Name _____

#13 Acids & Bases
Quantitative Chemistry

Student Learning Map

Unit EQ: What are acids and bases, and what role do they play in the world around us?

Key Learning: Acids and bases are unique compounds that have a variety of applications, not only in Chemistry, but in the world around us.

UNIT CONCEPT:

1. Properties	2. pH	3. Neutralization Reactions	4. Applications

LESSON ESSENTIAL QUESTIONS:

a. What are the properties of acids and bases? b. How do acids and bases ionize in water?	a. How do we measure the strength of acids and bases? b. How do I calculate pH?	What happens when an acid and a base combine?	a. Why is acid rain a serious environmental concern? b. What other roles do acids and bases play in the world?

LESSON ESSENTIAL VOCABULARY:

Acid Base Litmus Scientists: Arrhenius Brønsted-Lowry Lewis Dissociation Amphoteric Conjugate Acid Conjugate Base Hydronium Polyprotic	K_w pH pOH	Salt Titration	Acid Rain Buffers

Date:

1a. Properties of Acids and Bases

EQ: What are the properties of acids and bases?

A. General Characteristics

	Acids	Bases
Properties		
Litmus ***Definition:***		
Reactions		

B. Examples

Acids	Bases

Date:

1a. Properties of Acids and Bases (cont.)

C. Scientists

	Acids	Bases
1. Arrhenius		
2. Brønsted-Lowry		
3. Lewis		

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1b. Ionization

EQ: How do acids and bases ionize in water?

Conductivity Demo

A. Dissociation – Process by which compounds split into ions.

Strong Acids	**Weak Acids**
Dissociate _____.	Dissociate _____.
Example:	Example:
Diagram:	Diagram:

Date:

1b. Ionization (cont.)

B. Terms

1. Amphoteric –

2. Conjugate Acid –

3. Conjugate Base –

4. Hydronium –

5. Polyprotic Acids –

C. Problems

Write the ionization for the reaction of the following acids and water. Label **all** acids, bases, conjugate acids, and conjugate bases. *For multi-step problems, the conjugate base from one step becomes the acid in the next.*

1. HBr

2. HF

3. H_2CO_3 (2 step)

4. HNO_3

5. H_3PO_4 (3 step)

Date:

2a. Acid and Base Strength

EQ: How do we measure the strength of acids and bases?

pH scale – _____

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Strong Acids & Bases are considered dangerous (burn skin, eat away at materials).
Weak Acids & Bases are generally safer (used in foods and baking products).

Examples:

Strong Acids	**Strong Bases**
Weak Acids	**Weak Bases**

Date:

2b. pH Calculations

EQ: How I calculate pH?

A. K_w Constant

1. Since water is an _____ substance, it can behave as an acid OR a base.

2. The constant for the dissociation of water is referred to as K_w. At 25°C, this value is equal to 1.0×10^{-14}.

   Therefore, in any solution…

   $$\mathbf{[H^+][OH^-] = 1.0 \times 10^{-14}}$$

3. Types of Solutions

   a. _____

   b. _____

   c. _____

4. Problems

   Calculate either $[H^+]$ or $[OH^-]$ for each solution at 25°C and indicate whether the solutions are neutral, acidic, or basic.

   1. 1.0×10^{-6} *M* H^+

   2. 3.2×10^{-12} *M* H^+

   3. 7.9×10^{-5} *M* OH^-

   4. 1.0×10^{-7} *M* OH^-

   5. 3.14 *M* H^+

Date:

2b. pH Calculations (cont.)

B. Calculating pH & pOH

1. Equations

2. Problems

Solve the problems below and indicate whether the solutions are neutral, acidic, or basic.

a. Calculate the pH of a solution containing 9.18×10^{-11} *M* H^+.

b. Determine the hydroxide ion concentration in mol/L of a solution with a pOH of 7.8.

c. What is the pOH of a solution with a pH of 4.56?

d. Calculate the pH of a solution containing 3.18×10^{-5} *M* OH^-.

Date:

2b. pH Calculations (cont.)

Problems (cont.)

e. Calculate the pOH of a solution containing 4.55×10^{-10} *M* OH^-.

f. Determine the hydrogen ion concentration in mol/L of a solution with a pH of 8.9.

g. What is the pH of a solution with a pOH of 12.5?

h. Calculate the pOH of a solution containing 5.8×10^{-8} *M* H^+.

C. Calculating pH for Strong Acids

1. Since strong acids completely dissociate into ions….

   [Conc. Of Acid] = [Conc. Of H^+] {For a Monoprotic Strong Acid}

   To calculate the pH, simply take the –log of the acid's concentration.

2. Problems

   Calculate the pH of the following strong acid solutions.

   a. 0.10 M HCl

   b. 0.0010 M HNO_3

   c. 0.0250 M HCl

Date:

3. Neutralization Reactions

EQ: What happens when an acid and a base combine?

Lakeside Town:

A. What are Neutralization Reactions?

1. Definition - Neutralization Reaction:

   _____

   _____

2. The salt is formed from _____

   _____

3. The pH _____

B. Writing Acid-Base Equations

Predict the products of the following neutralization reactions. Be sure to write the correct formulas for the salts.

1. $HCl + KOH \rightarrow$

2. $HNO_3 + Ca(OH)_2 \rightarrow$

3. $HF + LiOH \rightarrow$

4. $H_2SO_4 + NaOH \rightarrow$

5. $HBr + Al(OH)_3 \rightarrow$

Date:

3. Neutralization Reactions (cont.)

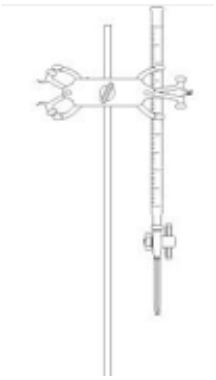
C. Titrations & Calculations

1. Definition - Titration:

   _____

   _____

2. Equipment



3. Common Titration Indicators

   a. Phenolphthalein –

   b. Bromothymol Blue –

4. Problems

   Note: This is Stoichiometry, Not Dilution!

   a. A 25.0 mL solution of 0.10 M HCl is titrated with 0.20 M NaOH until the indicator changes color. What volume of NaOH was used?

      $HCl + NaOH \rightarrow H_2O + NaCl$

Date:

3. Neutralization Reactions (cont.)

Problems (cont.)

b. How many grams of $Ca(OH)_2$ are needed to neutralize 4.5 mL of 2.00 M HCl?

$Ca(OH)_2 + 2HCl \rightarrow 2H_2O + CaCl_2$

c. A 100. mL sample of an unknown solution of HNO_3 is placed in a flask and titrated with 0.25 M KOH. A color change occurs once 34.2 mL of KOH have been added. What must have been the molarity of the HNO_3 solution?

$HNO_3 + KOH \rightarrow H_2O + KNO_3$

d. What volume of 3.0 M H_2SO_4 is needed to react completely with 1.5 L of 0.50 M NaOH?

$H_2SO_4 + 2NaOH \rightarrow 2H_2O + Na_2SO_4$

e. A sample of vinegar containing acetic acid is placed in a flask and titrated with 0.100 M NaOH. A color change occurs after 13.6 mL of NaOH have been added. What was the mass of acetic acid in the vinegar?

$HC_2H_3O_2 + NaOH \rightarrow H_2O + NaC_2H_3O_2$

Date:

4a. Acid Rain

EQ: Why is acid rain a serious environmental concern?

A. What Is Acid Rain?

_____

B. What Causes Acid Rain?

1. Rain is naturally acidic due to _____.

2. However, when _____ are burned, several other gases are released into the air. When they combine with rain water, they form _____.

    a. Sulfur Dioxide – _____

    b. Nitrogen Dioxide – _____

C. What Is Affected By Acid Rain?

1. Buildings / Statues – _____
2. Lakes – _____
3. Forests – _____

_____

Date:

4a. Acid Rain (cont.)

D. How Can We Fix The Problem?

1. Restoration

Liming - _____

_____

Disadvantages:

2. Prevention

a. _____

_____

b. _____

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4b. Acid & Base Applications

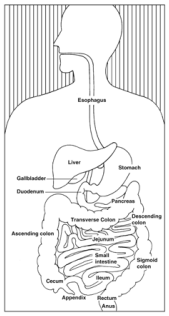
EQ: What other roles do acids and bases play in the world?

A. Cavern Formation

1. Limestone (_____) exists above a cavern.
2. _____ groundwater dissolves _____ from the limestone.
3. As water drips down through the cave, calcite is re-deposited, creating _____.
4. Calcite is white, but it combines with minerals such as _____ to create colors like red, black, and orange.

Date:

4b. Acid & Base Applications (cont.)

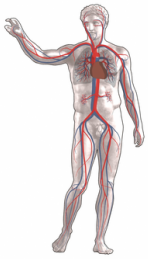


B. The Human Body

1. Digestive System

_____ dissolves food in the stomach.

2. Circulatory System



a. Chemical reactions in the blood need to occur at a specific pH.

b. This pH needs to stay between _____. (Slightly basic.)

c. This range is maintained by _____.

* Characteristics of a Buffered Solution:

1.

2.

C. Defense Mechanisms

Formic Acid –

1. Insects –

2. Stinging Nettle Plants –