Lab - Solubility Product

Purpose: To determine the molar solubility and the solubility product of a sparingly soluble compound.

Procedure:

Part 1: Serial dilution of calcium ions.

1) Arrange a well plate so that you have 12 wells across from left to right.
2) Put 5 drops of 0.10 M calcium nitrate in well #1 in the first row. Make sure to hold the dropper vertically when dispensing the drops, and make sure no air bubbles are in the tubes.
3) Place 5 drops of distilled water in each of the wells #2 through #12.
4) Add 5 drops of 0.10 M calcium nitrate to well #2.
5) Use an empty dropper and draw the liquid in well #2 up into the dropper and then squirt the liquid back into the well. This will mix the water and calcium nitrate solution. The solution in well #2 is now half as concentrated, or 0.050 M in Ca^{+2} ion.
6) Use your empty dropper to remove the solution from well #2 and put 5 drops of this solution into well #3.
7) Put the remaining solution back into well #2.
8) Mix the solution in well #3 as before with the empty dropper.
9) Continue this serial dilution procedure, adding 5 drops of the previous solution to the 5 drops of distilled water in each well down the row until you fill the last one, #12.
10) Mix the solution in well #12, and discard 5 drops.
11) Determine the concentration of Ca^{+2} ions in each well. Verify the concentration of calcium ions in well #12 is 4.9×10^{-5} M.

Part 2: Adding the hydroxide

1) Place 5 drops of 0.10 M sodium hydroxide to each of the wells #1 through #12. When the sodium hydroxide is added to each well, the initial concentrations of the reactants are halved, as each solution dilutes the other.
2) Mix each well with a toothpick. Now, the concentration of Ca^{+2} ions in well #12 is 2.4×10^{-5} M.
3) Allow three or four minutes to allow the solutions to react. Observe the pattern of precipitation.
4) At one point, the concentration of both ions becomes too low for precipitate to form. We will assume that the first of these wells indicates a saturated solution.

Part 3: Checking by dilution of sodium hydroxide

1) Repeat the procedure in part 1, this time using 5 drops of 0.10 M sodium hydroxide instead of calcium nitrate.
2) After completing step 10 from part 1, add 5 drops of 0.10 M calcium nitrate to each of the wells and mix with a toothpick.
3) Again, allow a few minutes for reaction, observe the pattern of precipitation, and assume the first well with no precipitate is the saturated solution.

Data Table:

Calcium Ion Serial Dilution
First well with no precipitation: ____________
Concentration of Ca^{+2}: ____________
Concentration of OH^{-}: ____________

Hydroxide Ion Serial Dilution
First well with no precipitation: ____________
Concentration of Ca^{+2}: ____________
Concentration of OH^{-}: ____________

Calculations and Analysis:

1) Using the concentrations in the first well with no precipitate in the calcium ion dilution series, calculate the solubility product constant (K_{sp}).
2) Using the concentrations in the first well with no precipitate in the hydroxide ion dilution series, calculate the solubility product constant (K_{sp}).
3) How did the values obtained from the two trials compare? Look up the accepted value for the K_{sp} of calcium hydroxide and compare the values.
4) Does this method give you values that are too high or too low? What could make the method better?
5) Would the results be better if the concentrations of the last well where precipitation occurred were averaged with the first well where there was no precipitate? Try this and see if the values are closer to the accepted value.

6) Based on your average K_{sp}, calculate the mass of calcium hydroxide that would dissolve in 100 mL of water.