

CLASS 11 PHYSICS • CHAPTER 11

The Isothermal Process

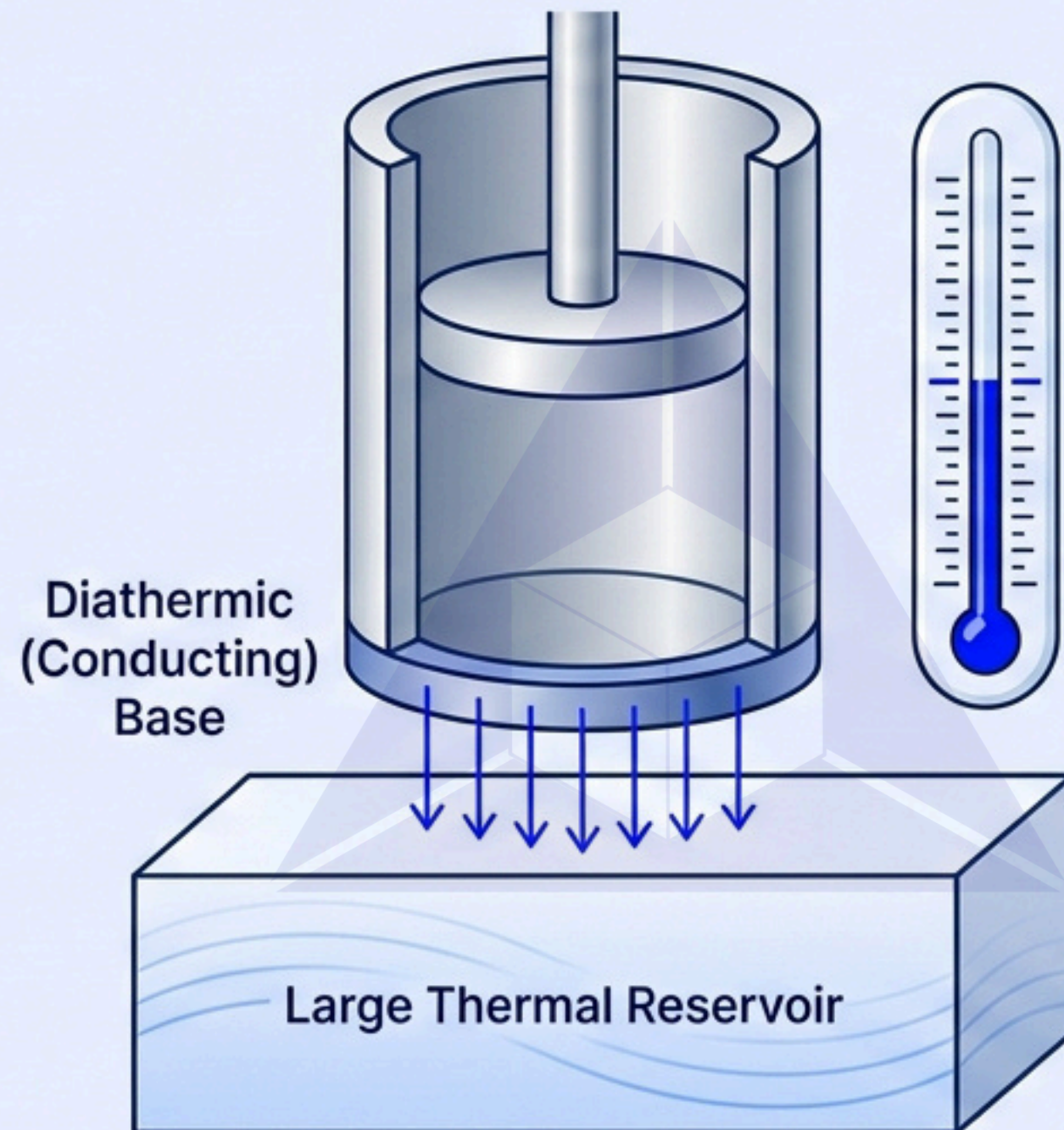
Mastering Constant Temperature
Thermodynamics



CORE CONCEPT

Temperature Remains Constant

- In an isothermal process, the temperature (T) of the system does not change.
- Occurs when a system is in a metallic cylinder placed in a large heat reservoir.
- Heat exchange happens so slowly that the system remains in perfect thermal equilibrium with its surroundings.



Deriving the Isothermal Equation

Start with the Ideal Gas Equation: $PV = \mu RT$



Since mass (μ), the gas constant (R), and Temperature (T) are all fixed...



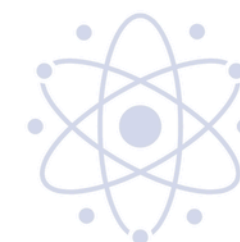
$$PV = \text{constant}$$

Result: Pressure of a given mass of gas varies inversely with its volume.



You've Learned the Theory. Let's Test Them Now.

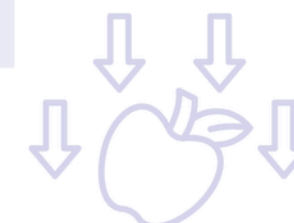
$$E=mc^2$$



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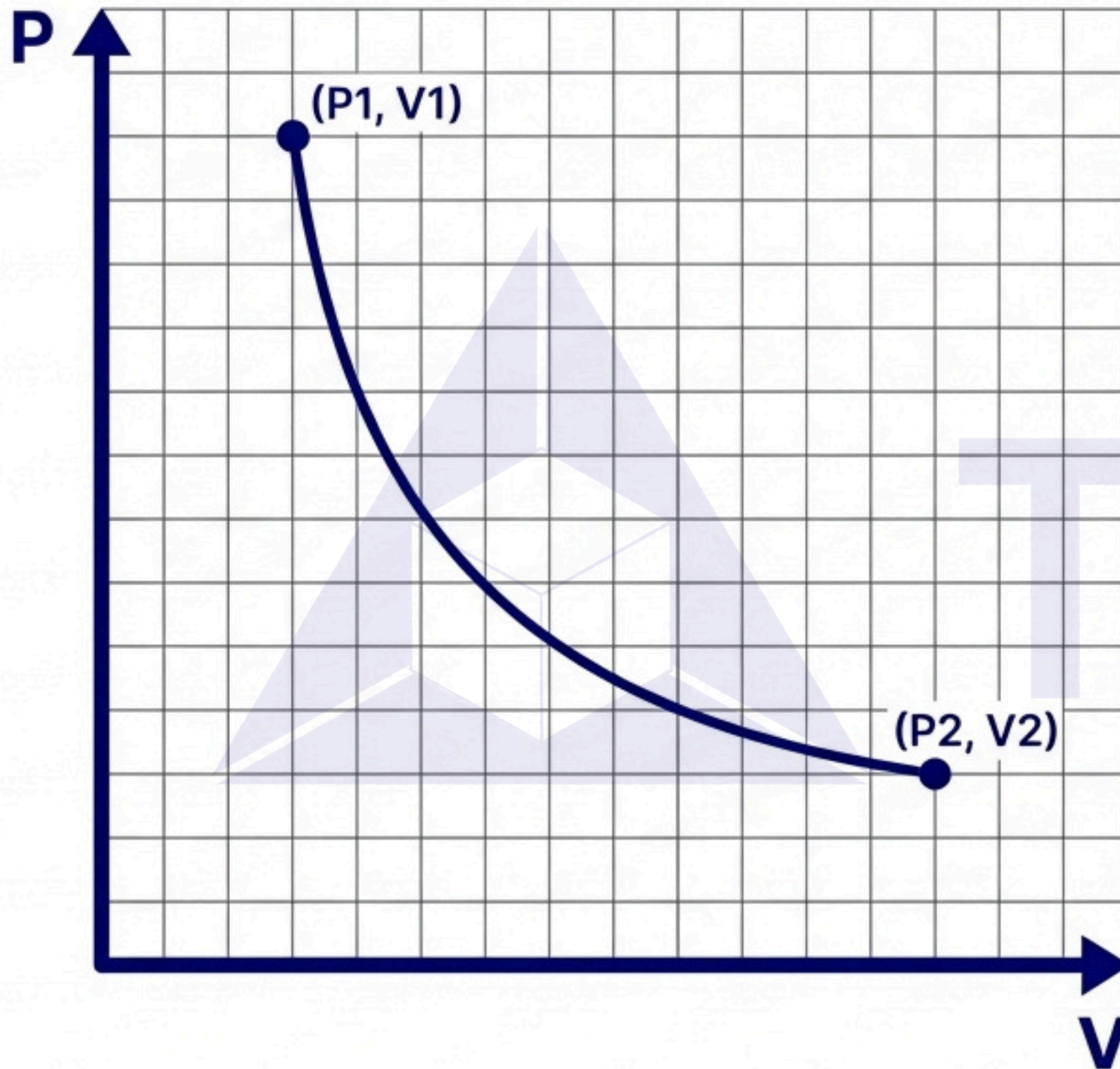
FIGURE FOCUS

Visualizing Boyle's Law

- The pressure-volume curve for a fixed temperature is called an isotherm.
- This inverse relationship ($P \propto 1/V$) is the graphical representation of Boyle's Law.

[EXAM TIP]

A quasi-static isothermal expansion is an idealized, reversible process.



EQ. (11.12)

Calculating Work Done

$$W = \mu R T \ln(V_2/V_1)$$

Diagram illustrating the variables in the equation for work done during isothermal expansion/compression:

- μ : Number of moles
- R : Universal gas constant
- T : Constant Temperature
- V_1 and V_2 : Initial and Final Volume

$$W > 0$$

Isothermal Expansion (Gas absorbs heat and does work).

$$W < 0$$

Isothermal Compression (Work is done on the gas, heat is released).

The Thermodynamic Master Key

Internal Energy (U) of an ideal gas depends only on temperature.



Since T is constant, there is no change in internal energy: $\Delta U = 0$.



Using the First Law ($\Delta Q = \Delta U + \Delta W$) $\rightarrow Q = W$

(Heat supplied to the gas equals the work done by the gas)

Isothermal Process Checklist

- ✓ **Condition:** Temperature remains constant ($T = \text{const}$).
- ✓ **Equation:** $PV = \text{constant}$ (Follows Boyle's Law).
- ✓ **First Law:** $\Delta U = 0$, meaning Heat (Q) = Work (W).
- ✓ **Work Formula:** $W = \mu RT \ln(V_2/V_1)$.



You've Learned the Theory.

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