

Name: _____
110 points
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Test 3
Chemistry 361
May 4th, 2001

$$\kappa_T = (\partial V / \partial p)_T / V \quad \alpha = (\partial V / \partial T)_p / V \quad C_{V,m} = 3 R / 2 \text{ (monatomic perfect gas)}$$
$$R = 8.31451 \text{ J mol}^{-1} \text{ K}^{-1} = 0.0820578 \text{ L atm mol}^{-1} \text{ K}^{-1} = 82.0578 \text{ cm}^3 \text{ atm mol}^{-1} \text{ K}^{-1}$$

Answer the following three multiple choice questions for 10 points each.

Must show complete work for full credit to be given:

1. A liquid mixture that boils at a single temperature (rather than a range) is called what?
A) azeotrope B) eutectic C) congruent melt D) incongruent melt E) isotope
2. Which of the following solvent properties would produce the largest melting point depression with a 0.1 molal solute present?
A) higher melting point, weaker intermolecular interactions
B) lower melting point, weaker intermolecular interactions
C) higher melting point, stronger intermolecular interactions
D) highest molecular weight E) lowest molecular weight
3. Which of the following will cause the chemical potential of a liquid to increase (identify all correct answers below)?
A) increase the pressure on the liquid B) increase the temperature of the liquid
C) reduce the pressure on the liquid D) reduce the temperature of the liquid
E) dissolve a solute in the liquid

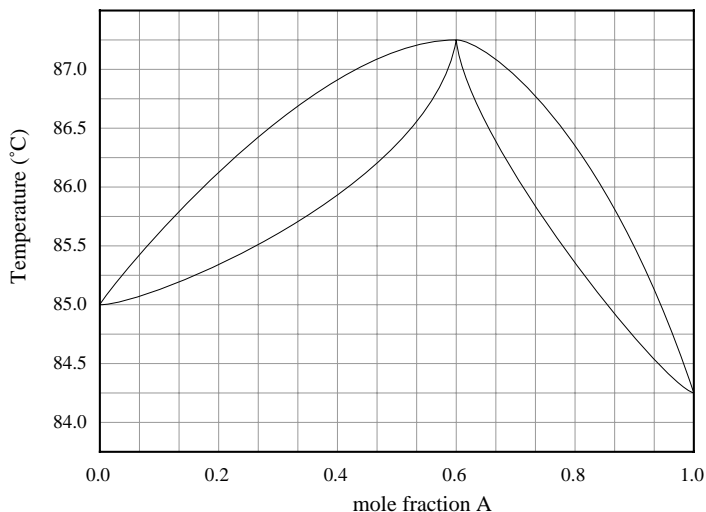
Choose two of the following three exercises for 20 points each:

4. It is found that the boiling point of a binary solution of A and B with mole fraction A, $x_A = 0.4217$, is 96°C . At this temperature the vapor pressures of pure A and B are 110.1 and 94.93 kPa, respectively. Is this solution ideal? What is the initial (before solution has boiled away) composition of the vapour above this solution.
5. At 25°C and 1 atm, a solution of 72.061 g of H_2O and 192.252 g of CH_3OH has a volume of 307.09 cm^3 . In this solution, $V_{m,\text{water}} = 16.488 \text{ cm}^3/\text{mol}$. Find $V_{m,\text{methanol}}$ in this solution.
6. In a 5.0 L compartment that is partitioned into two sides of 1.0 L and 4.0 L. In the 1.0 L compartment there is 1.0 atm of N_2 at 25°C and in the 4.0 L component there is 1.0 atm of H_2 at 25°C . Assuming ideal behavior, calculate the ΔG° and ΔS° of mixing when the partition is removed.

Choose one of the following four problems for 40 points:

7. Given the phase diagram below showing the liquid/vapor phase lines for a sample of A and B, derive the quantities of each species present in both the liquid and/or vapor phases if the temperature is 86.0° C and the total mole fraction is 0.800. Describe the composition of the vapor that would be produced if this composition were fractionally distilled.

Problem 7.



8. The volume of an aqueous solution of NaCl at 25°C was measured at a series of molalities b , and it was found that the volume fitted the equation below where V is the volume of a solution formed from 1.000 kg of water and b is understood to be expressed in molality units. Calculate the partial molar volume of the components in a solution of molality 0.150 mol kg⁻¹.

$$V (\text{cm}^3) = 1003 + 16.62 b + 1.77 b^{3/2} + 0.12 b^2$$

9. Calculate the difference in slope of the chemical potential against pressure on either side of (a) the normal freezing point and (b) normal boiling point of water. The densities of ice and water at 0°C are 0.917 and 1.000 g / cm³ respectively, and those of water and water vapor at 100°C are 958 and 0.598 g / L respectively. By how much does the chemical potential of water vapor exceed that of liquid water at 1.2 atm and 100°C?
10. The vapor pressure of water at 25°C is 23.76 torr and 760.0 torr at 100°C. Calculate the average ΔH_m of vaporization for water over the temperature range from 25°C to 100°C.