A-LEVEL PHYSICS • HOLIDAY HOMEWORK 假期作业

10 D.C. circuits – Part 1

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)		
series	串联			
parallel	并联			
electromotive force	电动势			
internal resistance	内阻			
Kirchhoff's first law	基尔霍夫第一定律			
junction	节点			
Kirchhoff's second law	基尔霍夫第二定律			
potential divider	分压器			

Recall

At IGCSE you built and measured circuits. Bring this with you:

- You used $V = IR$ and added resistors in **series** 串联 and **parallel** 并联.
- Current is the same all the way round a single loop.

At AS we treat real cells, two circuit laws, and a useful circuit called the potential divider.

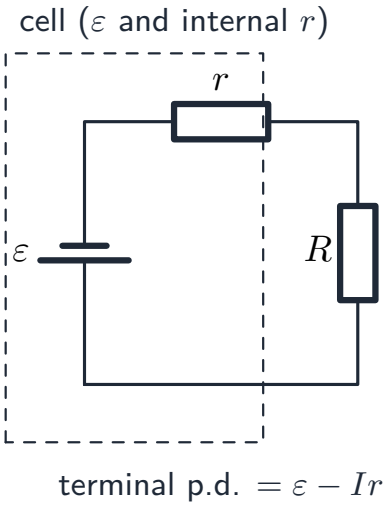
New ideas

1 E.m.f. and internal resistance

The **electromotive force** 电动势 ε of a cell is the energy it gives each unit of charge. A real cell also has some **internal resistance** 内阻 r, so when a current I flows the voltage you can use across the terminals is less:

$$V = \varepsilon - Ir.$$

Worked example. A cell with $\varepsilon = 12$ V and $r = 0.50\ \Omega$ supplies 2.0 A: $V = 12 - (2.0)(0.50) = 11$ V.

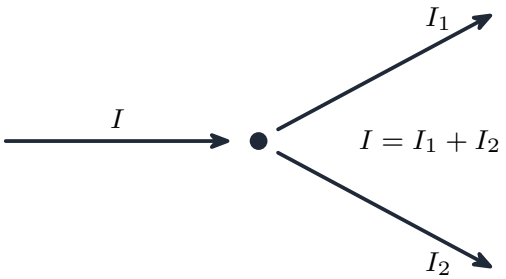


Watch out: the terminal voltage V is always *less* than the e.m.f. ε once current flows, because some energy is lost across the internal resistance r.

2 Kirchhoff's two laws

- **Kirchhoff's first law** 基尔霍夫第一定律 (charge is conserved): the total current into a **junction** 节点 equals the total current out.
- **Kirchhoff's second law** 基尔霍夫第二定律 (energy is conserved): around any loop, the sum of the e.m.f.s equals the sum of the voltage drops.

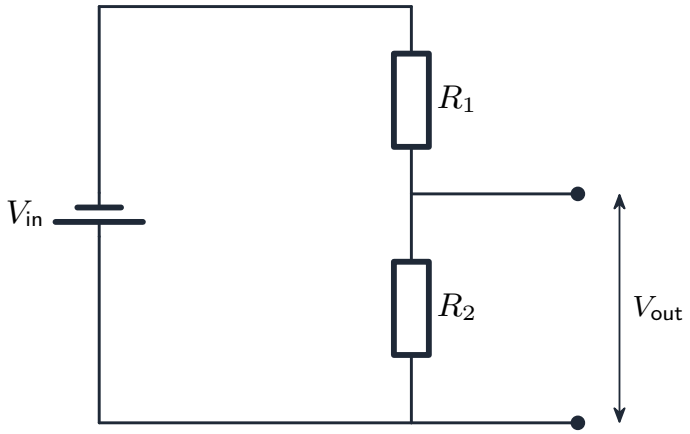
Worked example. 5.0 A flows into a junction and splits into two wires; one carries 2.0 A, so the other carries $5.0 - 2.0 = 3.0$ A.



■ 3 The potential divider

Two resistors in series share the supply voltage in proportion to their resistance. This is a **potential divider** 分压器. The voltage across R_2 is

$$V_{\text{out}} = \frac{R_2}{R_1 + R_2} V_{\text{in}}.$$



Worked example. $R_1 = 4.0\ \text{k}\Omega$, $R_2 = 2.0\ \text{k}\Omega$, $V_{\text{in}} = 9.0\ \text{V}$: $V_{\text{out}} = \dfrac{2.0}{6.0} \times 9.0 = 3.0\ \text{V}$.

Practice

10.1 A cell of e.m.f. 1.5 V and internal resistance 0.40 Ω supplies 0.50 A. Find the terminal voltage. [2]

10.2 At a junction, 3.0 A and 1.5 A flow in along two wires. Find the current flowing out along the third wire. [1]

10.3 Around a loop, a 9.0 V cell drives current through two resistors. One has 5.0 V across it. Use Kirchhoff's second law to find the voltage across the other. [2]

10.4 A potential divider has $R_1 = 3.0\ \text{k}\Omega$ and $R_2 = 1.0\ \text{k}\Omega$ across a 12 V supply. Find the output voltage across R_2. [3]

10.5 In that potential divider, explain what happens to the output voltage across R_2 if R_2 is *increased*. [2]

10.6 Challenge. A potential divider uses a thermistor as R_1 and a fixed resistor as R_2. Explain what happens to the output voltage across R_2 as the temperature rises. [2]