A-LEVEL PHYSICS • EXERCISE SHEET

# 10.1 Practical circuits

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

**KEY WORDS** resistance 电阻 • internal resistance 内阻 • terminal p.d. 端电压 • open circuit 开路 • cell 电池

## Objective

Build the skills to answer exam questions on **practical circuits** — e.m.f., p.d., and internal resistance.

**You must be able to:**

- define **e.m.f.** and distinguish it from **p.d.**
- explain **internal resistance** and use $V = \varepsilon - Ir$
- describe how to measure internal resistance

## 1 Worked examples

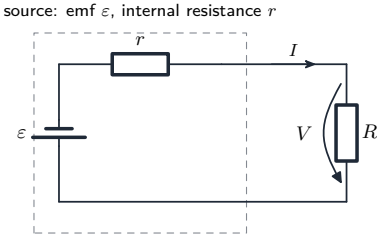
Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ **e.m.f. and p.d.**

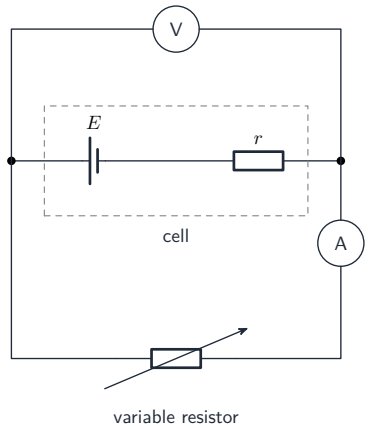
**e.m.f.** $\varepsilon$ = energy given to each coulomb by the source (in driving it round the whole circuit). **p.d.** = energy transferred from electrical form by each coulomb in a component. Both in volts.

■ **Internal resistance**

A real cell has **internal resistance** $r$. When current flows, $Ir$ is "lost" inside it, so the **terminal p.d.** is:






*Internal resistance in a practical cell*

$$V = \varepsilon - Ir.$$

- $I = 0$ (open circuit): $V = \varepsilon$;
- larger current → smaller terminal p.d.

**Worked example.** $\varepsilon = 1.5$ V, $r = 0.50\ \Omega$, $R = 2.5\ \Omega$: $I = \dfrac{\varepsilon}{R + r} = \dfrac{1.5}{3.0} = 0.50$ A; $V = \varepsilon - Ir = 1.5 - 0.25 = 1.25$ V.

To **measure** $r$: vary $R$, plot $V$ against $I$ — the intercept is $\varepsilon$ and the gradient is $-r$.

## 2 Practice

Now apply the methods above.

**2.1** Define the **e.m.f.** of a source. [1]

**2.2** Write the equation linking **terminal p.d.**, e.m.f., current and internal resistance. [1]

**2.3** State the terminal p.d. of a cell when **no current** flows. [1]

**2.4** State **one** cause of a cell's internal resistance. [1]

## 3 Exam-style questions

**3.1** A battery of e.m.f. 9.0 V drives two resistors, of 12 Ω and 6.0 Ω, connected in **parallel** with each other. The terminal p.d. is measured as 8.0 V. **Determine** the internal resistance of the battery, and the energy wasted inside it each second. [5]

**3.2** As the current drawn from a cell **increases**, the terminal p.d.: [1]

A B
C D

**A** increases
**B** decreases
**C** stays the same
**D** becomes equal to the e.m.f.

**3.3** Explain, in terms of **energy**, the difference between e.m.f. and p.d. [2]

**3.4** Describe how a graph can be used to find the **internal resistance** of a cell. [2]