

Notes:

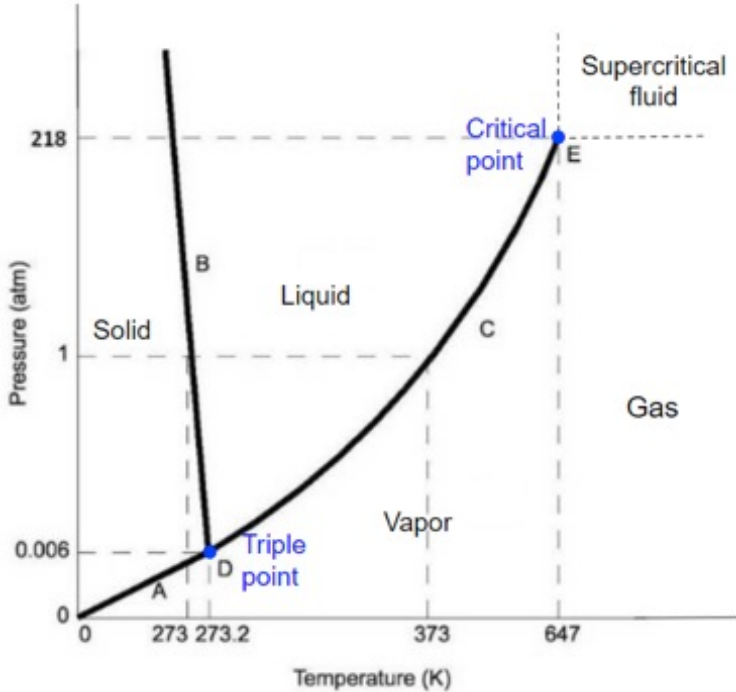
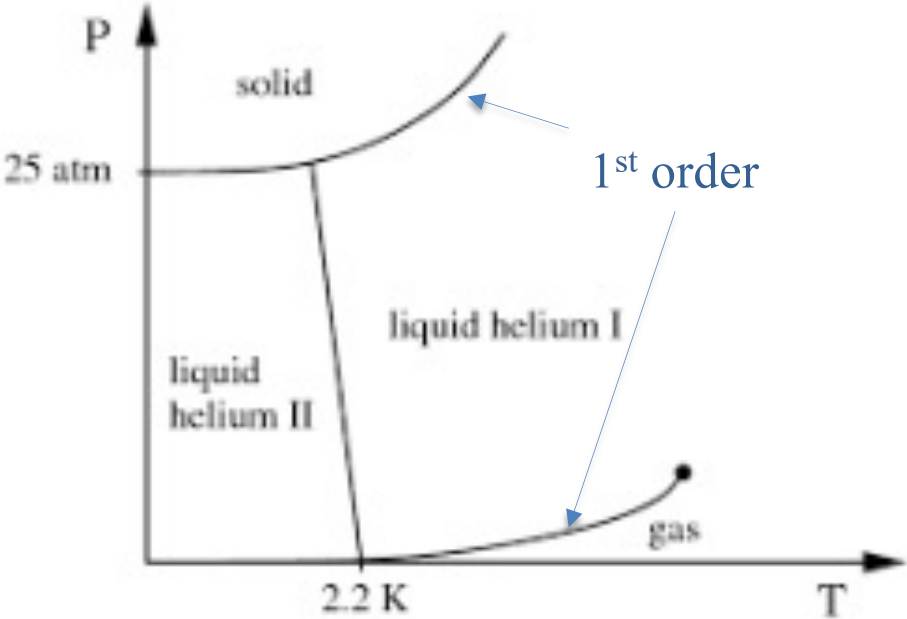
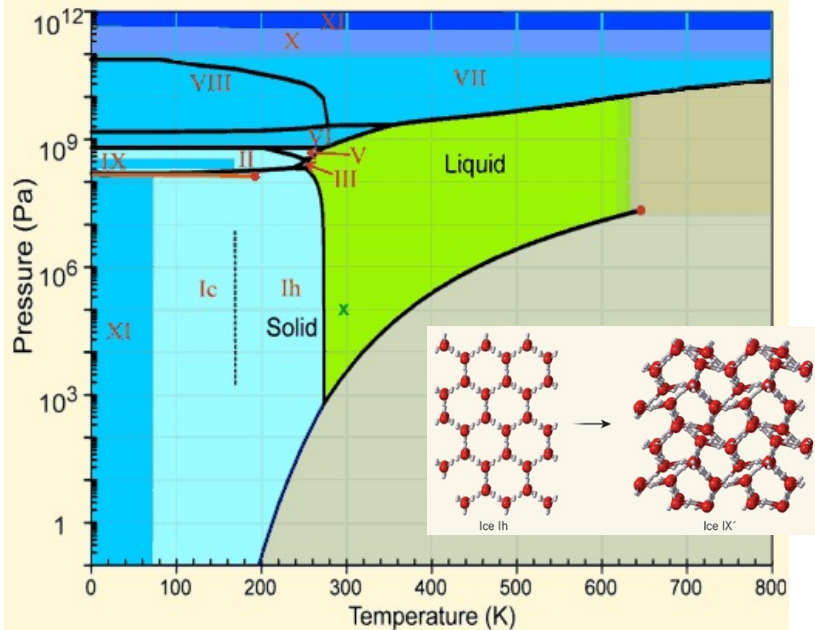
Homework : Set #9 due next Tuesday. Looking for volunteers, for problems 2, 4, 6.

Next week : I have a Wednesday jury duty call. It is likely I won't get picked to serve, but watch for an announcement before class just in case.

Also I have an unidentified HW8 paper. If you think it is yours let me know.

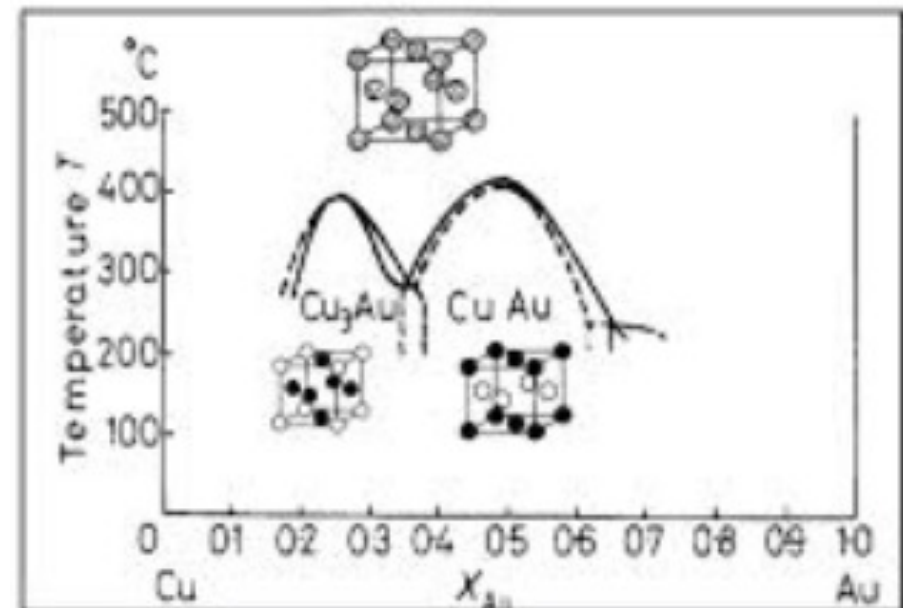
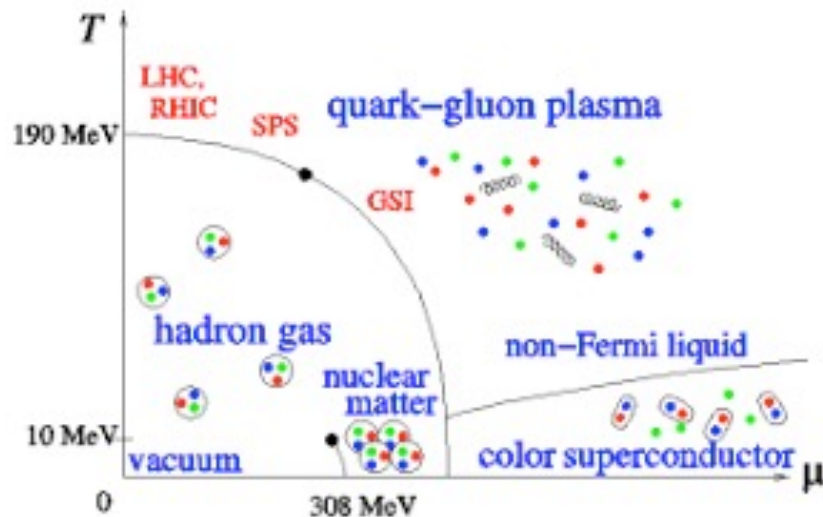
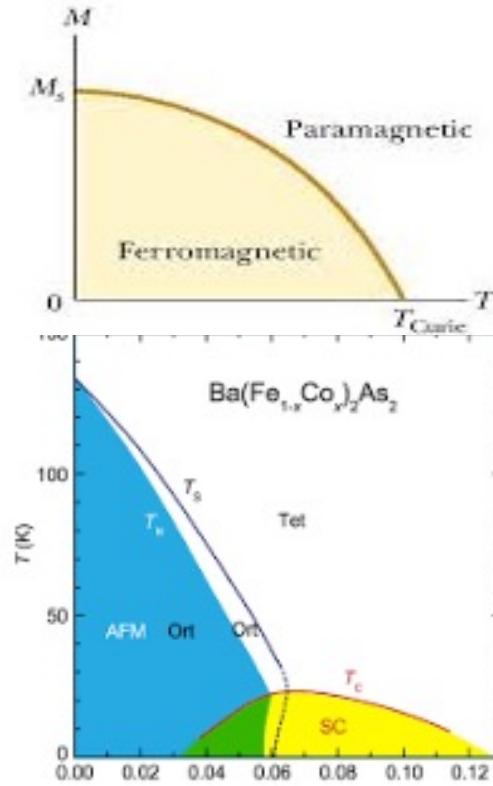
1st order Transformations:

- Consider P and T to be fixed, then find equilibrium.
- Gibbs free energy minimized.
- Phase transformation due to *instability in G vs external parameters.*



Phase Transformations:

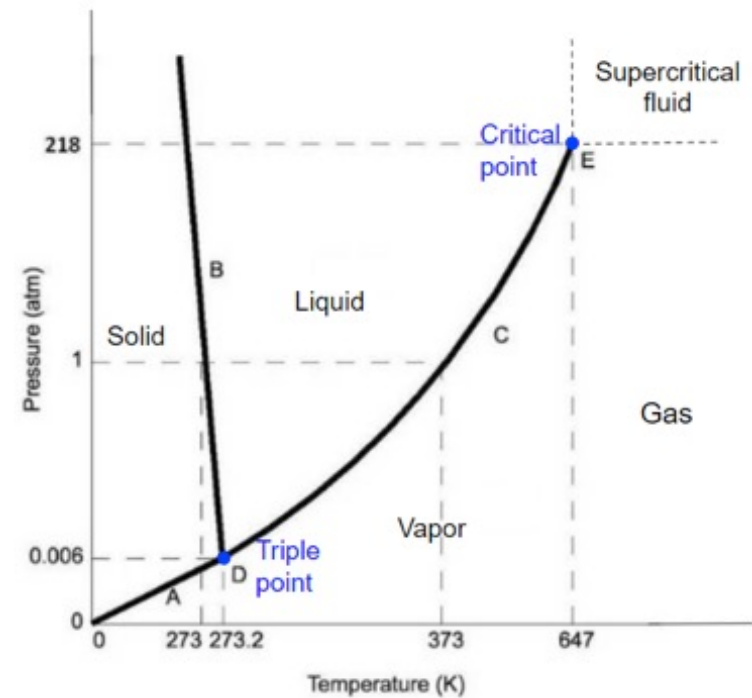
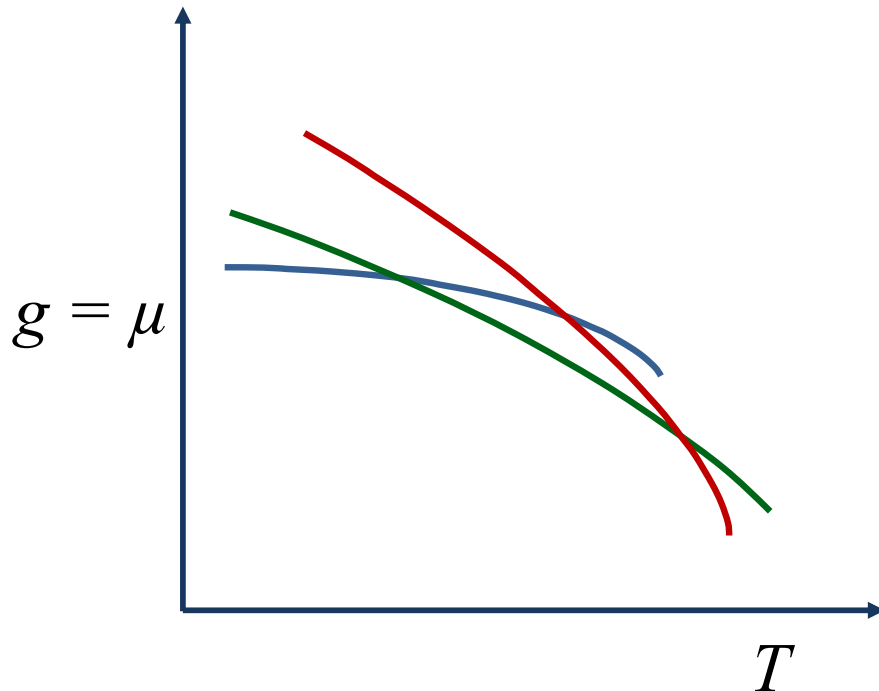
- Condensation, melting of solid/liquid/gas
- Magnetic phase transitions
- Solid-Solid structure changes
- Superconductivity, Superfluidity
- Order-disorder transformation in solids
- Bose condensation
- Quark-gluon plasma/hadron gas
- Higgs transformation early universe
- Topological phase transformations in solids



1st order Transformations, constant pressure:

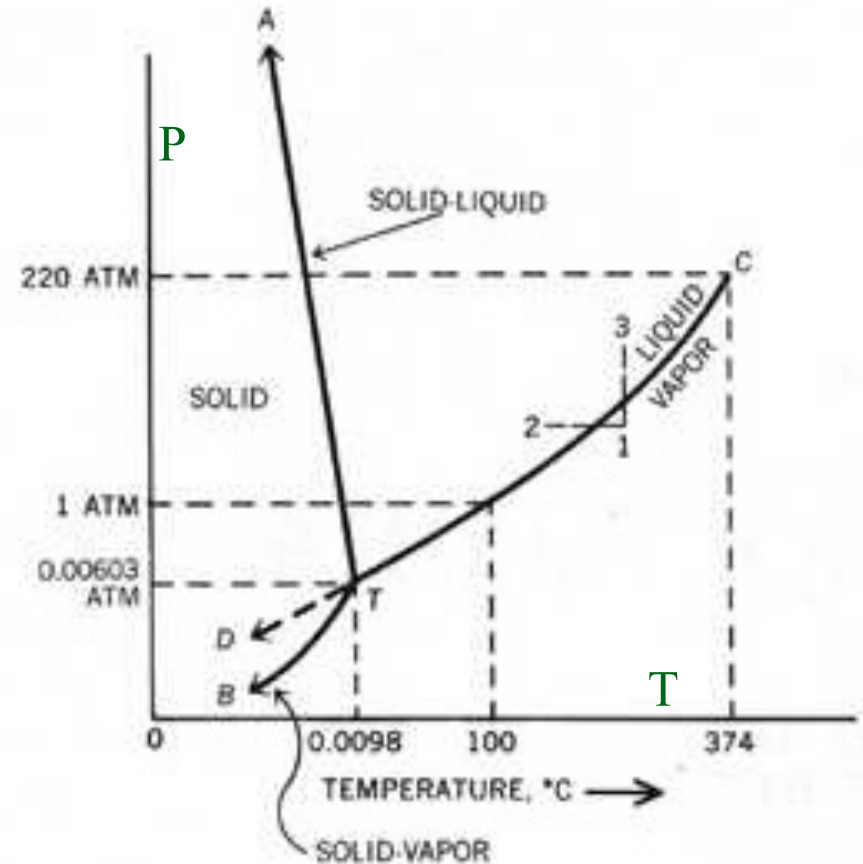
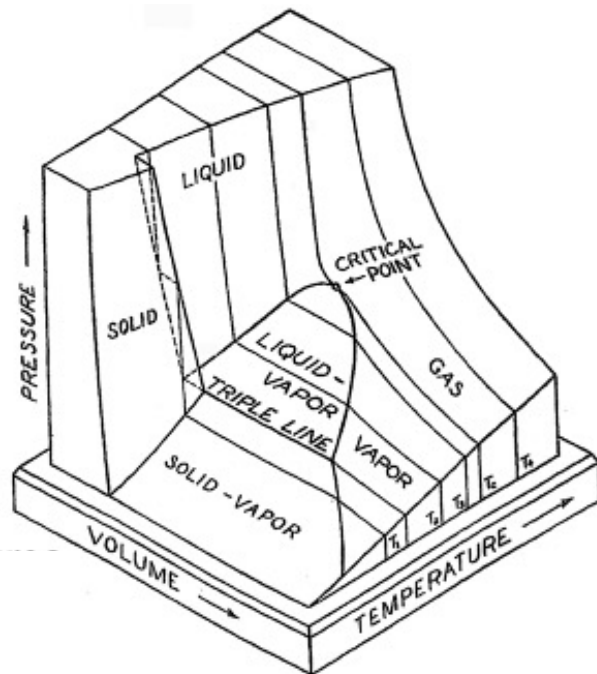
- Consider P and T to be fixed, then find equilibrium.
- Gibbs free energy minimized.
- Phase transformation due to instability in G vs external parameters.
- At equilibrium, 2 phases have same g, P, and T. (But not same V or S)

$$G = U - TS + PV$$



1st order Transformations:

- Consider P and T to be fixed, then find equilibrium.
- Gibbs free energy minimized.
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Latent heat:

1st order phase transition @ constant P

(1) Latent heat = enthalpy change:

$$L = \Delta H$$

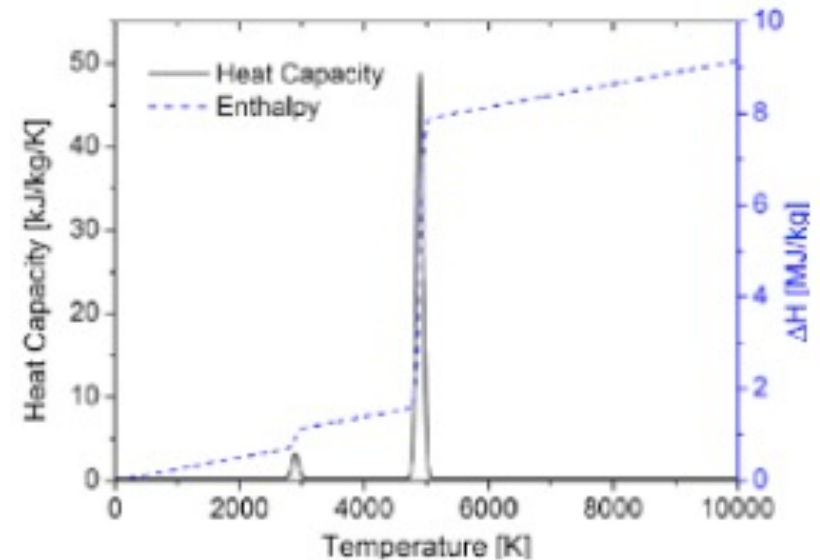
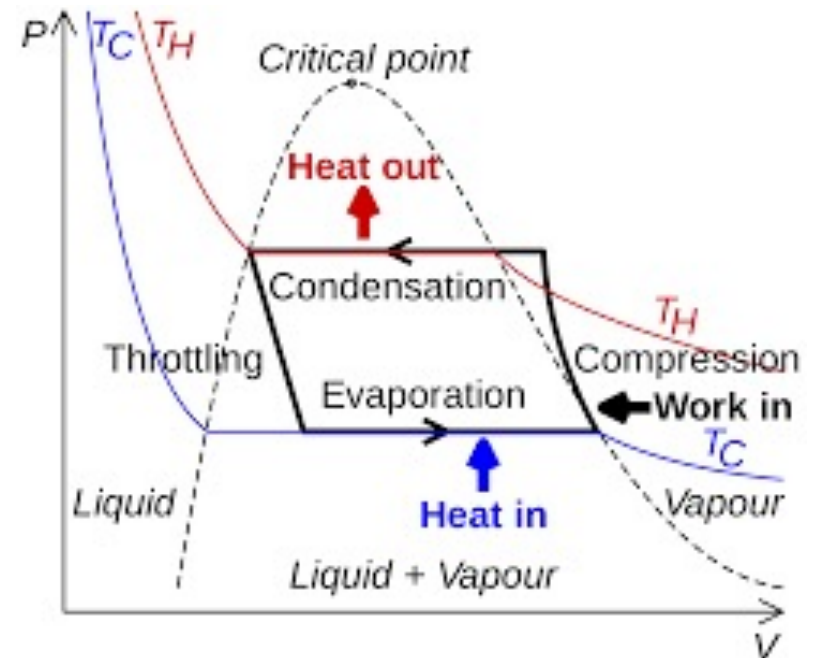
$$dH = TdS + VdP$$

H₂O vaporization, $L = 41,000$ J/mol
(0.4 eV $\approx 13 k_B T$ per molecule at 370 K).

(2) G constant across transformation:

$$G = H - TS \quad L \text{ gives } \underline{\text{entropy}} \\ \underline{\text{difference}}$$

$$L = T\Delta S \quad \underline{\text{between phases}}$$



Simulation, laser heating of metal layer
(Sotrop et al. 2013)

1st order Transformations:

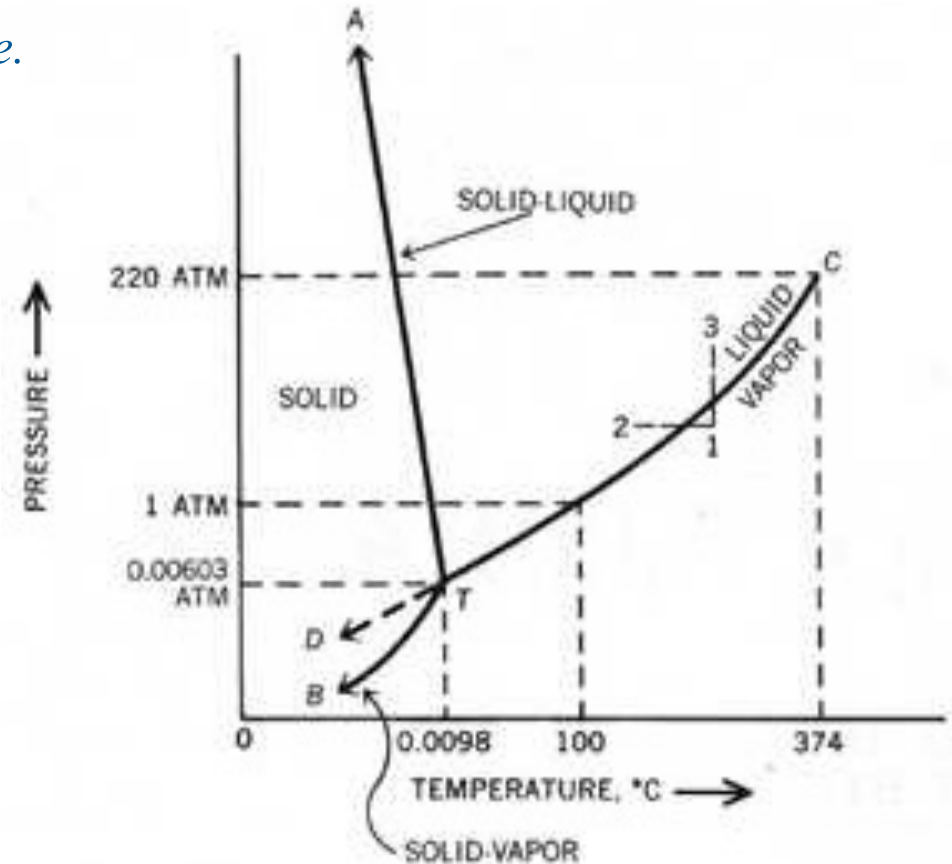
- Clausius-Clapeyron relation

$$dG = -SdT + VdP$$



$$\frac{dP}{dT} = \frac{L}{T\Delta V}$$

Describes slope
following
coexistence curve.



1st order Transformations:

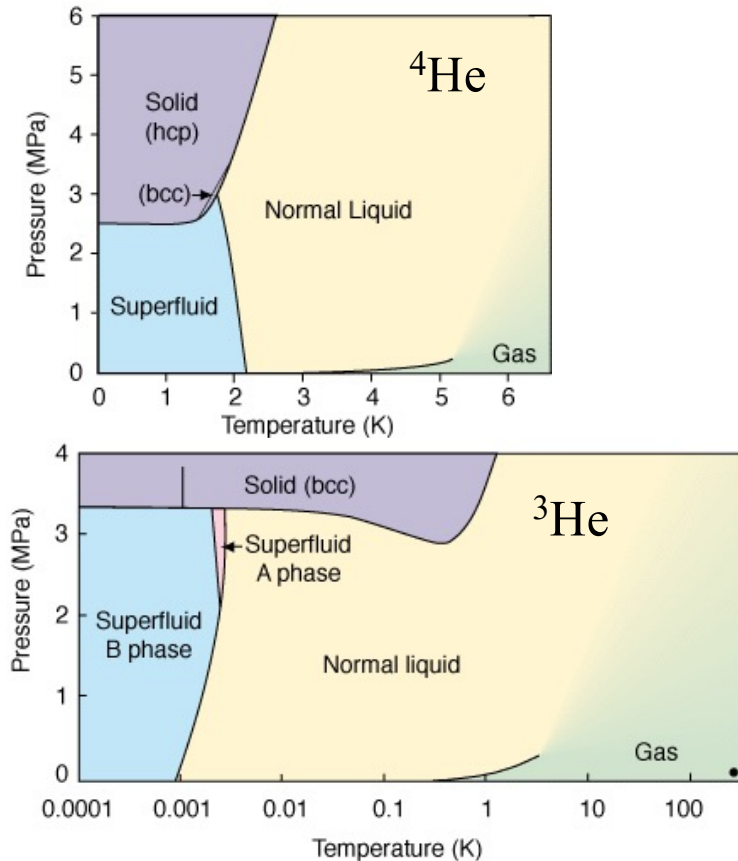
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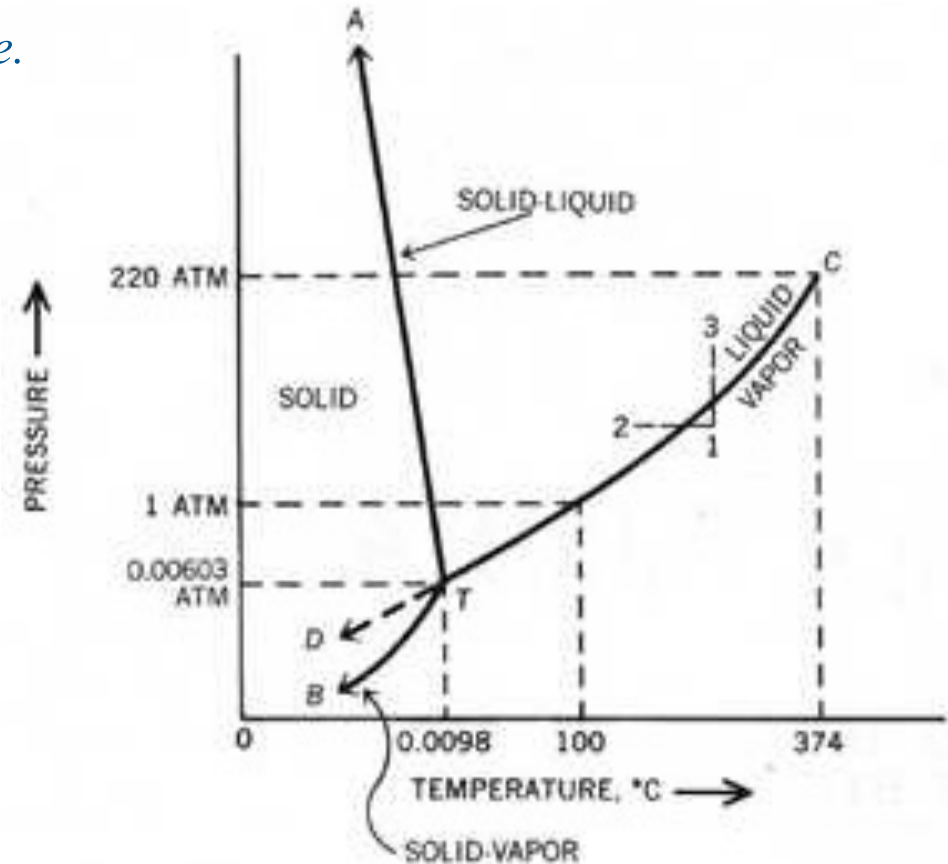
Describes slope following coexistence curve.



Q: Adiabatically compress a mixture of liquid water + ice.

- Temperature change?
- Which phase increases in amount, water or ice?

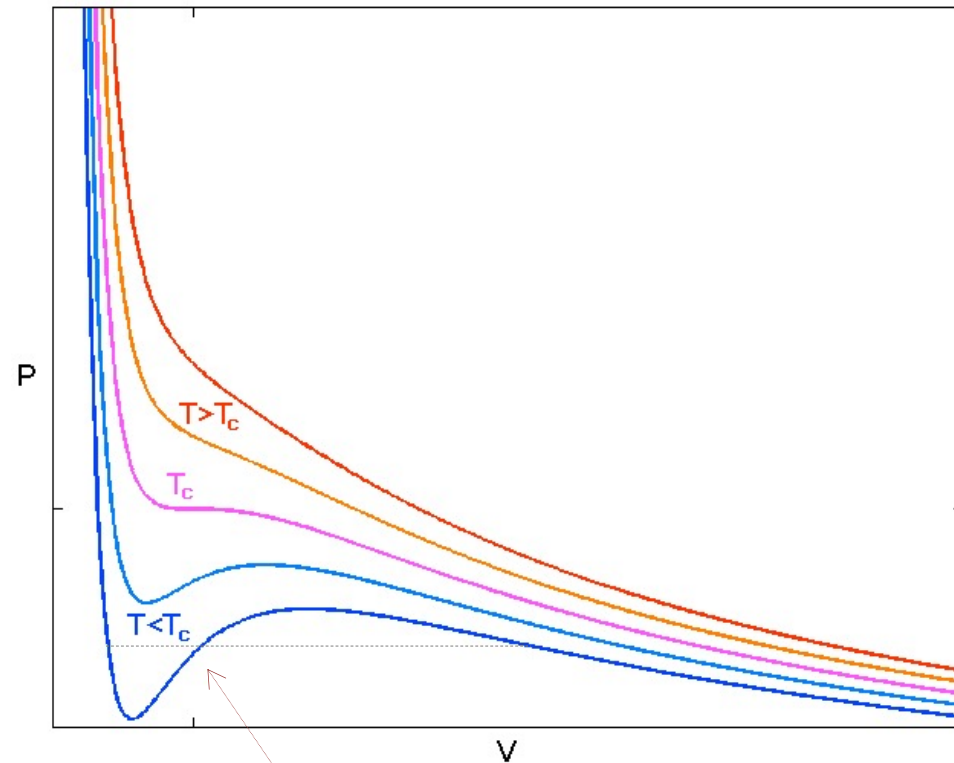
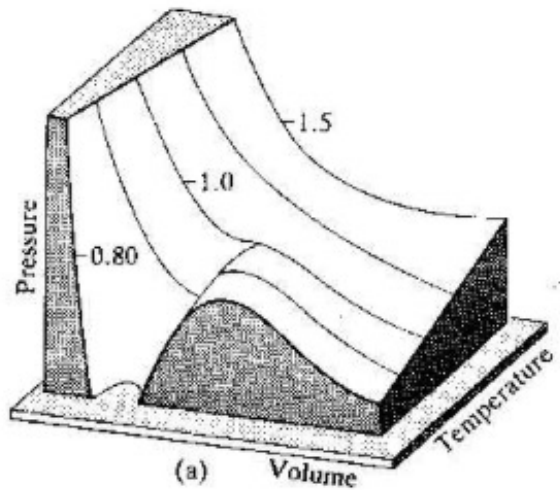
Q: Add salt to isolated water + ice mixture. Change in temperature?



Phase Transformations:

- Van der Waals gas:

$$\left[P + a \left(\frac{n}{V} \right)^2 \right] \left(\frac{V}{n} - b \right) = RT$$



$T < T_c$, always unstable point