Announcements

Monday, May 04, 2009

Exam 3 answer key will be posted in D2L tomorrow. See the key for explanations on the questions that were not graded.

Discussion assignment 2 phase 3 post due this Friday, May 8, at noon. Replies due before final exam.

Lecture 11 post MC assignment will be up tomorrow morning, due before class next Monday.

Extra credit labs: experiments 11 and 12 in your packet. Do them at home and bring the completed worksheets to the final exam. They are worth up to 5 extra credit points each.

Comprehensive final exam is next Monday, May 11 from 6:00 pm to 8:00 pm. The exam is 50 3-point multiple choice questions. (150 points total).

You are allowed **one handwritten 3x5" note card** (both sides) for the final exam.

Review session Monday, May 11 at 3pm.
This Wednesday?

Solution = a homogeneous mixture

In order for a solution to form, dissolving must occur.

$NaCl(s) + H_2O(l) \xrightarrow{stir}$ NaCl(aq) saltwater

solution

Components of a solution:

- **Solvent:** major component of mixture (the (l) if dissolving a (s))
- **Solute:** (or solutes) other dissolved substances

In NaCl(*aq*), H_2O = solvent
NaCl = solute

One of the **fluid phases** (ℓ) or (g) must be present in order for a solution to form.

Soluble (*s*) + (*l*) solvent → (l) solution. (aq) if H_2O is solvent

(*l*) + (*l*) → (l) solution if liquids are miscible

(*g*) + (*l*) solvent → (l) solution

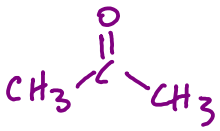
(*g*) + (*g*) → (g) solution for all gases!

(*s*) + (*s*) $\xrightarrow{melt}$ (l) soln $\xrightarrow{cool}$ (s) solution

brass: (s) soln of Cu + Zn

Like dissolves like (like polarities)

Recall that polar substances tend to dissolve other polar substances, and nonpolar substances tend to dissolve other nonpolar substances

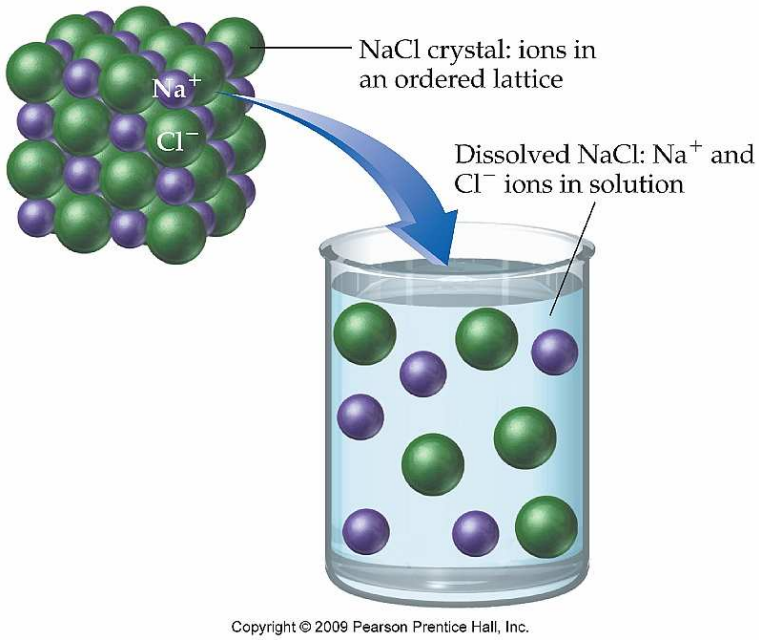
Common Polar Solvents	**Common Nonpolar Solvents**
H_2O	C_6H_{14} hexane
CH_3OH	C_7H_8 toluene
Acetone 	CCl_4 carbon tetrachloride
These tend to dissolve: Polar solutes (AND soluble ionic cpds)	These tend to dissolve: nonpolar solutes

Which solvent, water or hexane, will the following substances be more likely to dissolve in?

- ethanol (CH_3CH_2OH) H_2O both polar
- CBr_4 hexane (nonpolar)
- I_2 hexane
- $CuCl_2$ (ionic) H_2O
- NH_4Cl (NH_4^+ Cl^-) H_2O
- greases, oils, etc. hexane
  nonpolar

Dissolving an ionic compound

When an ionic compound dissolves, its ions **separate**!



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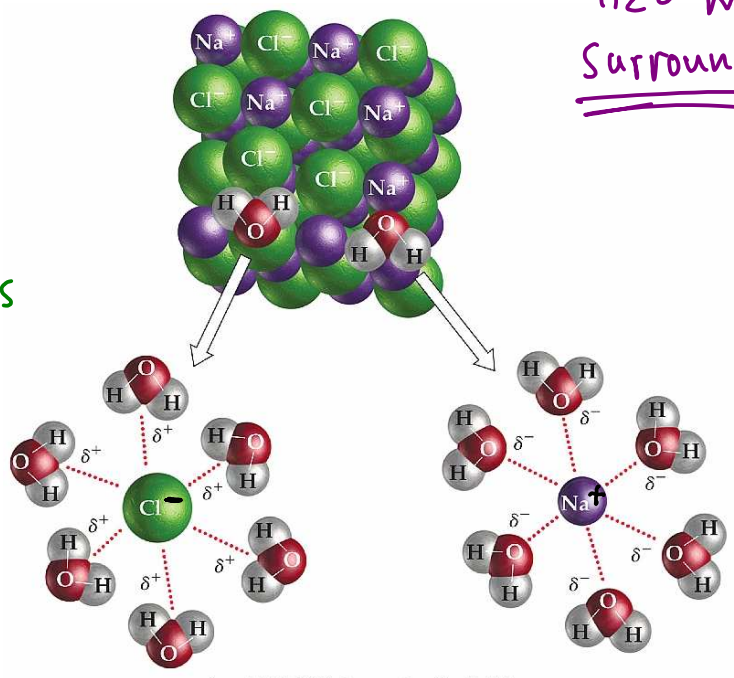
Only polar solvents can surround dissolved ions

H_2O molecules surround ions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(…but only if the ionic compound is **soluble**. Insoluble compounds remain in the ionic lattice)

Saturation

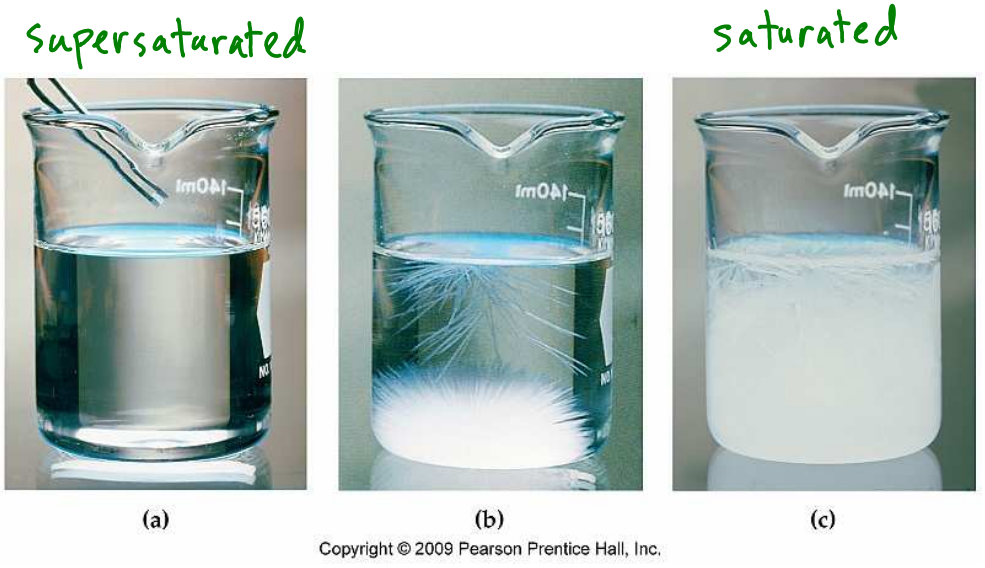
Even soluble compounds have a limit to how much solute will dissolve

Solubility of NaCl: 36 g per 100 mL H_2O

- **Saturated solution**: holds the maximum amount of solute
- **Unsaturated solution**: holds less than the max
- **Supersaturated solution**: temporarily has dissolved **more** than the maximum amount of solute

Examples:

- 15 g salt dissolved in 100 mL H_2O unsat.
- 50 g salt poured into 100 mL H_2O, with undissolved solid on the bottom Saturated
- 38 g salt completely dissolved in 100 mL H_2O supersaturated



Concentration: a measure of how much solute is dissolved in a solution

Mass percent concentration:

$$\text{mass \%} = \frac{\text{mass solute}}{\text{mass solution}} \times 100\%$$

solute + solvent

solute

solvent

12.1 g NaCl are dissolved in 120.1 g H_2O. What is the mass percent concentration?

$$\frac{12.1\text{ g}}{132.2\text{ g solution}} \times 100\% = \boxed{9.15\%}$$

solution

solute

Bleach is a 6.25% NaOCl (sodium hypochlorite) solution in H_2O. What mass NaOCl is in 487 g bleach?

solvent

When you're given a mass %, make a conversion factor out of it! **100 g** solution contains 6.25 g NaOCl.

solute

$$487\text{ g bleach soln} \times \frac{6.25\text{ g NaOCl solute}}{100\text{ g bleach soln}} = \boxed{30.4\text{ g NaOCl}}$$

Vinegar is 5.0% acetic acid in H_2O. How many grams of vinegar will 17.2 g acetic acid make?

$$17.2\text{ g acetic acid} \times \frac{100\text{ g vinegar}}{5.0\text{ g acetic acid}} = \boxed{340\text{ g vinegar}}$$

Molarity (M) = $\frac{\text{moles solute}}{\text{liters solution}} = \frac{\text{mol}}{\text{L}}$

14.2 g NaCl is dissolved in H_2O to make 250. mL solution. What is the molarity of the solution?

$$M = \frac{\text{mol NaCl}}{\text{L soln}} = \frac{0.24298 \text{ mol NaCl}}{0.250 \text{ L}} = \boxed{0.972 \text{ M NaCl}}$$

$$14.2 \text{ g NaCl} \times \frac{1 \text{ mol NaCl}}{58.44 \text{ g NaCl}} = 0.24298 \text{ mol NaCl}$$

$$250 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.250 \text{ L}$$

What mass of NaCl(s) is required to make 250. mL of 3.5 M NaCl(aq) solution?

$$\frac{3.5 \text{ mol NaCl}}{1 \text{ L soln}}$$

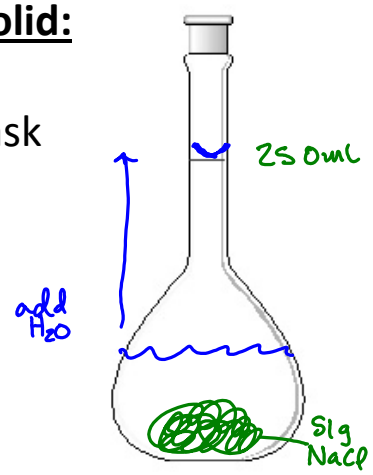
Molarity is a conversion factor between: mol ⟷ L

$$250. \text{ mL soln} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{3.5 \text{ mol NaCl}}{1 \text{ L soln}} \times \frac{58.44 \text{ g NaCl}}{1 \text{ mol NaCl}} =$$

$$= \boxed{51 \text{ g NaCl}}$$

To prepare a solution by dissolving a solid:

1. Measure mass of solid
2. Add to correct size volumetric flask
3. Dissolve the solid in water
4. Add H_2O to line
   to make correct volume of solution



volumetric flask

How do you prepare 1.5 L of a 2.75 *M* $Cu(NO_3)_2(aq)$ solution by dissolving $Cu(NO_3)_2(s)$?

calculate g of $Cu(NO_3)_2$. MM = 187.56 g/mol

$$1.5\text{ L soln} \times \frac{2.75\text{ mol } Cu(NO_3)_2}{1\text{ L soln}} \times \frac{187.56\text{ g } Cu(NO_3)_2}{1\text{ mol } Cu(NO_3)_2} = \boxed{7.7 \times 10^2\text{ g } Cu(NO_3)_2}$$

✯ Dissolve 770 g solute in a 1.5 L volumetric flask then add H_2O to the line.

How many mL of solution will 2.87 g $CaCl_2(s)$ make if the solution is 0.85 *M*? MM $CaCl_2$ = 110.98 g/mol

$$2.87\text{ g } CaCl_2 \times \frac{1\text{ mol } CaCl_2}{110.98\text{ g } CaCl_2} \times \frac{1\text{ L soln}}{0.85\text{ mol } CaCl_2} \times \frac{1000\text{ mL}}{1\text{ L}} = 30.\text{ mL}$$

$$= 3.0 \times 10^1\text{ mL}$$

Dilution: adding solvent to an existing solution

Dilution will decrease the concentration.

The dilution equation: $M_1V_1 = M_2V_2$

M_1 = before dilution; M_2 = after dilution

How do you prepare 500. mL of a 1.5 *M* solution by dilution of a 6.0 *M* stock solution?

have: 6.0 M stock soln (M_1)

want: 500. mL of 1.5 M soln (V_2, M_2)

$$\frac{M_1V_1}{M_1} = \frac{M_2V_2}{M_1}$$

$$V_1 = \frac{(1.5\,M)(500.\,mL)}{(6.0\,M)} = 1.3 \times 10^2\ mL$$

130 mL of stock soln

If 75.0 mL of 12 *M* HCl(*aq*) are diluted to 425 mL, what is the final concentration?

$M_1V_1 = M_2V_2$

solve for M_2

$$M_2 = \frac{M_1V_1}{V_2} = \frac{(12\,M)(75.0\,mL)}{(425\,mL)}$$

$$= 2.1\ M$$