## Today

I. Last Time
II. Adiabatic Compression
III. Heat Capacities
IV. Henry's Guest Lecture on Conductivity of an Ideal Gas

I. Apologies again for making a hash of the notion of adiabaticity because it is important:

We studied **isothermal** compression on Wednesday, that is compression at a fixed temperature.
Today we'll start off with **adiabatic** compression, which is compression where no heat enters or leaves the system.

In physics, we also say that a process is adiabatic when it is done very slowly.

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In isothermal compression we found:

$$W = \Delta U - Q = 0 - Q = -Q.$$

We also derived the

$$W = NkT \ln\left(\frac{V_i}{V_f}\right).$$

## II. Adiabatic Compression

Tightly fitted cylinder with insulated piston and walls that doesn't exchange heat with its environment and we want to compress the gas on the inside.

Inputs

1st Law: $\Delta U = Q + W \rightarrow \Delta U = W$

Equipartition Thm.: $U = \frac{f}{2}NkT$

Because $N$ is fixed $dU = \frac{f}{2}NkdT$. Last input, ideal gas law: $PV = NkT$.

$$\text{Then we have } \frac{f}{2}NkdT = -PdV.$$

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Cancelling we get

$$\frac{f}{2}\frac{dT}{T} = \frac{-dV}{V}$$

Doing the integral, we have

$$\frac{f}{2}\ln\frac{T_f}{T_i} = -\ln\frac{V_f}{V_i}$$

## II. Adiabatic Compression

$$\frac{f}{2}(\ln T_f - \ln T_i) = (\ln V_i - \ln V_f)$$

$$\frac{f}{2}(\ln T_f) + \ln V_f = \ln V_i + \frac{f}{2}(\ln T_i)$$

$$(\ln T_f^{\frac{f}{2}}) + \ln V_f = \ln V_i + (\ln T_i^{\frac{f}{2}})$$

$$\ln(V_f T_f^{\frac{f}{2}}) = \ln(V_i T_i^{\frac{f}{2}})$$

$$V_f T_f^{\frac{f}{2}} = V_i T_i^{\frac{f}{2}} \quad \text{(adiabatic compression)}$$

Or, much more nicely, $VT^{f/2}$ = const., throughout the whole process!

## III. Definition of Heat capacity

When we add heat to a system , its temperature increas3es. By how much?

$$C \equiv \frac{Q}{\Delta T} \text{ in other words } \Delta T = \frac{Q}{C}.$$

IV. For the last part of today's class, see the very nice slides from Henry's guest lecture, which are also on our website.