

10.3 Potential dividers

Name: _____ Class: _____ Date: _____

Total: 19 marks

KEY WORDS null method 零点法 • potential divider 分压器 • galvanometer 检流计
 • potentiometer 电位差计 • thermistor 热敏电阻

Objective

Build the skills to answer exam questions on **potential dividers** — the divider equation, the uniform wire, and sensor circuits.

You must be able to:

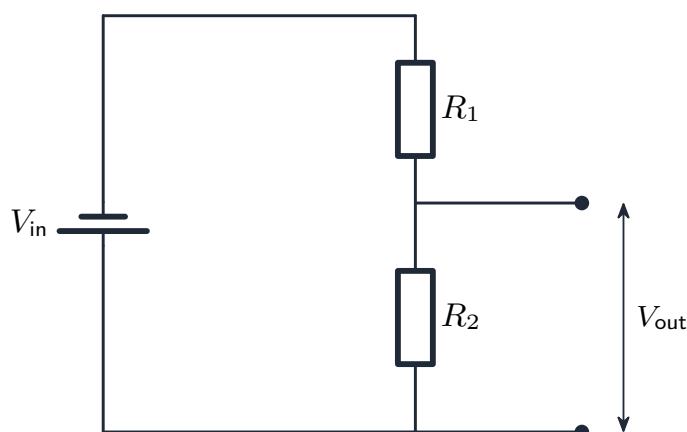
- use the **potential divider** equation
- explain why p.d. is proportional to **length** on a **uniform** wire ($V \propto L$)
- explain **thermistor** and **LDR** divider circuits, and the potentiometer null method

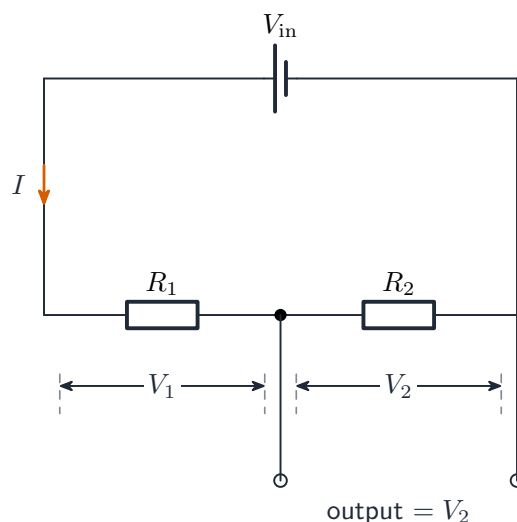
1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Potential divider

Two resistors in series share V_{in} in proportion to their resistances. The output across R_2 is:





A potential divider splits the voltage

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

Worked example. 6.0 V across 2.0 k Ω + 4.0 k Ω , output across the 4.0 k Ω : $V_{\text{out}} = 6.0 \times \frac{4.0}{6.0} = 4.0$ V.

■ Uniform wire: $V \propto L$

A **uniform** resistance wire has the same resistance per unit length, so resistance is proportional to length ($R = \rho L/A$ with ρ, A constant). A length of wire is just a potential divider, so the **p.d. across a length is proportional to that length**:

$$V = V_{\text{wire}} \cdot \frac{L}{L_{\text{total}}}.$$

Worked example. A 2.0 V supply is across a uniform wire of length 100 cm. The p.d. across the first 30 cm is $V = 2.0 \times \frac{30}{100} = 0.60$ V. This $V \propto L$ rule is the basis of the **potentiometer**.

■ Sensor circuits

Replace a resistor with a **sensor**: a **thermistor** (R falls as temperature rises) or an **LDR** (R falls as light rises). The output voltage then changes with temperature or light, and can switch a load.

■ Potentiometer

A uniform wire with a sliding contact compares e.m.f.s by a **null method**: slide until a **galvanometer** reads **zero** (no current), so the balance lengths are in the ratio of the e.m.f.s.

2 Practice

Now apply the methods above.

2.1 State what a **potential divider** does. [1]

2.2 A 6.0 V supply is across a 2.0 k Ω and a 4.0 k Ω resistor in series. Find the p.d. across the 4.0 k Ω resistor. [2]

2.3 A uniform wire of length 80 cm has 4.0 V across its ends. Find the p.d. across the first 20 cm. [2]

2.4 State what happens to a **thermistor's** resistance as temperature rises. [1]

3 Exam-style questions

3.1 A 12 V supply is across $R_1 = 3.0 \text{ k}\Omega$ and $R_2 = 1.0 \text{ k}\Omega$ in series. Find V_{out} taken across R_2 . [2]

3.2 A 6.0 V supply of negligible internal resistance is connected to a variable resistor R in series with a uniform resistance wire XY of resistance $8.0\ \Omega$.

(a) R is adjusted so the p.d. across XY is 2.4 V. Calculate R . [3]

(b) Explain why the p.d. between any two points on wire XY is **proportional to the distance** between them. [2]

3.3 In a divider, a thermistor is in series with a fixed resistor and the output is taken across the **thermistor**. The temperature **rises**. Explain what happens to the output voltage. [3]

3.4 Explain how an **LDR** in a potential divider can be used to switch a lamp **on** when it gets dark. [3]