

11.5 Compound DC Circuits

Name: _____ Class: _____ Date: _____

Total: 11 marks**KEY WORDS** parallel 并联 • series 串联 • internal resistance 内阻 • resistance 电阻

Objective

Build the skills to answer exam questions on **compound DC circuits**.**You must be able to:**

- combine resistors in **series** 串联 ($R_s = R_1 + R_2 + \dots$) and in **parallel** 并联 ($\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$)
- account for the **internal resistance** 内阻 of a real battery and its terminal voltage
- analyse a circuit with mixed series and parallel sections

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Series and parallel

- Series:** same current, $R_s = R_1 + R_2 + \dots$ (resistance adds up).
- Parallel:** same voltage, $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$ (total is **less** than the smallest).

■ Internal resistance

A real cell has internal resistance r , so the terminal voltage is $V = \mathcal{E} - Ir$.

■ Example

Two $4.0\ \Omega$ resistors in parallel: $\frac{1}{R_p} = \frac{1}{4} + \frac{1}{4} \Rightarrow R_p = 2.0\ \Omega$.

2 Practice

2.1 Two $6.0\ \Omega$ resistors are connected in series. Find the total resistance. [1]**2.2** The same two $6.0\ \Omega$ resistors are connected in parallel. Find the total resistance. [2]**2.3** A battery of emf $12\ \text{V}$ and internal resistance $0.50\ \Omega$ drives a current of $2.0\ \text{A}$. Find the terminal voltage. [2]

3 Exam-style questions

3.1 Resistors in series have a total resistance equal to [1]

- A** less than the smallest
- B** the sum of the individual resistances
- C** their average
- D** their product

3.2 Adding another resistor in parallel makes the total resistance [1]

- A** larger
- B** smaller
- C** unchanged
- D** infinite

3.3 A $3.0\ \Omega$ and a $6.0\ \Omega$ resistor are in parallel across a $12\ \text{V}$ supply.

(a) Find the combined resistance. [2]

(b) Find the total current drawn from the supply. [2]

Solutions

2.1 $R_s = 6.0 + 6.0 = 12\ \Omega$.

2.2 $\frac{1}{R_p} = \frac{1}{6.0} + \frac{1}{6.0} = \frac{2}{6.0} \Rightarrow R_p = 3.0\ \Omega$.

2.3 $V = \varepsilon - Ir = 12 - 2.0(0.50) = 11\ \text{V}$.

3.1 B.

3.2 B.

3.3 (a) $\frac{1}{R_p} = \frac{1}{3.0} + \frac{1}{6.0} = \frac{3}{6.0} \Rightarrow R_p = 2.0\ \Omega$. (b) $I = \frac{V}{R_p} = \frac{12}{2.0} = 6.0\ \text{A}$.