Common Ion Effect

Objectives

- Determine solubility of KHT in a solution.
- Investigate effect of common ion on KHT solubility.
- Determine K_{sp} for KHT.

Solubility Equilibria

- **Solubility Rules** - **qualitative** prediction about solubility
- **Solubility Expression** - **quantitative** prediction about solubility or, how much will dissolve)
- The solid component is in equilibrium with the dissolved ions.

$$\mathbf{BaSO_4\ (s) \rightleftharpoons Ba^{2+}\ (aq) + SO_4^{2-}\ (aq)}$$

- **Solubility Product Constant, K_{sp}** – similar to other equilibrium expressions (K_c, K_a , etc.)

$$\mathbf{K_{sp} = [Ba^{2+}]\ [SO_4^{2-}]}$$

- **Solubility** – quantity that dissolves to form a saturated solution.
  - Units are g/L or mol/L.

K_{sp} and Solubility

- K_{sp} remains constant with constant temperature.
- Solubility is affected by pH and concentration of other ions.

The Common-Ion Effect

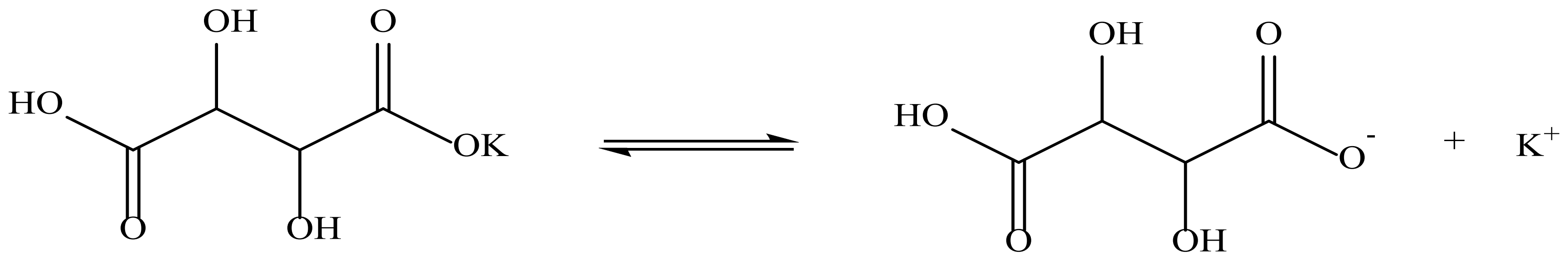
- Solubility of a slightly soluble salt is *decreased* by presence of second solute with a common ion (**F^- ions,** in the example, below)

$$\mathbf{CaF_2\,(s) \rightleftharpoons Ca^{2+}(aq) + F^-(aq)}$$

- Addition of NaF (**F^- ions**) to a solution of CaF_2
    - Shifts the equilibrium to the ← **LEFT**, forming more CaF_2
    - Reducing its solubility; hence, precipitation)

Potassium Bitartrate (KHT)

- Today, we will study the solubility of *KHT*, a slightly soluble salt, a.k.a., *Cream of Tartar* (a by-product of winemaking ; used in baking powders).
- We will calculate K_{sp} in the presence of varying concentrations of a common ion.

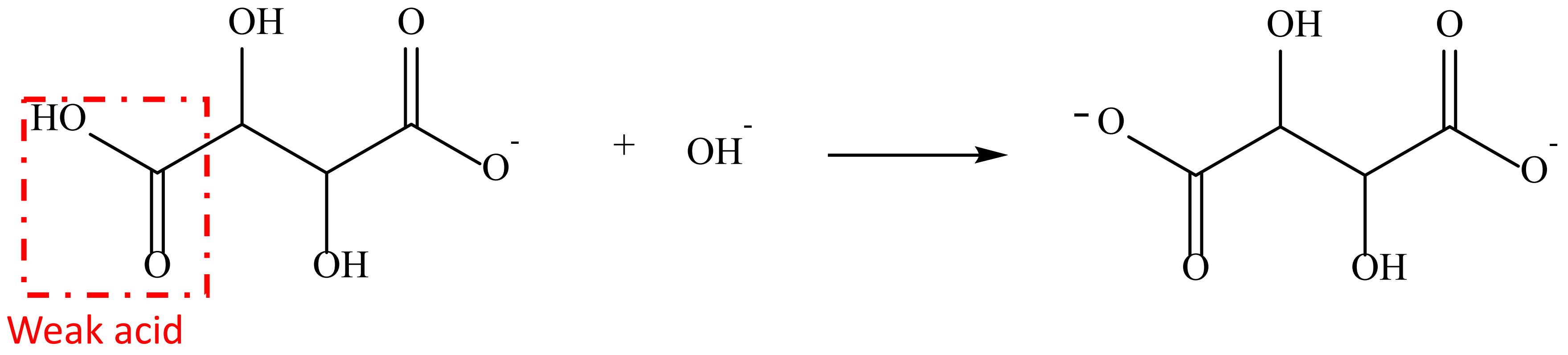


$$KHT\ (s) \rightleftharpoons K^{+}\ (aq) + HT^{-}\ (aq)$$

$$K_{sp} = [K^{+}]\ [HT^{-}]$$

Potassium Bitartrate, cont.

- To solve for K_{sp} , we need $[K^+]$ and $[HT^-]$
- HT^- is a weak acid. We will titrate it with a strong base (NaOH).

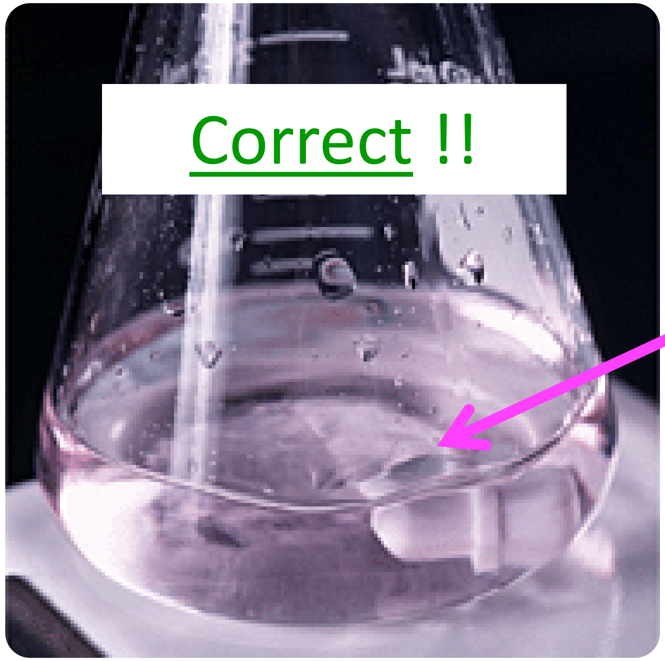


$$HT^- (aq) + OH^- (aq) \rightleftharpoons T^{2-} (aq) + H_2O (l)$$

At the equivalence point,

moles OH^- = moles HT^- and moles HT^- = moles KHT

… which will lead you to solubility of KHT



Question: How does one know when the equivalence point is reached?

Answer: *Use an acid-base indicator!*

- Phenolphthalein
  - Use 2-3 drops only
  - Colorless in acidic solutions
  - Pink in solutions pH ≥ 8

Faint pink color

The point where the indicator changes color is called the ***end point*** *and is the* approximation of the *equivalence point*.

Procedure : Step 1

- Nine (9) possible mixtures of KCl and NaCl
- See TA for your assigned mixture
  - Each pair will make *2* mixtures !!!
  - ALL mixtures must be chosen !!!
  - No more than 3 pairs of students can use the same mixture!

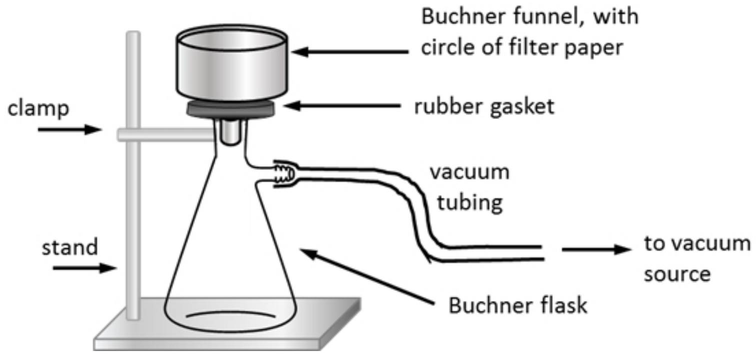
Mixture	0.1 M KCl (mL)	0.1 M NaCl (mL)
1	0	100
2	20	80
3	30	70
4	40	60
5	50	50
6	60	40
7	70	30
8	80	20
9	100	0

Procedure, cont.

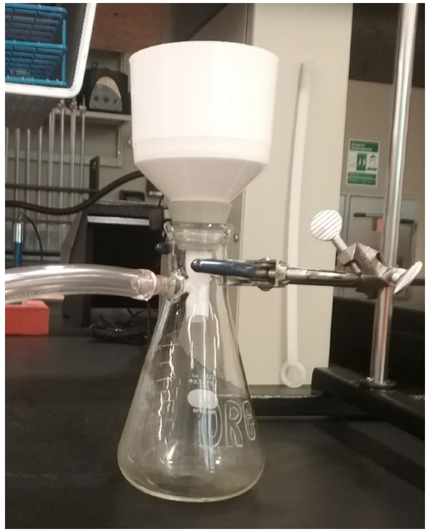
- Perform vacuum filtration
- Use 2 burets (label both!)
  - Buret 1 – KHT solution
    - Use to measure 25.0 mL into an Erlenmeyer flask.
    - Record exact volume!
  - Buret 2 – NaOH solution
    - Use for titration to add the KHT to the Erlenmeyer flask which contains 2-3 drops of phenolphthalein indicator.
- Do three titrations for every mixture

Before leaving lab, see your TA and enter the following into the Excel spreadsheet on the lab computer:

- **Names**
- **Mixture #**
- **Volume KHT**
- **Volume NaOH**



Vacuum Filtration



Hazards and Waste

- Dispose all the solution in the Aqueous Waste container