

14 • Solutions and Their Behavior

STUDY QUESTIONS

- A solution of salt (molar mass 90 g mol^{-1}) in water has a density of 1.29 g/mL . The concentration of the salt is 35% by mass.
 - Calculate the molality of the solution.
 - Calculate the molarity of the solution.
 - Calculate the total number of moles in the solution.
 - Calculate the mole fraction of the salt in the solution.
- Ethylene glycol ($\text{C}_2\text{H}_4(\text{OH})_2$; 150 grams) is added to ethanol ($\text{C}_2\text{H}_5\text{OH}$; 250 grams).
 - Calculate the mass % of ethylene glycol in the solution.
 - Calculate the molality of ethylene glycol in the solution.
 - Calculate the mole fraction of ethylene glycol in the solution.
- Concentrated sulfuric acid contains very little water, only 5.0% by mass. It has a density of 1.84 g/mL . What is the molarity of this acid?
- The lattice energy of a salt is 350 kJ/mol and the solvation energies of its ions add up to 320 kJ/mol for the preparation of a 0.50 M solution. In the preparation of this solution would the solution get colder or warmer? What is the driving force for this solution process?
- Addition of excess sodium nitrate to water to form a saturated solution results in the following equilibrium. The solution process is endothermic. $\text{NaNO}_3(\text{s}) \rightleftharpoons \text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$

How could the concentration of sodium nitrate in the solution be increased?

 - add more $\text{NaNO}_3(\text{s})$
 - increase the pressure on the solution
 - increase the temperature
 - stir the solution more vigorously
- The value of Henry's law constant k_{H} for oxygen in water at 24°C is $1.66 \times 10^{-6} \text{ M/torr}$.
 - Calculate the solubility of oxygen in water at 25°C when the total external pressure is 1 atm and the mole fraction of oxygen in the air is 0.20.
 - Calculate the solubility at the same temperature with the same atmospheric composition but at an increased pressure of 2 atm.
 - What would happen to the solubility of the oxygen gas if the temperature was increased?

7. Ethanol and methanol form an almost ideal solution. If 64 g of methanol is mixed with 69 g of ethanol, what is the total vapor pressure above the solution?
The vapor pressure of pure methanol at this temperature = 90 torr.
The vapor pressure of pure ethanol at this temperature = 45 torr.
8. A 3.0 molal solution of naphthalene in cyclohexane boils at 89.4°C. What is the boiling point of pure cyclohexane? Although solid naphthalene is slightly volatile, assume its volatility is zero in this calculation. The constant k_b for cyclohexane is $+2.80 \text{ K m}^{-1}$.
9. Which of the following solutions would you expect to have the lowest freezing point? Assume that the values of i are ideal.
- | | |
|--------------------------|--------------------------------------|
| a. 0.010m NaCl | d. 0.050m glycerol |
| b. 0.100m sugar | e. 0.060m $\text{Ca}(\text{NO}_3)_2$ |
| c. 0.070m KNO_3 | f. 0.075m KCl |
10. In order to depress the freezing point of water to -12°C , how much magnesium nitrate would you have to add to 500 grams of water? Assume that the van't Hoff factor i is the ideal value. k_f for water is -1.86 K m^{-1} .

Ignore questions 11 & 12.