

Final Exam. for Physical Chemistry for Energy Science
Department of Nuclear Engineering, Seoul National University
12/17/00 Monday PM 1:00-4:00

Three hour, closed book, two spike sheets plus formula booklet allowed

1. (35) For Van der Waals Gas;
- A. How can you determine the constant, a ?
 - B. How can you determine the constant, b ?
 - C. Derive expressions for critical temperature, pressure and volume.
 - D. Using Table 1.4, show that the van der Waals EOS is reduced to;

$$(Pr + 3/Vr^2)(Vr - 1/3) = 8 * Tr/3$$

where Pr , Tr , and Vr are reduced variables, as defined in the class.

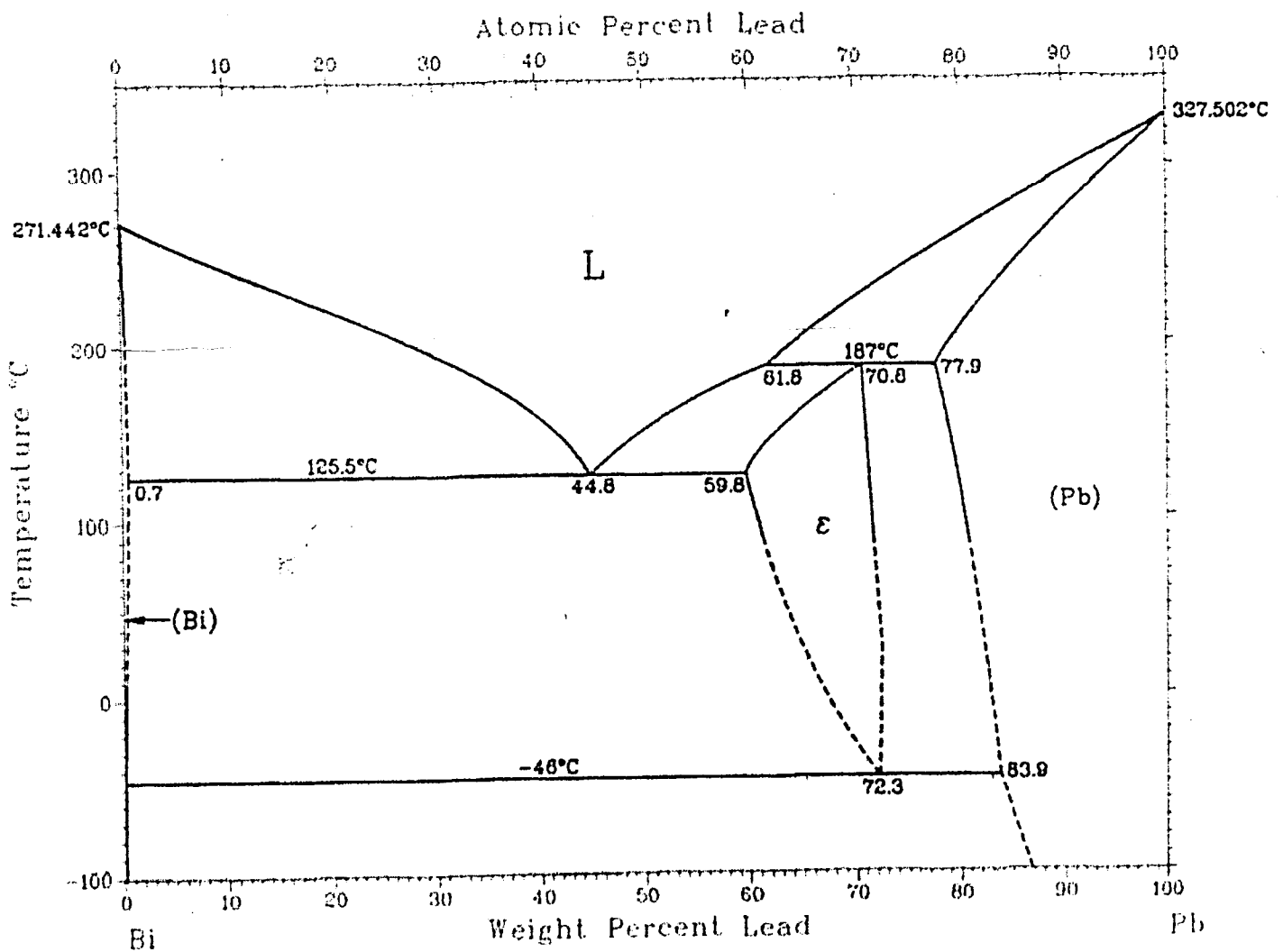
- E. What are shortcomings of Van der Waals Model?
- F. What is the law of corresponding state?

2. (20) Provide your view on the following fundamental questions;
- A. What is the most concise definition of temperature?
 - B. What is proof of "energy conservation principle" ?
 - C. Why is Boltzmann's formula, $S = k \ln W$, valid?
 - D. Why the specific heat of solids increases with temperature while those of liquid and gas are fairly temperature-independent?
 - E. What $S_0 = 0$ at 0 K?

3. (20) Hydrogen gas was mistakenly inserted into a lab with a 60 m³ of free and fixed volume. Final mole fraction was found to be 20 %. Hydrogen explosion is possible when hydrogen fraction is between 5 to 85 %. Assuming ideal gas law, answer the following;

- A. What is the maximum heat produced when the explosion was completed?
- B. How much hydrogen is left at end?
- C. What if final temperature and pressure?
- ✓ D. Show that adiabatic compressibility K_T and isentropic compressibility K_S is related as follows;

$$K_T = K_S + TV\alpha^2/C_p$$
4. (20) Thermodynamics forms basis of physical chemistry. Answer the followings;
- ✓ A. From $TdS \geq dq$, how can you explain that an isolated system gets randomized?
- B. From $dA = -SdT + \sum(\text{potential})(\text{volume})$, how can you include nuclear energy into the expression?
- ✓ C. Derive Gibbs phase rule ($P+F=C+2$).
- D. For eutectic melting of Pb and Bi, following phase diagram is given. Sketch Gibbs free energy diagram at 200 C.



8. (35) For the ionization of $\text{KCl}=\text{K}^+ + \text{Cl}^-$

ion	Standard E(V)	Limiting ionic conductivity (cm ² -S/eq. Mol)	Ionization potential (V)	Electron affinity (V)
K^+	-2.925	73.5	4.339	0.502
Cl^-	1.3595	76.34	13.01	3.615

- A. The first two columns provide data for aqueous solution. What is the standard Gibbs free energy of dissociation of KCl?
- B. What is the ionic mobility of each ion?
- C. Solubility limit of KCl is given as 34 gm/kg water. What is the conductivity of a KCl solution that shows undissolved crystals at the bottom of beaker?
- D. Albert Einstein has shown that ionic diffusivity in solution is related to the mobility by $u_i = D_i/kT$. Determine diffusivity of each ion.
- E. The last two columns of the table shows data for plasmarized gas. What is the standard Gibbs free energy of dissociation of KCl in gas?
- F. Why the values in A and E differ?

END