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2015-2016 Second Semester

**WS 14.1 Acids and Bases: Definitions and Properties, Arrhenius & Bronsted-Lowry**

1. Compare and contrast the Arhennius definition and the Bronsted-Lowry definition.

2. Does the Bronsted-Lowry definition make the Arhennius definition null and void?

Explain.

3. Using the Arhennius definition, classify the following compounds as acid, base or neither.

i. NaOH

ii. HC2H3O2

iii. H3PO4

iv. CaSO4

v. Mg(OH)2

vi. LiOH

vii. HCl

viii. (NH4)2CO3

ix. HI

4. Using the Bronsted Lowry definition, classify each of the following compounds as acid or base.

i. HC2H3O2 + CO32-  C2H3O21- + HCO31-

ii. NH3 + H2O  NH4+ + OH-

5. Which of the following represent conjugate acid-base pairs?

i. H2SO4, SO42-

ii. H2PO4-, HPO42-

iii. HClO4, Cl-

iv. NH4+, NH2-



6. In each of the following chemical equations, label each compound acid or base. i. NH3 + H3O+  NH4+ + H2O

ii. CH3OH + NH2-  CH3O- + NH21-

iii. OH- + H3O+  H2O + H2O

iv. NH2 + H2O  NH3 + OH-

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7. Write the conjugate acid for each of the following:

a. HSO41-

 b. SO32- c. ClO4-

d. H2PO4-

8. Write the conjugate base for each of the following:

i. HCO3- ii. H2PO4- iii. HCl

iv. HSO4-

9. Write a chemical equation showing how each of the following species behaves as an acid when dissolved in water:

a. HC2H3O2

b. HI

c. H2SO4

d. HNO3

10. Write a chemical equation showing how each of the following species behaves as a base when dissolved in water:

a. NH3

b. Cl-

c. HSO4-

d. ClO4-

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**WS 14.2 Acids and Bases: Weak vs. Strong; Concentration and pH**

1. Identify the following compounds, first as acid or base, then strong or weak.

i. H2SO4

ii. NaOH

iii. HC2H3O2

iv. H2CO3

v. NH3

vi. HF

vii. Mg(OH)2



2. Calculate the [H+] concentration, using the [OH-] shown below:

i. 5.72  10-3 M
 ii. 9.45  10-12 M iii. 4.21  10-7 M

3. Calculate the [OH-] concentration using the [H+] shown below:

i. 9.65  10-2 M

ii. 3.31  10-8 M iii. 6.62  10-13 M

4. Determine the pH for the following, given the [H+], then identify whether it is acidic or basic:

i. 1.0  10-7 M ii. 3.2  10-12 M

5. Determine the pH of the following, given the [OH-], then identify whether it is acidic or basic :

i. 4.83  10-2 M ii. 9.4  10-6 M

6. Determine the pOH of the following, given the [H+]:

i. 1.0  10-7 M ii. 3.2  10-12 M

7. Determine the pOH of the following, given the [OH-]:

i. 4.83  10-2 M ii. 9.4  10-6 M

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8. Given the following pH values, determine the [H+] for each solution:

i. 3.0 ii. 7.0

9. Given the following pH values, determine the [OH-] for each solution:

i. 4.23 ii. 7.65

10. Given the pOH for each of the following problems, calculate the pH:

i. 8 ii. 3

11. Determine the pH of each solution:

i. 1  10-2M NaOH

ii. 3.5  10-2 M KOH

iii. 8.5  10-4 M LiOH

12. Determine the pH of solutions with each of the following concentrations:

i. 5.4  10-12 M HCl

ii. 2.21  10-11 M HI

iii. 5.43  10-13 M HNO3

13. A nitric acid solution is found to have a pH of 2.70. Determine each of the following:

i. [H+]

ii. [OH-]

iii. number of moles of HNO3 required to prepare 5.50 L of this solution

iv. the mass of the moles of HNO3 in the solution in part (c)

14. A potassium hydroxide solution is found to have a pH of 12.5. Determine each of the following:

i. [H+]

ii. [OH-]

iii. number of moles of KOH required to prepare 1.75 L of this solution

iv. the mass of the moles of KOH in the solution in part (c)

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**WS 14.3 Neutralization and Titration**

1. For each of the following acid-base titration combinations, determine the number of moles of the fist substance listed that would be the chemically equivalent amount of the second substance.

a. NaOH with 1.0 mol HCl

b. HNO3 with 0.75 mole KOH

c. Ba(OH)2 with 0.20 moles HF

2. Suppose that 15 ml of 2.5  10-2 M H2SO4 is required to neutralize 10.0 ml of an aqueous solution of KOH. What is the molarity of the KOH solution? **(7.5 x 10-2M)**

3. In a titration experiment, a 12.5 ml sample of 1.75  10-2 M Ba(OH)2 just neutralized

14.5 ml of HNO3 solution. Calculate the molarity of the HNO3 solution. **(3.02 X 10-2M)**

4. What volume of 0.1296M LiOH is required to neutralize 25 ml of 0.413 M HBr?
 **(79.7 mL)**

5. What volume of 0.550 M HCl is used, if 86.2 ml of 0.765 M sodium hydroxide is used to neutralize it. **(120 mL)**

6. If 40.8 ml of 0.106 M sulfuric acid neutralize a 0.50 M solution of potassium hydroxide, what volume of the solution was present? **(17.3 mL)**

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**WS 14.4 Neutralization and Titration**

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? **(0.0432 M)**

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? **(0.0036 M)**

3. If it takes 50 mL of 0.5 M KOH solution to completely neutralize 125 mL of sulfuric acid solution (H2SO4), what is the concentration of the H2SO4 solution? **(0.10 M)**

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

5. If 75 ml of 0.823 M HClO3 requires 95.5 ml of Ba(OH)2 for complete neutralization, what is the concentration of the Ba(OH)2 solution? **(0.32 M)**

6. What is the concentration of a solution of NaOH if 21.2 ml of a 0.0800 M solution of

HCl are needed to neutralize 25 ml of the base? **(0.07 M)**

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**WS 14.5 Review Problems**

1. What is the [OH-] of a 4.0  10-4 M solution of Sr(OH)2? (**8.0 x 10-4 M**)

2. Given the following [H+] solution, determine the pH of each solution

a. 1.0  10-7 M

b. 3.2  10-12 M

c. 1  10-11 M

d. 4.5  10-9 M

3. Complete the following neutralization reactions. Balance each reaction. a. HCl + NaOH 

b. HNO3 + KOH 

c. Ca(OH)2 + HNO3 

d. Mg(OH)2 + HCl 

4. Calculate the pH of a solution that has an [H+] concentration of 8.4  10-11 M. (**10.1**)

5. What is the concentration of OH- in a 5.4  10-5 M solution of LiOH? (**5.4 x 10-5 M**)

6. Calculate the molarity of H+ in a solution that has a pH of 8.90. (**1.26 x 10-9 M**)

7. Find the molariy of a Ca(OH)2 solution, given that 428 ml of it is neutralized in a titration by 115 ml of 6.7  10-3 M HNO3. **(9.0 X 10-4 M)**

8. In the reactions below, identify each compound as acid or base:

a. H3O+ + ClO-  H2O + HClO

b. H2O + CO32-  OH- + HCO3-

c. H2S + HPO42-  HS- + H2PO4-

9. Write the conjugate base for each of the following acids:

a. H2O

b. H2CO3

c. CH3COOH

d. NH4+

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**WS 14.6 Review Problems**

1. What is the [H+] concentration for a solution with an [OH-] concentration of

2.5 X 10-8? (**4.0 x 10-7 M**)

2. What is the [H+] for a solution that has a pH of 6.3? (**5.0 x 10-7 M**)

3. Suppose that a 5.0  10-5 M solution of Ba(OH)2 is prepared. What is the pH of the solution? (**9.7**)

4. Calculate the [H+] concentration of a solution with a pH of 2.50. (**3.2 x 10-3 M**)

5. Calculate the pH for the solution in question #1. (**6.4**)

6. In a titration, 25.9 ml of 3.4  10-3 M Ba(OH)2 neutralized 16.6 ml of HCl solution.

What is the molarity of the HCl solution? **(1.06 x 10-2 M)**

7. A 0.250M solution of HNO3 is neutralized by 71.4 ml of a 4.2  10-2M solution of

KOH in a titration. Determine the volume of the HNO3 solution. **(12.0 mL)**

8. Write the conjugate acid for each of the following bases:

a. H2O b. HS- c. Br-

d. NH2-

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