Lecture 28: Solutions 2

*Read:* BLB 4.1, 4.5; 13.4

*HW:* BLB 4:3, 15, 37, 61, 72, 73; 13:39, 47
Sup 4:1–3; 13:8–11

*Know:*
  - solutions
  - concentrations

*Need help?? Get help!!* TAs in CRC (211 Whitmore) and SI—hours on Chem 110 website; my office hours (Mon 12:30–2 & Tues 10:30–12 in 324 Chem Bldg [or 326 Chem])

Bonus deadline for BST #8: Intermolecular forces, March 26
Bonus deadline for BST #9: Solutions & dilutions, April 2

Check out the grade-u-lator @
http://courses.chem.psu.edu/chem110/spring/grade.htm

*Exam #3:* Monday, April 6 @ 6:30 pm; Sign up for the conflict exam, if needed. Last day to sign up is Wed, April 1

*Late drop deadline:* Friday, April 10 @ 11:59 pm via elion
Expressing concentration

- **weight %** = \( \frac{\text{mass of component}}{\text{total mass}} \times 100 \)  
  \((\& \text{ ppm, ppb})\)

- \(X_a\) = mole fraction = \( \frac{\text{moles of component}}{\text{total moles}} \)

- \(M = \text{molarity} = \frac{\text{moles of solute}}{\text{liters of solution}}\)

- \(m = \text{molality} = \frac{\text{moles of solute}}{\text{mass (kg) of solvent}}\)

- \(pH = – \log [H^+]\)
Example:
A solution containing equal masses of glycerol (C$_3$H$_8$O$_3$) and water has a density of 1.10 g/mL. Calculate **A** the weight percent of glycerol; **B** the molality of glycerol; **C** the mole fraction of glycerol; and **D** the molarity of glycerol in the solution.
Example:
What is the final concentration of Na$^+$ if 40.0 mL of 0.13 M sodium chloride is mixed with 40.0 mL of 0.13 M sodium carbonate?
Example:
Concentrated nitric acid is 71% by mass. (a) What is the molarity of this solution? (b) What is the mole fraction of nitric acid in this solution? The density is 1.42 g/mL.
Electrolytes

• a substance that yields ions when dissolved in water; solution will conduct electricity

• strong electrolytes – ionic or molecular compounds that ionize in solution
  \[ \text{NaCl}(s) + \text{H}_2\text{O} \rightarrow \text{Na}^+(aq) + \text{Cl}^-(aq) + \text{H}_2\text{O} \]
  \[ \text{HCl}(aq) + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq) \]

• weak electrolytes – molecular compounds that are ionized in solution (in equilibrium—more later on in semester)
  \[ \text{NH}_3(aq) + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+(aq) + \text{OH}^-(aq) \]
  \[ \text{CH}_3\text{COOH}(aq)+\text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^-(aq)+\text{H}_3\text{O}^+(aq) \]

• nonelectrolytes – molecular compounds that do not ionize in solution
  \[ \text{C}_6\text{H}_{12}\text{O}_6(s)+\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(aq)+\text{H}_2\text{O} \]
  (glucose)
Flowchart for identifying electrolytes

- **note:** ionic compounds are strong electrolytes but they could be insoluble(!!!)

- **memorize strong acids & bases** (BLB Table 4.2); If a compound is an acid or a base, but NOT one of the strong acids or bases, then it MUST be a weak electrolyte

- **Common misconception:** electrolytes are ionic compounds: this is NOT TRUE (e.g., HCl)
Memorize these strong acids (& bases)

<table>
<thead>
<tr>
<th>Strong Acids</th>
<th>Strong Bases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric, HCl</td>
<td>Group 1A metal hydroxides (LiOH, NaOH, KOH, RbOH, CsOH)</td>
</tr>
<tr>
<td>Hydrobromic, HBr</td>
<td>Heavy group 2A metal hydroxides [Ca(OH)$_2$, Sr(OH)$_2$, Ba(OH)$_2$]</td>
</tr>
<tr>
<td>Hydroiodic, HI</td>
<td></td>
</tr>
<tr>
<td>Chloric, HClO$_3$</td>
<td></td>
</tr>
<tr>
<td>Perchloric, HClO$_4$</td>
<td></td>
</tr>
<tr>
<td>Nitric, HNO$_3$</td>
<td></td>
</tr>
<tr>
<td>Sulfuric, H$_2$SO$_4$</td>
<td></td>
</tr>
</tbody>
</table>

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Electrolytes (con’t.)

• strong or weak electrolytes are **NOT** determined by *how much* of a compound goes into solution

• rather, strong or weak electrolytes **ARE** determined by *what the compound does* once it is in solution!

**examples:**

CH$_3$COOH: very soluble in water **but weak electrolyte** (partially ionizes)

Ba(OH)$_2$: very slightly soluble in water **but strong electrolyte** (completely ionizes) once it gets into solution
Examples of water soluble compounds

Are these strong, weak or non-electrolytes in aqueous solution?

HCl

NaCl

CH₃OH

CH₃COOH (acetic acid)

NH₃

Fe(NO₃)₂

CuSO₄

Ca(OH)₂
Examples:
What species are present upon dissolving each of the following substances in water.

MgI₂

HOCH₂CH₂OH

Al(NO₃)₃

NH₄Cl

The correct formula for ammonium carbonate is ________.

A. (NH₄)₂CO₃
B. NH₄CO₂
C. (NH₃)₂CO₄
D. NH₄CO₃
E. N₂(CO₃)₃
Before next class:

**Read:** BLB 4.1, 4.5; 13.4

**HW:** BLB 4:3, 15, 37, 61, 72, 73; 13:39, 47
Sup 4:1–3; 13:8–11

**Know:**
- electrolytes
- solutions

**Answers:**
- p. 3: (A) 50.0 weight %; (B) 10.9 \( m \); (C) \( X_{\text{C}_3\text{H}_8\text{O}_3} = 0.164 \); (D) 5.98 M
- p. 4: 0.195 M
- p. 5: (a) 16.0 M; (b) 0.412
- p. 11: (bottom): A