Acid and Bases Exam Review
Honors Chemistry
3 April 2012

Chapter 14- Acids and Bases

Section 14.1- Acid and Base Properties

- List five general properties of aqueous acids and bases

Properties of Acids	Properties of Bases
Aqueous solutions of acids have a sour taste	Aqueous solutions of bases taste bitter
Acids change the color of acid-base indicators	Bases change the color of acid-base indicators
Some acids react with active metals and release hydrogen gas, H_2.	Dilute aqueous solutions of bases feel slippery
Acids react with bases to produce salts, water, and heat	Bases react with acids to produce salts, water, and heat
Acids conduct electric current	Bases conduct electric current

- Name common binary acids and oxyacids, given their chemical formulas
  - HCl- Hydrochloric Acid
  - H_2SO_4 – Sulfuric Acid
  - Name 2 more examples
    - Hydrobromic Acid
    - Chloric Acid
  - Naming rules? (you will not be provided with an ion sheet for the exam)
    - Binary acid- acid that contains only two different elements (hydrogen + another element that is not oxygen)
      - Name starts with the prefix "hydro-"
      - The root name of the second element follows the prefix
      - Root is followed by the suffix "-ic"
      - Followed by the word "acid"
    - Oxyacid- acid that is a compound of hydrogen, oxygen, + another element.
      - Base name of ion + "-ic" + acid
- List acids commonly used in industry and the laboratory and give examples of each
  - Remember Strong Acids = HI, $HClO_4$, HBr, HCl, H_2SO_4, $HClO_3$
  - ** Strong Bases are metal hydroxides, ammonia is not strong
  - What are some acids you have used in lab?
    HCl, H_2SO_4, vinegar (acetic acid)
  - Name at least one example of a weak acid.
    HCN, H_3PO_4, HF, CH_3COOH, H_2CO_3, H_2S, HCO_3^-
- Define acid and base according to Arrhenius's theory of ionization. List an example of each.
  - Arrhenius Acid = chemical compound that increases the concentration of hydrogen ions, H^+ (or H_3O^+), in aqueous solution. Ex. HCl
  - Arrhenius Base = chemical compound that increases the concentration of hydroxide ions, OH^-, in aqueous solution. Ex. NaOH
- Explain the difference between strong and weak acids and bases. List an example of each.
  - Strong Acid = ionizes completely in solution. Ex. HCl
  - Weak Acid = releases few hydronium ions in aqueous solution. Ex. CH_3COOH

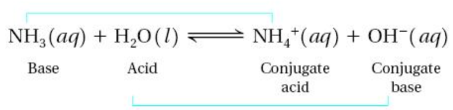
  - Strong Base = dissociates completely in solution. Ex. NaOH
  - Weak Base = releases few hydroxide ions in aqueous solution. Ex. NH_3

Section 14.2- Acid and Base Theories

- Define and recognize Brønsted-Lowry acids and bases and give an example of each.
  - Brønsted-Lowry acid = Molecule or ion that is a proton donor. Ex. HCl
  - Brønsted-Lowry base = Molecule or ion that is a proton acceptor. Ex. NH_3
- Define a Lewis acid and a Lewis base and give an example of each.
  - Lewis acid = An atom, ion, or molecule that accepts an electron pair to form a covalent bond. Ex. BF_3
  - Lewis base = An atom, ion, or molecule that donates an electron pair to form a covalent bond. Ex. F^-
- Name compounds that are acids under the Lewis definition but not under the Brønsted-Lowry definition
  Ex. BF_3

Section 14.3- Acid and Base Reactions

- Describe a conjugate acid, a conjugate base, and an amphoteric compound. Give an example of each.
  - Conjugate acid = A conjugate acid is the product formed when a base gains a hydrogen ion.
  - Conjugate base = A conjugate base is the product that remains when an acid donates a hydrogen ion.
  - Amphoteric compound = Any species that can react as either an acid or a base. Ex. H_2O

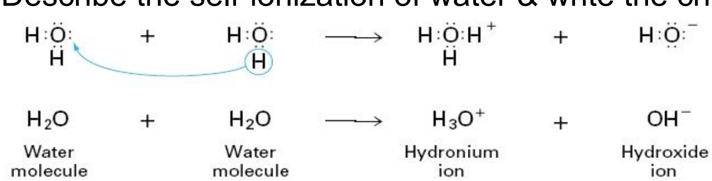


- Explain the process of neutralization- Reaction of hydronium ions and hydroxide ions to form water, salt, and heat.
  - $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$ + heat
- Define acid rain, give examples of compounds that can cause acid rain, and describe the effects of acid rain
  - Industrial processes produce NO, NO_2, CO_2, SO_2, and SO_3
  - Dissolve in atmospheric water to produce acidic solutions that fall to the ground in the form of rain or snow
  - $SO_{3(aq)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$

Chapter 15- Acid-Base Titration and pH

Section 15.1- The pH scale

- Describe the self-ionization of water & write the chemical reaction out.



- Define pH, and give the pH of a neutral solution at 25°C.
  - pH = A measure of how basic of acidic a solution is, based on the number of hydronium or hydroxide ions. Calculated using logs with a base of 10.
  - A neutral solution has a pH of 7.
  - An example of neutral solution is distilled (or pure) water (H_2O).

- Explain and use the pH scale.

Table 19.5

Relationship among $[H^+]$, $[OH^-]$, and pH

	$[H^+]$ (mol/L)	$[OH^-]$ (mol/L)	pH	Aqueous system
	1×10^{0}	1×10^{-14}	0.0	← 1*M* HCl
Increasing acidity	1×10^{-1}	1×10^{-13}	1.0	← 0.1*M* HCl
	1×10^{-2}	1×10^{-12}	2.0	← Gastric juice; ← Lemon juice
	1×10^{-3}	1×10^{-11}	3.0	
	1×10^{-4}	1×10^{-10}	4.0	← Tomato juice
	1×10^{-5}	1×10^{-9}	5.0	← Black coffee
	1×10^{-6}	1×10^{-8}	6.0	← Milk
Neutral	1×10^{-7}	1×10^{-7}	7.0	← Pure water
	1×10^{-8}	1×10^{-6}	8.0	← Blood
Increasing basicity	1×10^{-9}	1×10^{-5}	9.0	← Sodium bicarbonate, sea water
	1×10^{-10}	1×10^{-4}	10.0	← Milk of magnesia
	1×10^{-11}	1×10^{-3}	11.0	← Household ammonia
	1×10^{-12}	1×10^{-2}	12.0	← Washing soda
	1×10^{-13}	1×10^{-1}	13.0	← 0.1*M* NaOH
	1×10^{-14}	1×10^{0}	14.0	← 1*M* NaOH

- Given $[H_3O^+]$ or $[OH^-]$, find pH.
- Given pH, find $[H_3O^+]$ or $[OH^-]$.
- Be able to use logs on your (non-programmable) calculator.

The pH scale ranges from 0 to 14.

It is a logarithmic scale (based on 10).

The most acidic solution has a pH of 0.
The most basic solution has a pH of 14.
A neutral solution has a pH of 7.

What is the formula to calculate pH?
$pH = -\log[H^+]$
What is the formula to calculate pOH?
$pOH = -\log[OH^-]$
pH + pOH = 14.

What is the K_w of water? Ion-product constant

In pure water, $[H_3O^+] = 1.0 \times 10^{-7}$ M.

In pure water, $[OH^-] = 1.0 \times 10^{-7}$ M.

$K_w = [H_3O^+] \times [OH^-] = 1.0 \times 10^{-14}$ M.

Section 15.2- Titrations

- Describe how an acid-base indicator functions. Give an example of an indicator that you used.
    - Acid-base indicators are compounds whose colors are sensitive to pH
    - Red litmus paper turns blue for basic solutions
    - Blue litmus paper turns red for acidic solutions
    - Universal indicator paper turns a range of colors depending on the pH.
    - Transition interval- pH range over which an indicator changes color
    - pH meter- determines the pH of a solution by measuring the voltage between the two electrodes that are placed in the solution
    - Ex. Phenolphthalein Indicator

- Explain how to carry out an acid-base titration.
    - What is a titration? (definition)
        - The controlled addition and measurement of the amount of a solution of known concentration required to react completely with a measured amount of solution of unknown concentration

    - What is the purpose of performing a titration? *sketch
        - To determine the molarity (or concentration) of the unknown solution

    - How do you perform a titration? ((started in lab yesterday, you will be titrating vinegar on Monday)
        - Buret = graduated glassware used to hold titrant
        - Standard Solution = solution of KNOWN concentration- will be the base
        - Unknown Solution = solution of UNKNOWN concentration- will be the ethanoic acid in vinegar
        - Indicator = changes color at the equivalence point (phenolphthalein)
        - Equivalence Point = when the two solutions are present in equal concentrations (neutralization reaction has occurred and indicator changed color)

- Calculate the molarity of a solution from titration data.
  - Molarity refers to the number of molecules of a substance in a solution; a 1M solution contains 1 mole (6.02×10^{23} molecules or particles) of the substance in 1 liter of solution. Normality refers to compounds that have multiple chemical functionalities, such as sulfuric acid, H_2SO_4: a 1M solution of H_2SO_4: will contain only one mole of H_2SO_4 in 1 liter of solution, but if you titrate the solution with base, you will find that it contains two moles of acid. This is because a single molecule of H_2SO_4 contains two acidic protons. Thus, a 1M solution of H_2SO_4 will be 2N.

- Describe a way you could determine if an unknown solution is acidic or basic (inquiry lab).
  - Add phenolphthalein indicator to each acid and base in the reaction well. The indicator should have no effect on the acids (the solution will remain the same color), but the bases should turn pink.
  - Use Blue or Red Litmus paper or universal indicator paper

- Describe how you could rank acidic or basic solutions in order of increasing concentration. (inquiry lab).
  - Perform a microscale titration and record how many drops each takes to neautralize the solution. More drops = higher concentration.
  - React with a solid (Acids with $CaCO_3$, Bases with $FeCl_3$) and observe the reaction that takes place. More bubbles/ stronger reaction = higher concentration.

Problems:

1. Identify the acid, base, conjugate acid, and conjugate base in the following reactions.
   a. $HCN_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow HSO_4^-{}_{(aq)} + CN^-{}_{(aq)}$
   HCN, acid
   SO_4^{2-}, base
   HSO_4^-, conjugate acid
   CN^-, conjugate base
   b. $CH3COO^-{}_{(aq)} + H_2S_{(aq)} \rightarrow CH_3COOH_{(aq)} + HS^-{}_{(aq)}$
   $CH3COO^-$, base
   H_2S, acid
   CH_3COOH, conjugate acid
   HS^-, conjugate base
2. Identify the Lewis acid and Lewis base in the following reactions.
   a. $Al^{3+} + 6H_2O \rightarrow Al(H_2O)_6^{3+}$
   Al^{3+}, Lewis acid
   $6H_2O$, Lewis base
   b. $2NH_3 + Ag^+ \rightarrow Ag(NH_3)^{2+}$
   NH_3, Lewis base
   Ag^+, Lewis acid
3. Calculate the pH if the hydrogen ion concentration is 4.73×10^{-5} M.
   pH = 4.3

4. Calculate the hydroxide ion of a solution with a pH of 8.25.
   1.8×10^{-6} M

Problems continued:

5. A 0.130 M solution of acetic acid has a hydronium ion concentration of 1.53×10^{-3} M. Calculate the pH of the acid.

   pH = 2.815

6. A 50.0 mL sample of nitric acid is titrated to it end point with 25.2 mL of 2.50 M KOH. What is the concentration of the acid?
   1.26 M

7. What is the molarity of a NaOH solution if 38.0 mL of the solution is titrated to its end point with 14.0 mL of 0.750 M sulfuric acid?
   0.553 M

8. What volume of 0.12 barium hydroxide is needed to neutralize 12.2 mL of 0.25 M HCl?
   13 mL

9. A cleaner containing NaOH with a volume of 35.2 m: was neutralized with 25.4 mL of 2.50 mL sulfuric acid. Calculate the molarity of NaOH in the cleaner.
   3.61 M

10. What is the molarity of 55.3 mL of sulfuric acid if it is titrated to its end point with 122.7 mL of 0.75 M calcium hydroxide?
    1.7 M