Week 10: 30 Oct thru 05 Nov; Lectures 28-30
Learning Objectives

**Electrolytes**

- Know the difference between a molecular compound and an ionic compound
- Know the definition of electrolyte.
- Know the difference between strong, weak and non-electrolytes.
- Be able to identify acids, bases, and salts.
- (Memorize the 7 strong acids and the 7 strong bases.)
- Be able to identify electrolytes and whether they are strong or weak.
- Be able to write the process that occurs when an electrolyte dissolves in solution.
- Be able to calculate the concentration if ions present when a strong electrolyte dissolves

**Concentration Dilution**

- Know the definition of molarity (M) and how to determine the concentration of a solution.
- Be able to determine the concentration of species after dilution.
- Be able to determine concentration of species in solution when two solutions are mixed.

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**Concentration and Dilution Problem Solving Technique**

**STEP 1** Write out the chemical process (what is happening on the atomic scale?)

**STEP 2** Draw pictures (what is happening on the macroscopic level?)

Organize information given in the problem. (Put this information directly under the pictures but be sure it is clear what M refers to, i.e., is M the concentration of salt? Or the concentration of one of the ions?)

**STEP 3** Solve for unknowns by using $M_1V_1 = M_2V_2$ or other relationships

**STEP 4** What are you asked for? The process outlined in step 2 will help you clarify what you want to know. Use the stoichiometry of the chemical process (step 1) or $MV = \text{moles}$ to obtain desired answer.

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- Know the definitions of the following concentration terms.
- Be able to convert between different concentration units.
  - Strategy: write definitions of both concentration units: the one given, the one you want to convert to.
  - Work forward or backward to find the numerator and denominator of the new concentration units.
  - Notice: you won’t necessarily need all information given. Indicate the extra information.

\[
\text{mass fraction} = \frac{\text{mass of component } i}{\text{total mass}}
\]

weight \% = mass fraction $\times 100\%$

\[
\text{mole fraction} = X_i = \frac{\text{moles of component } i}{\text{total moles}}
\]

parts per million = ppm = $X_i$ or mass fraction $\times 10^6$

parts per billion = ppb = $X_i$ or mass fraction $\times 10^9$

parts per trillion = ppt = $X_i$ or mass fraction $\times 10^{12}$

\[
\text{molarity} = M = \frac{\text{moles of solute}}{L \text{ of solution}}
\]

\[
\text{molality} = m = \frac{\text{moles of solute}}{\text{mass (kg) of solvent}}
\]
Flow Chart to Identify Electrolytes

Water soluble Compound

molecular

Is it an acid?

Yes

Is it a strong acid?

Yes

Strong Electrolyte

no

weak electrolyte

No

Is it a molecular base? (eg. NH₃)

yes

weak electrolyte

no

Strong electrolyte

non electrolyte
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Homework Problems
Due by Thurs. Nov. 7

1A. When a solution forms, what interactions between particles are involved? Which are exothermic? Which are endothermic?

1B. An ionic salt is dissolved in water. The temperature of the solution increases. Draw an energy diagram taking into account the interaction between the ions in the salt, the interactions between water molecules and the water-salt interactions.

2. What is the difference between an electrolyte and a non-electrolyte? (Provide examples.)

Classify each of the following as a strong or weak electrolyte or non-electrolyte:

**NaBr, C₆H₁₂O₆, NH₃, H₃PO₄, NaOH** (use the flow chart on page 82 if needed)

3. Which of the following are weak electrolytes?

   1. CH₃COOH (HC₂H₃O₂)
   2. CH₃COONa
   3. C₆H₁₂O₁₁ (table sugar)
   4. NaClO₄

   A. 1 and 2 are weak electrolytes
   B. 1 and 3 are weak electrolytes
   C. 1, 2 and 3 are weak electrolytes
   D. 4 is the only weak electrolyte
   E. 1 is the only weak electrolyte

4A. What ions and/or molecules are present in relatively large proportions in a solution of a weak acid HClO (aq)?

4B. What ions and/or molecules are present in relatively large proportions in a solution of a strong base Ba(OH)₂ (aq)?

5. Which of the following aqueous solutions would you expect to be the best conductor of electric current?

   A. 1.0 M sugar (C₆H₁₂O₆)
   B. 1.0 M CaCl₂
   C. 1.0 M ethanol (C₂H₅OH)
   D. 1.0 M acetic acid (HC₂H₃O₂)
   E. 1.0 M NH₄OH

6A. What is molality? What is molarity?

6B. The figure to the right shows two volumetric flasks containing the same solution at two temperatures. When going from 25 °C to 65 °C what does NOT change?

   i. molarity of the solution
   ii. density of solution
   iii. molality of solution
   iv. mole fraction of solute

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7. How much 0.154 M NaCl, “physiological saline,” can be prepared by dilution of 100 mL of a 6.0 M NaCl solution?
   A. 1.1 L  
   B. 910 mL  
   C. 90 mL  
   D. 540 mL  
   E. 3.9 L

8. How many milliliters of a 132.00 mL solution of 1.98 M AlCl₃ must be used to make 162.00 mL of a solution that has a concentration of 0.630 M Cl⁻(aq)?
   A. 1.61 mL  
   B. 7.73 mL  
   C. 17.2 mL  
   D. 41.5 mL  
   E. 51.5 mL

9. A 24.00 mL sample of a solution of Pb(ClO₃)₂ was diluted with water to 52.00 mL. A 17.00 mL sample of the dilute solution was found to contain 0.220 M ClO₃⁻(aq). What was the concentration of Pb(ClO₃)₂ in the original undiluted solution?
   A. $3.60 \times 10^{-2}$ M  
   B. $7.19 \times 10^{-2}$ M  
   C. 0.238 M  
   D. 0.156 M  
   E. 0.477 M

10. The mole fraction of CO₂ in a certain solution with H₂O as the solvent is $3.6 \times 10^{-4}$. What is the approximate molality of CO₂ in this solution?
    A. 0.00036 m  
    B. 0.0065 m  
    C. 0.020 m  
    D. $2.0 \times 10^{-5}$ m  
    E. 6.5 m

11. 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.

12. What is the mole fraction of HCl in a 36% by weight aqueous solution of HCl?
    A. 0.11  
    B. 0.22  
    C. 0.36  
    D. 0.64  
    E. 0.99

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

14. 27.0 L of HCl gas at STP is dissolved in water, giving 785 mL of solution. What is the molarity of the HCl solution?
    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.
Recitation Worksheet

Electrolytes

1. In which of the pairs listed below are both compounds strong electrolytes?
   Are any strong acids or bases? Are there any non electrolytes?

   I. CH₃COOH and HClO₄
   II. HF and NH₃
   III. NaCl and Sr(OH)₂
   IV. HCl and C₆H₁₃OH

Concentration Dilution

2. A 30.00 mL sample of Mg(NO₃)₂ was diluted with water to 60.00 mL. A 20.00 mL sample of the dilute solution contained 0.300 M NO₃⁻ (aq). What was the concentration of Mg(NO₃)₂ in the original, undiluted solution?

3A. What is the concentration of hydroxide ions after 50 mL of 0.25 M NaOH is added to 120 mL of 0.20 M Na₂SO₄?

3B. What is the concentration of hydroxide ions after 50 mL of 0.25 M NaOH is added to 120 mL of 0.20 M Sr(OH)₂?

3C. What is the concentration of sodium ions after 50 mL of 0.25 M Na₂SO₄ is added to 120 mL of 0.20 NaOH M?

4. The mole fraction of carbon dioxide (Xₐₙ₉) in water is 0.25. Determine the molality and molarity of CO₂. (Assume the density of the solution is 1g/mL)

5. The mole fraction of CuCl₂ in a certain solution with H₂O as the solvent is 1.74 × 10⁻³. What is the molality of CuCl₂ in this solution? What is the molality of chloride ions?

6. A solution is prepared by dissolving 15.0 g of NH₃ in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. What is the mole fraction of NH₃ in the solution?

7. A solution contains 15 ppm (by mass) of benzene. The density of the solution is 1.00 g/mL. Which statement is true?
   A. There are 15 mg of benzene in 1.0 g of this solution.
   B. 100 g of the solution contains 15 g of benzene.
   C. 1.0 g of the solution contains 15 × 10⁻⁶ g of benzene.
   D. 1.0 L of the solution contains 15 g of benzene.
   E. The solution is 15% by mass of benzene.
8. Using the figure below, calculate the minimum mass of potassium nitrate required to form a saturated solution in 250 g of water at 20°C?