

CLASS 11 PHYSICS • CHAPTER 11

The First Law of Thermodynamics

Understanding the Conservation of Energy in Thermal Systems

The Three Pillars of Thermodynamics

ΔQ



Heat supplied to the system by the surroundings.

ΔU



Change in the internal energy of the system.

ΔW



Work done by the system on the surroundings.

The General Principle of Energy Conservation

Eq. (11.1)

Energy supplied
to the system...

$$\Delta Q = \Delta U + \Delta W$$

...and the rest
goes into work
work on the
environment.

...goes partly to increase
the internal energy...

EXAM TIP: The First Law is simply the general law of conservation of energy applied to thermal systems.



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$$E=mc^2$$



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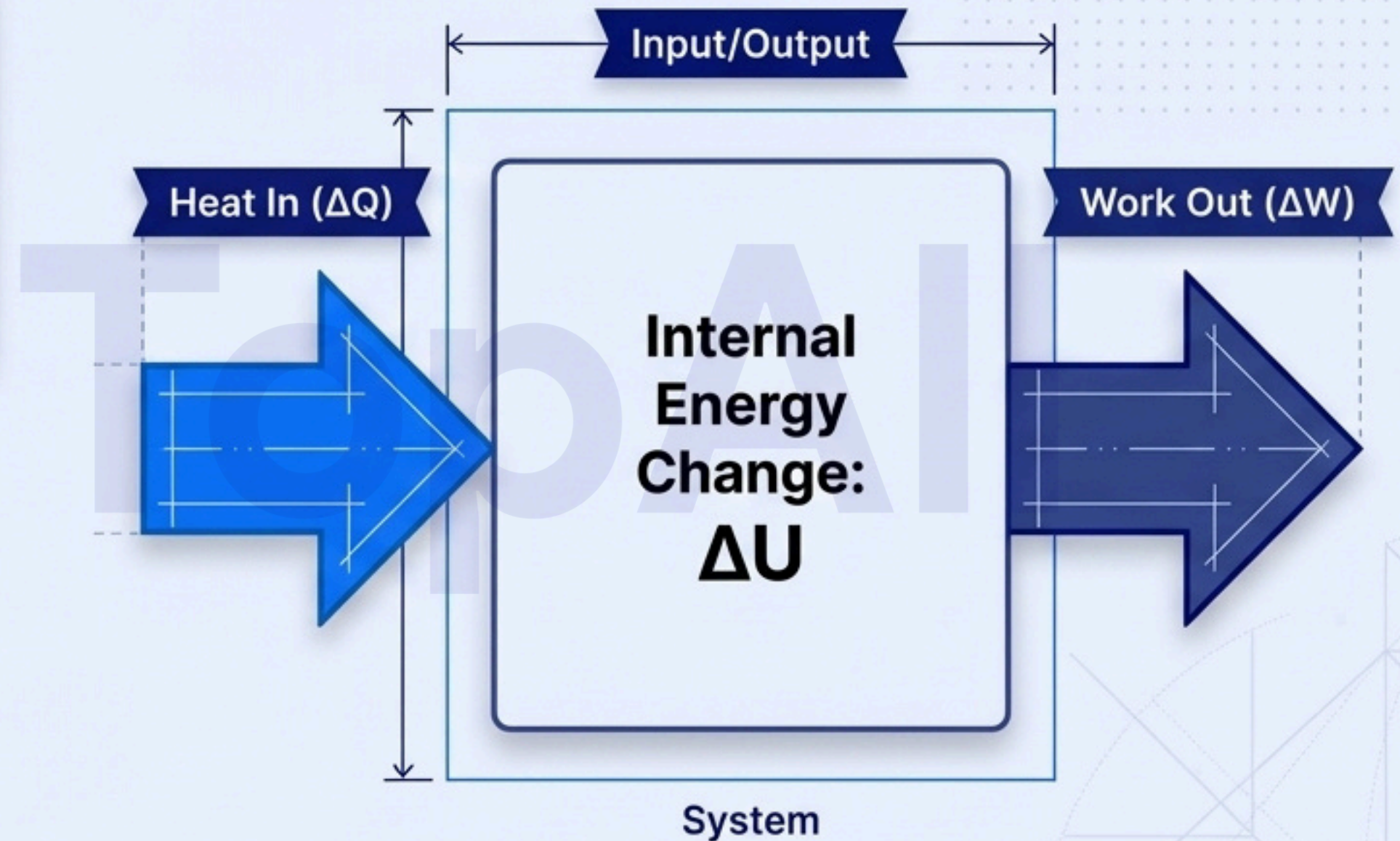


An Alternative Perspective

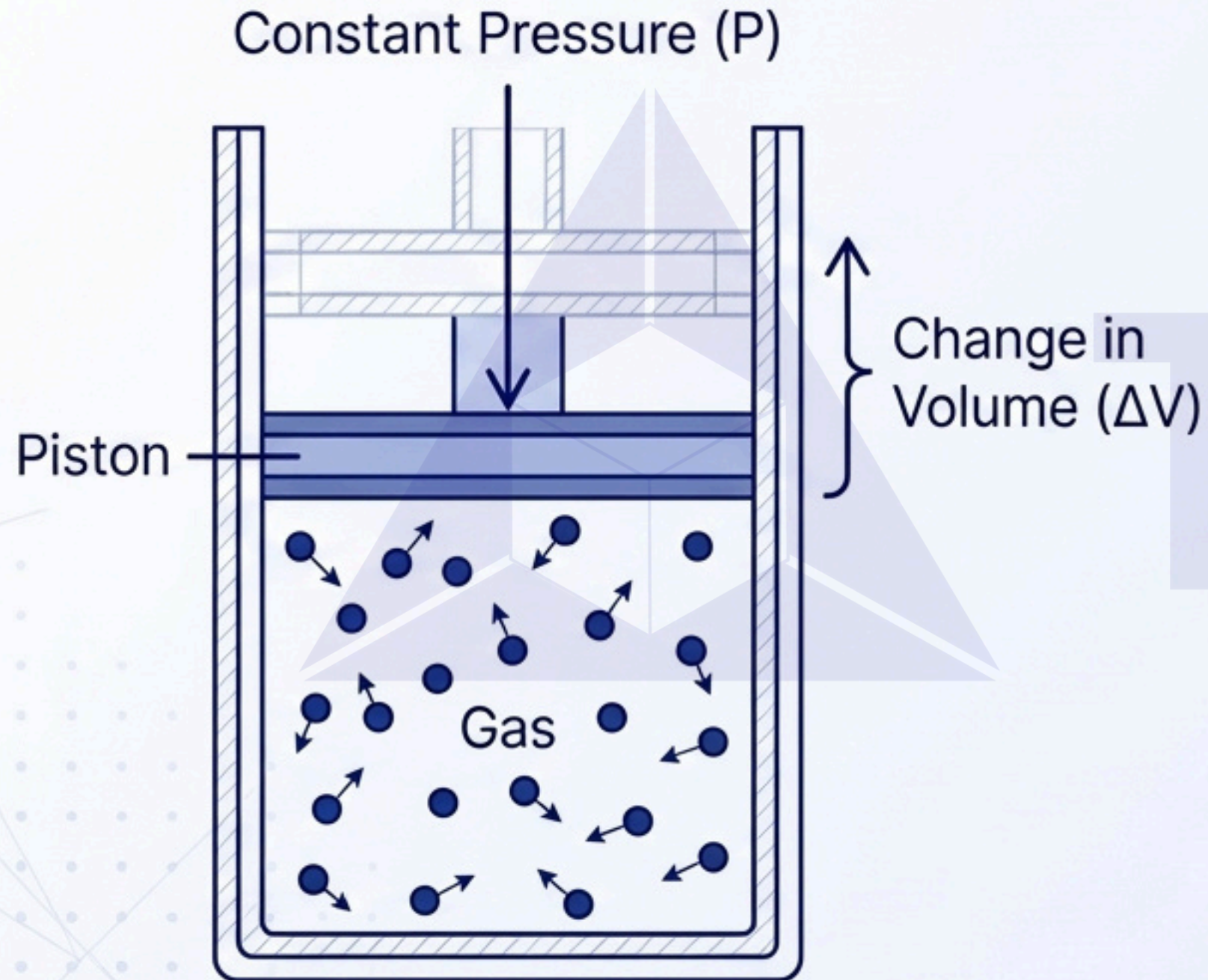
Eq. (11.2)

$$\Delta Q - \Delta W = \Delta U$$

- This form highlights the net change inside the system.
- Heat In (ΔQ) minus Work Out (ΔW) equals the Change in Internal Energy (ΔU).
- If a system does exactly as much work as the heat it absorbs, its internal energy remains constant ($\Delta U = 0$).



Gas Against Constant Pressure



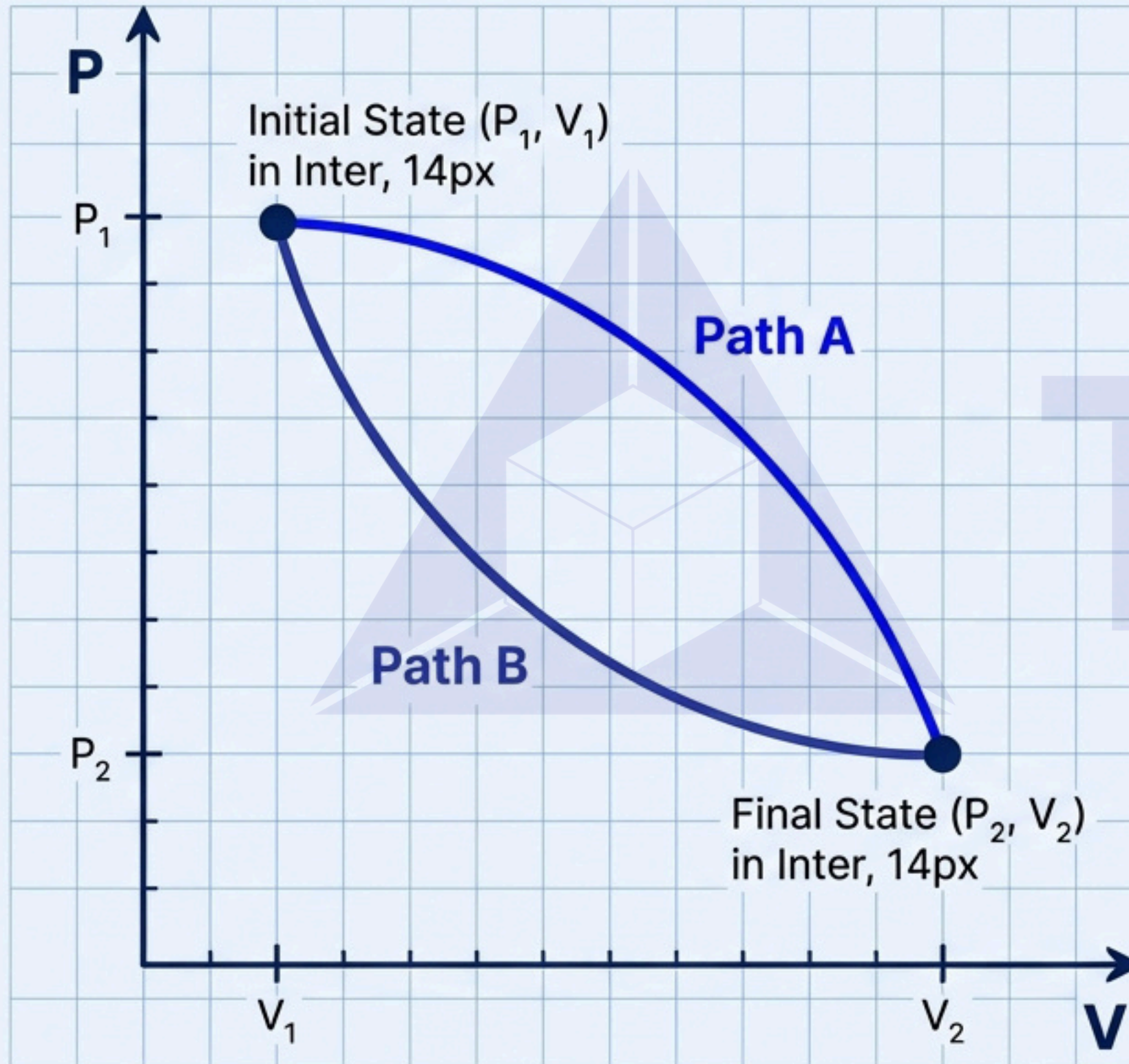
$$\text{Work Formula: } \Delta W = P\Delta V$$

Substitute into First Law:

$$\text{Eq. (11.3) } | \Delta Q = \Delta U + P\Delta V$$

Note: Force is pressure $\times$ area, and displacement $\times$ area = volume change.

Does the "Journey" Matter?



ΔU (Internal Energy)

STATE DEPENDENT. Depends only on the initial and final states. The path does not matter.

ΔQ and ΔW (Heat & Work)

PATH DEPENDENT. The amount of heat and work varies depending on the specific route (Path A vs. Path B).

Even though ΔQ and ΔW depend on the path, their difference ($\Delta Q - \Delta W$) is always path-independent!

Key Takeaways

- First Law: The law of energy conservation applied to thermodynamics (Eq 11.1: $\Delta Q = \Delta U + \Delta W$).
- Gas Expansion: Work done against constant pressure is $\Delta W = P\Delta V$ (Eq 11.3: $\Delta Q = \Delta U + P\Delta V$).
- Variables: Internal Energy (U) is a state variable. Heat (Q) and Work (W) are path-dependent.

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