# 5.2 Kirchoff's laws worksheet

Kirchhoff's Current Law - states that the current entering a point in a circuit is equal to the summation of the currents exiting.

Kirchhoff's Voltage Law - states that the summation of all voltage drops in a closed loop must equal to zero which is a result of the electrostatic field being conservative.

(Conventional) current flowing through the cell has a positive voltage (gains energy). Current going through a resistor has a negative voltage (loses energy).

Example Problem
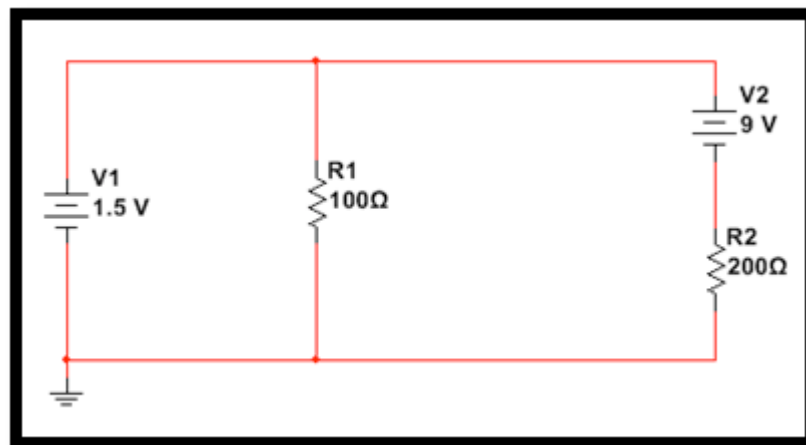
Begin by labelling the junctions in our circuit, J_1 and J_2. Then we label the currents as I, I_1 and I_2 in an arbitrary direction as shown in the figure below. (Direction of currents will be confirmed once we complete the problem).
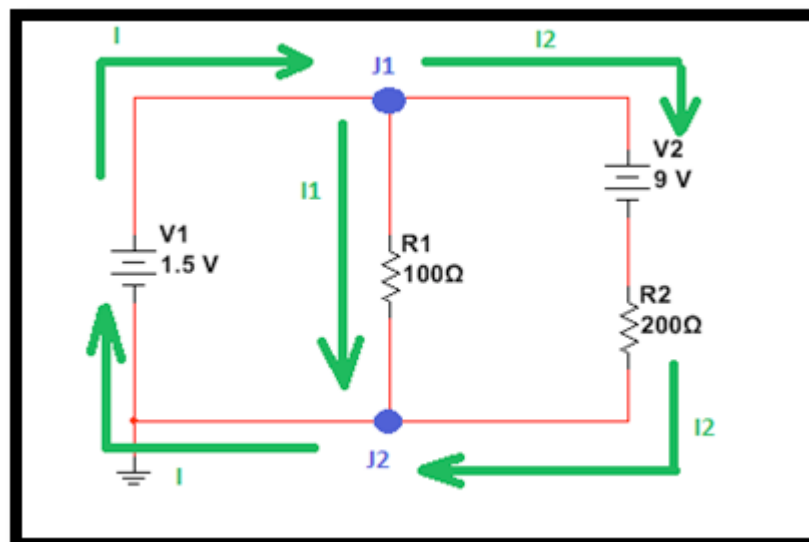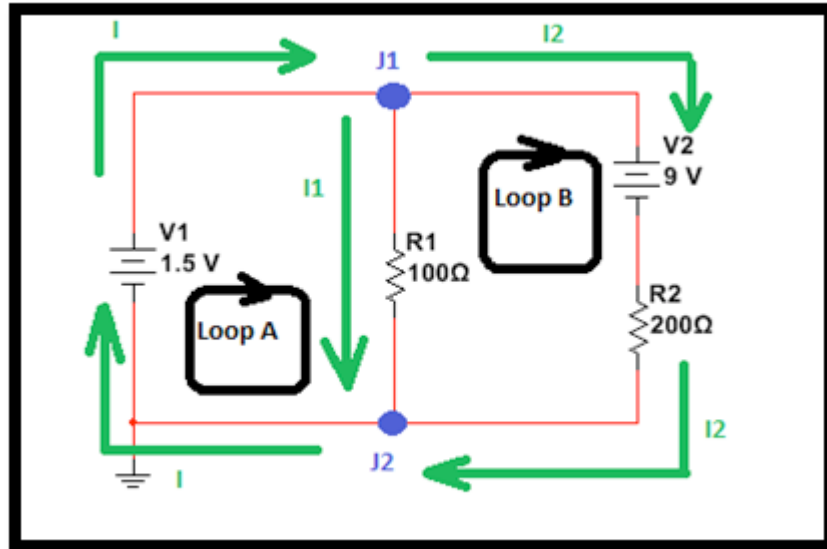

<u>**Junction J_1:**</u>

$I = I_1 + I_2$ (equation 1)

<u>**Junction J_2:**</u>

$I_1 + I_2 = I$ (which is the exact same equation we got from J_1 above)

Determine the voltage drops V_{R1} and V_{R2} across each resistor.

Begin by labelling the loops as loop **A** and loop **B** as shown below.

Loop A: (start from the upper left corner and move clockwise)

$-I_1$ x (100 Ω) + 1.5V = 0 (equation 2)

Therefore: **I_1 = 0.015 A**

Loop B:

$-9V - I_2$ x (200 Ω) + I_1 x (100 Ω) = 0 (equation 3)

Substituting the value of I_1 into equation 3 yields:

$-9 - I_2$ x (200 Ω) + (0.015)(100 Ω) = 0

-7.5 = (200) x I_2 therefore: **I_2 = -0.0375 A**

And then **I = -0.0225 A**

Note that the negative sign of the current indicates that the arbitrary direction we chose is the opposite of the actual direction the current is flowing in.
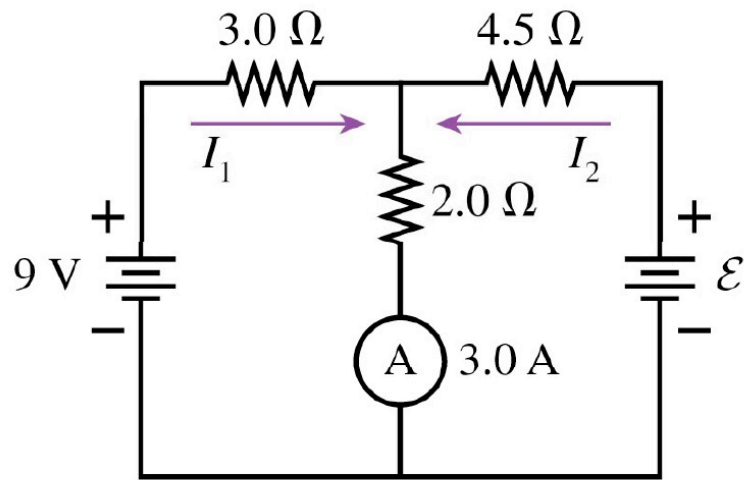
Answer Sub-Step 3: Determine the values of V_{R1} and V_{R2} based on our calculated values for I_1 and I_2

V_{R1} = I_1 x R_1 = (0.015 A) x (100 Ω) therefore **V_{R1} = 1.5V**

V_{R2} = I_2 x R_2 = (-0.0375 A) x (200 Ω) therefore **V_{R2} = -7.5V**

Find all the currents and voltages across each resistor and cell in the following circuits;

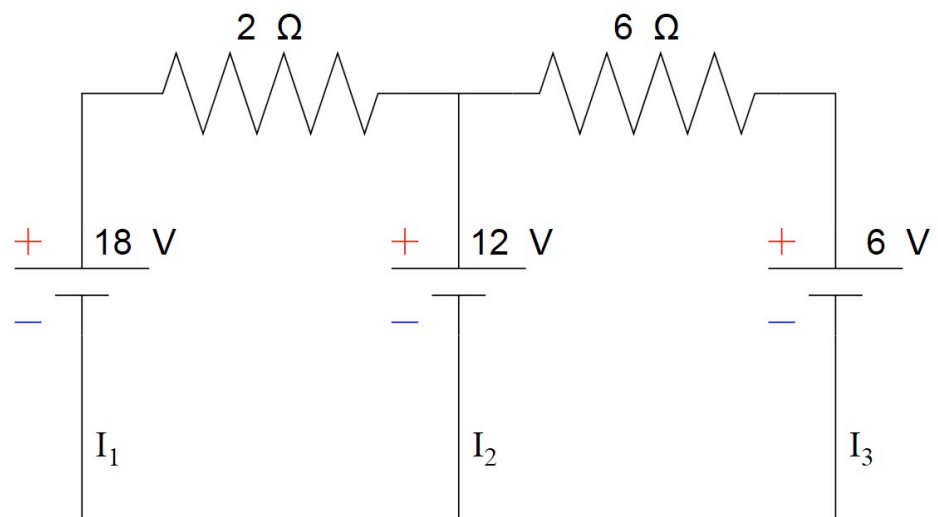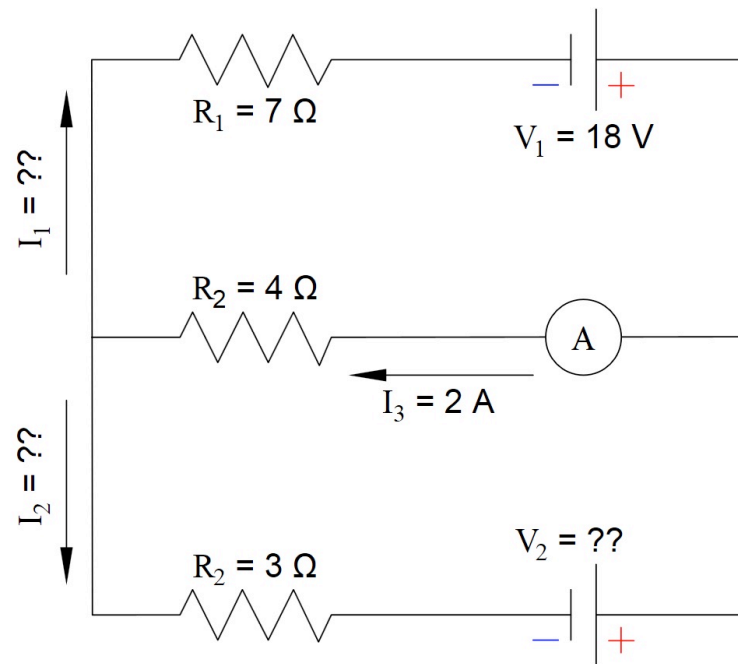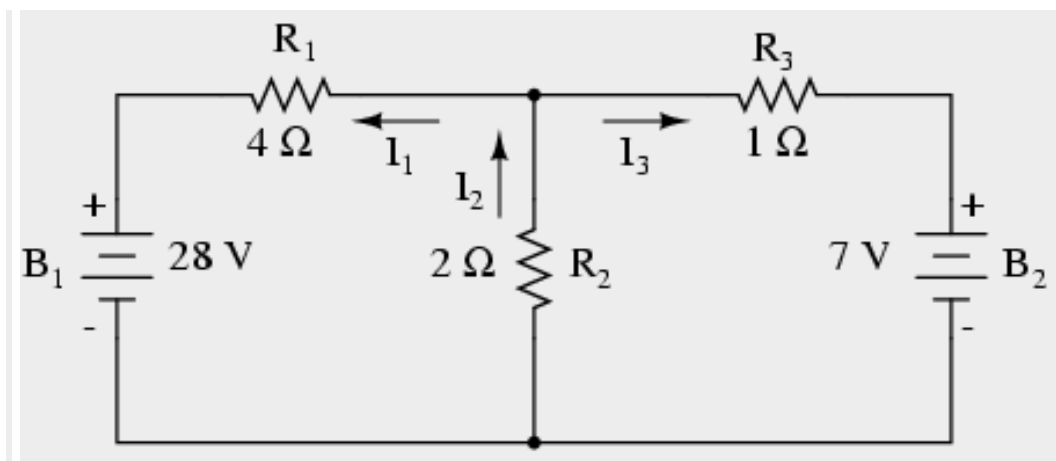**1.**

2.

3.

4.

$R_1 = 7\ \Omega$

$V_1 = 18\ V$

$I_1 = ??$

$R_2 = 4\ \Omega$

A

$I_3 = 2\ A$

$I_2 = ??$

$V_2 = ??$

$R_2 = 3\ \Omega$

5.

R_1

$4\ \Omega$ I_1

I_2

R_3

I_3 $1\ \Omega$

B_1 $28\ V$

$2\ \Omega$ R_2

$7\ V$ B_2

6.

$12V$ 4Ω

I_1

2Ω

a b

I_3 I_2

$8V$ 6Ω