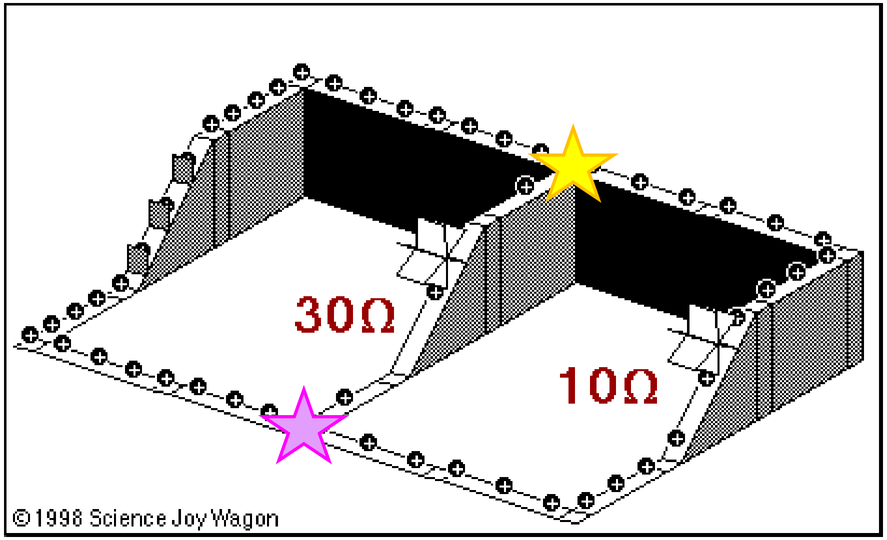
Circuit Analysis

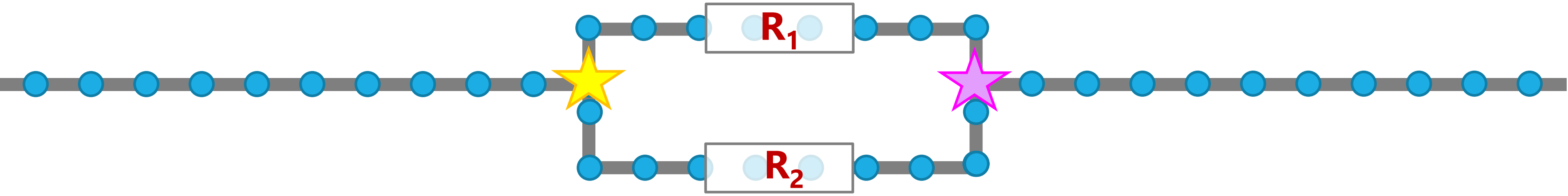
IB PHYSICS | ELECTRICITY

Review of Parallel Circuits

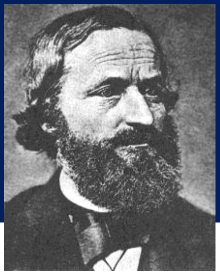
- Separate branches
- Current splits up between the different pathways



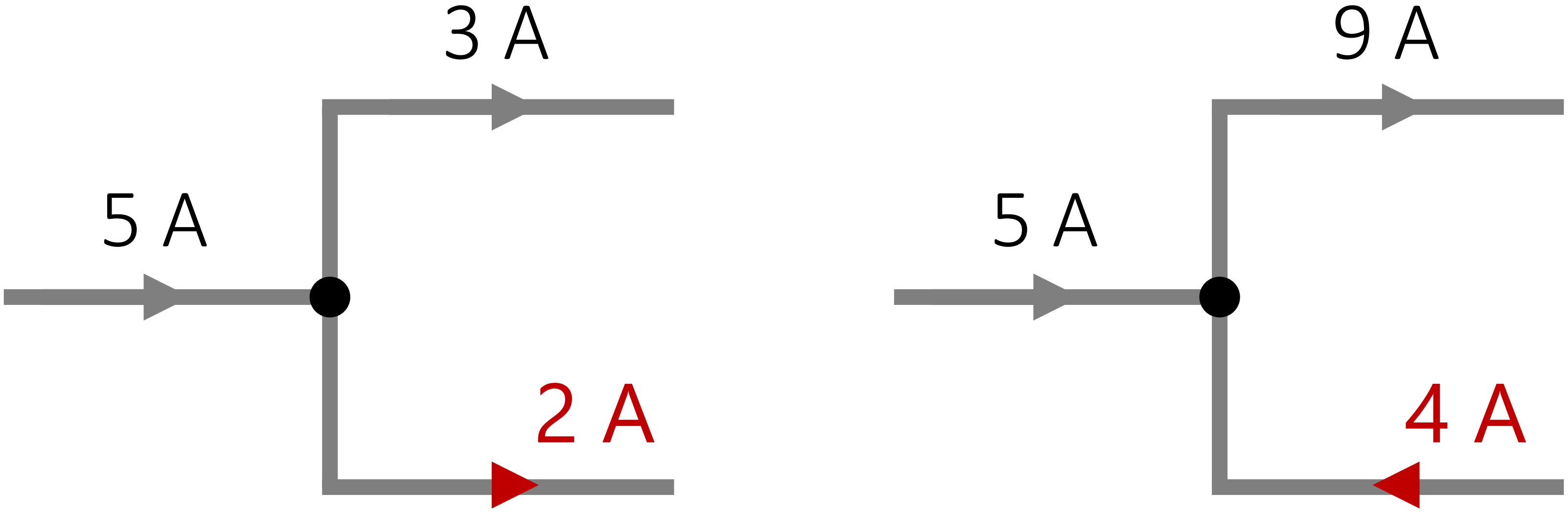
Junctions



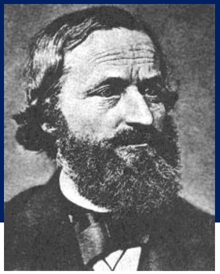
Kirchhoff’s First Law



The total current coming into a junction must equal the total current leaving the same junction



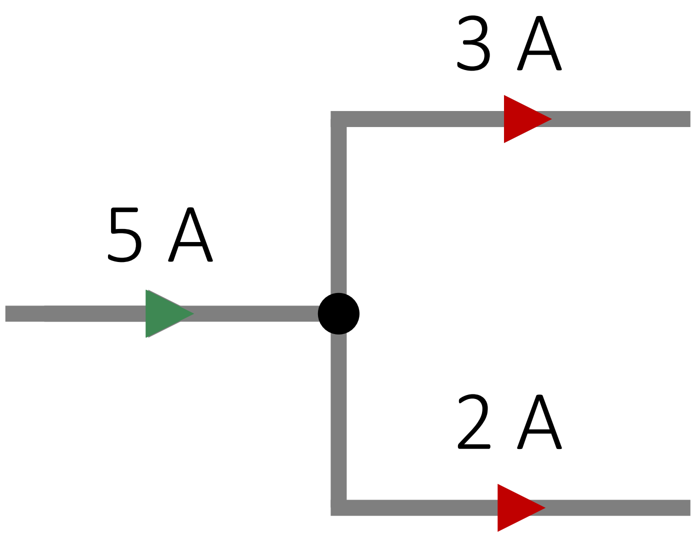
Kirchhoff's First Law



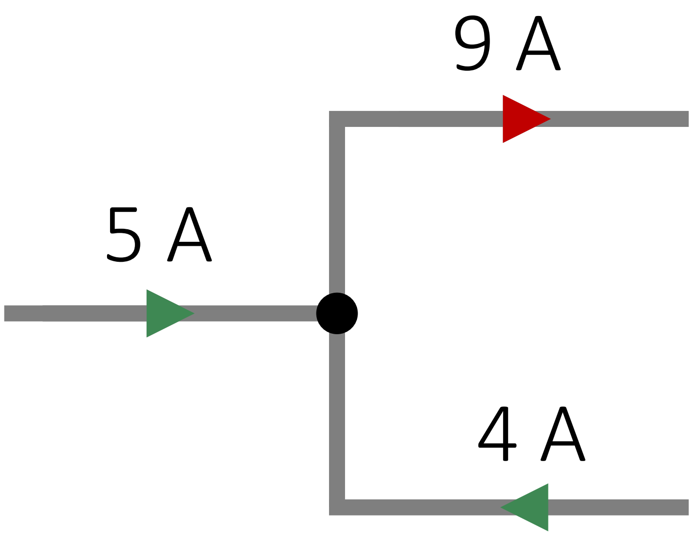
$$\Sigma I = 0 \ (junction)$$

Entering Junction	→●	Positive
Exiting Junction	●→	Negative

(+5) + (-3) + (-2) = 0



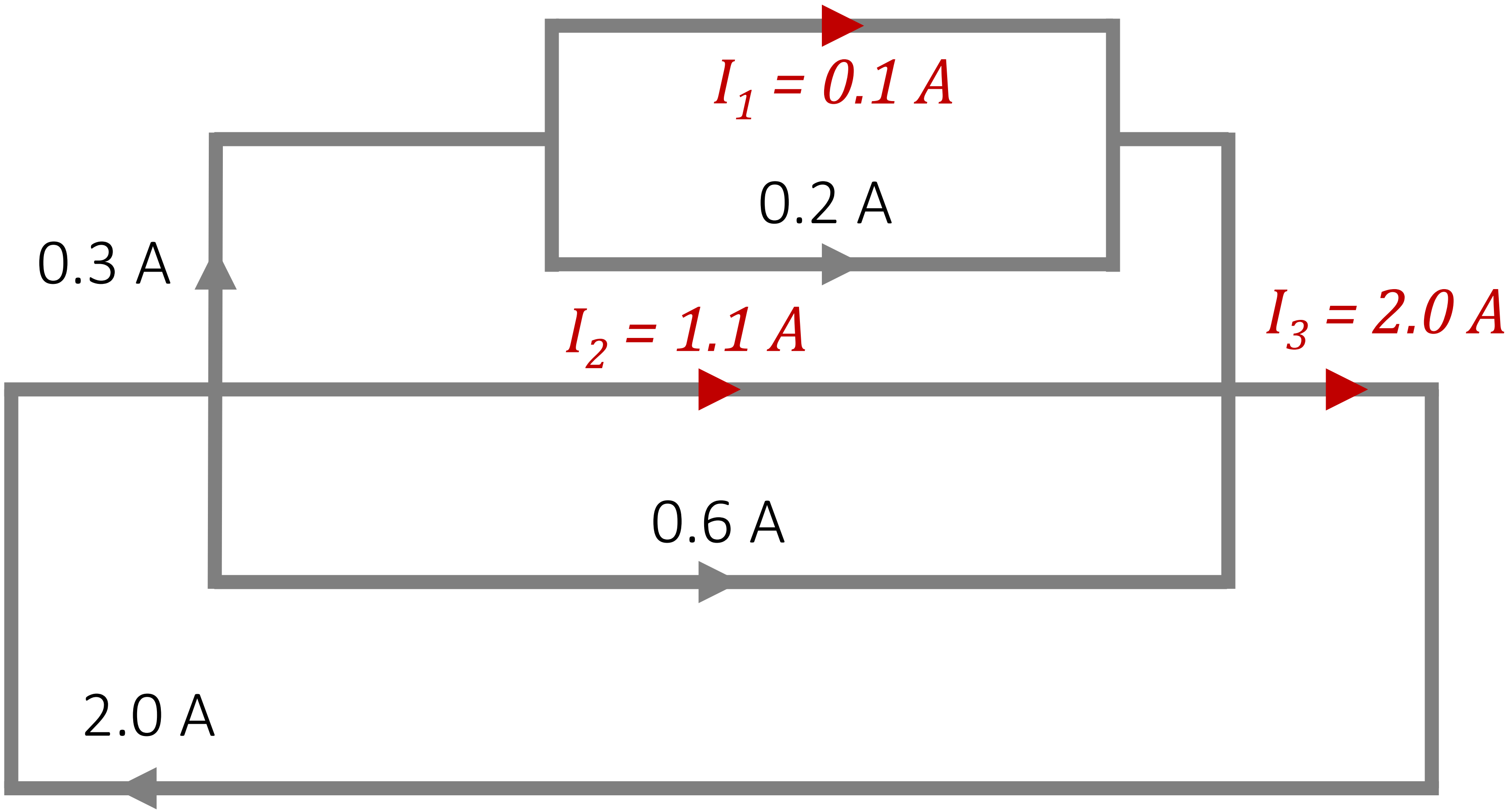
(+5) + (-9) + (+4) = 0



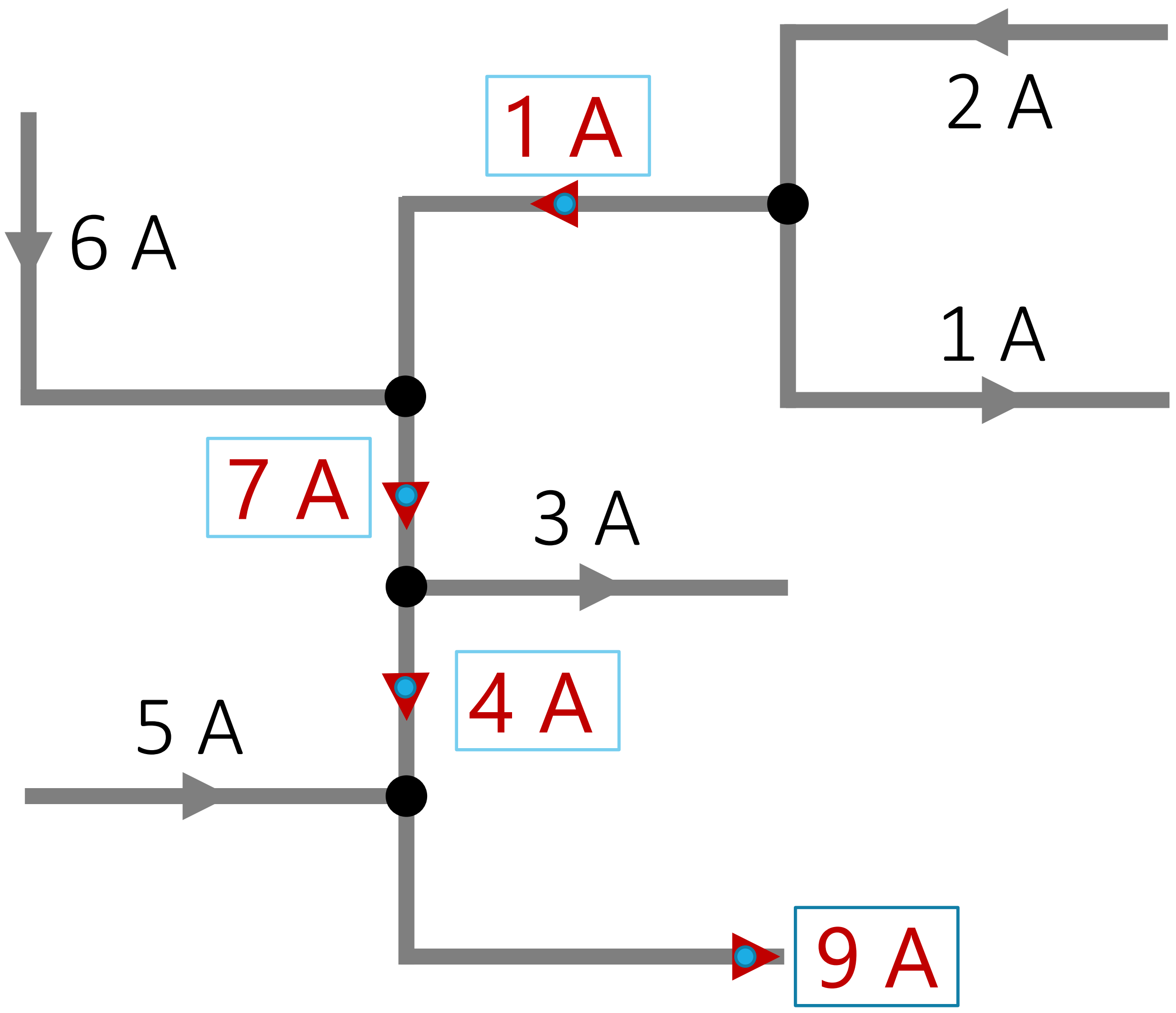
IB Physics Data Booklet

Sub-topic 5.1 – Electric fields	Sub-topic 5.2 – Heating effect of electric currents
$I = \frac{\Delta q}{\Delta t}$ $F = k\frac{q_1 q_2}{r^2}$ $k = \frac{1}{4\pi\varepsilon_0}$ $V = \frac{W}{q}$ $E = \frac{F}{q}$ $I = nAvq$	Kirchhoff's circuit laws: $\Sigma V = 0$ (loop) $\Sigma I = 0$ (junction) $R = \frac{V}{I}$ $P = VI = I^2R = \frac{V^2}{R}$ $R_{\text{total}} = R_1 + R_2 + \cdots$ $\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$ $\rho = \frac{RA}{L}$
Sub-topic 5.3 – Electric cells	**Sub-topic 5.4 – Magnetic effects of electric currents**
$\varepsilon = I(R + r)$	$F = qvB\sin\theta$ $F = BIL\sin\theta$

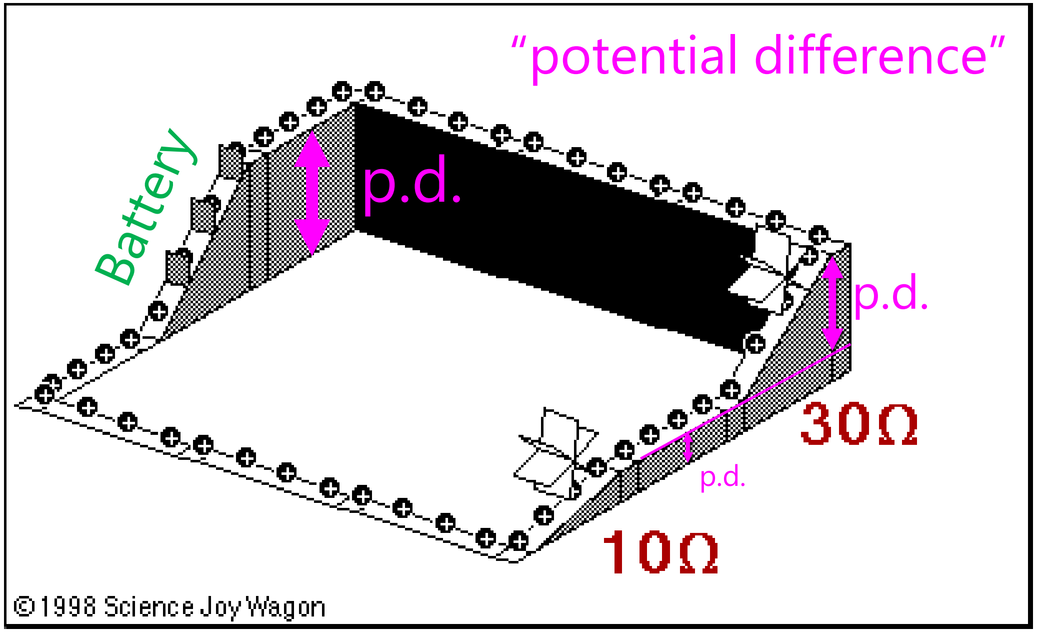
Find the Missing Currents



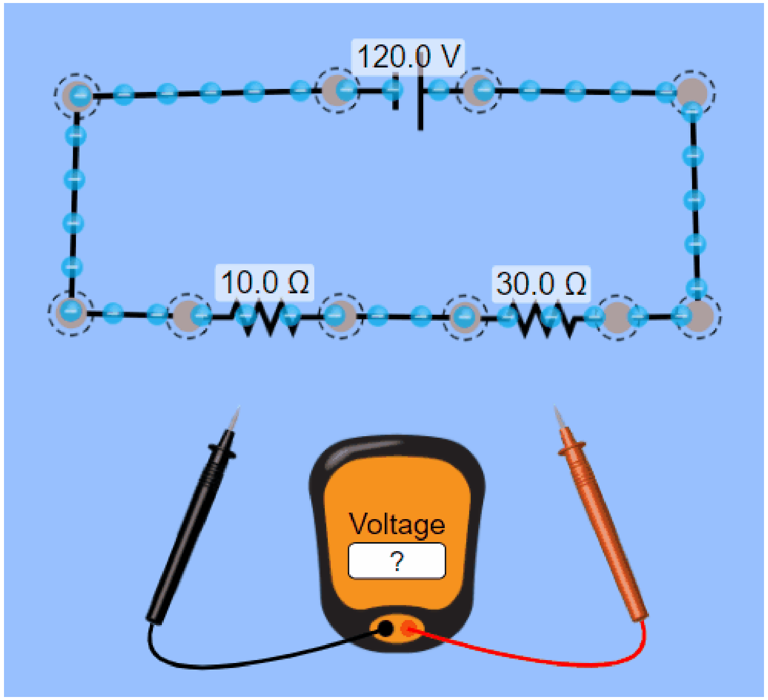
Follow the Current...



Review of the Water Flow Model

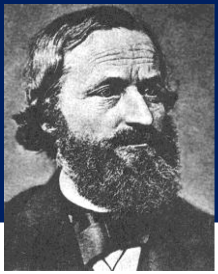


Each resistor has a "voltage drop"



The voltage used by the resistors equals the voltage supplied by the battery

Kirchhoff’s Second Law



The sum of the voltages (potential differences) provided must equal the voltages dissipated across components

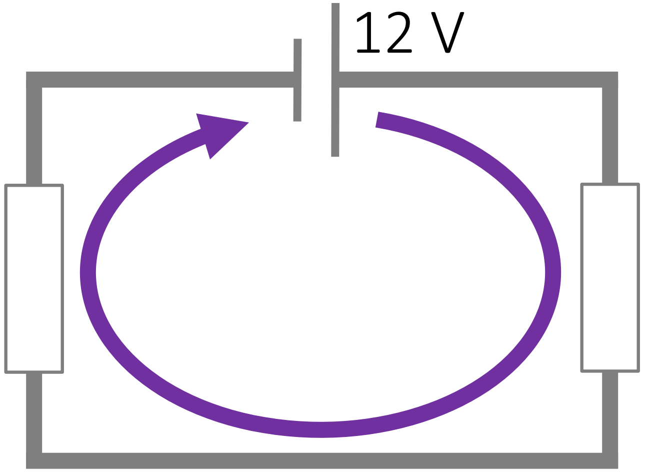
$$\Sigma V = 0 \ \ (loop)$$

Across Batteries

Negative to Positive	→ ⊣|⊢	Positive
Positive to Negative	→ |ı	Negative

Over Resistors:

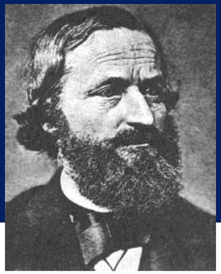
Always Negative



$(+12) + (-4) + (-8) = 0$

Resistor

Kirchhoff's Second Law



$$\Sigma V = 0 \ \ (loop)$$

Across Batteries

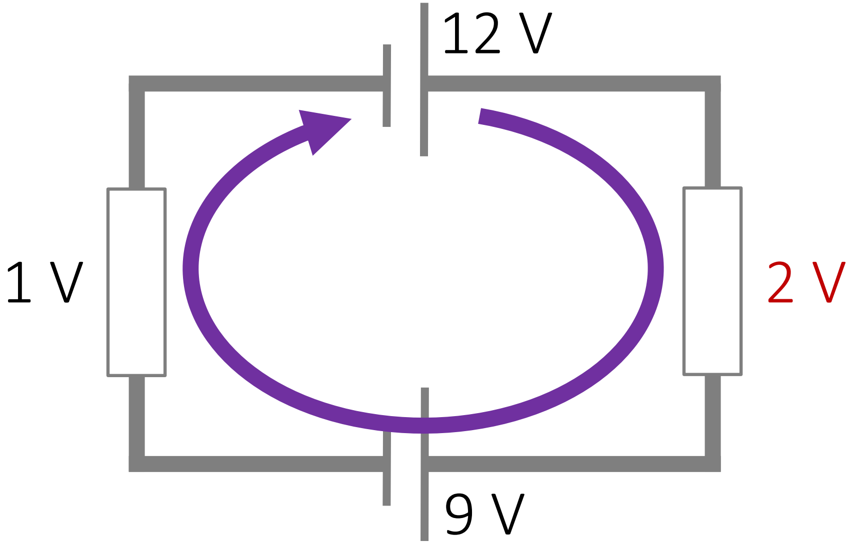
Negative to Positive	→ -||-	Positive
Positive to Negative	→ -||-	Negative

Over Resistors:

Always Negative

(+12) + (-2) + (-9) + (-1) = 0

Resistor



IB Physics Data Booklet

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$\varepsilon = I(R + r)$	$F = qvB\sin\theta$ $F = BIL\sin\theta$

The Tools for your Toolbox ☺

Ohm's Law: If you know two of the three electrical properties: V, I, or R

$$R = \frac{V}{I}$$

Kirchhoff's Voltage Law

$$\Sigma V = 0 \;\; (loop)$$

Kirchhoff's Current Law

$$\Sigma I = 0 \;\; (junction)$$

Series Combination

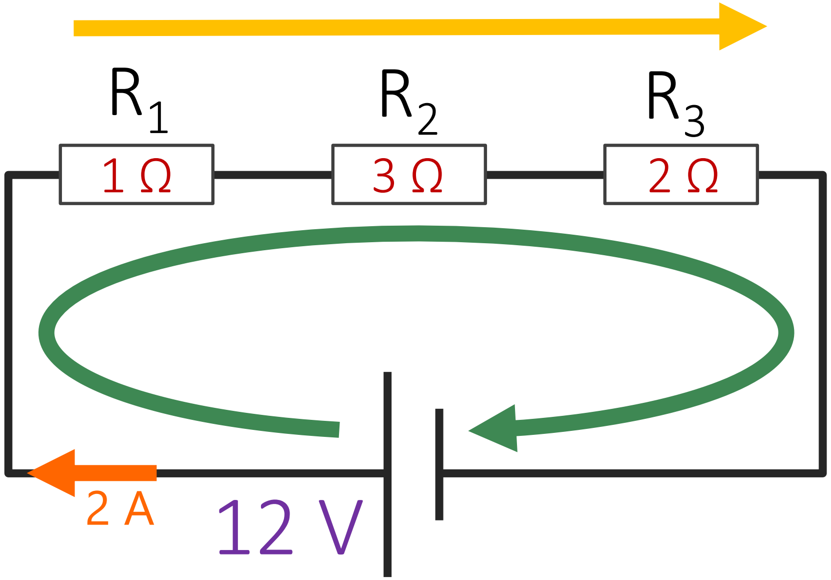
$$R_{total} = R_1 + R_2 + \cdots$$

Parallel Combination

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$

Calculating Circuits - Series

No Junction: Current is the same throughout



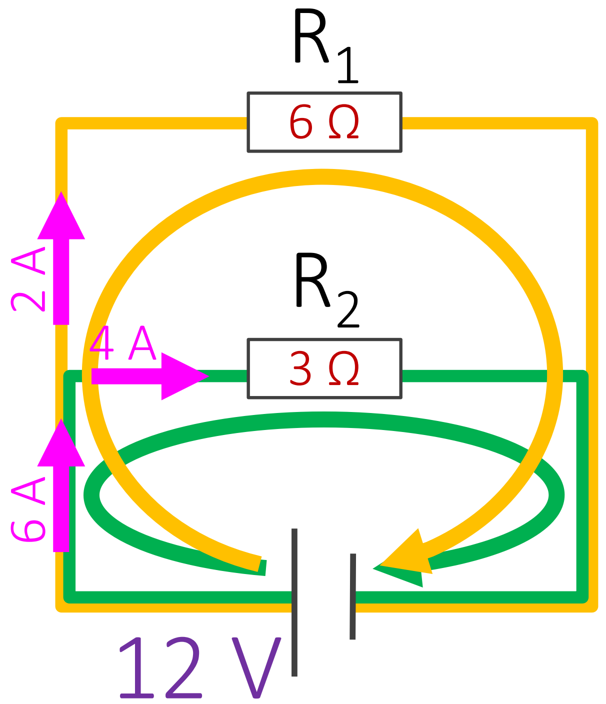
Loop: Voltage supplied equals voltage dissipated

	V	I	R
R_1	2 V	2 A	1 Ω
R_2	6 V	2 A	3 Ω
R_3	4 V	2 A	2 Ω
Total	12 V	2 A	6 Ω

$$R_T = 1 + 3 + 2 = 6\ \Omega$$

$$I_T = \frac{V}{R} = \frac{12}{6} = 2\ A$$

Calculating Circuits - Parallel



	V	I	R
R_1	12 V	2 A	6 Ω
R_2	12 V	4 A	3 Ω
Total	12 V	6 A	2 Ω

$$R_T = (6^{-1} + 3^{-1})^{-1} = 2\,\Omega$$

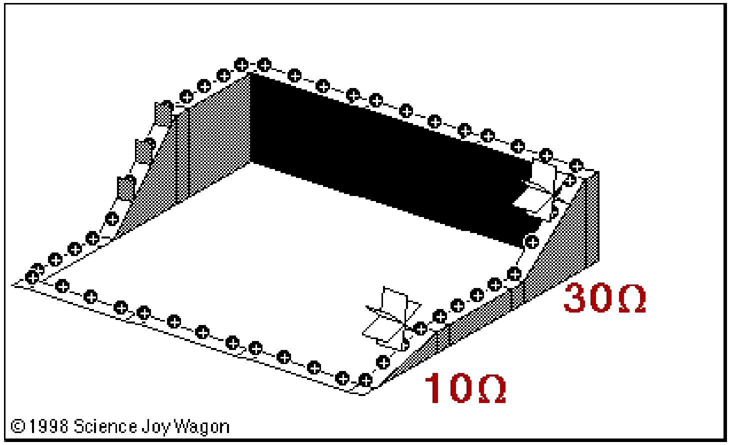
$$I_T = \frac{V}{R} = \frac{12}{2} = 6\text{ A}$$

$$I = \frac{V}{R} =$$

Loop: Voltage supplied equals voltage dissipated

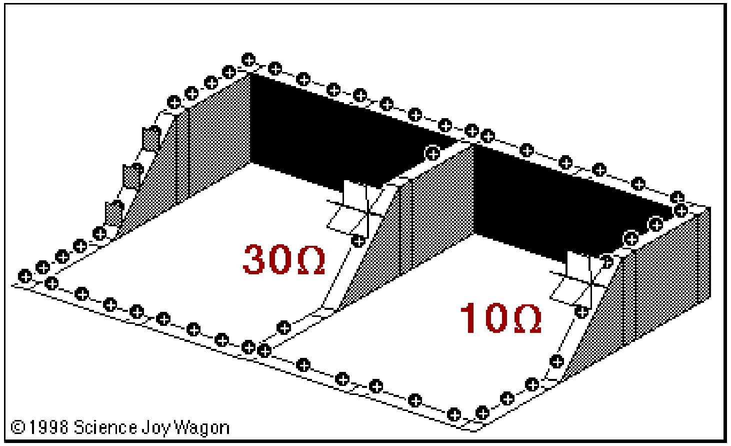
Junction: Current in = Current out

Patterns



Series Circuit

- Voltage is divided between components
- Current is the same for all components



Parallel Circuit

- Voltage is the same for each branch
- Current splits at each junction

Lesson Takeaways

- ❑ I can use Kirchhoff's First Law to determine an unknown current at a junction
- ❑ I can use Kirchhoff's Second Law to determine an unknown voltage drop in a loop
- ❑ I can calculate voltage, current, and resistance for every component in a simple series or parallel circuit
- ❑ I can compare and contrast the properties for simple series and parallel circuits