Announcements for Wednesday, 06NOV2024

- none

ANY GENERAL QUESTIONS? Feel free to see me after class!

Try These On Your Own

- Write a balanced net ionic equation for the reaction that takes place when an aqueous solution of iron(II) nitrate is mixed with an aqueous solution of potassium phosphate.

$$3\ Fe^{2+}(aq) + 2\ PO_4^{3-}(aq) \rightarrow Fe_3(PO_4)_2(s)$$

- Write a balanced net ionic equation for the reaction that takes place when solid sodium chloride is added to an aqueous solution of silver acetate.

$$NaCl(s) + Ag^{+}(aq) \rightarrow AgCl(s) + Na^{+}(aq)$$

- Write balanced molecular, complete ionic, and net ionic equations for the reaction that takes place when aqueous copper(II) acetate reacts with an aqueous solution of calcium hydroxide.

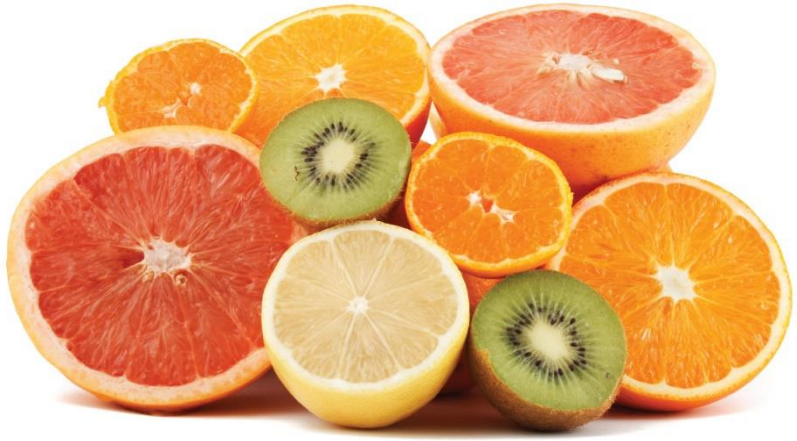
molecular: $Cu(C_2H_3O_2)_2(aq) + Ca(OH)_2(aq) \rightarrow Cu(OH)_2(s) + Ca(C_2H_3O_2)_2(aq)$

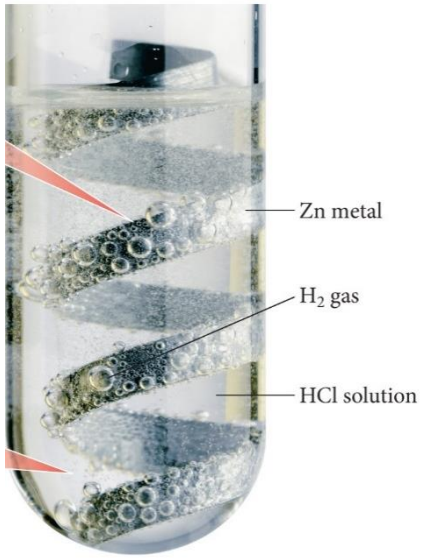
CIE: $Cu^{2+}(aq) + 2\ C_2H_3O_2^{-}(aq) + Ca^{2+}(aq) + 2\ OH^{-}(aq) \rightarrow Cu(OH)_2(s) + Ca^{2+}(aq) + 2\ C_2H_3O_2^{-}(aq)$

NIE: $Cu^{2+}(aq) + 2\ OH^{-}(aq) \rightarrow Cu(OH)_2(s)$

Acids

- **acid =** a compound that is an H^+ (proton) donor
- Arrhenius definition: an acid is **a molecular compound that dissociates** in water to generate H^+/H_3O^+ ions (and the associated anions)
  - formula usually starts with Hs followed by one or more nonmetals
  - if an organic acid you may see "COOH" in the formula
- not all Hs in a molecule are ionizable in water
- monoprotic vs. diprotic vs. polyprotic acids
- strong acids: dissociate ***completely***
  - **MEMORIZE THESE:** HCl, HBr, HI, HNO_3, H_2SO_4 , $HClO_4$
- weak acids: dissociate *partially*
  - if a compound is an acid but not one of the ones you memorized, it will be considered a weak acid





Naming Acids

names of acids are derived from the names of the anion

1. binary acids

- anions are either monatomic or non-oxyanions (F^-, Cl^-, S^{2-}, CN^-, etc.)
- prefix "hydro" + base name + ***-ic*** acid
- HI = hydroiodic acid H_2S = hydrosulfuric acid HCN = hydrocyanic acid

2. oxyacids

- anions are oxyanions (NO_3^-, ClO_4^-, SO_3^{2-}, PO_4^{3-}, CH_3COO^-, etc.)
- ***-ate*** turns to ***-ic*** acid
- H_2CO_3 = carbonic acid $HClO_3$ = chloric acid H_3PO_4 = phosphoric acid
- ***-ite*** turns to ***-ous*** acid
- H_2SO_3 = sulfurous acid HClO = hypochlorous acid HNO_2 = nitrous acid

Bases

- **base =** a species that is a proton (H^+) acceptor
- Arrhenius definition: a base is a compound (either ionic or molecular) that generates OH^- (hydroxide) ions when placed into water
- strong bases vs. weak bases
- DO NOT CONFUSE STRONG BASES (ionic) WITH ALCOHOLS (molecular)

Acid Base Reactions

- **neutralization reaction =** reaction between an acid and a base in which an H^+ ion is transferred from the acid to the base
  - **it is a proton-transfer reaction**
- produces a **salt** (a soluble ionic compound formed as a result of neutralization) and (often) **water**
  - $HBr\ (aq) + LiOH\ (aq) \rightarrow$ **$LiBr\ (aq)$** + **$H_2O\ (\ell)$**
  - $HCl\ (aq) + NH_3\ (aq) \rightarrow$ **$NH_4Cl\ (aq)$**
- strong acid/strong base neutralizations can have the same net ionic equation
  - $H^+\ (aq) + OH^-\ (aq) \rightarrow H_2O\ (\ell)$
- to predict products, transfer the H^+s from acid to base and write down what results
- **complete neutralization =** when ALL ionizable H^+s react with base
  - $H_2SO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Na_2SO_4\ (aq) + 2\ H_2O\ (\ell)$

Try These On Your Own

- 10.0 g $Ca(OH)_2(s)$ was needed to completely neutralize 266 mL HCl(aq). What was the molarity of HCl(aq)?

- What volume of 2.5 M NaOH (aq) must be added to 100. mL of 0.50 M H_3PO_4 (aq) to completely neutralize the acid?

Try This

0.600 mol of NaOH is required to completely neutralize 28.4 g of an unknown triprotic acid. Which of the following could be that acid?

$$3\ NaOH + H_3X \longrightarrow Na_3X + 3\ H_2O$$

$$0.600\ \text{mol NaOH} \times \frac{1\ \text{mol}\ H_3X}{3\ \text{mol NaOH}} = 0.200\ \text{mol}\ H_3X$$

$$\text{molar mass}\ H_3X = \frac{28.4\ \text{g}}{0.200\ \text{mol}} = 142\ \text{g/mol}$$

A. H_3PO_4 (98.0 g/mol)

B. H_3PO_3 (82.0 g/mol)

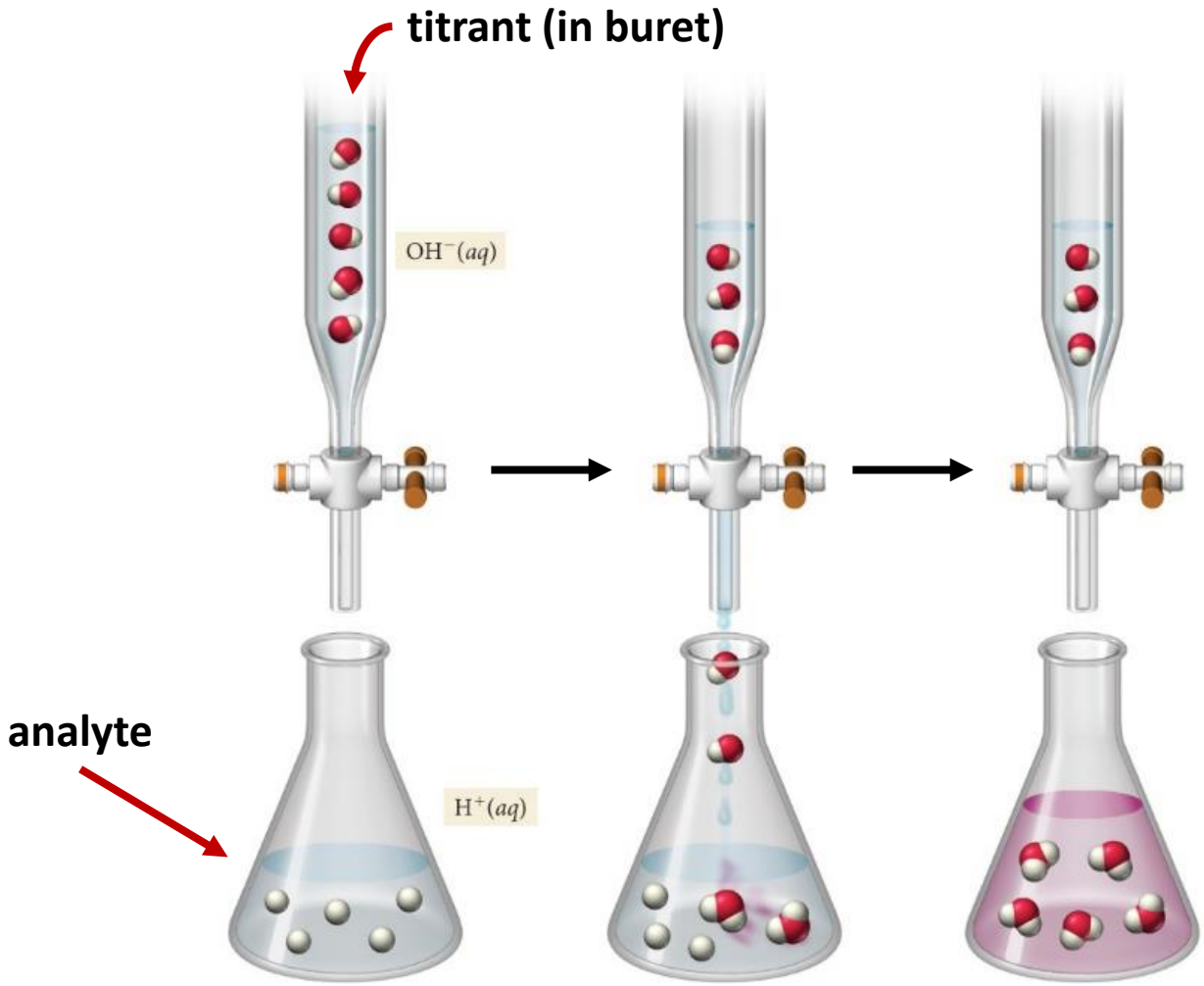
C. H_3AsO_4 (142 g/mol)

D. $HOC(COOH)(CH_2COOH)_2$ (192 g/mol)

E. H_3N (17.0 g/mol)

Titration

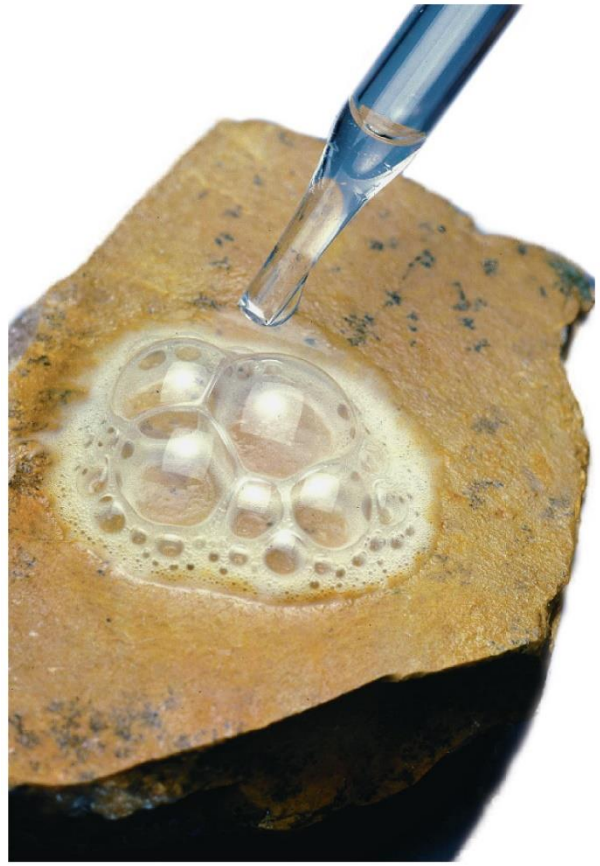
- a common laboratory procedure in which a substance in a solution of known concentration (the **titrant**) is reacted with another substance in a solution of *unknown* concentration (the **analyte**)
- **equivalence point =** the point of a titration in which all of the analyte has been reacted with the titrant
- **indicator =** a chemical compound that changes color at the equivalence point



STUDENT NOTE: Cover on your own…know what a titration is and that the calculations are based simply solution stoichiometry

Gas-Evolution Reactions

- some ions, when reacted with **acid** form **gaseous products** *directly*:
  - sulfides: $S^{2-}(aq) + \mathbf{2\ H^+}(aq) \rightarrow \mathbf{H_2S(g)}$
- some ions react with **acid** to form **gaseous products** by going through an ***unstable intermediate***:
  - carbonates: $CO_3^{2-}(aq) + \mathbf{2\ H^+}(aq) \rightarrow \mathbf{H_2CO_3}(aq) \rightarrow \mathbf{CO_2(g)} + H_2O(\ell)$
  - bicarbonates: $HCO_3^-(aq) + \mathbf{H^+}(aq) \rightarrow \mathbf{H_2CO_3}(aq) \rightarrow \mathbf{CO_2(g)} + H_2O(\ell)$
  - sulfites: $SO_3^{2-}(aq) + \mathbf{2\ H^+}(aq) \rightarrow \mathbf{H_2SO_3}(aq) \rightarrow \mathbf{SO_2(g)} + H_2O(\ell)$
  - bisulfites: $HSO_3^-(aq) + \mathbf{H^+}(aq) \rightarrow \mathbf{H_2SO_3}(aq) \rightarrow \mathbf{SO_2(g)} + H_2O(\ell)$
- reactions with **base**
  - ammonium: $NH_4^+(aq) + \mathbf{OH^-}(aq) \rightarrow \mathbf{NH_4OH}(aq) \rightarrow \mathbf{NH_3(g)} + H_2O(\ell)$



$HCl(aq) + CaCO_3(s)$