Chapter 13

1. Which one of the following statements is true?
   A. The heat of solution in H\textsubscript{2}O for KOH is the same as that for KOH+H\textsubscript{2}O.
   B. For a compound to spontaneously dissolve in H\textsubscript{2}O at 25°C, the solution process must be exothermic.
   C. Ne is less soluble in H\textsubscript{2}O at 2 atm pressure than at 1 atm pressure.
   D. C\textsubscript{2}H\textsubscript{4} is very soluble in liquid NH\textsubscript{3}.
   E. None of the above.

2. Given the solutes NaCl and I\textsubscript{2} and the solvents NH\textsubscript{3}(l) and C\textsubscript{7}H\textsubscript{16} (heptane), which is true?
   A. NaCl and I\textsubscript{2} are both more soluble in NH\textsubscript{3} than in C\textsubscript{7}H\textsubscript{16}.
   B. NaCl and I\textsubscript{2} are both more soluble in C\textsubscript{7}H\textsubscript{16} than in NH\textsubscript{3}.
   C. NaCl is more soluble in NH\textsubscript{3}; I\textsubscript{2} is more soluble in C\textsubscript{7}H\textsubscript{16}.
   D. NaCl is more soluble in C\textsubscript{7}H\textsubscript{16}; I\textsubscript{2} is more soluble in C\textsubscript{7}H\textsubscript{16}.
   E. In order to determine relative solubilities in these cases one must know whether the solution reactions are exothermic or endothermic.

3. The Henry's law constant for He gas in H\textsubscript{2}O at 30°C is 3.7 × 10\textsuperscript{-4} M/atm; that for N\textsubscript{2} at 30°C is 6.0 × 10\textsuperscript{-4} M/atm. If a gaseous He-N\textsubscript{2} mixture that has a He mole fraction of 0.30 is placed over the water
   A. the concentration of dissolved He will be greater than that of dissolved N\textsubscript{2}.
   B. the concentration ratio of dissolved He to dissolved N\textsubscript{2} would be 0.62.
   C. the concentration ratio of dissolved He to dissolved N\textsubscript{2} will be 0.26.
   D. the concentration ratio of dissolved He to dissolved N\textsubscript{2} will be 0.18.
   E. the concentration ratio of dissolved He to dissolved N\textsubscript{2} will be 0.49.

4. A saturated solution of silver chloride, AgCl is weakly conducting for electricity because
   A. AgCl is essentially 100% ionized in solution, but is not very soluble.
   B. AgCl is quite soluble, but only dissociates into ions slightly, in solution.
   C. AgCl does not produce ions itself, but rather induces hydrolysis to give AgOH and HCl, in water.
   D. AgCl is only slightly ionized in solution, and also is only slightly soluble.
   E. None of the above is a true statement.

5. Which one of the following would you expect to me MOST soluble in water?
   A. CH\textsubscript{3}OH
   B. CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}OH
   C. CH\textsubscript{3}CH\textsubscript{2} CH\textsubscript{2} CH\textsubscript{2}CH\textsubscript{2}OH
   D. CH\textsubscript{3}CH\textsubscript{2} CH\textsubscript{2} CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{3}
   E. \begin{chemicalstructure}
   \begin{picture}(30,30)
   \thicklines
   \put(30,0){\vector(-25,0){15}}
   \put(30,0){\vector(-25,20){15}}
   \put(30,0){\vector(-25,-20){15}}
   \end{picture}
   \end{chemicalstructure}
6. Which one of the following would you expect to be LEAST soluble in water
   A. CH₃OH
   B. CH₃CH₂CH₂OH
   C. CH₃CH₂ CH₂ CH₂CH₂OH
   D. CH₃CH₂ CH₂ CH₂CH₂CH₃
   E. \[
   \begin{align*}
   &\text{CH}_2\text{OH} \\
   &\text{CH}_2\text{OH}
   \end{align*}
   \]

7. Rank these in order of decreasing solubility in water.
   i) \[
   \begin{align*}
   &\text{CH}_2\text{OH} \\
   &\text{CH}_3
   \end{align*}
   \]
   ii) \[
   \begin{align*}
   &\text{HO} \\
   &\text{CH}_2\text{OH} \\
   &\text{CH}_3
   \end{align*}
   \]
   iii) CH₃CH₂OH
   A. i > ii > iii
   B. iii > i = ii
   C. ii > iii > i
   D. iii > ii > i
   E. i = ii > iii

8. The mole fraction of CO₂ in a certain solution with H₂O as the solvent is 3.6 × 10⁻⁴. The molality of CO₂ in this solution is about
   A. 0.00036 m
   B. 0.0065 m
   C. 0.020 m
   D. 2.0 × 10⁻⁵ m
   E. 6.5 m

9. A solution contains 4.00 g NaOH, 5.61 g KOH, and 1.03 g RbOH in 90.0 g of water. The solution has a density of 1.08 g/mL. What is the molality of OH⁻?
   A. 2.33 m
   B. 2.09 m
   C. 2.52 m
   D. 2.16 m
   E. None of the above is within 2% of the correct answer.
10. The mole fraction of HCl in a 36% by weight aqueous solution of HCl is
   A. 0.11
   B. 0.22
   C. 0.36
   D. 0.64
   E. 0.99

11. A solution whose density is 0.935 g/mL contains 30.0% by weight H₂CO, 10.0% C₂H₅OH
    and 60.0% H₂O. The molarity of the H₂CO is
   A. 9.34 M
   B. 2.32 M
   C. 0.0107 M
   D. 4.51 M
   E. 0.0214 M

12. 27.0 L of HCl gas at STP is dissolved in water, giving 785 mL of solution. The molarity of the
    HCl solution is:
   A. 9.46 M
   B. 1.53 M
   C. 0.946 M
   D. 15.3 M
   E. None of the above is within 1% of the correct answer.

13. Arrange the following aqueous solutions in order of increasing boiling points:
    1. 0.1 M Fe₂(SO₄)₃
    2. 0.2 M BaCl₂
    3. 0.3 M glucose (blood sugar)
    4. 0.2 M LiCl
    5. 0.2 M AlCl₃
   A. 3, 4, 2, 1, 5
   B. 2, 4, 5, 1, 3
   C. 5, 3, 1, 4, 2
   D. 3, 4, 1, 2, 5
   E. 3, 5, 2, 1, 4

14. Consider a solvent whose molecular weight is 100.0 amu and whose vapor pressure at 25°C
    is 25.00 mm Hg. 100.0 g of a solute whose molecular weight is 50.00 amu is dissolved in
    1.000 kg of that solvent. The solute is not an electrolyte. The vapor pressure of the pure
    solute is 0.01 mm Hg at 25°C. What is the vapor pressure of the solution at 25°C?
   A. 0.01 mm Hg
   B. 20.8 mm Hg
   C. 22.7 mm Hg
   D. 24.9 mm Hg
   E. 25.0 mm Hg
15. The compound ethylene glycol, C₂H₆O₂, is widely used as an automotive antifreeze. What is the minimum weight, in grams, of this compound that must be added to 8 kg of water to produce a solution that will protect an automobile cooling system from freezing at −20°F (−28.9°C)? Ethylene glycol is a non–electrolyte.

A. 32.0  
B. 121  
C. 7720  
D. 965  
E. 5342

16. 7.50 g of a compound having the empirical formula CH₂O is dissolved in water to form 100.0 mL of solution. This solution does not conduct electric current and is found to have an osmotic pressure of 12.2 atm at 25°C. The molecular formula for the compound is

A. CH₂O  
B. C₃H₆O₆  
C. C₅H₁₀O₅  
D. C₆H₁₂O₆  
E. None of the above is the correct answer

17. The addition of nonvolatile solute to a solvent

A. increases the boiling point, decreases the freezing point and increases the vapor pressure of the solvent.  
B. decreases the boiling point, decreases the freezing point and decreases the vapor pressure of the solvent.  
C. decreases the boiling point, increases the freezing point and increases the vapor pressure of the solvent.  
D. increases the boiling point, decreases the freezing point and decreases the vapor pressure of the solvent.  
E. increases the boiling point, decreases the freezing point but leaves the vapor pressure of the solvent unaffected.

18. Arrange the following aqueous solutions in order of increasing vapor pressure:

1. 0.5 M NaCl  
2. 0.4 M Na₂SO₄  
3. 0.1 M KCl  
4. 0.1 M Al₂(SO₄)₃  
5. 0.1 M C₆H₁₂O₆ (sugar)

A. 1, 2, 3, 4, 5  
B. 5, 4, 3, 2, 1  
C. 2, 1, 4, 3, 5  
D. 4, 2, 3, 1, 5  
E. 5, 3, 4, 1, 2