**agenda**

- TD is the macroscopic science of systems at equilibrium: behavior.
- Test-taking tips
- Equilibrium: maximize $S$ or minimize $U$, $G$, ... balance of energy.
- Review lecture (bonds,Wins, etc), entropy (available states), and $T$ / state sampling) matters.
- problems
  - Know how to classify system (every exam!).
- open questions
  - isolated / closed / open / adiabatic

First Law: $\Delta U = q + w$ for overall process calc. (real processes can't convert $q \to w$ 100%)

work: $dw = \text{F} \text{d}x$, $\eta_q = \frac{\Delta V}{\text{V}}$ - intensive

$\Delta U = q + w$ isobaric = $-p \Delta V$

isochoric $= 0$

Entropy 2nd Law: $\Delta S^{\text{univ}} \geq 0$ for spontaneous (reversible) process.

$\text{d}S = \frac{\Delta S^{\text{rev}}}{T}$

\[ \Delta S = \frac{\Delta H^{\text{rev}}}{T} \]

we have used.

\[ nC_P \text{d}T = \Delta H = q_P \]

\[ nC_v \text{d}T = \Delta U = q_v \]

$\text{d}S_T = \text{d}T + \frac{\text{d}P}{P} \text{d}V$ from ideal gas law.

\[ \{ \text{TD property calc} \} \]

\[ \Delta S = \frac{\Delta U}{T} + \frac{\text{P} \text{dV}}{T} \]

\[ \text{equil. condition calc. for equil. properties, using constraints (e.g., } dU_2 = dU_3 ) \]

Graphs: your friends!

- higher slope = higher $C_P$

- Know how to show supercooling /heating: can draw

Similar
- $V$ vs. $T$ gives ax for slope.

Misc.

- Concept: reversible processes (at equil., no dissipation) allow calcs. for real processes at same initial final states (for all state functions).

\[ \text{PDF: } \begin{cases} 
\frac{\text{d}H}{\text{d}T} = \frac{\text{d}S}{\text{d}T} + \frac{\text{P} \text{dV}}{T} \\
\text{H} = H(T,P) \end{cases} 
\]

\[ U = U(S,V); C = C(T,P); F = F(T,V) \]

problems: we went over PS3 #3, #6 on the board.

I recommended: PS3 #4, Q2003 (like PS3 #6 but check part e.)!); Q2004 (should be straightforward).