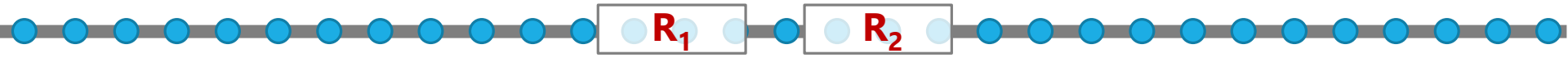
# Equivalent Resistance

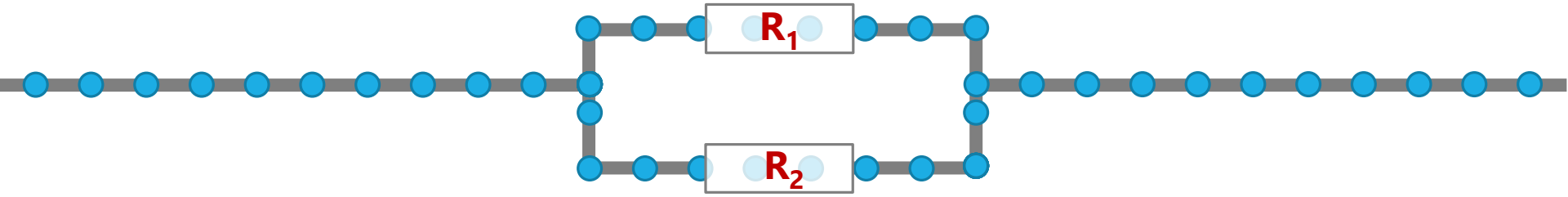
IB PHYSICS | ELECTRICITY

# Series and Parallel

## Series

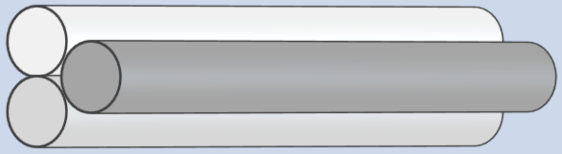



## Parallel



# Straw “Resistor”

A good physical model for current travelling through resistors is blowing through a straw.

| | |
|---|---|
| **1 resistor** |  |
| **3 resistors in series** |  |
| **3 resistors in parallel** |  |

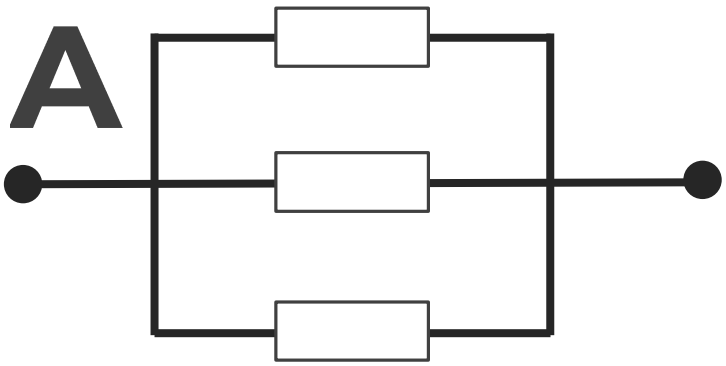
# Combining Resistors

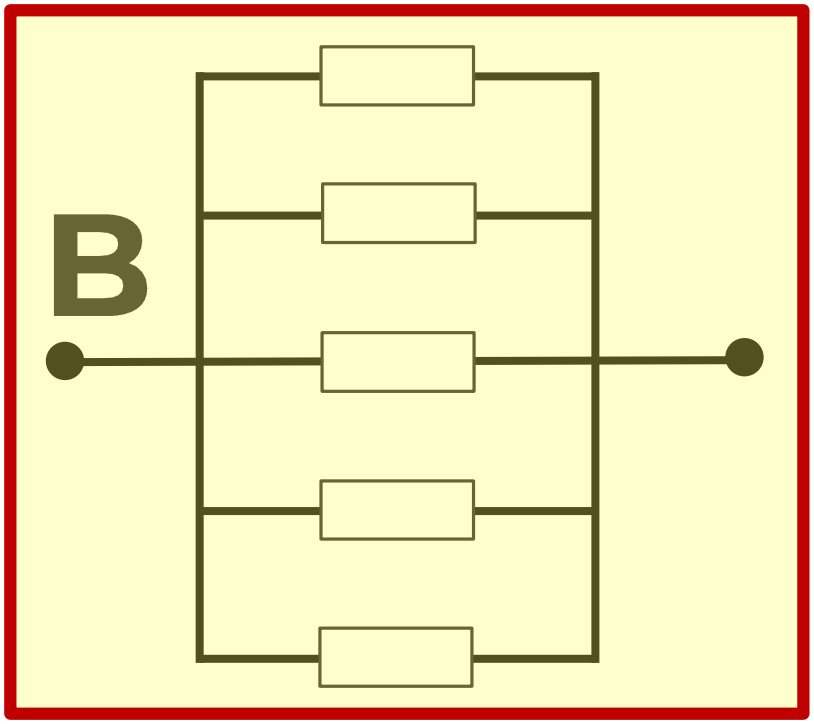
Adding resistors in series
**increases** overall resistance

Adding resistors in parallel
**decreases** overall resistance

# Compare these Combos…

Which example has the lowest overall resistance? Assume that every resistor is the same.

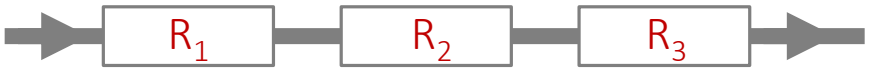


# Combining Resistors | Series

When combining resistors in series, the resistances are simply added up as if they were one large resistor

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



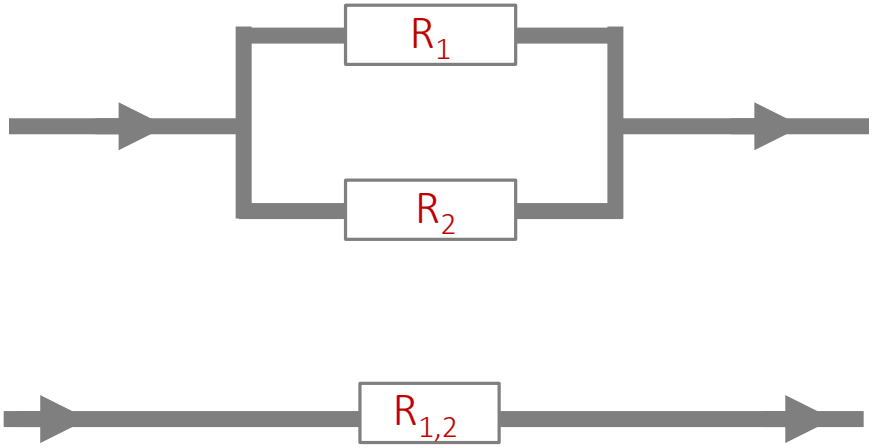
# Combining Resistors | Parallel

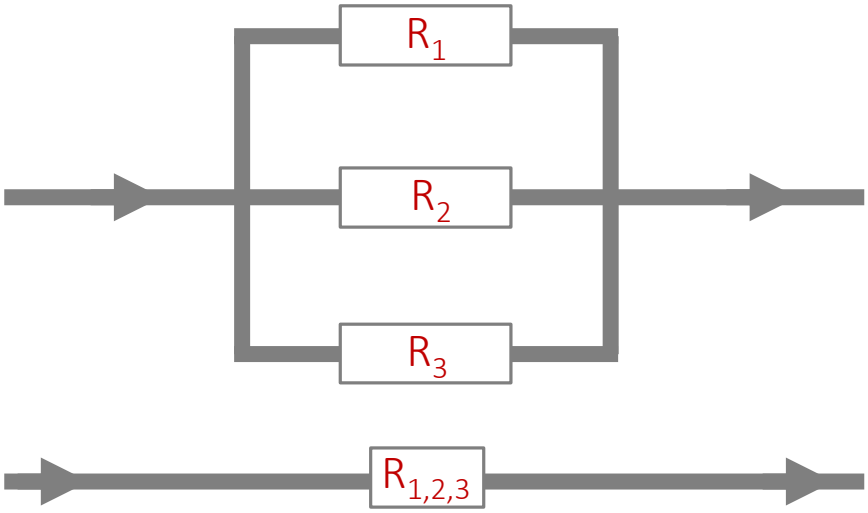
When combining resistors in parallel, the overall resistance decreases to produce a smaller equivalent resistance

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

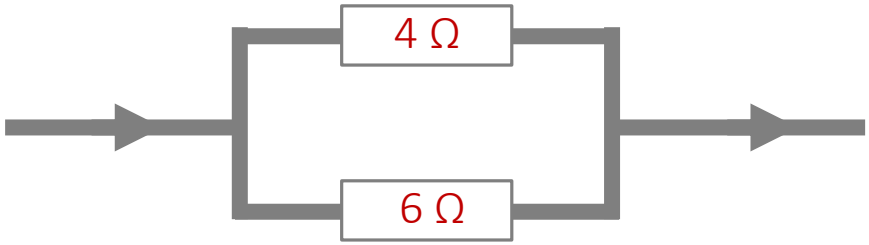
$$R_{total}{}^{-1} = \left(R_1{}^{-1} + R_2{}^{-1} + \cdots\right)$$

$$R_{total} = \left(R_1{}^{-1} + R_2{}^{-1} + \cdots\right)^{-1}$$



# Combining Resistors – Try This




$$R_T = 4 + 6 + 8 = 18\ \Omega$$

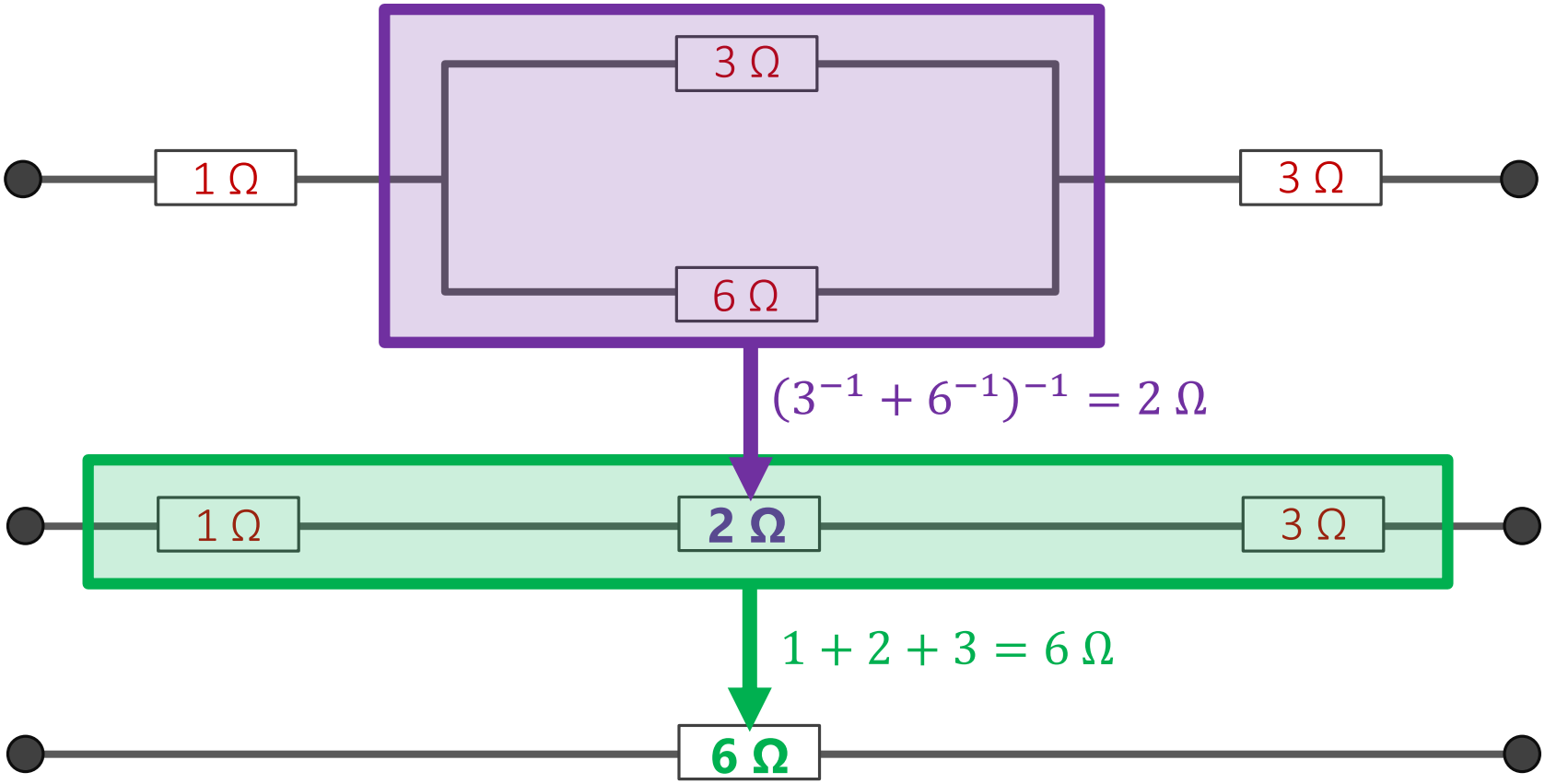
$$\frac{1}{R_T} = \frac{1}{4} + \frac{1}{6} \Rightarrow R_T = \frac{1}{\frac{1}{4} + \frac{1}{6}}$$

$$R_T = (4^{-1} + 6^{-1})^{-1} = 2.4\ \Omega$$

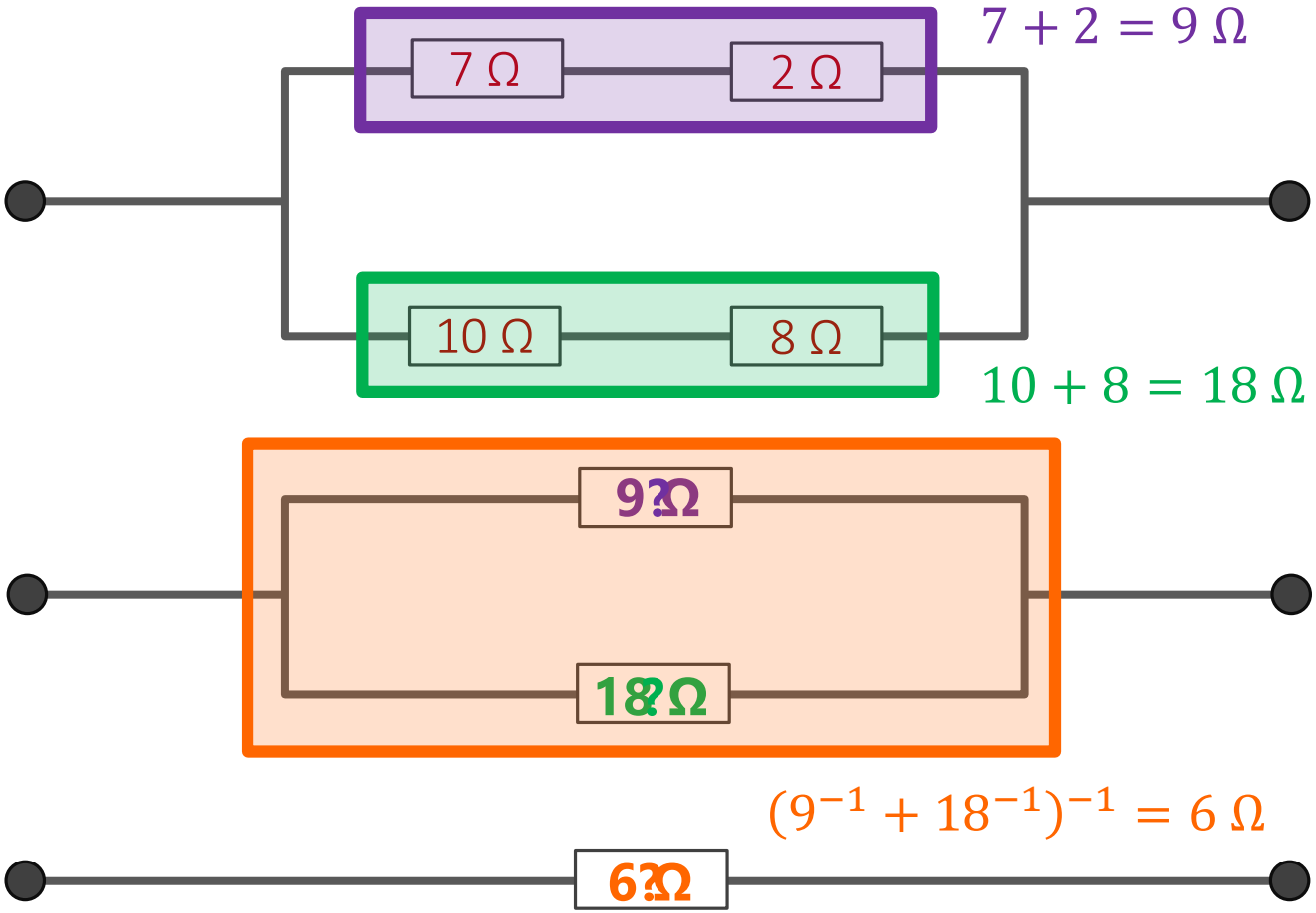
# IB Physics Data Booklet

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

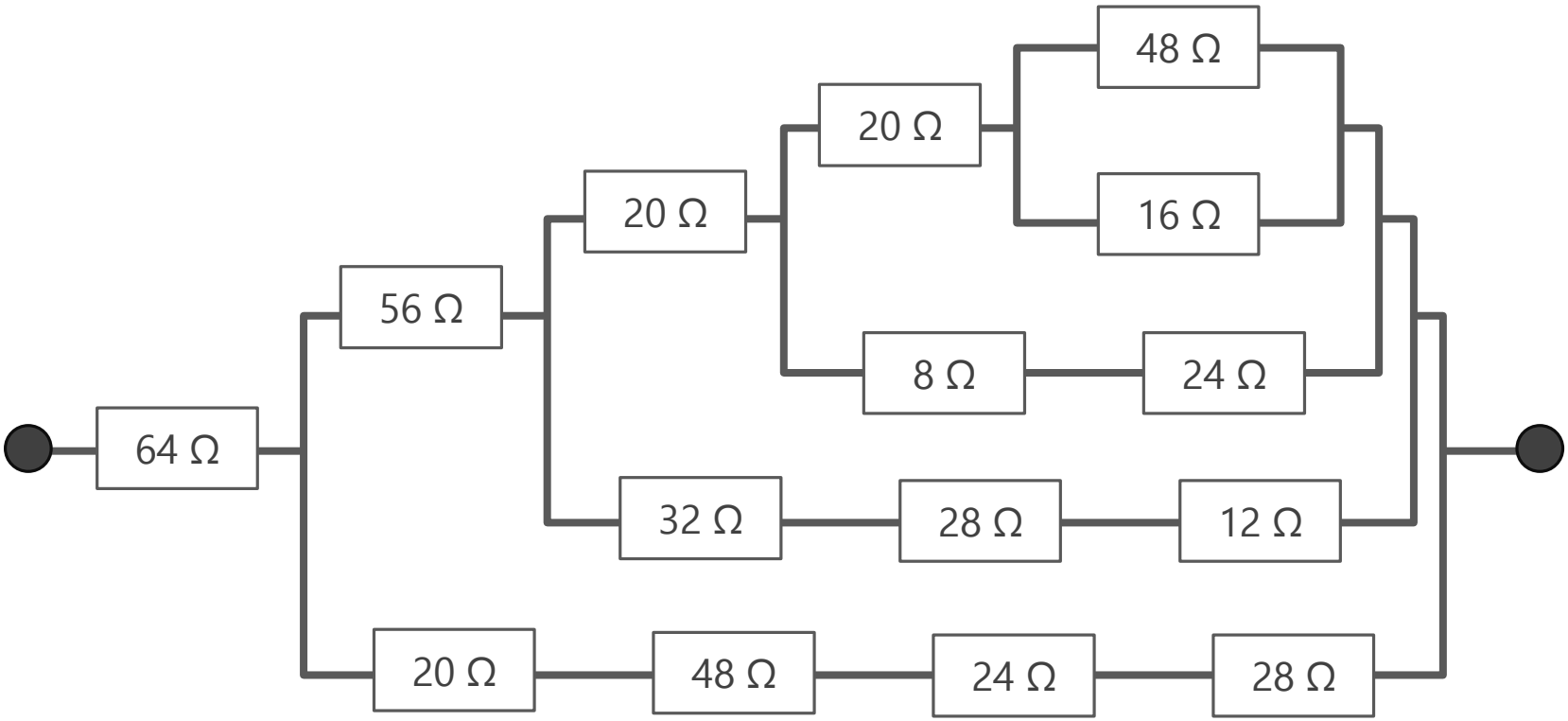
# Equivalent Resistance



# Try This | Equivalent Resistance



# This could be bigger…



# Lesson Takeaways

- ❑ I can calculate the equivalent resistance for combinations of resistors in series and parallel
- ❑ I can systematically step through the calculation of the equivalent resistance for a complex combination