

Problem Set 12: Ideal & Nonideal Solutions, Colligative Properties

Due Oct 9, 2008

1. Problem 5.10 (p. 187):
Calculate the changes in entropy for the following processes:
(a) mixing of 1 mole of nitrogen and 1 mole of oxygen,
(b) mixing of 2 moles of argon, 1 mole of helium, and 3 moles of hydrogen.
Both (a) and (b) are carried out under conditions of constant temperature (298 K) and constant pressure. Assume ideal behavior.
2. Problem 5.16 (p. 187):
A miner working 900 ft below the surface had a soft drink beverage during the lunch break. To his surprise, the drink seemed very flat (that is, not much effervescence was observed upon removing the cap). Shortly after lunch, he took the elevator up to the surface. During the trip up, he felt a great urge to belch. Explain.
3. Problem 5.12 (p.187)
Which of the following has a higher chemical potential? If neither answer "same".
(a) $\text{H}_2\text{O}_{(s)}$ or $\text{H}_2\text{O}_{(l)}$ at water's normal melting point,
(b) $\text{H}_2\text{O}_{(s)}$ at -5°C and 1 bar or $\text{H}_2\text{O}_{(l)}$ at -5°C and 1 bar,
(c) benzene at 25°C and 1 bar or benzene in a 0.1 M toluene solution at 25°C and 1 bar.
4. Problem 5.13 (p. 187):
A solution of ethanol and n-propanol behaves ideally. Calculate the chemical potential of ethanol in solution relative to that of pure ethanol when its mole fraction is 0.40 at its boiling point (78.3°C).
5. The osmotic pressure exerted by the components inside a red blood cell are equivalent to a solution of 0.31 M sucrose. The components which generate this pressure inside the cell cannot quickly pass through the cell membrane.
 - (a) If a red blood cell is placed into a solution of 0.31 M sucrose (the sucrose cannot pass through the membrane), would you expect the cell to shrink, expand, or stay the same?
 - (b) If a red blood cell is placed into pure water, would you expect the cell to shrink, expand, or stay the same?
 - (c) If a red blood cell is placed into a solution of 0.31 M NaCl (the salt cannot pass through the membrane), would you expect the cell to shrink, expand, or stay the same?
 - (d) If a red blood cell is placed into a solution of 0.31 M urea (the urea **does** pass through the membrane quickly), would you expect the cell to shrink, expand, or stay the same?
6. Problem 5.25 (p. 187):
Explain why jams can be stored under atmospheric conditions for long periods of time without spoilage.
7. Problem 5.41 (p. 188):
Acetic acid is a polar molecule than can form hydrogen bonds with water molecules. Therefore, it has a high solubility in water. Yet acetic acid is also soluble in benzene (C_6H_6), a nonpolar solvent that lacks the ability to form hydrogen bonds.
A solution of 3.8 g of CH_3COOH in 80 g C_6H_6 has a freezing point of 3.5°C . Calculate the molar mass of the solute, and suggest what its structure might be. (Hint: Acetic acid molecules can form hydrogen bonds among themselves.)