

# Determination of $K_{sp}$ for Calcium Hydroxide

## 15 February 2018



*This is what it looks like... It costs \$160/ton.*



*Hmmm. So if we all chip in \$4...*



*Photo credit:  
Alibaba.com*

# Objectives: To determine a useful value: an equilibrium constant.

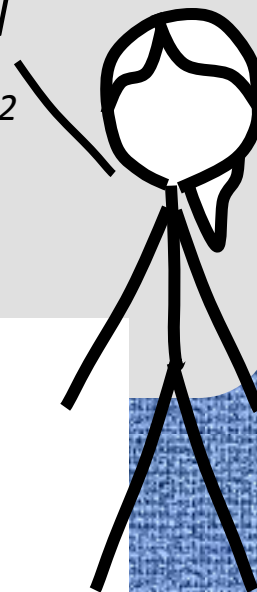


*Today we will perform a colorful titration on our way to estimating a value of an equilibrium constant for a sparingly soluble salt.*

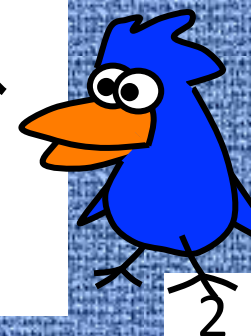
## Overview:

1. The equilibrium constant of a sparingly soluble ionic solid.
2. Overview of the experiment and calculations.
3. The titration
4. Procedure: What we do today
5. Your lab report

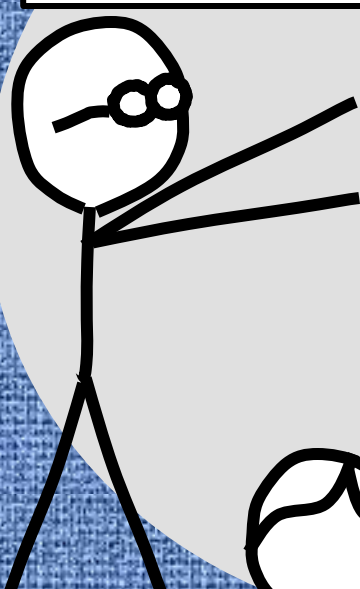
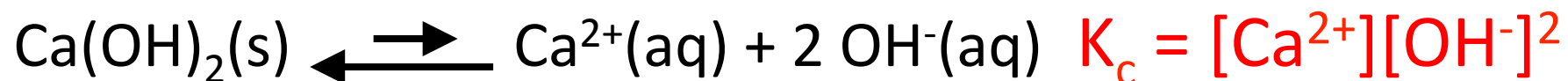
*The salt we will study is  $\text{Ca}(\text{OH})_2$  which is only a little soluble.*




*I use the word sparingly sparingly.*



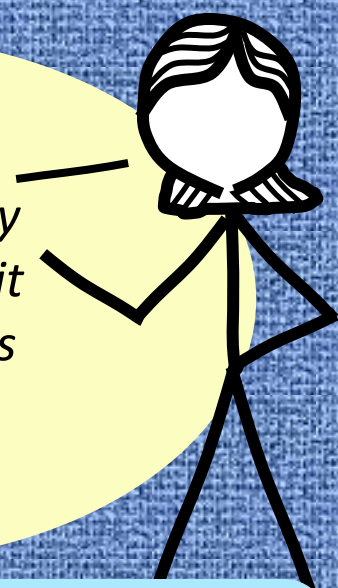
# 1. The equilibrium constant of a sparingly soluble ionic solid.



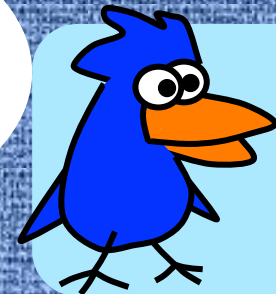
*This is the equilibrium we will study. We know  $K_c$  is stuff on the right divided by stuff on the left and we ignore solids.*



*Arrows going both ways means we have an equilibrium.*



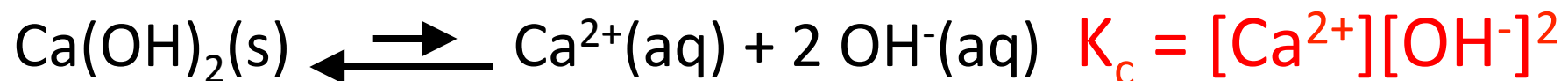
*Calcium hydroxide does not dissolve very much, but the little bit that does, dissociates 100% into ions...*



*...because all ionic substances that dissolve dissociate 100% into ions. Even sparingly soluble ionics.*

**Info for Introduction**

## 2. Overview of the experiment and calculations

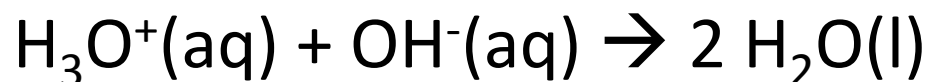


If we titrate the  $\text{OH}^{-}$  with a known concentration of  $\text{HCl}(\text{aq})$ , we can figure out moles of  $\text{HCl}$  used by using

$$n_{\text{acid}} = M_{\text{acid}} V_{\text{acid}}$$

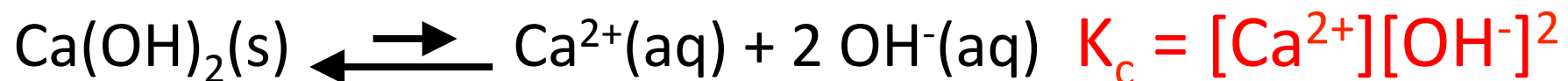
And from there we can figure out the moles of  $\text{OH}^{-}$  that were present from the 1:1 stoichiometry of the acid-base titration. The moles of  $\text{OH}^{-}$  equals the moles of  $\text{H}_3\text{O}^{+}$ ,  $n_{\text{base}} = n_{\text{acid}}$ .

$$n = MV$$



Info for  
Introduction

## 2. Overview of the experiment and calculations



Here's our "road map". From moles of  $\text{OH}^{-}$ , we get the molarity of  $\text{OH}^{-}$ . That gives us  $[\text{Ca}^{2+}]$  from the 2:1 stoichiometry. With  $[\text{OH}^{-}]$  and  $[\text{Ca}^{2+}]$  we calculate  $K_c$ ! Easy peasy.



$$n_{\text{OH}^{-}} = n_{\text{H}_3\text{O}^{+}}$$

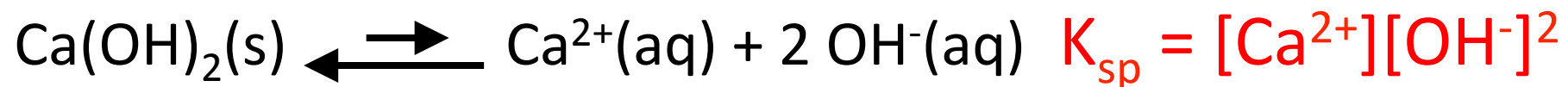
$$[\text{OH}^{-}] = \frac{n_{\text{OH}^{-}}}{V_{\text{original Ca(OH)}_2 \text{ Sol'n}}}$$

$$[\text{Ca}^{2+}] = \frac{[\text{OH}^{-}]}{2}$$

$$K_c = [\text{Ca}^{2+}][\text{OH}^{-}]^2$$

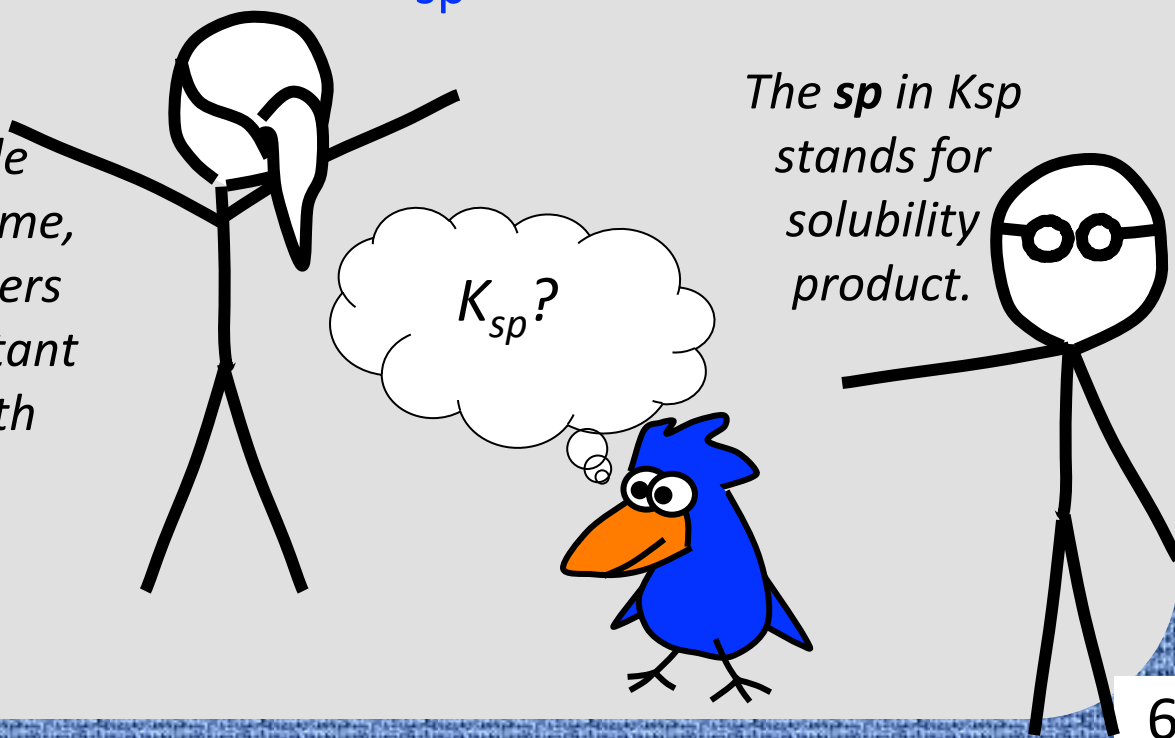
Info for  
Introduction

## 2. Overview of the experiment and calculations



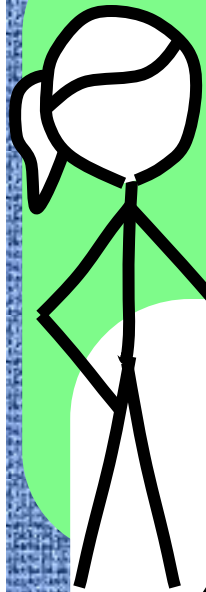
$$K_c = [\text{Ca}^{2+}][\text{OH}^{-}]^2 \quad \text{or} \quad K_{\text{sp}} = [\text{Ca}^{2+}][\text{OH}^{-}]^2$$

*Here is the simplest slide ever!  $K_c$  is given a new name,  $K_{\text{sp}}$  – just to remind readers that the equilibrium constant has something to do with solubility.*

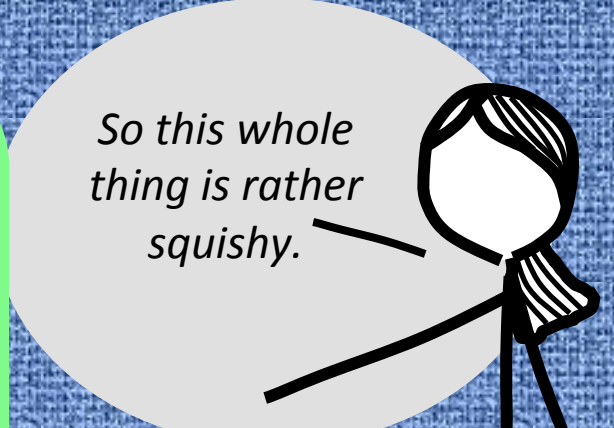


*The **sp** in  $K_{\text{sp}}$  stands for solubility product.*

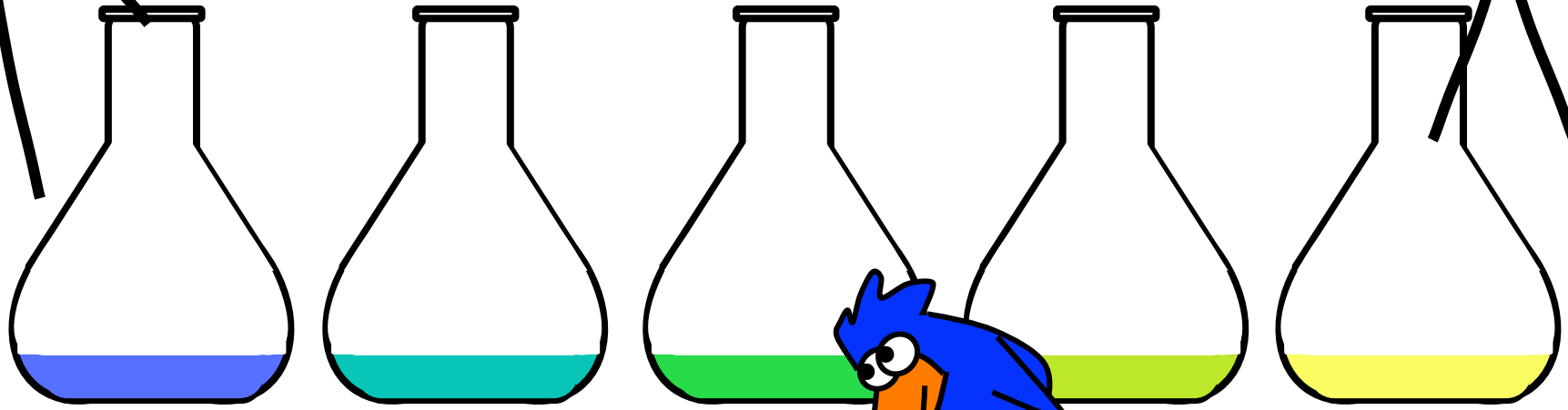
### 3. The titration



*As the titration proceeds (with adequate swirling), our end-point is when the solution is no longer blue-green, but before it gets yellowish-green.*



*So this whole thing is rather squishy.*



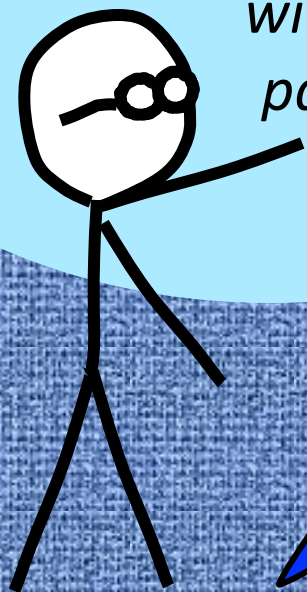
*This is the one!*

**Info for Introduction**

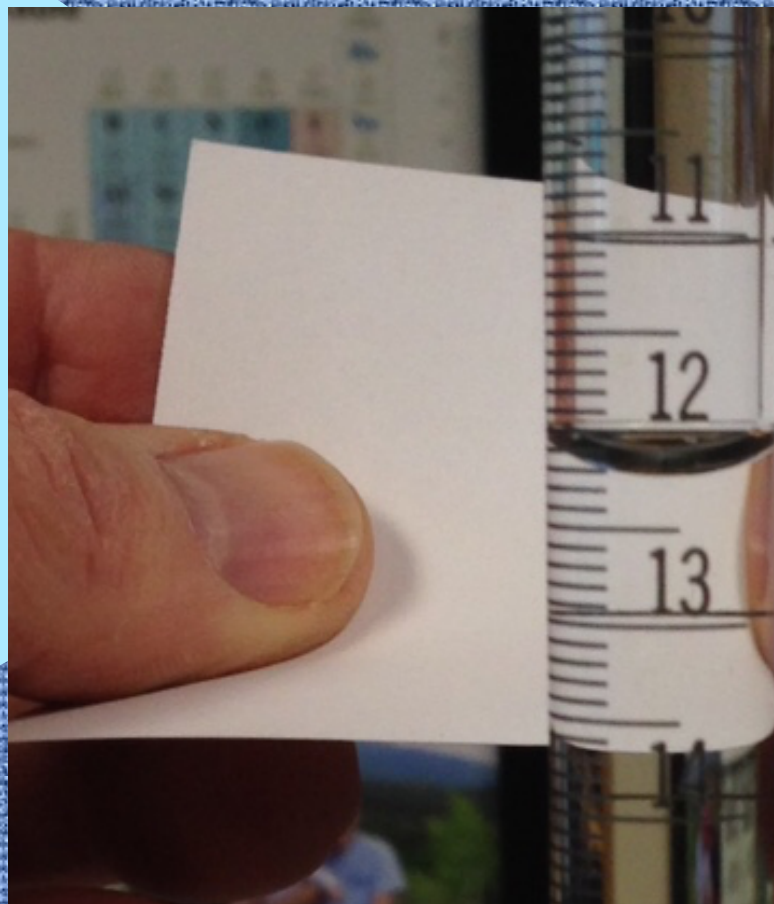
### 3. The titration

*Use a 3 x 5 notecard as a light scoop...*

*... and compare what you get with your partner.*



*This is how to prevent buret reading errors.*

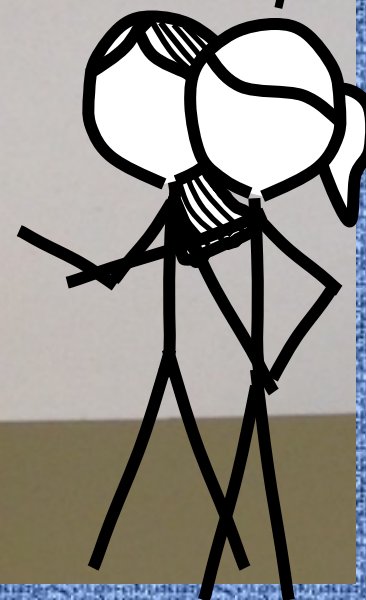


*What did you get?*

*12.22. You?*

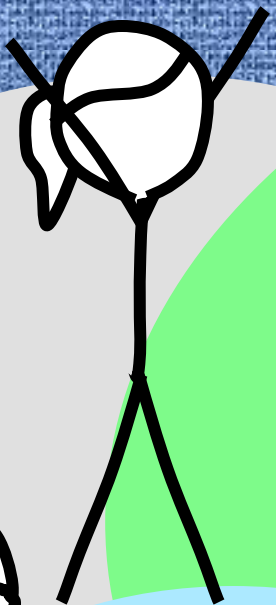
*The same*

*Good!*

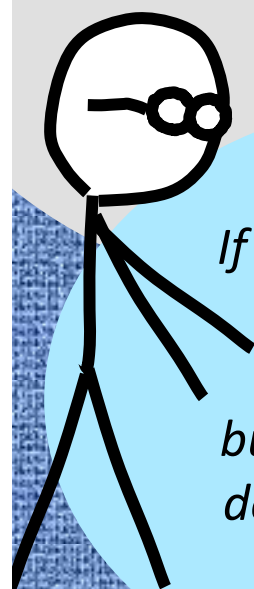




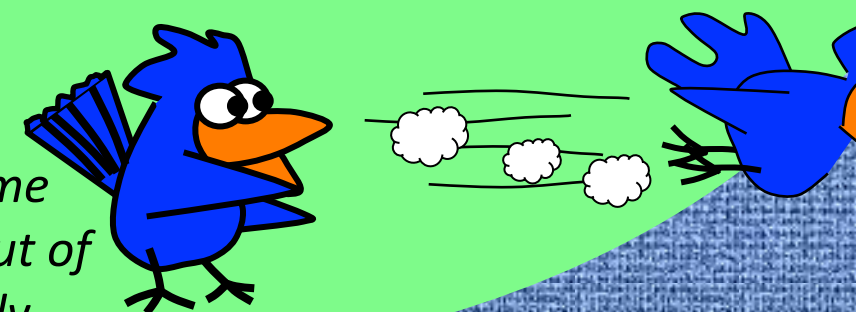
### 3. The titration

A stick figure with a large white circle above its head, indicating it is thinking.

*We can speed titrate! The volume of acid used in the first trial will be similar to the volumes needed in the next trials. That lets us “speed titrate”. Suppose the first titration took 15.05 mL? That means the other titrations will take about the same – so we can jet in the first 12 or 13 mL and then slow down for the perfect middle-green.*

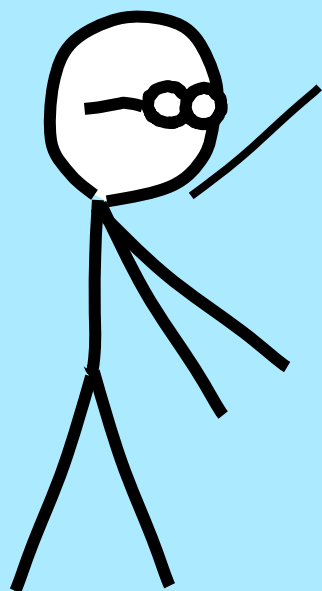
A stick figure wearing glasses, pointing towards the text.

*If you “think” maybe you should add one more drop, write down the buret volume before you do – just in case it was a bad idea.*

A cartoon blue bird with an orange beak and feet, running quickly to the right. Motion lines and a cloud of dust behind it suggest speed.

*This is me getting out of lab early.*

## 4. Procedure: What we do today



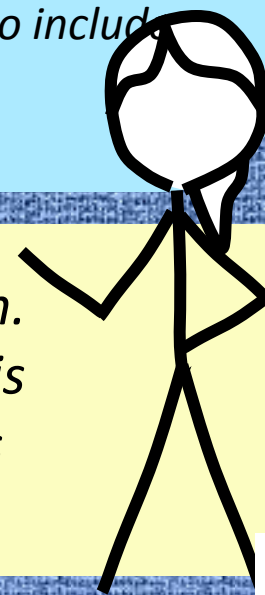
- ① *Take time writing an introduction in your own words before lab.*
- ② *Record observations and details as carefully as possible. Show your calculations with formulas, units, and significant figures!*
- ③ *After the first titration is done, the subsequent titrations will take about the same volume of HCl(aq).*
- ④ *Compare your  $K_{sp}$  with the literature value (from our textbook or the internet). Cite your reference.*
- ⑤ *The cover sheet summarizes everything that you need to include with your report.*



*Only this one way will work!*

*You'll be entering data into a Google form. Exponential numbers are entered as in this example:  $8.00 \times 10^{-6}$  would be entered as*

**8.00E-6** – note there are no spaces!



# 5. Your lab report

- ① First, the cover page with TA initials.
- ② Next, the trimmed copy pages from your lab notebook stapled together. Staple all together.
- ③ **On-line results** due at the end of class today. **Late submissions are not graded – see the syllabus.**
- ④ No attached pages today.
- ⑤ Turn in lab report **before** the start of class tomorrow. **Late labs may not be graded – see the syllabus.**

