Lesson Plans for *Slightly Soluble Salts* 4*:* **Using Q and LeChatelier's Principle**
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**Learning Goals: Students will be able to:**

- Calculate Q.
- Predict what would be observed on a macroscopic level to a solution by comparing Q to $K_{sp}$.
- Use microscopic illustrations, to help explain the predictions.
- Use LeChatelier's Principle to predict how changing the amount of water will affect the solution.

**Background**: I teach a dual credit chemistry course using Chemistry 6th Edition Zumdahl Houghton Mifflin, NY, 2003. The students in my class are taking their first high school chemistry course and receive credit for the first semester of college chemistry and credit for the corresponding lab. I have written a series of five activities using the *Soluble Salts* simulation to be used throughout the year. This is the fourth in the series. I plan to use this during second semester as part of Equilibrium and predicting system changes by calculating Q and using LeChatlier's principle (section13.5-6,& 15.6). This will immediately follow activity 3.

**Pre-activity:**

We will have just finished activity three, so I should be able to go into this one with little introduction.

Have a test tube with water and some baking soda. Put a little in and shake. Start over and put a large amount in. Relate Q and K using $NaHCO_3$ (mm=84) equation. Solubility is 10.3 g/100ml or $K_{sp}$ = 1.5 (ignoring the acid/base equilibrium).

Demonstrate temperature effects on the $NO_2 \leftrightarrow N_2O_4$ equilibrium (I have a closed container of it that I can put in hot or cold water for this purpose). Talk about how temperature would affect a solution of baking soda.

**Post-activity:** There are some clicker questions.

Discuss how temperature affects the equilibrium and make sure that students realize that $K_{sp}$ is temperature dependant.

**Helpful simulation notes:**

- $Tl_2S$ has such a small solubility (8/4) that the number of dissolved particles varies significantly so it would not be a good one to use for calculating $K_{sp}$.
- Notice that the volume is much smaller for NaCl.
- Need to enter amounts in the ion total spot to use the sim for Q=K, Q > K and Q < K

Useful information:

| Compound | $K_{sp}$ expression (x is moles/l dissociated) | Molar mass | Common information | | | From sim | |
|---|---|---|---|---|---|---|---|
| | | | Solubility in moles/L | $K_{sp}$ | Solubility in g/100ml | # Cations at saturation | # Anions at saturation |
| NaCl | $x^2$ | 58.5 | 6.0 | 36 | 35 | 180 | 180 |
| AgBr | $x^2$ | 188 | 7.3E-7 | 5.3 E-13 | 1.4E-5 | 45 | 45 |
| $Tl_2S$ | $(2x)^2x$ | 441 | 5.3E-8 | 6 E-22 | 2.3E-6 | 8 | 4 |
| $Ag_3AsO_4$ | $(3x)^3x$ | 463 | 1.4E-6 | 1.0 E-22 | 6.4E-5 | 255 | 80 |
| CuI | $x^2$ | 190 | 1.0E-6 | 1.1E-12 | 1.9E-5 | 64 | 64 |
| $HgBr_2$ | $x(2x)^2$ | 361 | 2.5E-7 | 6.2E-20 | 9E-6 | 16 | 32 |
| $Sr_3(PO_4)_2$ | $(3x)^3(2x)^2$ | 452.8 | 2.5E-7 | 1E-31 | 1.1E-5 | 45 | 30 |