11 Combining resistors and circuit rules – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
equivalent resistance	等效电阻			
Kirchhoff's junction rule	基尔霍夫电流定律			
Kirchhoff's loop rule	基尔霍夫电压定律			

Recall

In Part A you used $V = IR$ and $P = IV$ for single components. Now handle circuits with **several** resistors:

- Resistors in a line add up; resistors side by side share the current.
- Whatever current flows into a junction must flow out again.

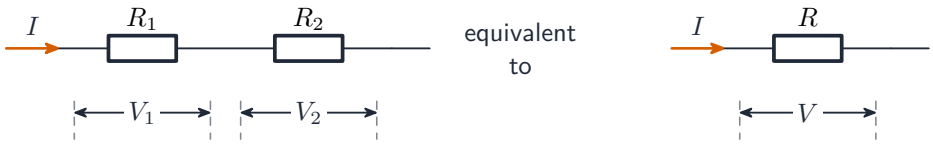
Each idea has a worked example before the Practice.

New ideas

■ 1 Combining resistors

Replace several resistors with one **equivalent resistance** 等效电阻:

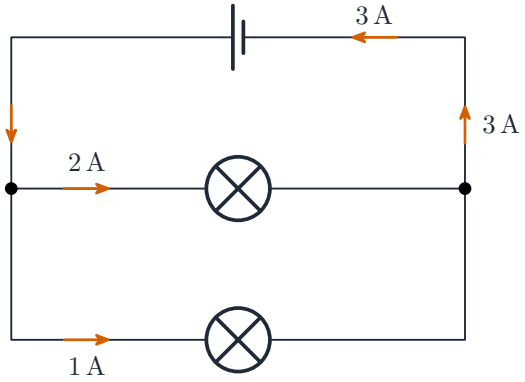
- **Series:** $R_{\text{eq}} = R_1 + R_2 + \cdots$ (they add).
- **Parallel:** $\dfrac{1}{R_{\text{eq}}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \cdots$ (the total is **less** than the smallest one).



Worked example. A 4.0 Ω and a 12 Ω resistor in **parallel**: $\frac{1}{R_{\text{eq}}} = \frac{1}{4} + \frac{1}{12} = \frac{4}{12}$, so $R_{\text{eq}} = 3.0\ \Omega$ – smaller than either one.

2 The junction rule

Kirchhoff's junction rule 基尔霍夫电流定律 says the current flowing **into** a junction equals the current flowing **out** (charge is conserved).



at each junction: $3\,\text{A} = 2\,\text{A} + 1\,\text{A}$

Worked example. If 4.0 A enters a junction and one branch carries 3.0 A, the other branch must carry $4.0 - 3.0 = 1.0$ A.

3 The loop rule

Kirchhoff's loop rule 基尔霍夫电压定律 says that, going around any complete loop, the voltage gains (from the battery) and drops (across resistors) add up to **zero** (energy is conserved).

4 Capacitor circuits

An **RC circuit** has a resistor and a capacitor. The capacitor charges up (or discharges) gradually, over a time set by $\tau = RC$. Right at the start it acts like a plain wire; once fully charged it blocks the current.

Watch out: putting resistors in **parallel** makes the total resistance **smaller** than the smallest one – because you have opened extra paths for the current. Series makes it larger.

Practice

Try these in order. The methods are all above.

2.1 Find the equivalent resistance of a 3.0 Ω and a 5.0 Ω resistor in **series**. [2]

2.2 Find the equivalent resistance of a 6.0 Ω and a 3.0 Ω resistor in **parallel**. [3]

2.3 A current of 5.0 A enters a junction. One branch carries 2.0 A. Find the current in the other branch. [2]

2.4 State the two conservation ideas behind Kirchhoff's junction rule and loop rule. [2]

2.5 State whether the total resistance of two resistors in parallel is larger or smaller than the smallest resistor, and explain briefly. [2]