Exercise walk-through

Kirchhoff's Loop Rule ▪ 11.6

eXercise

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**

Method — The loop rule

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

Method — 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).

Method — Signs

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

Practice 2.1 ▪ 1 mark

State Kirchhoff's loop rule.

Solution 2.1

Method: The loop rule

Worked steps

the sum of the potential differences around any closed loop is zero B1.

Practice 2.2 ▪ 1 mark

State the conservation law the loop rule expresses.

Solution 2.2

Worked steps

conservation of energy B1.

Practice 2.3 ▪ 2 marks

A single loop has a 10 V battery and resistors $2.0\ \Omega$ and $3.0\ \Omega$ in series. Find the current.

Solution 2.3

Worked steps

$10 = I(2.0 + 3.0) \Rightarrow I = 2.0$ A M1 A1.

Exam-style 3.1 ▪ 1 mark

Kirchhoff's loop rule sums the potential differences around a closed loop to

A the emf

B zero

C a maximum

D infinity

Solution 3.1

Method: The loop rule

A the emf

B zero ✓

C a maximum

D infinity

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

The loop rule expresses conservation of

A charge

B energy

C momentum

D mass

Solution 3.2

A charge

B energy ✓

C momentum

D mass

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

A single loop contains a 12 V battery and resistors of $3.0\ \Omega$ and $1.0\ \Omega$ in series.
(a) Write the loop equation.
(b) Find the current.

Solution 3.3

Worked steps

(a) $12 = I(3.0) + I(1.0)$ M1 A1. (b) $I = \dfrac{12}{4.0} = 3.0$ A B1.