Physics 122
Thermal Physics

Lecture Notes

Outline

What is an Adiabatic Process?

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Occurs when:

- Process is very fast
- System is thermally insulated

First Law of Thermodynamics

Physics 122 sign convention:
Work done *by the environment on the system* is positive.

$$\boxed{\Delta E = Q + W}$$

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For an adiabatic process:

$$\boxed{\Delta E = W}$$

Physical Interpretation

- **Compression:**

$$W > 0 \Rightarrow \Delta E > 0 \Rightarrow T \uparrow$$

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Examples:

- Diesel engine compression
- Opening a soda bottle
- Spraying deodorant

Ideal Gas Processes

$$PV = nRT$$

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Isothermal:

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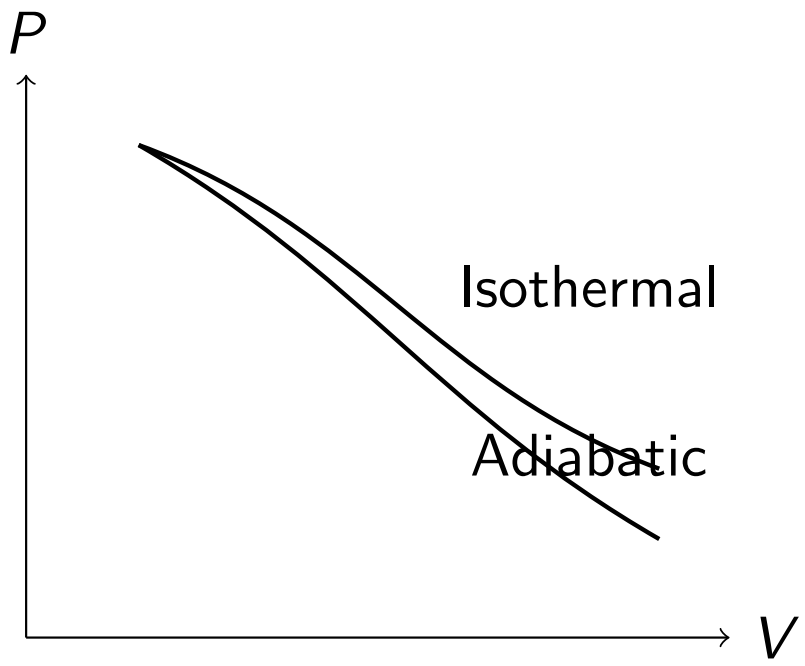
Adiabatic:

$$\boxed{PV^{\gamma} = \text{constant}} \quad \gamma = \frac{C_P}{C_V}$$

P–V Diagram



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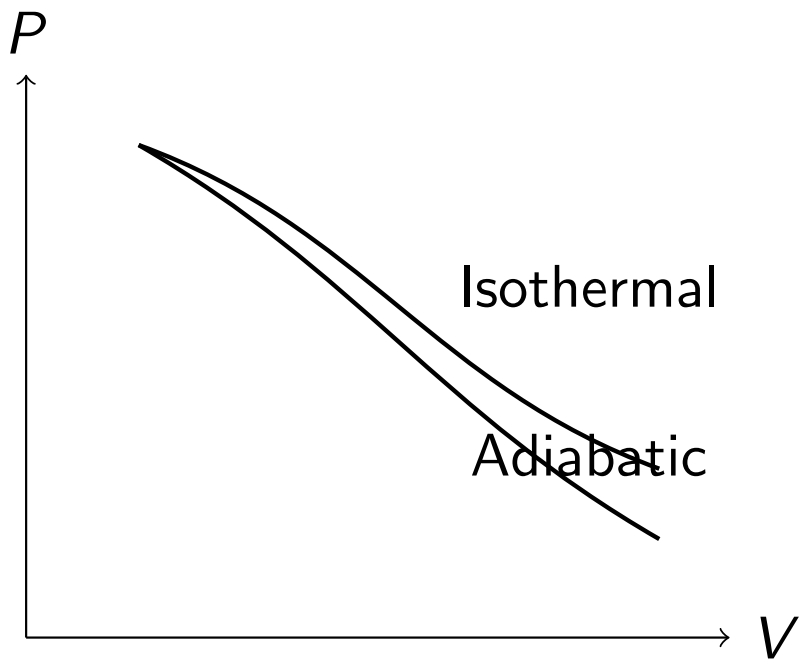

Adiabatic curves are steeper.

Linear Expansion

$$\boxed{\Delta L = \alpha L_0 \Delta T}$$

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- α = coefficient of linear expansion
- Units: K^{-1}
- Depends on material

Volume Expansion

$$\boxed{\Delta V = \beta V_0 \Delta T}$$

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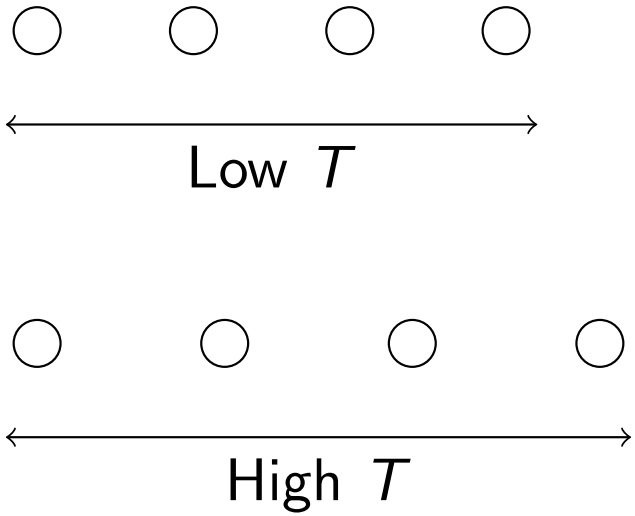
For isotropic solids:

$$\boxed{\beta \approx 3\alpha}$$

Microscopic Picture



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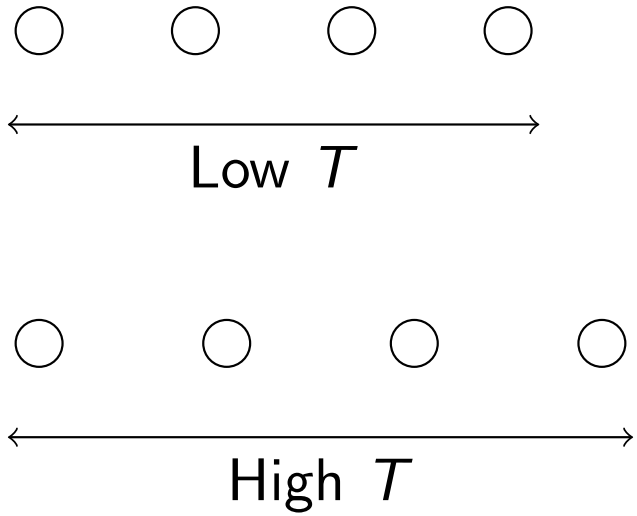

Higher temperature $\Rightarrow$ larger atomic vibrations $\Rightarrow$ expansion.

Linear Expansion Example

Given:

$$L_0 = 10\,\text{m}, \quad \alpha = 12 \times 10^{-6}\,\text{K}^{-1}$$

$$\Delta T = 40^\circ\text{C}$$

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Solution:

$$\Delta L = \alpha L_0 \Delta T$$

$$\boxed{\Delta L = 4.8\,\text{mm}}$$

Key Takeaways

- Adiabatic process: $Q = 0$
- Physics 122 convention: $\Delta E = Q + W$
- Compression heats, expansion cools
- Thermal expansion scales with ΔT