

9.1 Thermodynamic systems and energy accounts

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS internal energy • adiabatic

Objective

Thermodynamic systems and energy accounts. Original classroom practice for IB HL; not an official IB paper.

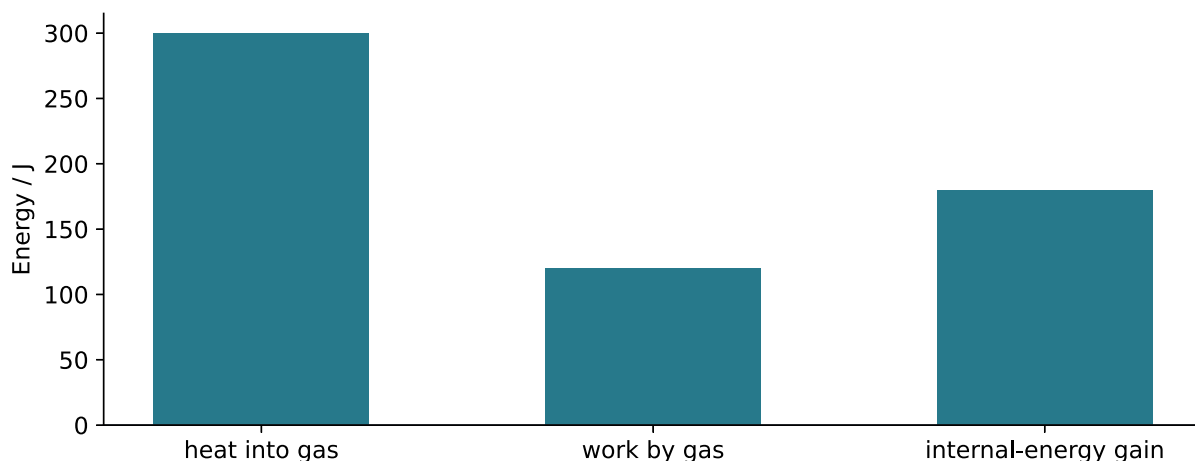
1 Key knowledge and worked examples

■ What would explain this observation?

- Compressing a gas can warm it even without a heater. Work is another path for energy transfer into the system.
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■ Build the model

- **Internal energy** is a property of the chosen system.
- Heat and work describe energy transfer across its boundary.
- For an ideal monatomic gas, internal energy depends on temperature and amount.
- **adiabatic** : A process with no heat transfer.
- internal energy: Total microscopic kinetic and potential energy of a system.



■ Choose evidence that can test it

- State a sign convention before using the first law.
- Here change in internal energy equals heat into the system minus work done by the system.
- Expansion work can reduce internal energy when no heat enters.

In the lab: Identify whether a process is isothermal, adiabatic or at constant volume. On a pressure-volume graph, area under the process curve gives work done by the gas. The path matters for work even when endpoints match.

■ Work from known quantities

- Known: gas gains 300 J by heating and does 120 J of work.
- With $\Delta U = Q - W$, $\Delta U = 300 - 120 = 180$ J.
- For adiabatic compression, $Q=0$ and work done by the gas is negative, so ΔU is positive.

Your turn: A gas gains 500 J of heat and does 200 J work. Find internal-energy change.

■ Check the conclusion and its limits

- Adiabatic does not mean constant temperature.
- Use the stated sign convention; some courses write work done on the gas with the opposite sign.

Not true: Every adiabatic process has constant temperature. Adiabatic fixes heat transfer ($Q = 0$), not temperature. An adiabatic compression raises temperature - bicycle pumps warm up - and an adiabatic expansion lowers it. Isothermal, not adiabatic, is the constant-temperature process.

Key:

- Internal energy is a property of the chosen system.
- State a sign convention before using the first law.
- Watch for: adiabatic does not mean constant temperature.

■ Write from an internal-energy change of 450 J

- A gas gains 800 J of heat and does 350 J of work.
- Find the change in internal energy. Adiabatic means no heat transfer, not constant temperature.

2 Practice

2.1 In this convention, what happens during adiabatic compression? Choose one answer.

- **A** Work done by the gas is positive
- **B** Heat must enter
- **C** Internal energy increases

[1]

2.2 A gas gains 500 J of heat and does 200 J work. Find internal-energy change. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Adiabatic fixes heat transfer ($Q = 0$), not temperature.

[2]

2.4 A process with no heat transfer: write the technical term.

[1]

3 Exam-style questions

3.1 A gas is compressed adiabatically by 150 J, then releases 40 J heat at fixed volume. Find total internal-energy change using work done by gas positive. [4]
