Thermodynamics 2 additional notes

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Thermodynamic processes

- Isochoric: no change in volume, $W = 0$
- Isobaric: no change in pressure
- Isentropic: no change in entropy, $Q = 0$
- Isothermal: no change in temperature, $\Delta U = 0$
- Adiabatic: no heat flow, $Q = 0$
- No difference between isentropic and adiabatic processes.

The mystery of the rubber band

- Stretch rubber band and hold it stretched for a bit
- Quickly allow rubber band to relax and touch it to your lip
- Discussion: rubber band is spring, elastic potential energy *should* turn into heat
- Rubber band feels cooler! Temperature and entropy
- Rubber is a disordered material made up of many polymer strands. When stretched, strands are more aligned/ordered.
- Order $\rightarrow$ disorder: entropy increases. $\Delta S = \Delta Q / T$.
- ΔQ positive: heat goes into rubber band from surroundings, which is why it feels cooler

Adiabatic processes

- đ$Q = 0$, so $dU = dW = -PdV$ (1)
- Equipartition: $U = \frac{1}{2} fNkT$ so $dU = \frac{1}{2} fNkdT$ (2)
- Ideal gas law: $P = NkT/V$

$$-PdV = \frac{f}{2} NkdT$$

$$-\frac{NkT}{V} dV = \frac{f}{2} NkdT$$

$$\frac{1}{V} dV = \frac{-f}{2} \frac{dT}{T}$$

$$\int \frac{1}{V} dV = \int \frac{-f}{2} \frac{dT}{T}$$

$$\ln V = \frac{-f}{2} \ln T + \ln B$$

$$\ln V = \ln \left(BT^{-f/2} \right)$$

$$V = BT^{-f/2}$$

$$VT^{f/2} = \text{B, another constant}$$

Other stuff

- Adiabatic processes are fast. When something happens so fast that basically no heat flows you can call it adiabatic. Isothermal processes are slow.
- Adiabats are steeper than isotherms