## **CONCEPT:** DAVIES EQUATION

We learned that the activity coefficient and ionic strength of a solution could be closely and accurately related by using the extended *Debye-Huckel equation*:

$$\log\gamma = \frac{-0.51z^2\sqrt{\mu}}{1+\left(\frac{\alpha\sqrt{\mu}}{305}\right)}$$

When the size parameter of the ion is unknown we can instead use the *Davies Equation*.

- Because of the lack of a size parameter this formula is most useful for monovalent ions.

$$\log\gamma = -0.51z^2\left(\frac{\sqrt{\mu}}{1+\sqrt{\mu}} - 0.3\mu\right)$$

| | Ionic Charge (z) | | |
|---|---|---|---|
| Ionic Strength | ±1 | ±2 | ±3 |
| 0.001 | 0.97 | 0.87 | 0.73 |
| 0.005 | 0.93 | 0.74 | 0.51 |
| 0.010 | 0.90 | 0.66 | 0.40 |
| 0.050 | 0.82 | 0.45 | 0.16 |
| 0.100 | 0.78 | 0.36 | 0.10 |
| 0.200 | 0.73 | 0.28 | 0.06 |
| 0.500 | 0.69 | 0.23 | 0.04 |
| 0.700 | 0.69 | 0.23 | 0.04 |

From the *Davies Equation*, all ions with the same magnitude in charge will have the same activity coefficient.

**EXAMPLE:** Calculate the activity coefficient of $Ca^{2+}$ in 0.025 M $Ca_3(PO_4)_2$.

## **CONCEPT:** DEPENDENCE OF SOLUBILITY ON PH

Recall that ionic compounds are composed of an anion and cation, either of which can create an acidic, basic or neutral solution.

### Cations ⊕

- Transition Metals
  ___ or higher charge will be acidic, less than ___ will be neutral
  $MnI_5$ ⟶
- Main Group Metals
  ___ or higher charge will be acidic, less than ___ will be neutral
  $AlF_3$ ⟶
- Positive Amines
  Positively charged amines are acidic
  $CH_3NH_3Cl$ ⟶

Cations can create solutions that are either acidic or neutral.

- _____ the pH increases the solubility of sparingly acidic salts.

### Anions ⊖

- Add an $H^+$ to the anion and if you create a weak acid then your negative ion is basic.
  $NaNO_2$ ⟶ $\xrightarrow{H^+}$
- Add an $H^+$ to the anion and if you create a strong acid then your negative ion is neutral.
  $KCl$ ⟶ $\xrightarrow{H^+}$

Anions can create solutions that are either basic or neutral.

- _____ the pH increases the solubility of sparingly basic salts.

### Amphoteric

- Acidic
  $HSO_4^-$ $HSO_3^-$ $H_2PO_4^-$
- Basic
  $HCO_3^-$ $HS^-$ $HPO_4^{2-}$

## **PRACTICE:** DEPENDENCE OF SOLUBILITY ON PH CALCULATIONS 1

**EXAMPLE 1:** $BaCO_3$ is the slightly soluble ionic salt that results from the reaction between $Ba(OH)_2$ and $H_2CO_3$. Identify the effect of increasing acidity on the solubility of the given compound.

**EXAMPLE 2:** Which salts will be more soluble in an acidic solution than in pure water?

a. CuBr

b. $Ag_2SO_4$

c. $BaSO_3$

d. $Sn(OH)_2$

e. $KClO_4$