

- 1) For each of the indicated molarities of ionic solid solutions, give the individual ion molarities. Also indicate the value of  $i_{\text{solute}}$  (van't Hoff factor), for each ionic solid.

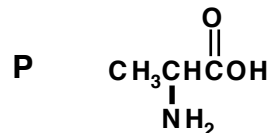
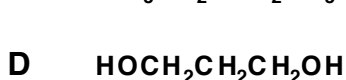
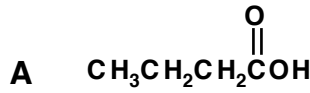
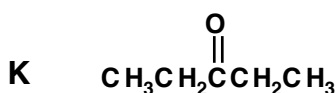
1.0 M KCl                      0.50 M Na<sub>2</sub>SO<sub>4</sub>                      0.10 M CaCl<sub>2</sub>                      0.25 M FeCl<sub>3</sub>  
2.5 M (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>                      0.010 M Pb(NO<sub>3</sub>)<sub>2</sub>                      0.001 M Na<sub>3</sub>PO<sub>4</sub>

- 2) Which of the compounds below are likely to be more soluble in water and which are likely to be more soluble in n-hexane?

(a) 4-amino-butanoic acid      (b) propyl pentanoate                      (c) 1,4-dimethylbenzene  
(d) 1,3,5-pentanetriol                      (e) 2,2,4-trimethylpentane                      (f) 2-amino-ethanol

- 3) Which of the following would be least soluble in water based on the hydrophobic molecule regions?

a) propanal      b) pentanal      c) heptanal



- 4) Which substance above, A or P, will have the greater solubility in water? Which substance above, K or D, will have the greater solubility in water? Which substance above, K or A, will have the greater solubility in water?
- 5) What is the molality of a solution of 112 g of glucose (180.2 g/mole) in 250.0 g of water?
- 6) Consider wine to be a 12.0% (by volume) solution of ethanol (46.07 g/mole) in water. The density of ethanol is 0.789 g/mL. If the volumes additive, what is the molarity of the ethanol in wine?
- 7) A solution is 5.41 M in H<sub>2</sub>SO<sub>4</sub> (98.09 g/mole) and has a density of 1.510 g/mL. Water is 18.02 g/mole.  
a) What is the mole fraction of H<sub>2</sub>SO<sub>4</sub>?  
b) What is the molality of H<sub>2</sub>SO<sub>4</sub>?
- 8) A water sample contains benzene (C<sub>6</sub>H<sub>6</sub> MW= 78.11 g/mol) at a concentration of 36.0 ppb. What is the molarity of the solution? Assume solution volume equals the water volume.
- 9) The Henry's Law constant for H<sub>2</sub> gas in water at 20 °C is  $8.5 \times 10^{-4} \text{ M} \cdot \text{atm}^{-1}$ . How many moles of hydrogen gas could dissolve in 50.0 mL of water at 20.0 °C when  $P_{\text{H}_2} = 0.963 \text{ atm}$ ?

Compound	Normal bp (°C)	K <sub>b</sub> (°C/m)	Normal fp (°C)	K <sub>f</sub> (°C/m)
Water, H <sub>2</sub> O	100.00	0.512	0.00	1.86
Benzene, C <sub>6</sub> H <sub>6</sub>	80.2	2.61	5.46	5.07

- 10) A liter of water dissolves 0.0434 grams of oxygen gas (32.00 g/mole) when the partial pressure of the oxygen gas is 1.00 atm at 20 °C.
- What is the molarity of the oxygen gas in solution?
  - What is the Henry's Law constant for oxygen in M/atm at 20 °C?
  - At 5.0 °C,  $6.07 \times 10^{-3}$  grams of oxygen dissolve in 100.0 mL of water at 1.00 atm P<sub>O<sub>2</sub></sub>. What is the Henry's Law constant for oxygen in M/atm at 5.0 °C?
- 11) A solution contains 64.3 g of sucrose (342.3 g/mole) in 200. g of water.
- What is the freezing point of the solution?
  - What is the boiling point of the solution?
- 12) A solution contains 64.3 g of CaCl<sub>2</sub> (111.0 g/mole) in 200. g of water.
- What is the freezing point of the solution?
  - What is the boiling point of the solution?
- 13) Assume seawater is a solution of 19.0 g/L of Cl<sup>-</sup>, 10.5 g/L of Na<sup>+</sup> and 1.35 g/L of Mg<sup>+2</sup>. What is the minimum pressure that must be applied to purify the water by reverse osmosis at 25.0 °C?
- 14) The vapor pressure of pure benzene (78.11 g/mole) at 23°C is 86.0 mm Hg and its density is 0.874 g/mL.
- What is the vapor pressure at 23 °C of a solution of 1.20 g of naphthalene (128.2 g/mole) in 25.6 g of benzene?
  - What is the boiling point of this solution?
  - What is the freezing point of this solution?
  - What is the molarity of this solution? (solution density = 0.915 g/mL)
  - What is the osmotic pressure of this solution?

### Answers

- 1) [K<sup>+</sup>]=[Cl<sup>-</sup>]=1.0 M;  $i_{\text{solute}}=2$  [Na<sup>+</sup>]=1.00 M, [SO<sub>4</sub><sup>-2</sup>]=0.50 M;  $i_{\text{solute}}=3$   
 [Ca<sup>+2</sup>]=0.10 M, [Cl<sup>-</sup>]=0.20 M;  $i_{\text{solute}}=3$  [Fe<sup>+3</sup>]=0.25 M, [Cl<sup>-</sup>]=0.75 M;  $i_{\text{solute}}=4$   
 [NH<sub>4</sub><sup>+</sup>]=5.0 M, [SO<sub>4</sub><sup>-2</sup>]=2.5 M;  $i_{\text{solute}}=3$  [Pb<sup>+2</sup>]=0.010 M, [NO<sub>3</sub><sup>-</sup>]=0.020 M;  $i_{\text{solute}}=3$   
 [Na<sup>+</sup>]=0.003 M, [PO<sub>4</sub><sup>-3</sup>]=0.001 M;  $i_{\text{solute}}=4$
- 2) a)W b)H c)H d)W e)H f)W
- 3) c 4) P, D, A
- 5) 2.49 m
- 6) 2.06 M 7a) 0.0905 b) 5.52 m
- 8)  $4.61 \times 10^{-7}$  M 9)  $4.1 \times 10^{-5}$  moles H<sub>2</sub>
- 10a) 0.00136 M b) 0.00136 M/atm c) 0.00190 M/atm
- 11a) -1.75 °C b) 100.481 °C
- 12a) -16.2 °C b) 104.45 °C
- 13) 25.7 atm (378 lb/in<sup>2</sup>)
- 14a) 83.6 mm Hg b) 81.2 °C c) 3.61 °C d) 0.320 M e) 7.77 atm