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## **14** • Solutions and Their Behavior

## STUDY QUESTIONS

- 1. A solution of salt (molar mass 90 g mol<sup>-1</sup>) in water has a density of 1.29 g/mL. The concentration of the salt is 35% by mass.
  - a. Calculate the molality of the solution.
  - b. Calculate the molarity of the solution.
  - c. Calculate the total number of moles in the solution.
  - d. Calculate the mole fraction of the salt in the solution.
- 2. Ethylene glycol ( $C_2H_4(OH)_2$ ; 150 grams) is added to ethanol ( $C_2H_5OH$ ; 250 grams).
  - a. Calculate the mass % of ethylene glycol in the solution.
  - b. Calculate the molality of ethylene glycol in the solution.
  - c. Calculate the mole fraction of ethylene glycol in the solution.
- 3. 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?
- 4. 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?
- 5. Addition of excess sodium nitrate to water to form a saturated solution results in the following equilibrium. The solution process is endothermic.  $NaNO_3(s) \rightleftharpoons Na^+(aq) + NO_3^-(aq)$

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

- a. add more NaNO<sub>3</sub>(s)
- b. increase the pressure on the solution
- c. increase the temperature
- d. stir the solution more vigorously
- 6. The value of Henry's law constant  $k_{\rm H}$  for oxygen in water at 24°C is 1.66 x 10<sup>-6</sup> M/torr.
  - a. 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.
  - b. Calculate the solubility at the same temperature with the same atmospheric composition but at an increased pressure of 2 atm.
  - c. 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 kb for cyclohexane is +2.80 Km<sup>-1</sup>.
- 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
  - b. 0.100m sugar
  - c. 0.070m KNO<sub>3</sub>

- d. 0.050m glycerol
- e.  $0.060 \text{m Ca}(\text{NO}_3)_2$
- f. 0.075m KCl
- 10. In order to depress the freezing point of water to  $-12^{\circ}$ 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.  $k_{\rm f}$  for water is -1.86 Km<sup>-1</sup>.

Ignore questions 11 & 12.