Winter 2012 Chem 1B Discussion Worksheet  
*Chapter 12: Physical Properties of Solutions*

The assignments are from: *Chemistry* by Raymond Chang; McGraw Hill Higher Education, 10th Edition, 2010

**Goals**
- Understand the difference between a solution and a heterogeneous mixture of compounds
- Understand how intermolecular forces between different compounds affect their mutual solubility and miscibility
- Know typical concentration units and be able to interconvert them
- Understand the effect of temperature and pressure on solubilities
- Understand the difference between colligative and solute-specific properties of solutions
- Understand that atmospheric chemistry is the most important science

(for your convenience, copies of the problems are provided on the next page if you do not have your book with you)

*If you have no time to solve all of the, do only the underlined ones*

**Concentration Units**
*Problems: 12.20, 12.22, 12.27, 12.117, 12.129*

**Gas solubility**
*Problems: 12.34, 12.38, 12.112*

**Colligative properties**
*Problems: 12.53, 12.64, 12.71, 12.74, 12.107,*
12.20 For dilute aqueous solutions in which the density of
the solution is roughly equal to that of the pure solv-
ent, the molarity of the solution is equal to its
molality. Show that this statement is correct for a
0.010 \( M \) aqueous urea (\( \text{NH}_2\text{C}_2\text{O} \)) solution.

12.22 The concentrated sulfuric acid we use in the labora-
tory is 98.0 percent \( \text{H}_2\text{SO}_4 \) by mass. Calculate the
molality and molarity of the acid solution. The den-
sity of the solution is 1.83 g/mL.

12.27 A 3.20-g sample of a salt dissolves in 9.10 g of water
to give a saturated solution at 25°C. What is the solu-
bility (in g salt/100 g of \( \text{H}_2\text{O} \)) of the salt?

12.34 A man bought a goldfish in a pet shop. Upon returning
home, he put the goldfish in a bowl of recently
boiled water that had been cooled quickly. A few
minutes later the fish was found dead. Explain what
happened to the fish.

12.38 The solubility of \( \text{N}_2 \) in blood at 37°C and at a partial
pressure of 0.80 atm is 5.6 \times 10^{-4} \text{ mol/L}. A deep-
sea diver breathes compressed air with the partial
pressure of \( \text{N}_2 \) equal to 4.0 atm. Assume that the total
volume of blood in the body is 5.0 L. Calculate the
amount of \( \text{N}_2 \) gas released (in liters at 37°C and
1 atm) when the diver returns to the surface of the
water, where the partial pressure of \( \text{N}_2 \) is 0.80 atm.

12.53 The vapor pressure of ethanol (\( \text{C}_2\text{H}_5\text{OH} \)) at 20°C is
44 mmHg, and the vapor pressure of methanol
(\( \text{CH}_3\text{OH} \)) at the same temperature is 94 mmHg. A
mixture of 30.0 g of methanol and 45.0 g of ethanol
is prepared (and can be assumed to behave as an
ideal solution). (a) Calculate the vapor pressure of
methanol and ethanol above this solution at 20°C.
(b) Calculate the molar fraction of methanol and eth-
anol in the vapor above this solution at 20°C. (c) Sugges-
t a method for separating the two components of
the solution.

12.64 A solution containing 0.8330 g of a polymer of
unknown structure in 170.0 mL of an organic solv-
ent was found to have an osmotic pressure of
5.20 mmHg at 25°C. Determine the molar mass of
the polymer.

12.74 At 25°C the vapor pressure of pure water is
23.76 mmHg and that of seawater is 22.98 mmHg.
Assuming that seawater contains only \( \text{NaCl} \), esti-
mate its molal concentration.

12.107 A solution contains two volatile liquids A and B.
Complete the following table, in which the symbol
\( \leftrightarrow \) indicates attractive intermolecular forces.

<table>
<thead>
<tr>
<th>Attractive Forces</th>
<th>Deviation from Raoult’s Law</th>
<th>( \Delta H_{\text{soln}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ( \leftrightarrow ) B, B ( \leftrightarrow ) B &gt;</td>
<td>Negative</td>
<td>Zero</td>
</tr>
<tr>
<td>A ( \leftrightarrow ) B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12.112 Ammonia (\( \text{NH}_3 \)) is very soluble in water, but nitro-
gen trichloride (\( \text{NCl}_3 \)) is not. Explain.

12.117 A 2.6-L sample of water contains 192 \( \mu \text{g} \) of lead.
Does this concentration of lead exceed the safety limit
of 0.050 ppm of lead per liter of drinking water? [\text{Hint:}
1 \( \mu \text{g} = 1 \times 10^{-6} \text{ g}. Parts per million (ppm) is defined
as (mass of component/mass of solution) \times 10^6.]

12.129 (a) Derive the equation relating the molality (\( M \)) of a
solution to its molarity (\( \mathcal{M} \)).

\[
\frac{m}{d} = \frac{M \mathcal{M}}{1000}
\]

where \( d \) is the density of the solution (g/mL) and \( \mathcal{M} \)
is the molar mass of the solute (g/mol). [\text{Hint: Start
by expressing the solvent in kilograms in terms of
the difference between the mass of the solution and
the mass of the solute.}] (b) Show that, for dilute
aqueous solutions, \( m \) is approximately equal to \( M \).