Pre-AP Chemistry – Unit 10 Acids and Bases

Objective 1: Students will name acids and bases and compare and contrast the following acid-base theories: Arrhenius, Brønsted-Lowry, and Lewis. [AB.19.C.1, AB.20.C.1]

Objective 2 Students will compare and contrast acid-base properties and perform calculations to quantify the relationships between pH, pOH, $[H^+]$, and $[OH^-]$ as they relate to acids and bases. [AB.21.C.1, AB.21.C.3]

Objective 3 Students will use titration as an analysis method for determining the concentration of unknown solutions via solution stoichiometry. [AB.22.C.1, AB.22.C.2, S.15.C.4]

Define the following vocabulary terms...

monoprotic acid, diprotic acid, triprotic acid, conjugate acid, conjugate base, conjugate acid-base pair, hydronium ion, amphoteric, Lewis acid, Lewis base, self-ionization, neutral solution, ion-product constant for water, acidic solution, basic solution, alkaline solution, pH, neutralization reaction, equivalence point, end point, standard solution, titration, and primary standard.

Objective 1

1. Name the following acids: HNO_2 , H_2SO_3 , HCl , HIO_2 , H_2S , HBrO , H_3PO_3 , HNO_3 , $HC_2H_3O_2$, $HClO_4$.
2. Write formulas for the following acids: hydrocyanic acid, sulfuric acid, hypofluorous acid, chloric acid, hydroasenic acid, chromic acid.
3. Explain why naming bases doesn't require a special system like acid naming.
4. Compare and contrast the Arrhenius theory of acids and bases to the Brønsted-Lowery theory.
5. Identify the conjugate acid-base pairs in the reactions below.

   a. $HSO_4^-(aq) + C_2O_4^{2-}(aq) \rightleftharpoons SO_4^{2-} + HC_2O_4^-(aq)$

   b. $H_2PO_4^-(aq) + HCO_3^-(aq) \rightleftharpoons HPO_4^{2-}(ag) + H_2CO_3(aq)$

   c. $H_2O + S^{2-}(aq) \rightleftharpoons HS^-(aq) + OH^-(aq)$

   d. $CN^-(aq) + HC_2H_3O_2(aq) \rightleftharpoons HCN(aq) + C_2H_3O_2^-(aq)$

   e. $HNO_2(aq) + H_2O \rightleftharpoons H_3O^+(aq) + NO_2^-(aq)$

6. Explain, using reaction examples, how ammonia can acts as a base according to all three acid-base theories.

Objective 2

1. Compare and contrast the properties of acids and bases.
2. Determine the pH in each of the following: (a) 0.40M HCl , (b) a solution with $[OH^-] = 1.2 \times 10^{-8}$, (c) a solution produced when 25.6g of CsOH is dissolved into 4520mL of water , (d) a solution with 100g of nitric acid in 780mL of solution.
3. A solution is prepared by dissolving 2.5g KOH into 1.6L of solution. Determine the following: (a) $[OH^-]$, (b) $[H^+]$, (c) pH, and (d) pOH.
4. How much more acidic (i.e. how many times more is the $[H^+]$ in a solution) is a solution of battery acid, with a pH of 0, than a sample of sprite, with a pH of 3?

Objective 3

1. Answer the following questions concerning the reaction of a strong acid and strong base shown below.

   $LiOH\ (aq) + HNO_3\ (aq) \rightarrow H_2O\ (l) + LiNO_3\ (aq)$

   An unknown solution of lithium hydroxide is to be tested with a solution of nitric acid that is known to have a concentration of 0.678M in order to determine its concentration. The lithium hydroxide is loaded in a buret and is used to titrate 25.00mL of the nitric acid solution to the bromothymol blue endpoint. 32.15mL of the lithium hydroxide is used.

   (a) Determine the moles of nitric acid titrated.
   (b) Use stoichiometry to determine the moles of lithium hydroxide used.
   (c) Determine the concentration of the lithium hydroxide by dividing the moles used by the volume used in the titration.
   (d) Why was bromothymol blue chosen as an indicator for this titration?

2. A student wishes to know the concentration of strontium hydroxide, $Sr(OH)_2$, in a particular solution. The student takes a known mass (0.6875g) of previously dried potassium hydrogen phthalate (a.k.a. "KHP", 204g/mol) which is a primary standard. The student dissolves the KHP in approximately 200mL of deionized water and adds some phenolphthalein indicator. The student then prepares a buret containing the strontium hydroxide solution for titration and records the beginning volume as 1.32mL. Titration to the phenolphthalein endpoint leaves the buret at 24.32mL. (a) Determine the concentration of the strontium hydroxide solution. (b) What properties does a primary standard have?

   $2\ KHP\ (aq) + Sr(OH)_2\ (aq) \rightarrow 2\ H_2O\ (l) + Sr(KP)_2\ (aq)$

3. Determine the pH of a solution when 110.0mL of 0.325M HCL is mixed with 365.0mL of 0.221M KOH.

   $HCl\ (aq) + KOH\ (aq) \rightarrow H_2O\ (l) + KCl\ (aq)$

4. A certain volume (255.0mL) of $Ba(OH)_2$ solution (1.25M) is titrated well beyond equivalence with 120.0mL of 4.0M HNO_3 solution. Determine the pH, pOH, $[OH^-]$, and $[H^+]$ in the resulting solution.

   $Ba(OH)_2\ (aq) + 2\ HNO_3\ (aq) \rightarrow H_2O\ (l) + Ba(NO_3)_2\ (aq)$

pH Practice Worksheet

1) What is the pH of a solution that contains 25 grams of hydrochloric acid (HCl) dissolved in 1.5 liters of water?

2) What is the pH of a solution that contains 1.32 grams of nitric acid (HNO_3) dissolved in 750 mL of water?

3) What is the pH of a solution that contains 1.2 moles of nitric acid (HNO_3) and 1.7 moles of hydrochloric acid (HCl) dissolved in 1000 liters of water?

4) If a solution has a $[H^+]$ concentration of 4.5×10^{-7} M, is this an acidic or basic solution? Explain.

5) An acidic solution has a pH of 4. If I dilute 10 mL of this solution to a final volume of 1000 mL, what is the pH of the resulting solution?

Titrations Practice Worksheet

Find the requested quantities in the following problems:

1) If it takes 54 mL of 0.1 M NaOH to neutralize 125 mL of an HCl solution, what is the concentration of the HCl?

2) If it takes 25 mL of 0.05 M HCl to neutralize 345 mL of NaOH solution, what is the concentration of the NaOH solution?

3) If it takes 50 mL of 0.5 M KOH solution to completely neutralize 125 mL of sulfuric acid solution (H_2SO_4), what is the concentration of the H_2SO_4 solution?

4) Can I titrate a solution of unknown concentration with another solution of unknown concentration and still get a meaningful answer? Explain your answer in a few sentences.

5) Explain the difference between an endpoint and equivalence point in a titration.