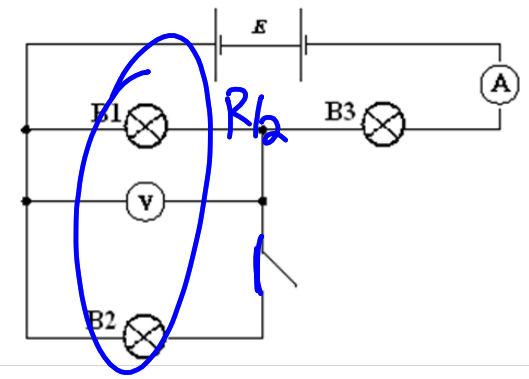
4. A battery with emf E is connected in a circuit with three identical light bulbs, as shown.

a) Determine the reading on the voltmeter when the switch is open and when it is closed.



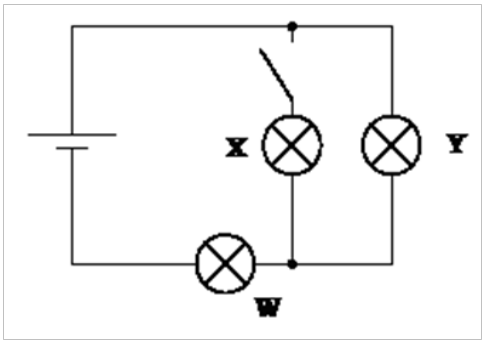
b) State what effect closing the switch has on the total resistance and total current as well as the current through each bulb and the brightness of each bulb.

When the switch closes . . .

	Current	Voltage	Power
B1	↓	↓	↓
B2	↑	↑	↑
B3	↑	↑	↑

↑
↓

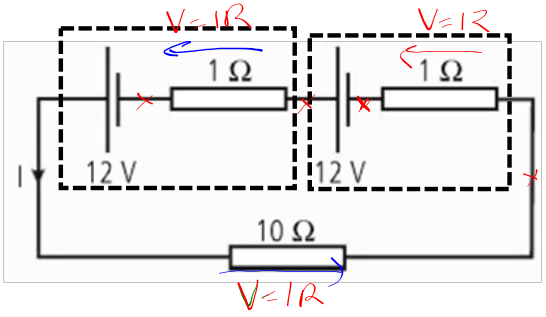
5. Three identical filament lamps (assume constant resistance) are connected to a source of emf as shown.
Predict what will happen when the switch is closed.



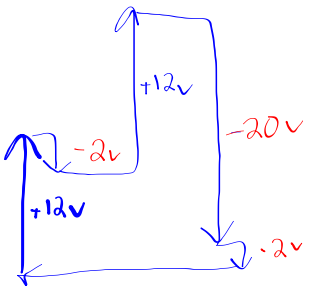
Circuits with Multiple Emfs

I. Emfs in series in the same direction: add the voltages

1. Determine the current in the following circuit.

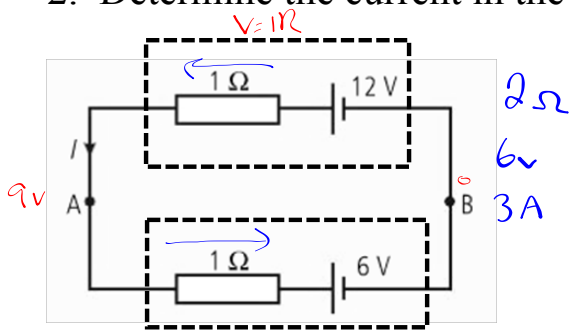


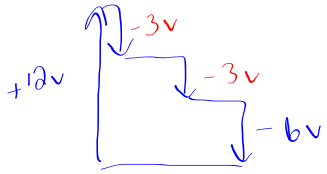
24 V
12 Ω
2 A



II. Emfs in series in opposite directions: subtract the voltages

2. Determine the current in the following circuit.

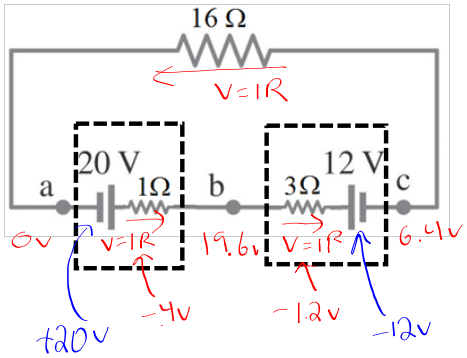




Application of series emfs in opposite directions: recharging a secondary cell

Direction of current flow: backwards through the secondary cell

3. Determine the current in the following circuit. Which is the primary cell and which is the secondary cell?

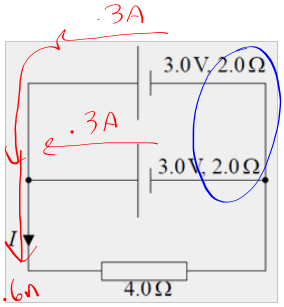


20Ω
8v
0.4A

$I = V_T/R_{eq} = 8v/20\Omega$

III. EMFs in parallel: same EMF but add internal resistances

4. Determine the current in the following circuit. Each identical cell has an emf of 3.0 V and an internal resistance of 2.0 ohms.



1Ω
3V
5Ω
.6A

Kirchoff's Circuit Laws

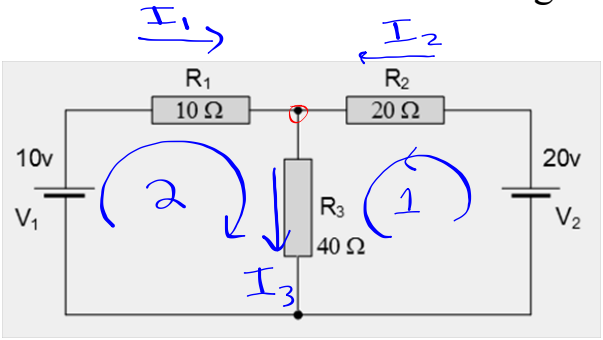
Loop Rule: Around any closed loop in a circuit, the sum of the EMFs equals the sum of the potential differences. (total voltage rises = total voltage drops)

Conservation of . . .energy **Formula: ΣV = 0**

Junction Rule: At any junction in a circuit, the sum of the currents entering the junction equals the sum of the currents leaving the junction. (total current in = total current out)

Conservation of . . .electric charge **Formula: ΣI = 0**

1. Determine the current through resistor R_3.



$I_1 + I_2 = I_3$

$V_2 - I_2R_2 - I_3R_3 = 0$

$V_1 - I_1R_1 - I_3R_3 = 0$

$I_1 + (1 - 2I_3) - I_3 = 0$

$I_1 + 1 - 3I_3 = 0$

$1 - 4I_3 + 1 - 3I_3 = 0$

$I_1 + I_2 - I_3 = 0$

$0 + 20I_2 + 40I_3 = 20 \rightarrow (I_2) + 2I_3 = 1$

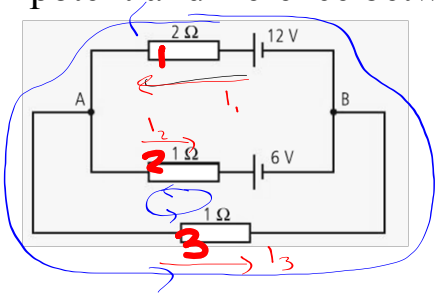
$10I_1 + 0 + 40I_3 = 10 \quad (I_1) + 4I_3 = 1$

$I_1 = -.143A$

$I_2 = +.429A$

$I_3 = +.286A$

2. Determine the currents in the following circuit as well as the potential difference between points A and B.



$12 - 2I_1 - I_3 = 0$

$6 + I_2 - I_3 = 0$