Name: _____ Date: _____

Gen Bio 1 Lab #2: Acids & Bases

Pre-lab reading assignment pages 40-42 (9th ed.) pages 39-42 (8th ed.)

Pre-lab vocabulary

1. acid-
2. base-
3. pH
4. neutral-
5. neutralize-
6. electrolytes-
7. buffer-
8. salt-

Solutions review: group activity

The concentration of a solute in a solution is generally expressed as percent (%) or molarity. **Molarity** defines the number of moles of a substance in a solution. A **mole** is a defined number of molecules of any substance (6.022×10^{23}). Since we cannot measure molecules, we use the molecular weight of a substance instead. **Molecular weight** is the sum of the **atomic masses** of all of the atoms in a substance expressed in **grams**.

Example:

Molecular wt. of water H_2O = the atomic mass of 2 Hydrogen atoms + 1 Oxygen atom.

The atomic mass of H is 1g and the atomic mass of O is 16g.

The molecular wt. of H_2O then = 2 (1) + 16 = 18g

Molarity of solutions is always based on the amount you would put in 1 liter (1000 ml) of solvent. i.e.

A 1 molar (M) solution = 1 mole of a substance in 1 liter of water.

A 0.5 M solution = 0.5 mole of a substance in 1 liter of water.

Problem 1: What is the molecular weight of 1 mole of NaCl where the atomic mass of Na = 23 and Cl = 35.4?

Problem 2:

a. How many grams of NaCl do you need to make 1 liter of a 1M NaCl solution?

b. How many grams of NaCl do you need to make 1 liter of a 0.5 M NaCl solution?

c. How may grams of NaCl do you need to make 500 ml of a 1 M NaCl solution?

d. Convert 10 mM to Molar _____ and scientific notation _____.

NOTE: 1 millimolar (mM) solution has 1 mMole of a substance in 1 liter of solution.
Thus, 1 mM = 0.001M or 10^{-3}M (scientific notation)

Objectives

1. Compare pH of common solutions using pH papers and pH meters.
2. Define neutralization and demonstrate using common solutions.
3. Define buffer and show how buffers stabilize the pH of a liquid.
4. Measure the ability of commercial antacids to buffer the pH of a liquid.

Acids & Bases

One important application of molarity is measuring the concentration of hydrogen ions (H^+) in a solution. pH (or whether the solution is acid, basic or neutral) is a convenient way of expressing the H^+ concentration ($[H^+]$). The pH of pure water is the standard by which all other solutions are compared, because it is neutral. Although very stable some water molecules dissociate into 2 ions:

$H_2O \leftrightarrow H^+ + OH^-$

The concentration of H^+ in pure water is 10^{-7} M.

How do we calculate pH?

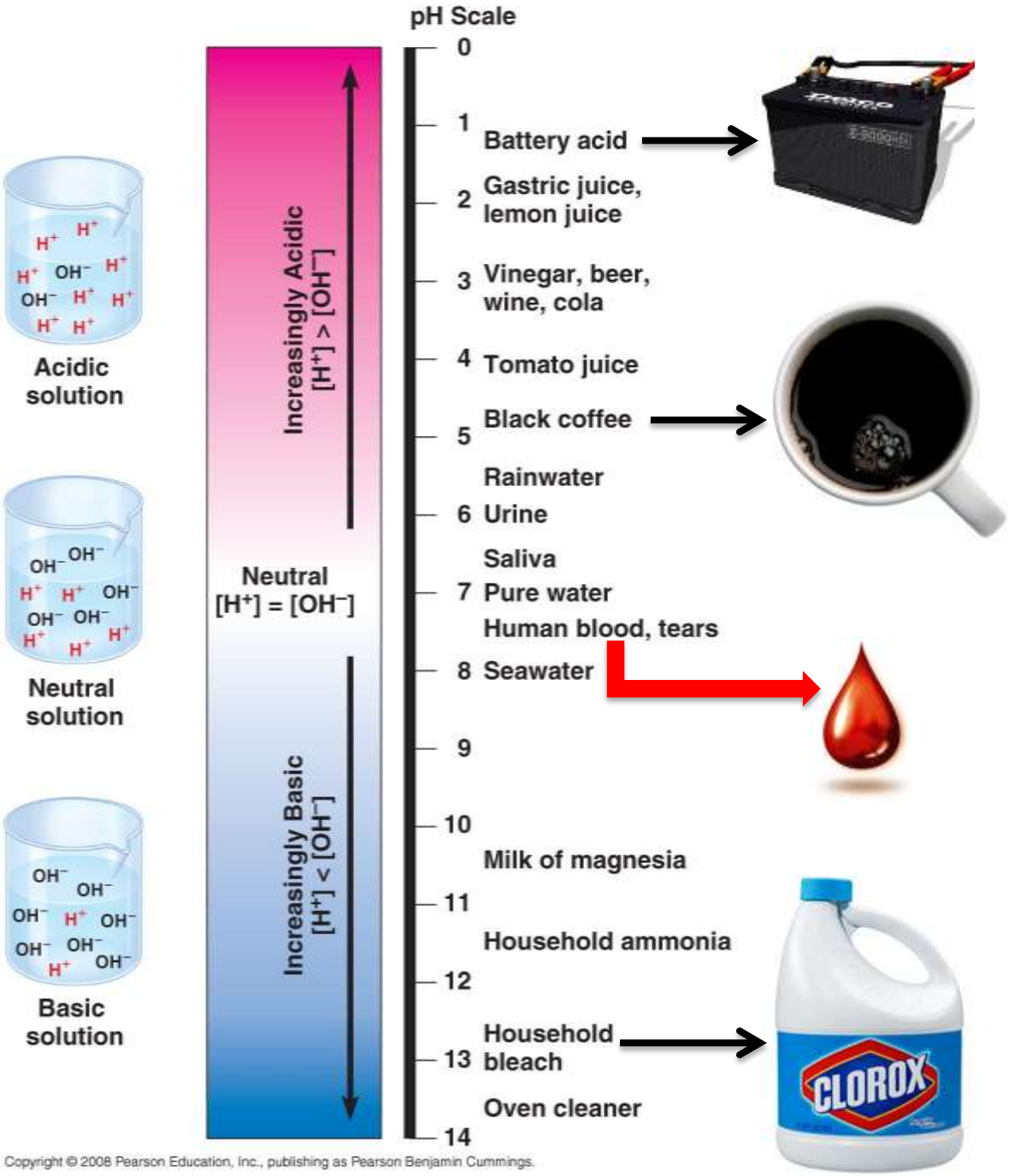
pH = - log of $[H^+]$

pH of water = - log of 10^{-7} M

= - (-7)

= 7

7.0 is considered a neutral pH. If the pH is lower than 7 the solution is an acid and if the solution has a pH higher than 7 it is a base. An **acid** can also be defined as a substance that donates H^+ when dissolved in water. A **base** then is a substance that absorbs H^+ or donates (OH^-) when dissolved in water. The pH scale ranges from 1 (10^0 M) to 14 (10^{-14} M) . Here are the pH's of some common substances:



Measuring pH

There are several methods used to measure pH, using indicator solutions, pH papers which are impregnated with indicators and pH electrodes. The pH electrodes are the most accurate but pH paper and indicators are a good estimate.

Materials

pH paper
10 ml of distilled water
10 ml of tap water
10 ml of Coke
10 ml of Windex
10 ml of Coke + Windex
10 ml of NaOH
10 ml of milk
Forceps

Procedure 1

1. For each of the following solutions, predict the pH – weak acid, strong acid, weak base, strong base, neutral.

2. Measure the pH of each solution using a **small** strip of pH paper. Using forceps, dip one end of the paper into the solution quickly and compare the color to the chart on the container.

Table 1

Solution	Predicted pH	pH measured with pH paper
Distilled water		
Tap water		
Milk		
NaOH		
Coke		
Windex		
Coke + Windex		

Questions:

Why would you need to know the exact pH of a solution?

Neutralization: If you combine equal quantities of equal concentrations of an acid and a base the pH will be neutral or 7.0. Why? Because the H^+ from the acidic solution combines with the OH^- from the basic solution to form HOH or H_2O which is neutral.

When you combined the Windex and Coke what happened to the pH?

Was it 7.0? Why or why not?

Procedure 2

Making Acid dilutions

Materials:
4 medium test tubes—labeled 1M, 100mM, 10mM, 1mM
100 ml H_2O
10 ml 1M HCl
pH paper

Procedure 2

1. Take the pH of the 1M HCl record it in the table below.
2. Make a 100mM solution of HCl by putting exactly 9 ml of H_2O in a test tube and pipetting exactly 1 ml of 1 M HCl. Cover with parafilm and vortex.
3. Make a 10 mM solution of HCl by putting exactly 9 ml of H_2O in a test tube and pipetting exactly 1 ml of your 100mM HCl. Cover with parafilm and vortex.
4. Make a 1 mM solution of HCl by putting exactly 9 ml of H_2O in a test tube and pipetting exactly 1ml of 10 M HCl. Cover with parafilm and vortex.
5. Measure the pH of each solution and record In Table 2.

Table 2

Solution	Predicted pH	pH measured with pH paper
1M HCl		
100mM HCl		
10mM HCl		
1 mM HCl		

Question:
What would this technique be useful for in medical science?

Procedure 3

Buffers

It is very important in living organisms that the pH of their solutions is kept within certain limits. For instance, in humans the pH of the blood must be within the range of 7.3 – 7.5. A blood pH outside this range may be fatal. Most biological solutions have buffers to maintain the pH within certain limits. Buffers can donate H^+ when the pH is too high (basic) and absorb H^+ when the pH is too low (acid) – within certain limits.

Materials:

4 medium test tubes
5 ml Distilled H_2O
5 ml Milk
5 ml 0.1M (PO_4) Buffer
5 ml 0.1 M HCl
5 ml 0.1M NaCl
pH paper

Procedure 3

Test the ability of buffers to stabilize pH.

1. Label 4 medium sized test tubes as follows: water, NaCl, 2% milk, PO_4.
2. Add 5 ml of each solution to the appropriate tube.
3. Measure the pH of each solution using the pH paper and record results on Table 3.
4. Add 5 drops of 0.1M HCl to each tube, mix, measure pH again and record in Table 3.

Table 3

Solution	pH Before	pH After
Distilled H_2O		
0.1M NaCl		
2% Milk		
0.1M (PO_4) buffer		

Questions:

Which solution changed the most?

Which solutions changed the least?

Which solution is the best buffer? Why?

Procedure 4

Test the effectiveness of commercial antacids.
Commercial antacids claim to neutralize stomach acid by absorbing excess H^+ (from HCl produced by the stomach.

Materials:
4 Tall test tubes
5 ml of Alka-Seltzer
5 ml of Maalox
5 ml of Tums
5 ml of Rolaids
Bromcresol purple
100 mM HCl made in Procedure 2

Procedure 4
1. Label 4 tall test tubes as follows: Alka-Seltzer, Maalox, Tums, and Rolaids.
2. Pipet 5 ml of each antacid solution - **STIR WELL BEFORE PIPETTING – into the appropriate tube.
3. Add 4 drops of bromcresol purple into each tube and mix.
4. Add 100mM HCl 1 drop at a time into the tubes until the solution turns from purple to yellow (this indicates an acid).
Be sure to mix after each drop and count the drops as you add them!!!!!!!!!!
5. Record the number of drops you added to each tube to obtain a yellow solution in Table 4.

Table 4

Solution	**Drops added**
Alka-Seltzer™	
Maalox™	
Tums™	
Rolaids™	

Questions:
Which antacid is the most effective? Why?

Which is the least effective?

Read the labels for each antacid and record the active ingredients.
Alka Seltzer_____

Maalox_____

Tums_____

Rolaids_____

Questions to e x p a n d your mind.

1. What are some "everyday applications" of pH and acidity?

2. Your stomach secretes hydrochloric acid. How would antacids "settle an upset stomach"?

3. Of all the solutions you tested which pH surprised you the most and which the least? Why?

4. **INTERNET QUESTION** How does Prilosec **or** Zantec work? (Choose 1 medication; Hint: They work differently from the other antacids used in our lab)