When comparing free energy of pure solvent free energy of solution is always lower.

2. lower VP.

(a) 1.5M $MgCl_2$ aqueous solution. $i = 3$.

0.25 $CaCl_2$ $i = 3$

0.75 KCl $i = 2$

4M sugar $i = 1$

Solution that have greatest colligative = ↓ VP.

Strong acids HCl = $i = 2$.

Poll What will happen if I add more solid salt to a saturated solution?

Saturated = Maxium concentration.

a. More salt will be dissolved

b. The solution wil become less saturated

c. The concentration will stay same. Since solution saturated, can't holds. ions are coming off and ions going on at same rate.

↓ dynamic equilibrium.

d. Need more info.

• Solubility given in practical units.

amount of solute that will dissolve given amount of solvent or solution.

→ Molar Solubility is maxium # Moles of solute that will dissolve in 1L solution at a given temp.

Equilibrium - rate of solute entering solvent = rate on solute entering solvent. rate off = rate on.

Poll How much of the rock dissolved?

A. None of rock dissolved

B. All of rock dissolved

(C) A tiny amount dissolved.

5.) Paper: Density 1.435 $\frac{g\ solute}{mL\ solution}$.

MM 111.07 g/mol $CaCl_2$

Solubility

$$\frac{64.7\ g\ CaCl_2}{164.7\ g\ solution} \left| \frac{1\ mol}{111.07\ g\ CaCl_2} \right| \frac{1.435\ g\ CaCl_2}{1\ mL\ solution} \left| \frac{1000\ mL}{1\ L} \right.$$

↑ Density.

5.1 M NaCl 5.4M do it on your own.

More soluble per mole not per Mass.

6 What is solubility of AgCl?

$AgCl(s) \rightarrow Ag^+(aq) + Cl^-(aq)$

$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10} = [x][x]$

Reaction $AgCl(s) \leftrightarrow Ag(aq) + Cl(aq)$

Initial Some ∅ ∅ zero.

Change $-x \quad +x \quad +x$

Some $-x \quad +x \quad +x$

$x^2 = 1.8 \times 10^{-10}$ $x = \sqrt{1.8 \times 10^{-10}}$ 1.3×10^{-5}

Poll Given a generic formula AX, where A is the cation and X is anion, and molar solubility that has been determined to be $1 \times 10^{-4} M$. Calculate the value of K_{sp}.

$AX_2 \rightarrow A^{2+} + 2X^-$ → $-y \quad +y \quad +2y$

Some ∅ ∅

$K_{sp} = [A^{2+}][X^-][X^-] = (y)(2y)(2y)$

$[A^{2+}][X^-]^2 = (y)(2y)^2 = 4y^3$

(F) $K_{sp} = 4 \times 10^{-12}$.

Which has lowest molar solubility?

If one to one ratio then the one with the biggest -12.25 rather than $2 \times 10^{-12.25}$ 20×10^{30} but its not one-to one ratio and there were 5 so you divide by 5 and get 10^{-6}.

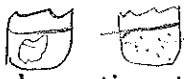
Unit 5 Day 5 Activity – Solubility
CH302 – Spring 2013
Vanden Bout/LaBrake

Name:_____

EID:_____

Today we will practice the skill of THINKING LIKE A CHEMIST while considering the concept of solubility. Platinum stars will be on the line.

Consider the following demonstration, and describe macroscopically.

1. Limestone ($CaCO_3$) is placed in a beaker of water. Salt ($CaCl_2$) is placed in a beaker of water.
   $CaCl_2$ completely dissolved. $CaCO_3$ didn't dissolve as much.
2. Describe the demonstration from a microscopic perspective using words and a picture.
   
   salt dissolved
3. Use chemical equations to model the changes.
   $CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$ ← insoluble by convention is not going 100%.
   $CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2Cl^-(aq)$

Be prepared to explain if called upon in class.

The extent of solubility is given by the "solubility" of soluble solutes. For example, the solubility of $CaCl_2$ at room temperature is listed on Wikipedia as 64.7 g/ 100 g water, whereas the solubility of NaCl is listed as 35.72 g/ 100 g water.

4. Which salt is more soluble $CaCl_2$ or NaCl on a mass percent basis?
   $CaCl_2$.

Molar mass
$CaCl_2$ 111.07 g/mol
NaCl 58.5 g.
Looking for molar solubility.

5. Express both of those solubilities in terms of molar solubilites (express in units of moles per liter of solution). At room temperature, the density of a saturated solution of $CaCl_2$ is 1.435 g/ml and the density of a saturated solution of NaCl is 1.199 g/ml. Which salt is more soluble in terms of molar solubility? $CaCl_2$ $\frac{64.4\text{ g solute}}{164.7\text{ g solution}} \left| \frac{1\text{ mol}}{111.07} \right.$

Moles of solute / Liters of solution.

For insoluble compounds, the extent of solubility is given by something called the ion product, Ksp. The ion product is the product of the molar concentrations of all the ions in the formula unit. The ion product for $CaCO_3$ is $Ksp = [Ca^{2+}][CO_3^{2-}]$. You can write ion products for any salt (soluble or insoluble). The ion product for $CaCl_2$ is

$Ksp = [Ca^{2+}][Cl^{-1}][Cl^{-1}]$ or $Ksp = [Ca^{2+}][Cl^{-1}]^2$

You can determine the molar solubility for a salt if the Ksp value is given. Or, if you know the molar concentrations of at least one ion in the solution, you can calculate the Ksp of the salt! The ion product is an equilibrium condition. That is, the Ksp is a mathematical expression of the concentrations of the ions in solution at the point of saturation.

6. The Ksp value for $CaCO_3$ is 8.7×10^{-9}. Calculate the concentration of the calcium ion at equilibrium using the relationship Ksp = $[Ca^{2+}][CO_3^{2-}]$.

9.3×10^{-5}

7. From the equilibrium concentration of Ca^{2+} ion, determine the molar solubility for $CaCO_3$ remembering the stoichiometric ratio that the calcium ion is in a one to one ratio with the formula unit.

Moles of solute / L of solution

9.3×10^{-5}

8. Just to practice another example – try to calculate the molar solubility of AgCl. The Ksp = 1.8×10^{-10}.

1.3×10^{-5}

Dr. VDB or LaB will now give you a mini lecture on how you can determine which compound is more or less soluble based on the value of Ksp.

To understand the power of the concept of the Ksp, you must be able to understand aqueous chemistry from a chemist's point of view.

9. Watch the demonstration of the precipitation reaction and describe it from a macroscopic point of view.

10. Given that the two solutions were ammonium carbonate and calcium chloride, write the chemical equation that describes the reaction.

11. Draw microscopic view of the reactants and the products.

12. Write out the total ionic equation, which is the shorthand way to model the pictures you have drawn in #11.

13. Write out the net ionic equation, which is how one demonstrates the species that are changing across the reaction. Label in your diagram from #11 those species that did not change with the word "spectator ion".

Be prepared to share your answers with the class if called upon.

14. Practice the skill of writing the formula unit, total ionic and net ionic equations for the reaction of mixing a solution of lead II nitrate with a solution of potassium chromate.