

11.5 Compound Direct Current Circuits

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS internal resistance 内阻 • terminal voltage 端电压 • ideal emf 电动势
 • equivalent resistance 等效电阻 • series 串联

Objective

Build the skills to answer exam questions on **compound direct current circuits**.

You must be able to:

- reduce a network of **series and parallel** resistors to one equivalent resistance
- model a real battery as an **ideal emf** 电动势 in series with an **internal resistance** 内阻
- distinguish a battery's **emf** from its **terminal voltage** 端电压 under load
- find the current and voltage for each element

1 Worked examples

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

■ Reducing a network

Combine resistors step by step: series add, parallel combine by $\frac{1}{R} = \sum \frac{1}{R_i}$, until one equivalent resistance remains.

■ Real battery

A real battery is an ideal emf ε in series with an internal resistance r , so the **terminal voltage** under load is

$$V = \varepsilon - Ir.$$

■ emf vs terminal voltage

The emf is the full "push"; the terminal voltage is what is left across the external circuit once Ir is lost inside.

2 Practice

2.1 A battery of emf 9.0 V and internal resistance 1.0 Ω drives 2.0 A. Find the terminal voltage. [2]

2.2 Two 8.0 Ω resistors in parallel are in series with a 4.0 Ω resistor. Find the total resistance. [2]

2.3 State the difference between the emf and the terminal voltage of a battery. [1]

3 Exam-style questions

3.1 A real battery is modelled as an ideal emf in series with [1]

A	B
C	D

- A a capacitor
 B an internal resistance
 C an inductor
 D nothing

3.2 The terminal voltage of a battery under load is [1]

A	B
C	D

- A greater than the emf
 B less than the emf
 C equal to zero
 D infinite

3.3 A 12 V battery of internal resistance $0.50\ \Omega$ is connected to a $5.5\ \Omega$ resistor.

(a) Find the current. [2]

(b) Find the terminal voltage. [2]

