Physical Chemistry Cumulative Exam

December 6th, 2018

Topic: thermodynamics

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1) (20 points) Chicago's winter is coming. Ice on Lake Michigan doesn't mean they're frozen solid. Please explain why Lake Michigan is going to have open water below the ice.

2) (20 points) Show that the integral of $\oint \frac{dq_{rev}}{T}$ round a Carnot cycle is zero. Then show that if the isothermal reversible step is replaced by an isothermal irreversible expansion, the integral is negative.

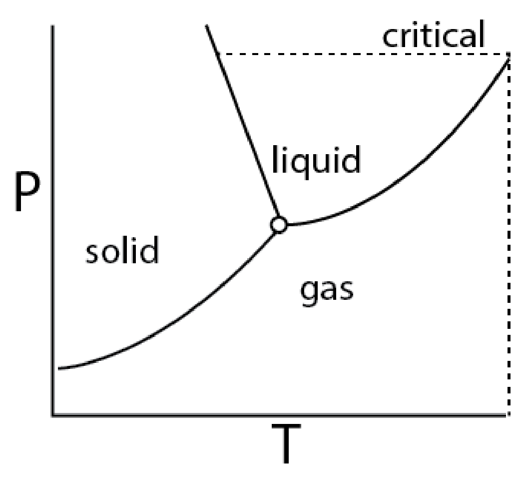
3) (30 points) An ice-making machine inside a refrigerator operates in a Carnot cycle. It takes heat from liquid water at 0.0∘C and rejects heat to a room at a temperature of 19.3 ∘C. Suppose that liquid water with a mass of 82.3 kg at 0.0∘C is converted to ice at the same temperature. Take the heat of fusion for water to be 3.34×10^5 J/kg.

a) How much heat $|Q_H|$ is rejected to the room?

b) How much energy E must be supplied to the device?

c) Your roommate decides to cool the kitchen by opening the door of the refrigerator. Will this strategy work? Explaining your reasoning. If it doesn't work, what will happen?

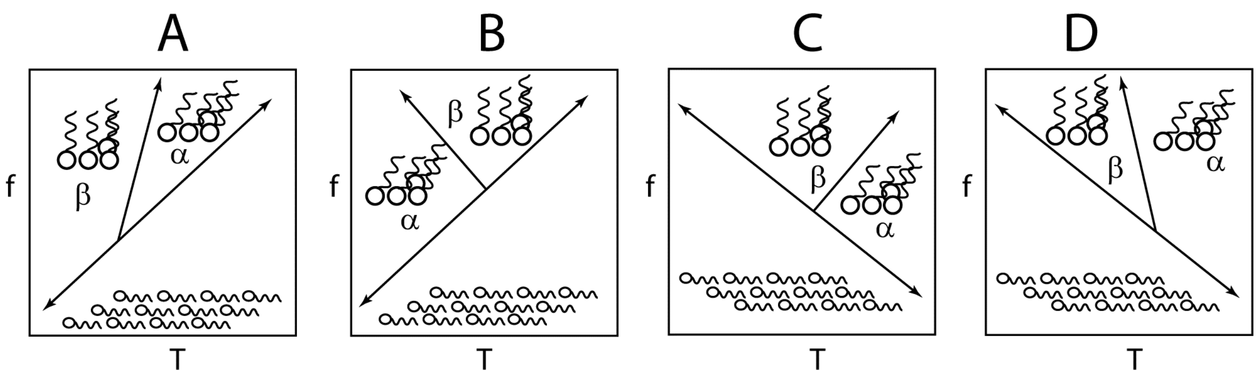
4) (10 points) Use this phase diagram to show how you can tell what happens to a solution's boiling point, partial pressure, and freezing point when you add salt to the water.



5) (10 points) For phospholipids on a water surface, there are three phases represented here, one liquid and two solids. If I calculate the Clausius-Clapyron equation for this system, where tension f is like pressure and area per mole is like V, I can determine: $\frac{\partial f}{\partial T} = \frac{\Delta H_m^o}{T \cdot \Delta A_m^o}$. Given the following information:

Phase	A_m^o (m^3 / mol)	H_m^o (kJ/mol)
liquid	12,000	60
solid □	4,000	10
solid □	2,000	30

which one of the following phase diagrams is possibly correct and explain why.



6) (10 points) What is the maximum number of phases that can stay at equilibrium in one component system and why?