**Background:** Acids and bases are responsible for a very unique type of reaction called, conveniently enough, acid-base reactions. In a Discovery, you will work in groups of 2 and complete a series of activities to *discover* information about the subject we are covering.

**IT IS EXTREMELY IMPORTANT THAT YOU READ ALL DIRECTIONS CAREFULLY**. *Doing these activities in the future will depend exclusively on your behavior and work ethic during these activities.*

**Part I—Acid-Base Reactions**

1. Directions: Read the section entitled “**Acid-Base Reactions**” and “**Neutralization is a reaction between ions**” on page 302 of your textbook. *Answer the following questions*:
2. What is a neutralization reaction?
3. What are spectator ions?
4. What are the spectator ions in the following acid-base reaction equations?
5. **H+ + SO4-2 + Al+3 + OH- 🡪 H2O + Al+3 + SO4-2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
6. **HNO3 + NaOH 🡪 H2O + Na+ + NO3-  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
7. **H2CO3 + KOH 🡪 H2O + K+ + HCO3-  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
8. Directions: Read the sections entitled “**Strong acids and bases react to form water and a salt**” and “**Neutral solutions are not always formed**” on page 303 of your textbook. *Answer the following questions:*
9. What does your book tell you a “**salt**” is in acid-base reactions?
10. Suppose you performed **2 different** acid-base reactions. In reaction **(A)**, the solution remained clear and only heat was produced. In reaction **(B)**, the solution became cloudy and a precipitate formed. **What do these results tell us about the *salt* in solution (A)? What about the *salt* in solution (B)?**
11. Suppose you add 20-mL of an **unknown strong acid** to 20-mL of an **unknown strong base**. Would this solution be safe to touch? *Explain why or why not.*

**Part II—pH Computer Demonstration**

Directions: For this activity, use the laptop set up on lab table #1. On the screen is an interactive computer demo entitled “**pH Scale**.” Familiarize yourself with some of the controls of the program (click-and-drag sliders and drop-down menus) and then press “Reset All.” *Answer the following questions by manipulating variables as specified.*

1. Check the box entitled “H3O+/OH- ratio.“ **Red dots** represent hydronium ions while **blue dots** represent hydroxide ions. *Adjust the pH slider up and down, observing how this changes the number of each type of ion.*
2. As you raise pH, which type of ion concentration increases? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. As you lower pH, which type of ion concentration increases? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Based on your observations, what does a high (greater than 7) pH indicate?
5. What does a low (lower than 7) pH indicate?
6. **Reset the simulation.** Check the box entitled “Molecule Count.”
7. From the drop down menu in the top right, select “vomit” (pH 2.0) and *record the number of hydronium ions.* \_\_\_\_\_\_\_\_\_\_
8. Then, select “battery acid” (pH 1.0) and *record the number of hydronium ions. \_\_\_\_\_\_\_\_\_*
9. Determine how many times more concentrated battery acid is than vomit. *To do this, divide the number of hydronium ions in battery acid by the number of hydronium ions in vomit (use a calculator):*

**Battery acid is \_\_\_\_times more concentrated than vomit.**

1. **Reset the simulation.** Check the box entitled “Molecule Count.”
2. From the drop down menu, select “drain cleaner” (pH 13.0) and *record the number of hydroxide ions. \_\_\_\_\_\_\_\_\_\_*
3. Then, select “hand soap” (pH 10.0) and *record the number of hydroxide ions. \_\_\_\_\_\_\_\_\_\_*
4. Determine how many times more concentrated drain cleaner is than hand soap. In this case, you are dealing with basic solutions. **Adjust your calculations accordingly.**

**Drain cleaner is \_\_\_\_times more concentrated than hand soap.**

1. **Reset the simulation.** Set up your own pH-simulation experiment. Briefly describe what you are investigating and record set-up and results.

**Part III—Titrations**

Directions: Read the following information about titrations carefully. *Answer the questions that follow.*

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| ***titsetup.gifTitrations:*** *Acid-base reactions involve the neutralization of acidic solutions with basic solutions. A titration is a technique used by chemists to determine the concentration of unknown acids. Using a basic solution of known concentration, chemists can experimentally determine the concentration of a sample of unknown strong acid.*  ***Standardization:*** *Before a chemist can perform a titration, a solution of strong base must be standardized. To do this, chemists add an indicator to a solution of 1.0 M hydrochloric acid, and add the base to the solution until the indicator just begins to change color (See figure 1). This standardization step is performed three times and the results averaged. This average is then used in a stoichiometry equation (More on this in Chem. I) to determine the concentration of the now-standardized base.*  ***Set-up*:***A titration apparatus is set up as shown in figure 2. Notice that the standardized NaOH is in the buret. The unknown acid is in the Erlenmeyer flask with 2-3 drops of indicator in it.*  ***Experiment:*** *Standardized NaOH is added slowly to the solution until the indicator just begins to turn and remain pink. A good titration should leave a solution with a very light pink color.* | Figure 1. *Titration Set-up* |

**Questions:**

1. What is the main purpose of a titration?
2. *Circle the correct answer:* The indicator, phenolphthalein, turns pink when a solution is **acidic** or **basic** ?
3. (A) Why is it important for a chemist to stop a titration when the solution is only beginning to change color?

(B) What is one way a chemist could get a solution to return to its colorless state?

1. *In groups of 4 (2 groups together), come to the front table and observe Mr. Mitchell demonstrate the use of a titration apparatus.*
2. What did you notice about the indicator as sodium hydroxide was initially added to the flask?
3. Why is it important to swirl the solution as the NaOH is added?
4. When reading a buret, there are 2 important procedures that must be followed. *What are these 2 procedures?*

**Part IV—Strong and Weak Acids**

Directions: For this activity, use the computer at the front of the room. On the screen is an interactive computer demo entitled “**Acid-Base Solutions**.” Familiarize yourself with some of the controls of the program (click-and-drag sliders and drop-down menus) and then press “Reset All.” *Answer the following questions by manipulating variables as specified.*

1. Note that the key for the acid-base equilibrium is below the reaction container on the screen. Set concentration to **“.001 M**” by *dragging the slider to the left*. Set the acid type to **maximum weakness** by *dragging the slider to the left*.
2. Describe the equilibrium of this system.*What do you notice about the amount of* ***“HA” (unreacted acid)*** *vs.* ***“A-“ (reacted acid)****?*
3. Lower the pH meter into the solution by **dragging the pH meter’s tip into the solution**. *What is the pH of the .001 M weak acid? \_\_\_\_\_\_\_\_\_\_\_*
4. **Reset the simulation.** Set concentration to “**.001 M**.” Set the acid type to **maximum strength** *by dragging the slider to the right.*
5. Describe the equilibrium of this system. *What do you notice about the amount of* ***“HA” (unreacted acid)*** *vs.* ***“A-“ (reacted acid)****?*
6. Lower the pH meter into the solution by **dragging the pH meter’s tip into the solution**. *What is the pH of the .001 M weak acid? \_\_\_\_\_\_\_\_\_\_\_*
7. **Reset the simulation.** Design an experiment for testing the conductivity of strong and weak bases. Briefly explain what you did to test this below:
8. Is the conductivity trend of strong and weak bases similar to that of strong and weak acids? Explain why or why not.

**Part V—Homework**

Directions: If you finish parts I and III and are waiting on a computer to become available (or if you finish the entire activity), use the information you have gained in this discovery + your book to begin work on the homework due tomorrow.

**Note:** This opportunity to avoid take-home work should be taken advantage of. *Failure to do so will eliminate these opportunities in the future.*