AP PHYSICS C: ELECTRICITY AND MAGNETISM • EXERCISE SHEET

11.6 Kirchhoff's Loop Rule

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

Objective

Build the skills to answer exam questions on **Kirchhoff's loop rule**.

You must be able to:

- state **Kirchhoff's loop rule** 基尔霍夫电压定律, $\sum \Delta V = 0$ around any closed loop
- explain it as a consequence of **conservation of energy** 能量守恒
- assign consistent **sign conventions** for emf sources and resistors
- write and solve **loop equations**

1 Worked examples

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

The loop rule

Around any closed loop, $\sum \Delta V = 0$ —the rises across the emf sources balance the drops across the resistors.

Why it holds

A charge returning to its starting point has the **same** potential energy, so the potential changes around the loop sum to zero (conservation of energy).

Signs

Going around the loop: a resistor traversed with the current is a **drop** ($-IR$); an emf traversed from $-$ to $+$ is a **rise** ($+\varepsilon$).

2 Practice

2.1 State Kirchhoff's loop rule. [1]

2.2 State the conservation law the loop rule expresses. [1]

2.3 A single loop has a 10 V battery and resistors 2.0 Ω and 3.0 Ω in series. Find the

current. [2]

3 Exam-style questions

3.1 Kirchhoff's loop rule sums the potential differences around a closed loop to [1]

- **A** the emf
- **B** zero
- **C** a maximum
- **D** infinity

3.2 The loop rule expresses conservation of [1]

- **A** charge
- **B** energy
- **C** momentum
- **D** mass

3.3 A single loop contains a 12 V battery and resistors of 3.0 Ω and 1.0 Ω in series.

(a) Write the loop equation. [2]

(b) Find the current. [1]

4 Go further

- work through the **11.6 Kirchhoff's Loop Rule** lesson on the **Learn** page;
- read the **Electric Circuits** section of the AP Physics C: E&M handout on the **Know** page.

Solutions

2.1 the sum of the potential differences around any closed loop is zero.

2.2 conservation of energy.

2.3 $10 = I(2.0 + 3.0) \Rightarrow I = 2.0$ A.

3.1 B.

3.2 B.

3.3 (a) $12 = I(3.0) + I(1.0)$. (b) $I = \dfrac{12}{4.0} = 3.0$ A.