A-LEVEL PHYSICS • HOLIDAY HOMEWORK 假期作业

10 D.C. circuits – 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)		
Series	串联			
Parallel	并联			
sensor	传感器			
thermistor	热敏电阻			
light-dependent resistor	光敏电阻			
terminal p.d.	端电压			

Recall

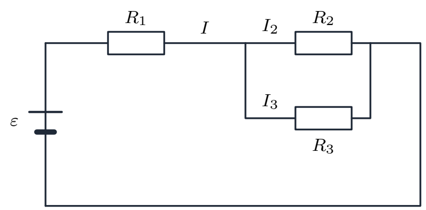
In **Part 1** you used e.m.f. and internal resistance ($V = \varepsilon - Ir$), Kirchhoff's two laws, and the potential divider. Part 2 adds combining resistors, using a divider to sense temperature or light, and measuring a cell's e.m.f. and internal resistance.

New ideas

Read these first. Each idea has a short worked example. Then do the Practice.

1 Combining resistors

- **Series** 串联 (same current): $R = R_1 + R_2 + \ldots$ — always bigger.
- **Parallel** 并联 (same p.d.): $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ — always *smaller* than any single resistor (two equal $R \to R/2$).



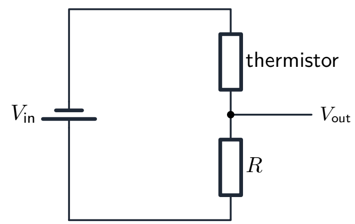
Worked example. A 4.0 Ω and a 12 Ω resistor in parallel: $\frac{1}{R} = \frac{1}{4.0} + \frac{1}{12} = \frac{3+1}{12} = \frac{1}{3}$, so $R = 3.0\ \Omega$.

2 Sensor circuits

Put a **sensor** 传感器 in a potential divider instead of a fixed resistor:

- a **thermistor** 热敏电阻 — its resistance falls as the temperature rises;
- a **light-dependent resistor** 光敏电阻 (LDR) — its resistance falls as the light gets brighter.

The divider's output voltage then changes with temperature or light, and can switch a heater or lamp on and off.

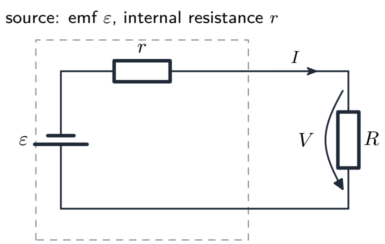


Worked example. In a thermistor-plus-fixed-resistor divider, a cold room gives the thermistor a high resistance; as it warms, that resistance falls and the output voltage shifts — enough to switch a fan on.

3 Measuring e.m.f. and internal resistance

Connect a cell to a variable resistor and record the **terminal p.d.** 端电压 V and current I as you change it. Plotting V against I gives the line $V = \varepsilon - Ir$:

- the y-intercept (at $I = 0$) is the e.m.f. ε;
- the gradient is $-r$ (the internal resistance).



Worked example. A V–I line cuts the axis at $V = 1.5$ V (so $\varepsilon = 1.5$ V) with a gradient of -0.50 V A^{-1} (so $r = 0.50\ \Omega$).

Watch out: resistors in parallel always give a total *smaller* than the smallest one — each extra path gives the current another way to flow.

Practice

10.1 Find the combined resistance of a 3.0 Ω and a 6.0 Ω resistor in **series**. [1]

10.2 Find the combined resistance of a 6.0 Ω and a 3.0 Ω resistor in **parallel**. [2]

10.3 State how the resistance of a thermistor changes as it gets warmer. [1]

10.4 When the terminal p.d. V is plotted against the current I for a cell, state what (a) the y-intercept and (b) the gradient represent. [2]

10.5 A cell of e.m.f. 1.5 V and internal resistance 0.50 Ω supplies a current of 0.60 A. Find the terminal p.d. [2]

10.6 Explain *why* adding a second resistor in parallel *lowers* the total resistance, even though you have added more resistor. [2]

10.7 Challenge. You have three identical 6.0 Ω resistors. State the largest and the smallest total resistance you can make using all three. [2]