Procedure: Calcium Acetate Synthesis

1. Place 100 g calcium carbonate in a beaker with a magnetic stir bar, add a stoichiometric quantity, 1 mol, of acetic acid
   a) The calcium carbonate can be reagent grade, or derived from eggshells or chalk. If not using a reagent, you will have to filter out the other solids before evaporating
   b) The acetic acid can be glacial (∼57mL, dilute to ∼300mL) or sourced from store bought vinegar (∼1.2L for 5% by mass vinegar)
2. Continue stirring the reaction mixture until the carbon dioxide bubbles stop forming
3. Heat the solution to evaporate the water. Remove from heat before the product burns and transfer to a watch glass to finish drying
4. Measure 35 g of the dried product, calcium acetate, and dissolve in 100 mL water
5. Slowly add the calcium acetate solution to 150 mL ethanol while stirring slowly with a glass stir rod until the desired consistency is reached. The calcium acetate should crash out of solution

Answer the following questions based on this procedure.

1. Write the chemical equation for the reaction between calcium carbonate and acetic acid. Explain why the carbon dioxide bubbles stop forming after some time.

2. Given $K_{\text{sp}}(\text{Ca}(\text{CH}_3\text{COO})_2) = 42$ in water, calculate the solubility of calcium acetate, and determine if the solution in step 4 is below saturation, at the saturation point, or supersaturated.

3. Explain why the solution crashes out when we add calcium acetate. How should $K_{sp,\text{ethanol}}$ compare to $K_{sp,\text{water}}$?

4. Verify precipitation occurs by comparing Q to $K_{sp,\text{ethanol}} = 1.01 \times 10^{-3}$ during step 5.

Homework Problem 28

1. Urea, a molecular solute with molar mass $60\,\frac{\text{g}}{\text{mol}}$ and van't Hoff factor $i = 1$, is dissolved in 100 g of water to form a solution. The difference between the freezing and boiling point of the solution is 105 °C. Determine the mass of urea that must be added to the water.

$$k_f = 1.86\,\frac{\text{K·kg}}{\text{mol}} \qquad k_b = 0.52\,\frac{\text{K·kg}}{\text{mol}}$$