

9.4 The First Law of Thermodynamics

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

KEY WORDS internal energy 内能 • first law 热力学第一定律 • pressure 压强 • heat 热量
• temperature 温度

Objective

Build the skills to answer exam questions on **the first law of thermodynamics**.

You must be able to:

- state the **first law of thermodynamics** 热力学第一定律 as $\Delta U = Q + W$
- analyse the **internal energy** 内能 change of a gas from the heat added and work done
- interpret **work** as the area under a curve on a pressure-volume (PV) diagram
- describe **isothermal**, **isobaric**, **isochoric**, and **adiabatic** processes

1 Worked examples

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

■ The first law

$\Delta U = Q + W$, where Q is the heat **added to** the gas and W is the work done **on** the gas. It is just conservation of energy for a gas.

■ Work on a PV diagram

The work is the **area** under the process curve. Compressing a gas (volume decreasing) does **positive** work on it.

■ Four processes

- Isothermal** — constant temperature ($\Delta U = 0$).
- Isobaric** — constant pressure.
- Isochoric** — constant volume ($W = 0$).
- Adiabatic** — no heat exchange ($Q = 0$).

2 Practice

2.1 State the first law of thermodynamics. [1]

2.2 A gas absorbs 500 J of heat while 200 J of work is done on it. Find the change in internal energy. [2]

2.3 State which of Q or W is zero in an isochoric (constant-volume) process, and why. [2]

3 Exam-style questions

3.1 In $\Delta U = Q + W$, the quantity Q is the [1]

A	B
C	D

A work done

B heat added

C internal energy

D temperature

3.2 An adiabatic process is one in which [1]

A	B
C	D

A $Q = 0$

B $W = 0$

C $\Delta U = 0$

D $\Delta T = 0$

3.3 A gas is compressed: 300 J of work is done on it while it releases 100 J of heat.

(a) Find the change in internal energy. [3]

(b) State whether its temperature rises or falls. [1]