Chemistry 116

Dr. Michelle Richards-Babb
"Dr. Babb"

Tasks for first week of class:

- Read syllabus.
- Purchase lab goggles, lab apron, and Chem 116 Lab Manual from WVU Bookstore or Book Exchange. NOTE: White lab aprons sold at Book Exchange are not suitable for chemistry laboratory.
- Complete as lab homework Appendices A and B in the Chem 116 Lab Manual. This homework is due at the beginning of your first lab, ***Wed. Aug. 31. Be sure to show all work. Include units and correct number of significant figures. For net ionic equations, show all intermediate work (balanced molecular, full ionic, and net ionic equations).***
- Check out Dr. Babb's Chem 116 website at http://www.as.wvu.edu/~mbabb. This site contains:
  - handouts, back tests, grades, answer keys, lecture notes, etc.
- Register for the online homework at http://www.masteringgenchem.com
  - Course ID: MCBABB57862 for Chem 116-001 (1 PM lecture)
  - Course ID: MCBABB70035 for Chem 116-003 (8:30 AM lecture)
- Begin the first ***Graded Online Homework*** assignment (116-Review) which is due ***Thursday Aug. 25 at 11:59 PM*** (late Thursday night).
- Begin working *Other Homework* as specified on the Homework Sheet.
- Attend the review sessions (net ionic equations, electrolytes, etc.) on ***Wed. Aug. 24***
  - *For Chem 116-004 lab at 8:30-9:20 AM in 126 Ming Hseih Hall*
  - *For Chem 116-002 lab at 12:30-1:20 PM in 208 Clark Hall*

Chapter 11

Solutions

Mixtures

Mixture – combination of two or more substances
– no chemical reaction occurs upon mixing
–heterogeneous (e.g. suspensions: blood or paint) or homogeneous

Homogeneous mixture – uniform mixture
– composition/properties are same throughout the sample
– *Types: colloids and solutions*

Homogeneous Mixtures
Colloid –
–
–
– Ex. milk, fog, mayonaisse, butter, cream, smoke, smog

Solution –
–
–
– Ex. seawater, tea, coffee

There are many different kinds of solutions….

Phase of Solute	Phase of Solvent	Appearance of Solution	Example
			O_2 in air
Liquid in	Gas	Gas	
			CO_2 in water (soda)
Liquid in	Liquid	Liquid	
			salt in water (seawater)
Liquid in	Solid	Solid	
			metal alloys e.g. brass (Zn/Cu) 14 kt Gold (Au/Ag)
Solid in	Gas	Gas	

What is the driving force for solution formation?

_____

_____

_____

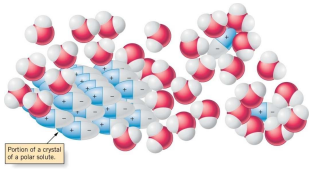
Solubility

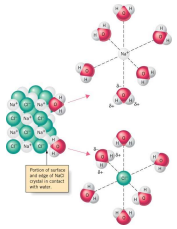
Solvent: water is the most common in general chemistry

Solute: What types of solutes will dissolve in water?

Answer:

General Rule of Thumb: _____





Example

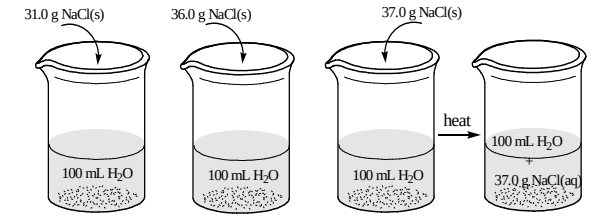
Which of the following would be more soluble in hexane (C_6H_{14}) than in water?

C_8H_{18} CH_3OH $CaBr_2$ Wax ($C_{20}H_{42}$)

NH_3 HCl C_6H_6 $HC_2H_3O_2$

Solubility

Solubility of NaCl = 36.0g/100 mL at 20 ºC.
A maximum of 36.0 g NaCl will dissolve per 100 mL of water at 20 ºC.



In each case: 1) How much NaCl dissolves? and 2) What type of solution results?

The CONCENTRATION of a solution relates to the proportion of solute to solvent!!

Solution Composition/Concentration

Solute: minor component
Solvent: major component
Solution: resulting mixture of solute and solvent

There are many different solution concentration units, which all provide same basic information…

We will discuss …….. A. Molarity
B. Weight/Mass Percent (Wt %), ppm, ppb
C. Mole Fraction
D. Molality

Molarity

Molarity tells you how many *moles of solute* are present in every *liter of solution* (solute-to-solution).

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{L solution}} = \text{M (Molar)}$$

Ex. 0.15 M KCl implies what?

Is molarity temperature dependent?

Weight/Mass Percent (Wt %)

1. The ***weight/mass %***, or % (w/w), tells you how many grams of solute are present per 100 grams of the solution (solute-to-solution).

$$\text{Weight Percent (w/w)} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\,\%$$

Ex. 2.5% K_2SO_4 implies what?

2. Related concentration Units:
   A. Parts per million, ppm (grams solute per 10^6 grams solution).

Ex. 2.5 ppm Ca^{+2} implies what?

   B. Parts per billion, ppb (grams solute per 10^9 grams solution).

Are weight percentages temperature dependent?

Mole Fraction

$$\text{Mole Fraction} = X = \frac{\text{moles component}}{\text{total molesof solution}} = \frac{n_{component}}{n_{total}} = \frac{n_i}{n_T}$$

Solute: $X_{solute} =$

Solvent: $X_{solvent} =$

$X_{solute} + X_{solvent} =$ _____

Are mole fractions temperature dependent?

Molality

Molality tells you how many *moles of solute* are present in every *kilogram of solvent* (solute-to-solvent).

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kg of solvent}} = \text{m (molal)}$$

$$\text{Ex. } 0.43\,\text{m } MgSO_4 = \frac{0.43\,\text{mol } MgSO_4}{1\,\text{kg water}}$$

Is molality temperature dependent?

Sample Questions

1. What is the mole fraction, molality, and molarity of a solution made by dissolving 20.0 g calcium chloride in 500. g of water?

2. A solution is 5.0 m NaCl. What is the mole fraction of NaCl and water in this solution?

3. A glycerol ($C_3H_8O_3$)-water solution is 40.0% glycerol and has a density of 1.101 g/mL. Calculate the molality, molarity, and mole fraction of glycerol in this solution.

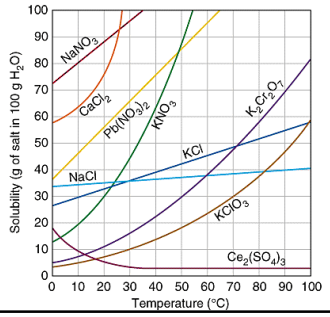
4. A 0.944 M solution of glucose, $C_6H_{12}O_6$ in water has a density of 1.0624 g/ml at 20 ºC. What is the molality of this solution?

5. A sample of hard water has 1.5 g Ca^{+2} in every 500. mL of water. Calculate the molarity, molality, and ppm Ca^{+2} in this sample.

Solubility of Solids in Liquid

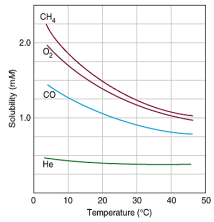
Effect of Pressure: Pressure has **NO** effect on the solubility of solid solutes in liquid solvents.
Why?

Effect of Temperature: Variable, but can be thought to depend somewhat on the sign for the ΔH for the dissolution process. Consider: $CuSO_4(s)$ w/ ΔH_{diss}=+ and $SrSO_4(s)$ w/ΔH_{diss}= -.

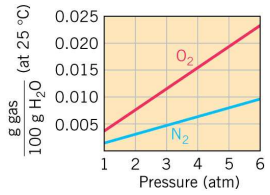


Solubility of Gases in Liquids

Effect of Temperature:
Solubility decreases with increase in temperature.
Why?



Effect of Pressure:
Solubility increases with increase in pressure.
Why?



Pressure and the Solubility of Gases

HENRY'S LAW

$$S_{gas} = k_H P_{gas}$$

Sample Questions

1. The Henry's-law constant of methyl bromide (CH_3Br), a gas used as a soil fumigating agent, is k = 0.159 mol/L-atm at 25 °C. What is the solubility (in mol/L) of methyl bromide in water at 25 °C and a partial pressure of 125 mm Hg? (0.0261 M)

2. 54 g of gaseous acetylene will dissolve in 1.0 L of liquid acetone at a partial pressure of 1520 torr. What is the Henry's Law constant for acetylene? What is the solubility of acetylene at 12 atm?