Supporting Conceptual Learning with Online Homework

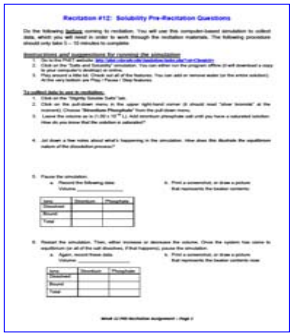
Susan Hendrickson and Laurie Langdon

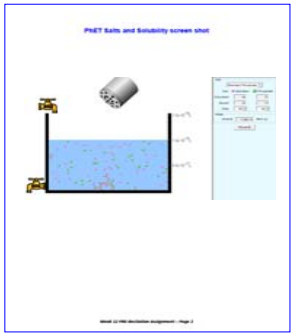
Department of Chemistry

Introduction

During the first two years of the SEI, new recitation materials were developed that emphasized conceptual understanding. More conceptual exam questions were also developed. However, we saw the need to develop homework questions that allow students to practice these ideas. Thus a set of 25 new homework questions (one per week) were written and incorporated into the weekly CHEM 1111 and 1131 WebAssign online homework assignments.

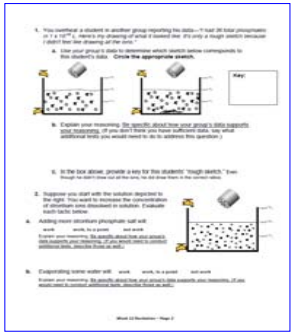
Recitation Materials

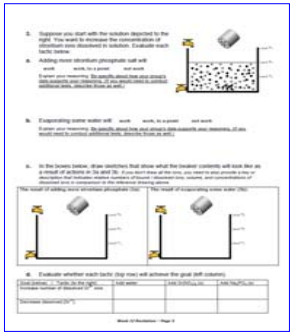

Recitation #12: Solubility Pre-Recitation Questions

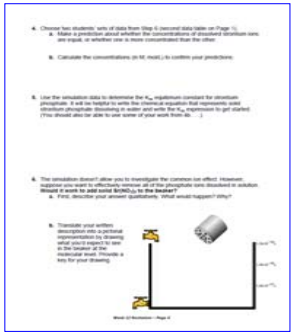

PhET Salts and Solubility screen shot

#12: Solubility equilibria

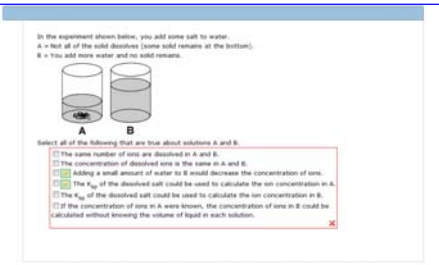
Part I: Using simulation data to explore / defend ideas about solubility







Solubility Equilibrium Homework Question

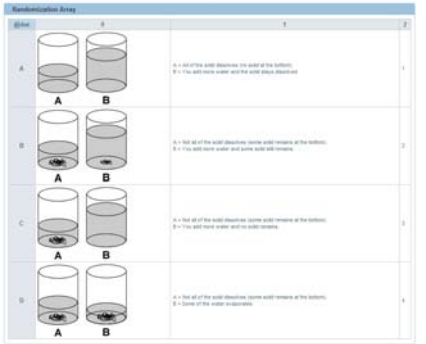

In the experiment shown below, you add some salt to water.
A = Not all of the solid dissolves (some solid remains at the bottom).
B = You add more water and no solid remains.

A B

Select all of the following that are true about solutions A and B.

- The same number of ions are dissolved in A and B.
- The concentration of dissolved ions is the same in A and B.
- Adding a small amount of water to B would decrease the concentration of ions.
- The K_{sp} of the dissolved salt could be used to calculate the ion concentration in A.
- The K_{sp} of the dissolved salt could be used to calculate the ion concentration in B.
- If the concentration of ions in A were known, the concentration of ions in B could be calculated without knowing the volume of liquid in each solution.

Randomization Array for Homework Question


Randomization Array

A B
A B
A B
A B

Some results and comments:

- Created Spring 2008
- Used in four semesters of CHEM 1131 with 1546 students
- Difficulty: only 27% correct on first attempt
- "Multiple select" questions tend to be difficult for students; each statement is a T/F question.

Message Boards for Question 1

(Recitation—solubility equilibrium; names have been changed)

Jack: Apr 6, 06:14 PM
Is the amount of salt at the bottom of each beaker meant to be the same??? Is the water level in A higher than B??? THANKS!

Jill (TA): Apr 6, 06:47 PM
Look at the description above the beakers if the picture isn't clear. The scribble indicates that there is some solid. Whether there is more or less can be inferred from the situation.

Sarah: Apr 8, 04:06 PM
I have the two beakers, the second one with more water and a little less precipitate compared to the first one. I have tried to work on this and can't figure out the correct answers. My biggest problem is if the concentrations are the same in A and B. Any help please?
^^^^Sorry, the concentration of dissolved ions

Claire: Apr 8, 06:26 PM
This one really confused me at first but I finally got it... The question doesn't state that the same amount of salt was put into each beaker, I think we're just supposed to assume that. ☐So, when trying to figure out if the concentrations or # of dissolved ions are the same in both beakers, you just have to look at whether there's solid present in both. If both solutions are saturated, can they have different concentrations of dissolved ions?☐Hope this helps!

Hendrickson, Susan: Apr 8, 09:49 PM
Beaker B is beaker A after more water is added or some water evaporates. So the amount of solid added IS the same because they are the same beaker. ☐☐Sara is correct though, you need to consider what it means when there is solid present in the beaker!

George: Apr 9, 03:34 PM
So if there is a solid present on the bottom of Beaker A and no solid in Beaker B then they do have different concentrations of dissolved ions? So can you use the concentration from A to solve for the concentration of B even if you don't have the amount of liquid available?

Hendrickson, Susan: Apr 9, 08:24 PM
George-☐☐If you are correct that the concentration in A and B are different, then could you solve for the concentration of B without knowing the volumes? Isn't this a dilution? And isn't the dilution equation $M_1V_1 = M_2V_2$?

Assessment Questions

Concept Survey:

15. You add enough table salt (NaCl) to a glass of water so that some undissolved solid remains at the bottom. You leave the glass on the counter for a week, and some of the water evaporates.

Day 1 → ? Day 8

Which statement best describes the contents of the glass on **Day 8**?

a. More solid will be at the bottom.
b. There will be fewer Na^+ ions dissolved in the water.
c. The concentration of salt dissolved in the water will be greater than on Day 1.
d. Statements (a) and (b) are both true.
e. Statements (a) and (c) are both true.

Answer: D (41.4% pre; 62.8% post)

Exam 3:

5. In the experiment shown below, the same amount of CuCl(s) was added to two different amounts of water as shown. Which of the following statements is true about the system shown below?

A B

A) The $[Cu^+]$ in beaker A must equal $[Cu^+]$ in beaker B.
B) The number of Cu^+ ions dissolved in beaker A equals the number of Cu^+ ions dissolved in beaker B.
C) Both flasks are saturated.
D) If solid CuCl is added to flask B, the $[Cu^+]$ would increase. (83.1%)
E) If additional solid CuCl is added to flask A, the number of Cu^+ ions dissolved would increase.

Final Exam:

41. The solid MX_2 is slightly soluble in water. Which of the following is **TRUE** about the relationship between the reaction quotient (Q) and the solubility product constant (K_{sp})?

A) If $Q > K_{sp}$, then MX_2 solid will not be formed.
B) If $Q < K_{sp}$, then MX_2 solid will not be formed. (68.3%)
C) If $Q = K_{sp}$, then MX_2 solid will not be formed.
D) Since MX_2 is slightly soluble, MX_2 solid is always formed, no matter what the relationship between Q and K_{sp}.

43. A salt (MX) was added to a beaker of water and some of the solid did not dissolve. If you add more MX solid to the beaker, which of the following happens?

A) The number of dissolved ions increases.
B) The number of bound ions increases. (90.3%)
C) The concentration of dissolved ions increases.
D) A, B and C are true.