Exercise walk-through

Compound DC Circuits ▪ 11.5

eXercise

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

Method — Series and parallel

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

Method — Internal resistance

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

Method — Example

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

Practice 2.1 ▪ 1 mark

Two $6.0\ \Omega$ resistors are connected in series. Find the total resistance.

Solution 2.1

Method: Series and parallel

Worked steps

$R_s = 6.0 + 6.0 = 12\ \Omega$ B1.

Practice 2.2 ▪ 2 marks

The same two $6.0\ \Omega$ resistors are connected in parallel. Find the total resistance.

Solution 2.2

Method: Series and parallel

Worked steps

$$\frac{1}{R_p} = \frac{1}{6.0} + \frac{1}{6.0} = \frac{2}{6.0} \Rightarrow R_p = 3.0\ \Omega \quad \text{M1 A1}.$$

Practice 2.3 ▪ 2 marks

A battery of emf 12 V and internal resistance $0.50\ \Omega$ drives a current of 2.0 A. Find the terminal voltage.

Solution 2.3

Method: Internal resistance

Worked steps

$V = \varepsilon - Ir = 12 - 2.0(0.50) = 11$ V **M1** **A1**.

Exam-style 3.1 ▪ 1 mark

Resistors in series have a total resistance equal to

A less than the smallest

B the sum of the individual resistances

C their average

D their product

Solution 3.1

Method: Series and parallel

A less than the smallest

B the sum of the individual resistances ✓

C their average

D their product

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

Adding another resistor in parallel makes the total resistance

A larger

B smaller

C unchanged

D infinite

Solution 3.2

Method: Series and parallel

A larger

B smaller ✓

C unchanged

D infinite

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

A $3.0\ \Omega$ and a $6.0\ \Omega$ resistor are in parallel across a 12 V supply.
(a) Find the combined resistance.
(b) Find the total current drawn from the supply.

Solution 3.3

Method: Series and parallel

Worked steps

(a) $\frac{1}{R_p} = \frac{1}{3.0} + \frac{1}{6.0} = \frac{3}{6.0} \Rightarrow R_p = 2.0\ \Omega$ M1 A1. (b) $I = \frac{V}{R_p} = \frac{12}{2.0} = 6.0$ A M1 A1.