

Guide to Chapter 11. Solutions and their properties

We will spend three lecture days on this chapter. You may want to start by reviewing the concepts of heterogeneous solutions (Chapter 2)

□ Read the introductory paragraph to Chapter 11.

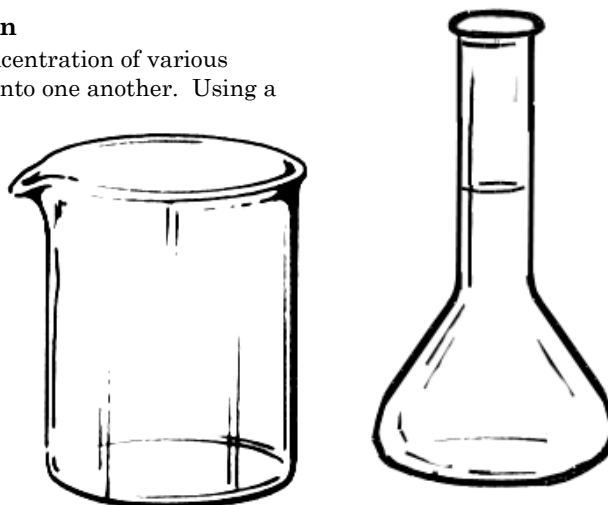
□ Read Section 11.1 Solutions and 11.2. Energy changes and the solution process.

- □ Learning Objective 1: Using your knowledge of energy terms involved in the solution process determine which solvent is best suited for a given solute.
- □ Learning Objective 2: Using the concept of intermolecular forces and the "like dissolves like" rule, determine which solvent is best suited for a given solute.
- □ Learning Objective 3: Know the definition of a suspension and a colloids.
- Do Problems 1 - 2 at the end of Section 11.2.
- Do the following end-of-chapter problems: 36, 38, 40, 42, 44

□ Read Section 11.3 Units of concentration

In this section, you will be determining the concentration of various solutions and then inter-converting them into one another. Using a sketched beaker and volumetric flask makes this job easier.

- □ Learning Objective 4: Be able to determine the concentration of a solution, taking into account whether the solute is an electrolyte or non-electrolyte. Concentration units include:
 - a. molarity
 - b. mass percent
 - c. mole fraction
 - d. molality
 - e. ppm and ppb



- □ Learning Objective 5: Know how to convert one unit of concentration measurement to another.
- Do Problems 3 – 10 at the end of the section.
- Do the following end-of-chapter problems: 48, 50, 52, 54, 58, 60, 62, 64, 66.

□ *Problem Club Question A. A solution is prepared by dissolving 25-g sucrose, (MM = 342) in 50-mL water. (a) Sketch the solution in a beaker. What is the (b) mole fraction of sucrose; (c) weight percent of sucrose and (d) molality of the sucrose solution? [$d(\text{H}_2\text{O}) = 1.00 \text{ g/mL}$]*

Answers: (b) 0.0256 (c) 33.3% (d) 1.46 molal

□ *Problem Club Question B. What is the (a) mole fraction and (b) weight percent of bromine in 2.20 molal Br_2 in CH_2Cl_2 solution? Start by sketching the solution.*

Answers: (a) 0.158 (b) 26%

□ *Problem Club Question C. How much naphthalene, C_{10}H_8 (MM = 128) must be added to 4.0-L CCl_4 ($d = 1.59 \text{ g/mL}$) in order to form a 3.00 molal solution? Start by sketching the solution.*

Answers: 2442 g naphthalene

□ *Problem Club Question D. Fingernail polish remover is made by mixing 50 mL acetone (propanone, $d = 0.79 \text{ g/mL}$; MM = 58) with 50 mL ethyl acetate (ethyl ethanoate - the ethyl ester of ethanoic acid; $d =$*

0.90 g/mL; MM = 88). Start by sketching the solution. (a) What is the mole fraction of each component? (b) What is the molality of acetone? (c) What is the weight percent of acetone?

Answers: (a) $X_{\text{acetone}} = 0.57$ and $X_{\text{ethyl acetate}} = 0.43$ (b) 15.1 molal (c) 46%

□ Problem Club Question E. A 40.0-g sample of sodium fluoride, NaF (MM = 42) is dissolved in enough water to make 250-mL. (a) Sketch the solution. (b) Calculate the molarity of NaF. (c) How much of this solution should be used in order to prepare 100.0-mL of a 0.50 M solution? (d) How much water must be added to 100-mL of the original solution (in 'a') in order to form a 0.70 M solution?

Answers: (a) must show volumetric flask (b) 3.81 M (c) 13.1 mL (d) add 444 mL

□ Problem Club Question F. Concentrated HCl is 12 M with a density of 1.18 g/mL. (a) Sketch and label the solution. Convert this to units of (b) molality and (c) mole fraction of HCl

Answers: (a) use volumetric flask (b) 16.2 molal (c) 0.225

□ Problem Club Question G. (ACS- Style) Answer: A

□ Problem Club Question H. (ACS- Style) Answer: B

□ Read Section 11.4 Some factors affecting solubility.

□ □ Learning Objective 6: Know the factors that have an effect on solubility.

□ □ Learning Objective 7: Use Henry's law to determine the solubility of a gas in a liquid.

□ Do Problems 11 and 12 at the end of the section.

□ Do the following end-of-chapter problems: 68, 70, 72

□ Problem Club Question I. (ACS- Style) Answer: D

□ Problem Club Question J. (ACS- Style) Answer: B

□ Problem Club Question K. (ACS- Style) Answer: D

□ Read Section 11.5. Physical behavior of solutions: Colligative properties and Section 11.6. Vapor pressure lowering of solutions: Raoult's law.

□ □ Learning Objective 8: Determine the vapor pressure of an ideal solution using Raoult's Law.

□ Do Problems 13 – 15 and 16 – 17 at the end of the section.

□ Do the following end-of-chapter problems: 34, 74, 78, 80, 86

□ Problem Club Question L. Calculate (a) the vapor pressure lowering and (b) the vapor pressure in an aqueous solution at 90 °C [$P_{\text{vap}} = 526$ mmHg] if the mole fraction of sucrose is 0.12.

Answers: (a) 63 mmHg (b) 463 mmHg

□ Problem Club Question M. The vapor pressure of pure chloroform at 70.0 °C is 1.34 atm. How much iodine, I_2 [MM = 254] should be dissolved in 1.0-L of $CHCl_3$ [$d = 1.49$ g/cm³; MM = 119.5] to lower the vapor pressure by 100 mmHg?

Answer: 344 g

□ Problem Club Question N. (ACS- Style) Answer: C

□ Read Section 11.7. Boiling point elevation and freezing point depression of solutions.

□ □ Learning Objective 9: Be able to determine the boiling or freezing point of a solution.

□ □ Learning Objective 10: Given the boiling or freezing point, be able to determine the molality of the solution.

□ Do Problems 18 – 22 at the end of the section.

□ Do the following end-of-chapter problems: 76, 82, 84, 90, 92

□ *Problem Club Question O. Calculate the freezing point and boiling point of a solution prepared by dissolving 25.0-g of propylene glycol, $C_3H_8O_2$ in 250 mL water [$d = 1.00 \text{ g/mL}$; $k_f = 1.86 \text{ deg/molal}$; $k_b = 0.52 \text{ deg/molal}$].*

Answers: freezing point = $-2.45 \text{ }^\circ\text{C}$ and normal boiling point = $100.68 \text{ }^\circ\text{C}$

□ *Problem Club Question P. How many grams of citric acid, $C_6H_8O_7$ [$MM = 126$], a non-electrolyte, would have to be added to 100.0-mL water to give a solution freezing at $-1.50 \text{ }^\circ\text{C}$? [$k_f = 1.86 \text{ deg/molal}$]*

Answer: 10.1 g

□ *Problem Club Question Q. When 20.25 g of lactic acid, $C_3H_6O_3$ [$MM = 90$] are dissolved in 250-mL acetone [$d = 0.791 \text{ g/mL}$] the resulting solution boils at $57.89 \text{ }^\circ\text{C}$. If the boiling point of pure acetone is $55.95 \text{ }^\circ\text{C}$, what is the boiling point constant, k_b for acetone?*

Answer: 1.71 deg/molal

□ *Problem Club Question R. (ACS- Style) Answer: A*

□ *Problem Club Question S. (ACS- Style) Answer: D*

□ *Problem Club Question T. (ACS- Style) Answer: C*

□ *Problem Club Question U. (ACS- Style) Answer: A*

□ *Problem Club Question V. (ACS- Style) Answer: A*

□ Read Section 11.8. Osmosis and osmotic pressure.

□ □ Learning Objective 11: Explain the process called osmosis. Define the terms: i. semipermeable membrane; ii. Isotonic; iii. reverse osmosis; and iv. osmotic pressure

□ □ Learning Objective 12: Given the molarity (or the necessary information to determine it), be able to determine the osmotic pressure of a solution.

□ □ Learning Objective 13: Given the osmotic pressure, be able to determine the molarity of the solution.

□ Do Problems 23 – 24 at the end of the section.

□ Do the following end-of-chapter problems: 94, 96

□ *Problem Club Question W. Calculate the osmotic pressure of an aqueous solution at $25 \text{ }^\circ\text{C}$ containing 50.0-g urea, $CO(NH_2)_2$ [$MM = 60$] per liter of solution*

Answer: 20.4 atm

□ *Problem Club Question X. (ACS- Style) Answer: B*

□ Read Section 11.9. Some uses of colligative properties.

□ □ Learning Objective 14: Given the molality and the boiling or freezing point, be able to determine the molar mass of the solute.

□ Do Problems 25 and 26 at the end of the section.

□ Do the following end-of-chapter problems: 98, 100, 102, 104

□ *Problem Club Question Y. The freezing point of p-dichlorobenzene is 53.1 °C; its k_f value is 7.10 deg/molal. A solution of 1.52-g of sulfanilamide (a sulfa drug) in 10.0-g of p-dichlorobenzene freezes at 46.7 °C. What is the molar mass of sulfanilamide?*

Answer: MM = 169

□ *Problem Club Question Z. (ACS- Style) Answer: D*

□ *Problem Club Question AA. (ACS- Style) Answer: E*

□ *Problem Club Question BB. (ACS- Style) Answer: B*

□ **Read Section 11.10. Fractional distillation of liquid mixtures.**

□ Do Problem 27 at the end of the section.

□ Do the following end-of-chapter problems: 88