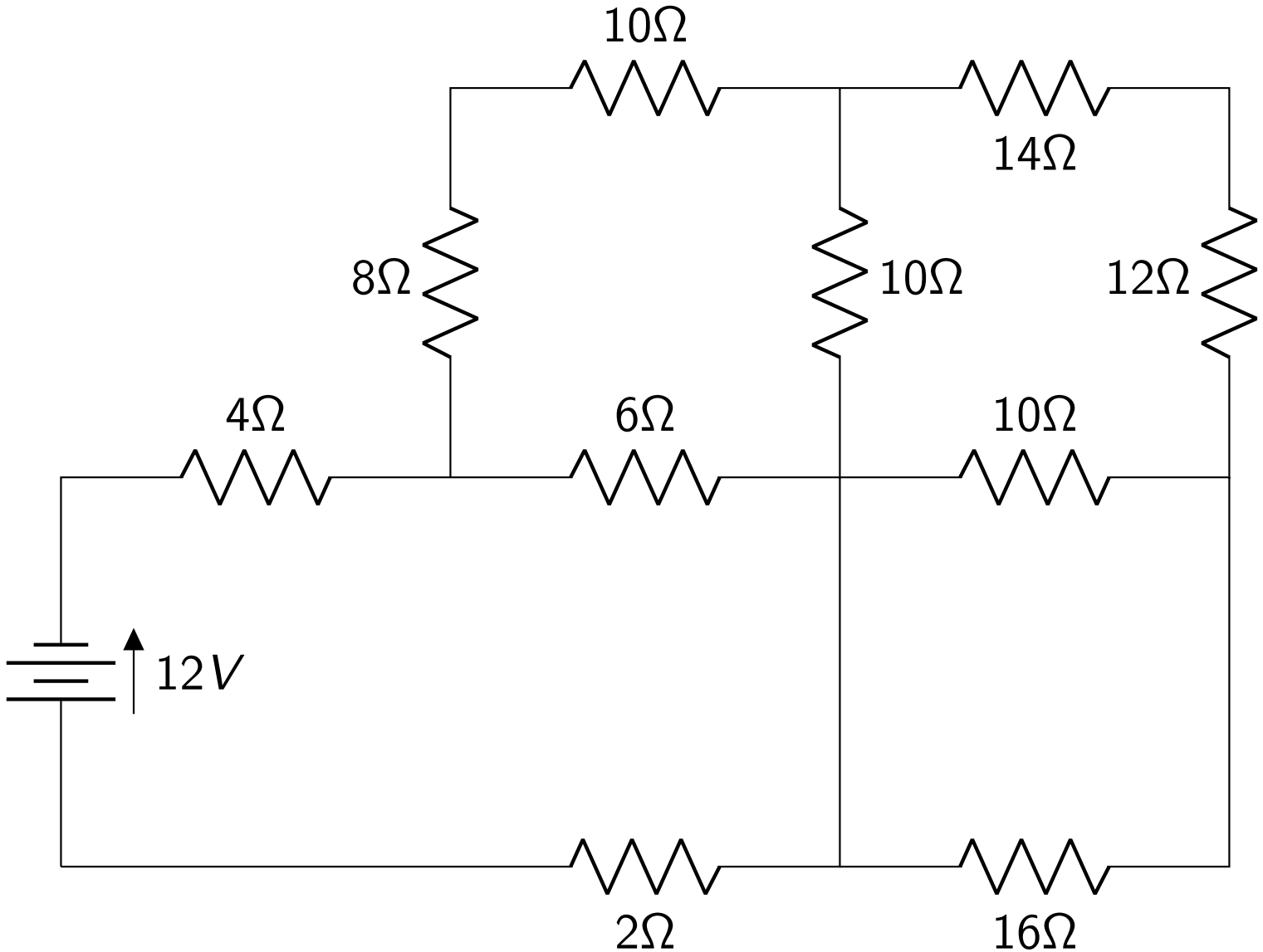
Calculate the current through each resistor.





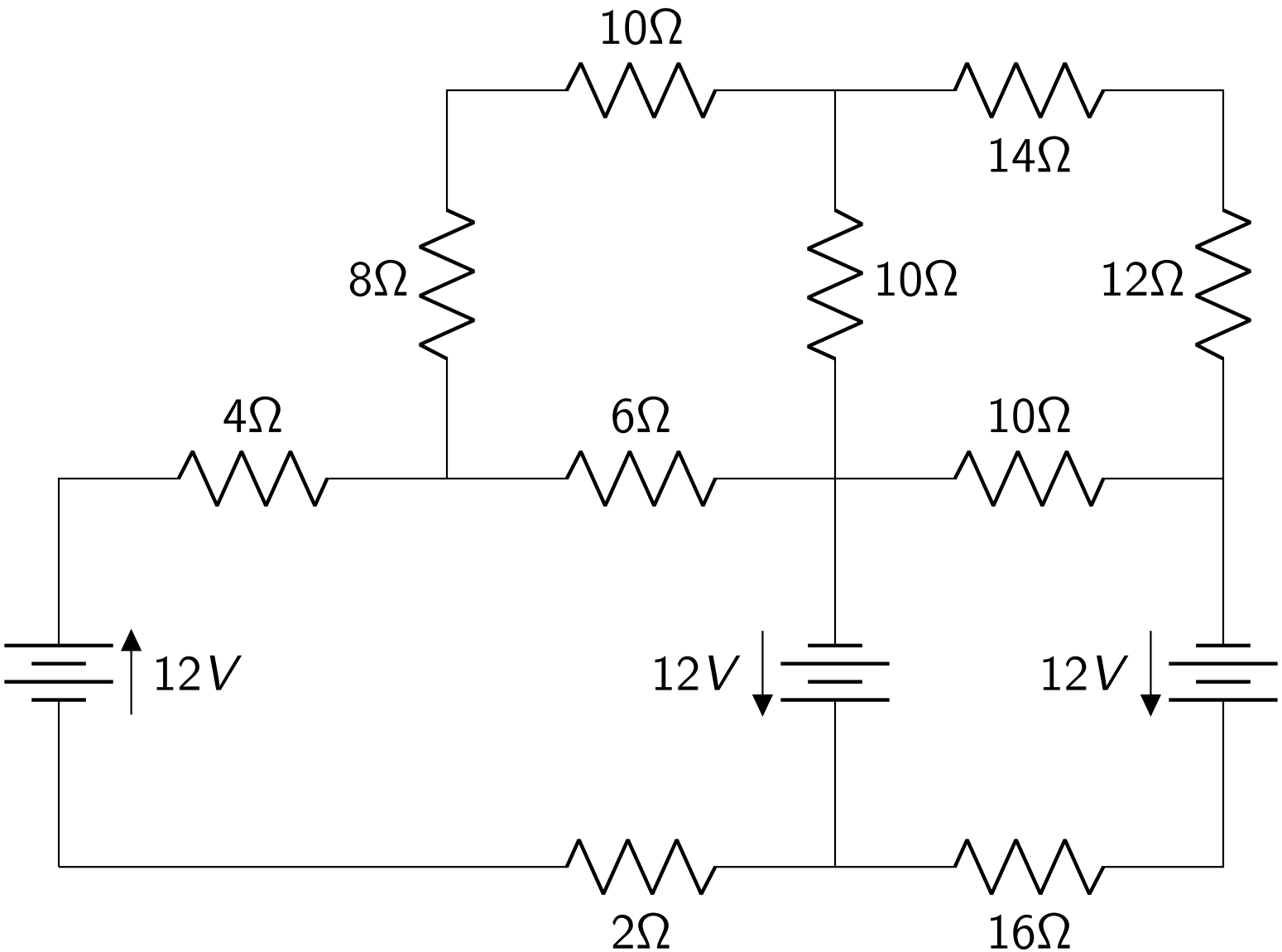
Revision

Find the current through each resistor



Revision (harder)

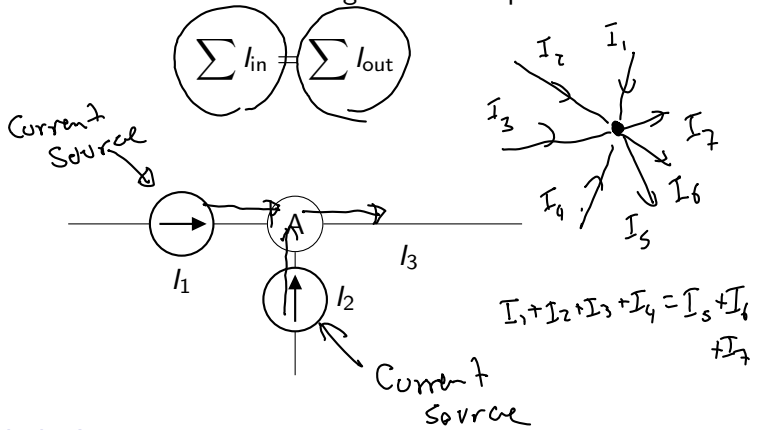
Find the current through each resistor



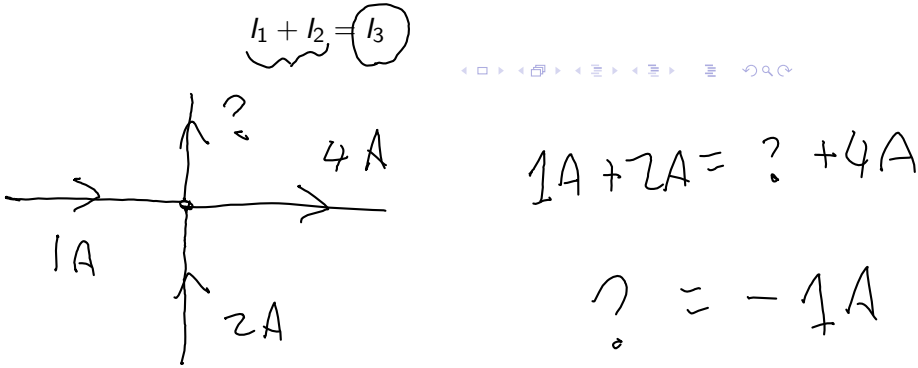
Kirchhoff's Current Law (KCL)

Definition

The algebraic sum of currents entering a node is equal to zero:



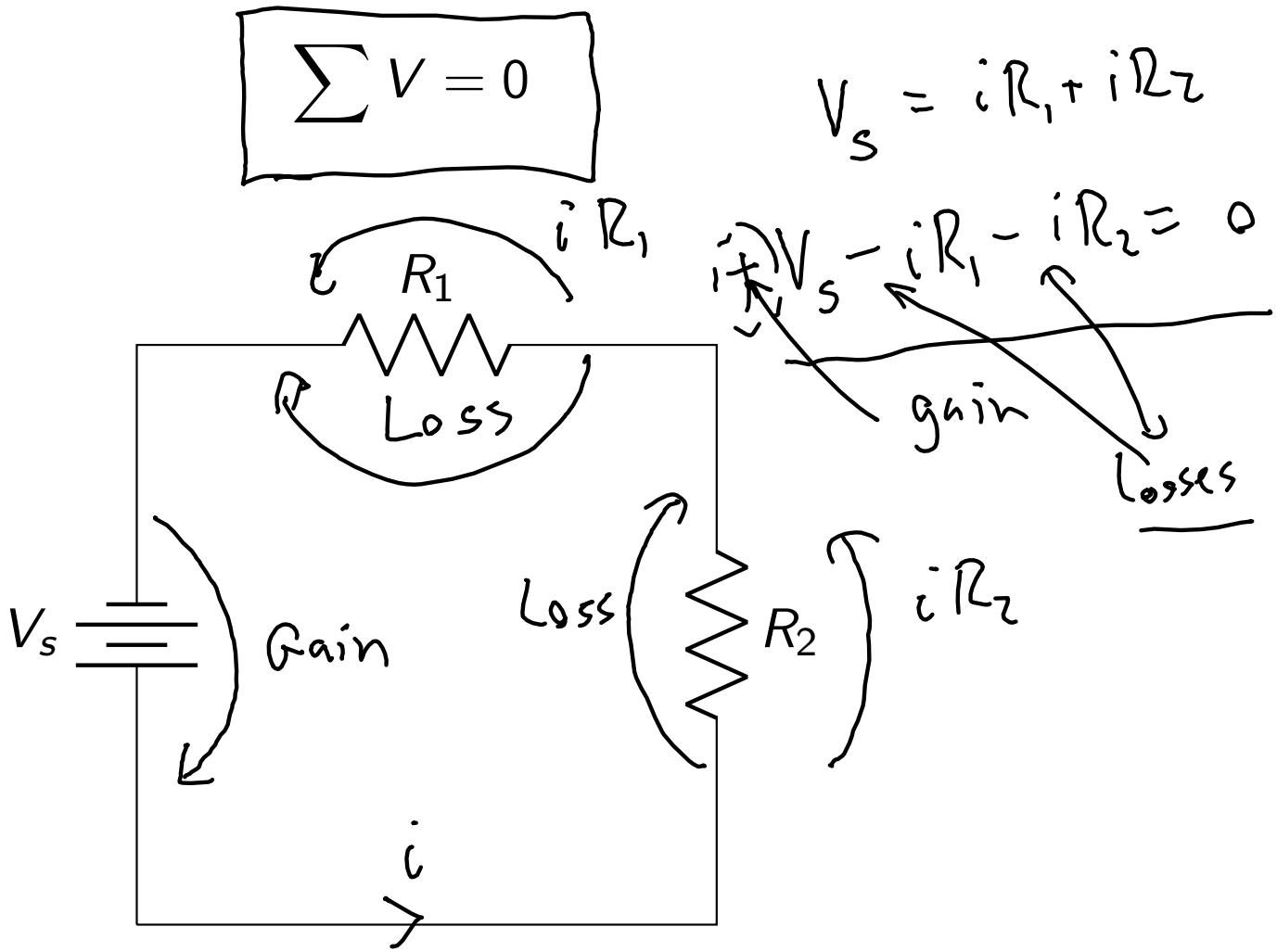
KCL at Node A



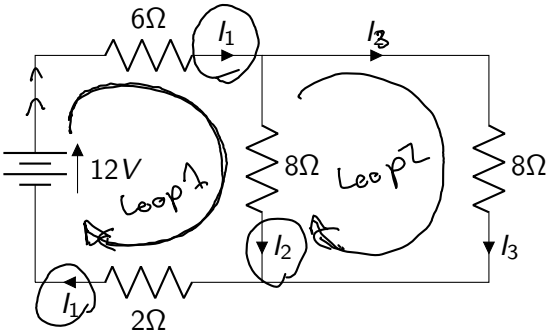
Kirchhoff's Voltage Law (KVL)

Definition

The algebraic sum of voltages in any closed loop is equal to zero:



Example: Solving a Circuit



KVL
Loop 1.
$12V - i_1 6\Omega - i_2 8\Omega - i_1 2\Omega = 0$
Loop 2
$0 - 8\Omega i_3 + 8\Omega i_2 = 0$

KCL
$i_1 = i_2 + i_3.$

$$8\Omega I_1 + 8\Omega I_2 + 0 I_3 = 12$$
$$0 I_1 - 8\Omega I_2 + 8 I_3 = 0$$
$$I_1 - I_2 - I_3 = 0$$

$$\begin{pmatrix} 8 & 8 & 0 \\ 0 & -8 & 8 \\ 1 & -1 & -1 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} 12 \\ 0 \\ 0 \end{pmatrix}$$

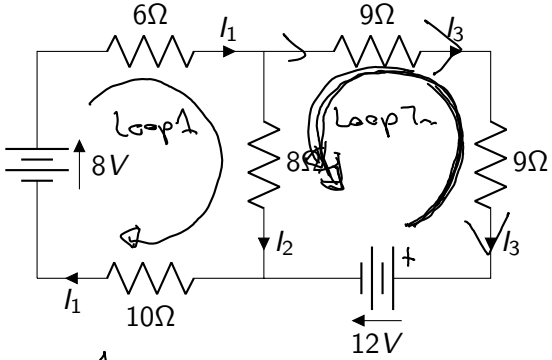
$M \qquad V = V'$

$V = M^{-1} V'$

$I_1 = 1$
$I_2 = \frac{1}{2}$
$I_3 = \frac{1}{2}$

Solution

example 2



Loop 1.

$8V - i_1 6\Omega - i_2 8\Omega - i_1 10\Omega = 0$

$8V - 16 i_1 - 8 i_2 - 0 i_3 = 0 \quad - (1)$

Loop 2

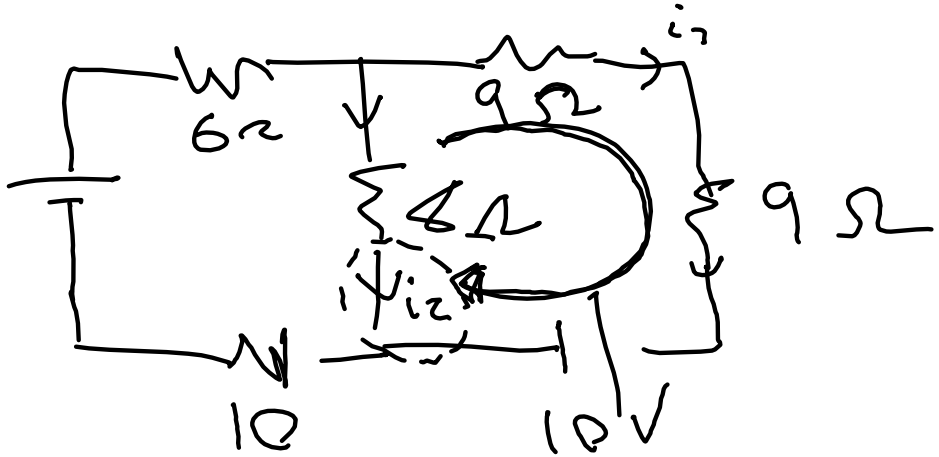
$12V + 18 i_3 - 8 i_2 = 0 \quad - (2)$

$i_1 = i_2 + i_3 \quad - (3)$

Gain - loss

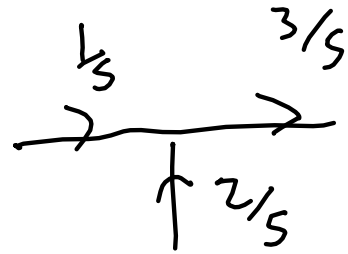
$12V - (\downarrow 18 i_3)$

Solution



$$(\text{Resistors}) = \text{Sources}$$

$$(18i_3 - 8i_2) = -10V$$

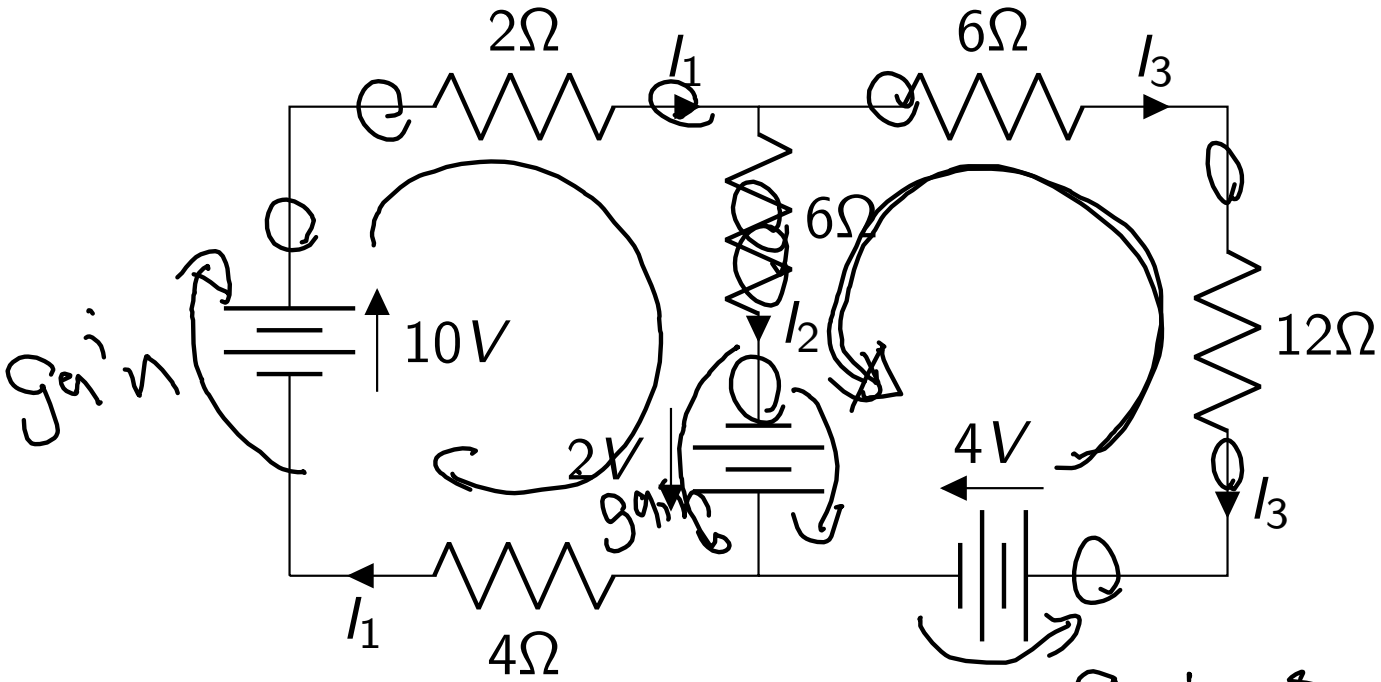


$$I_1 = \frac{1}{5}$$

$$I_2 = 3/5$$

$$I_3 = -(2/5)$$

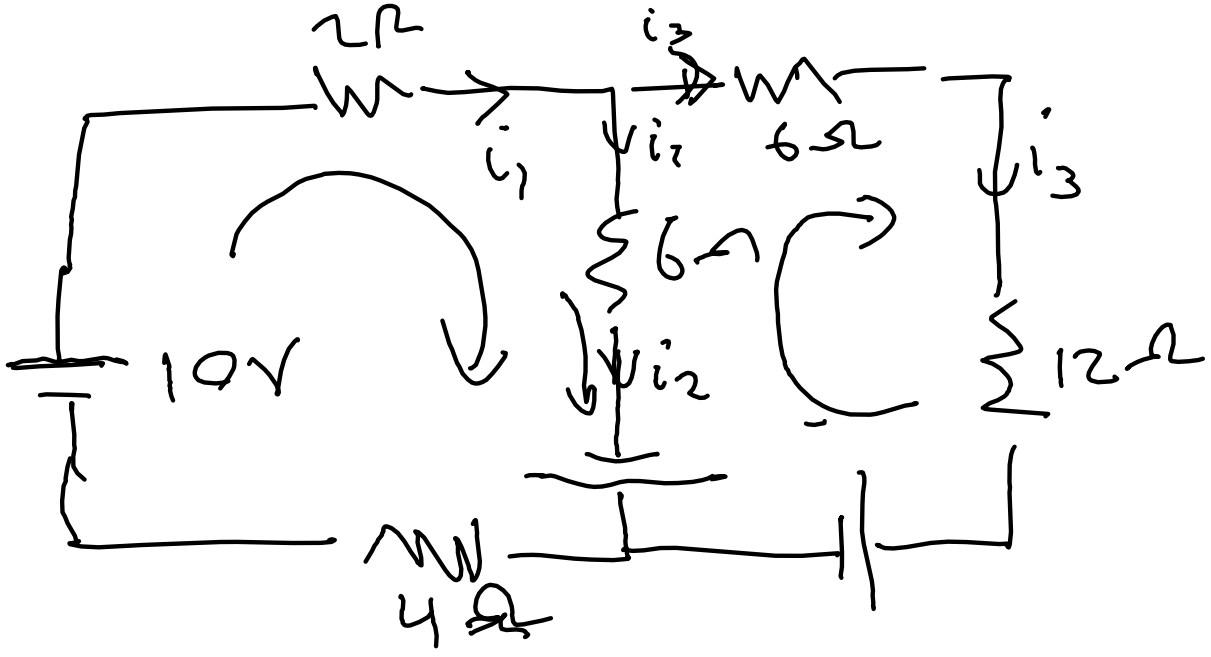
Example 3



$2i_1 + 4i_1 + 6i_2 = 12$ Loop 1.

$-18i_3 + 6i_2 = 6$ Loop 2

Solution



$$i_1 = i_2 + i_3$$

Summary of Kirchhoff's Laws

- KCL and KVL allow for complete circuit analysis.
- Can be applied in both DC and AC circuit analysis.