Experiment 15; Variation of Solubility with Temperature and Solvent

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Chemistry 122

2/6/2012

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Purpose: To determine the solubility of a substance as a function of temperature and to compare solubilities in different solvents.


Report Sheet: See attached report sheet

Sample Calculations: See attached sheet

Graphs: See attached graph
Report Questions:

2. Is your solute more soluble in the water/dioxane mixed solvent or in pure water at a given temperature? Explain the relative solubilities you observed in terms of intermolecular forces.

The solute potassium dichromate was more soluble in pure water than water/dioxane at a given temperature. In terms of intermolecular forces, the observed solubilities were due to the fact the water and solute are both polar.

3. For barium nitrate, $Ba(NO_3)_2$, the solubility in water is 8.7 g per 100 mL at 20 degC and 34.2 g per 100 mL at 100 degC. Write the equation for the solubility equilibrium, including heat as a reactant or product. What is the sign of $\Delta H_{soln}$?

$$Ba(NO_3)_2 + H_2O + Heat \leftrightarrow Ba^{2+} + 2NO_3^- \text{ and } \Delta H \text{ is positive.}$$

5. For MgSO4 dissolving in water, $\Delta H_{soln}$ is -91.2 kJ/mol. Write an equation that represents the solubility equilibrium for MgSO4 dissolving in water

$$MgSO_4(s) + H_2O(l) \leftrightarrow Mg^{2+}(aq) + SO_4^{2-}(aq) + heat. \text{ deltaH is negative therefore the reaction is exothermic and solubility decreases proportionately as the temperature increases.}$$

Conclusion:

The purpose of the experiment was to determine the solubility of a substance in relation to the temperature and solvent used. Using the solubility apparatus, a specific amount of the assigned compound was placed inside and mixed with a solvent. In two of the three parts of the experiment, the solvent was distilled water, in the third case the solvent was 70:30 water:dioxane solution. Different amounts of solvent were pipetted into the apparatus and the solution was then heated until all the compound dissolved. The solution was then cooled and the temperature at which crystals formed was recorded. The change between the first and second part was the amount of compound used in the experiment. The result of this was the different concentrations used and therefore the results from varied concentrations can be compared.

For the experiment, the solute used was dichromate. In Part A, the mass of the sample used was 5.6700g and the solvent was water. The volumes of 10, 15, 20, and 25mL formed crystals at 72.0, 63.0, 40.0, and 31.0 degrees C, respectively. In Part B, the mass of the sample was 1.7385g and the solvent was water. For the volumes of 10,15, and 20mL; the temperatures of crystal formation was 31.0, 17.0, and 10.0 degrees C, respectively. In Part C the mass of sample was 2.9660 and the solvent was water:dioxane. For the volumes of 10.0, 15.0, 20.0 and 25.0mL; the temperature of crystal formation was 71.0, 34.5, 18.0, and 13.0 degrees C, respectively.
After reviewing the data on the graphs, the comparison of temperature to solubility, there is a common trend throughout the data. As the temperature increases the solubility also increases. When the crystals formed at a higher temperature, the concentration was also higher than when crystals formed at a lower temperature. Another trend shown was the relationship of temperature to mole fraction. The mole fraction decreased as the temperature decreased, attributed to the change in concentration.

The experiment can very from person to person where they interpret the crystals to form, but as long as the same formation is recorded each time, the proportions should be the same. The heating of the water bath is not always uniform and can affect the experiment as well. Overall there are few areas for error in the experiment.