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.

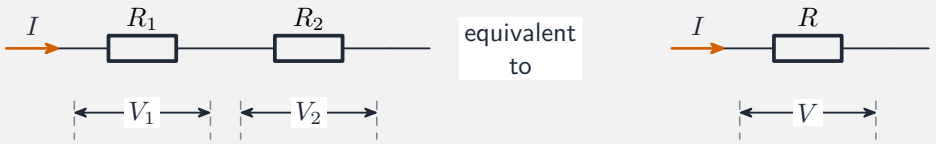
Each idea has a worked example before the Practice.

New ideas

■ 1 Combining resistors

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

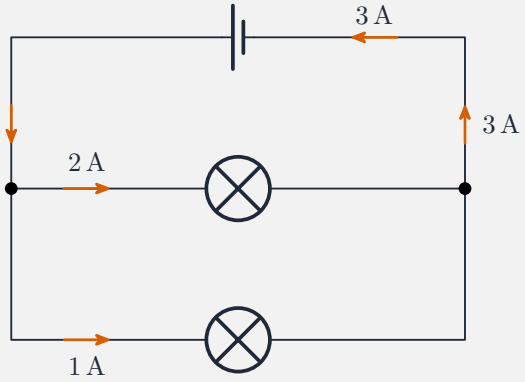
- **Series:** $R_{\text{eq}} = R_1 + R_2 + \cdots$ (they add).
- **Parallel:** $\dfrac{1}{R_{\text{eq}}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \cdots$ (the total is **less** than the smallest one).



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]