Natural Indicator Lab

Background:

Many natural substances, foods, flower petals, tree barks, etc. will change color when brought in contact with an acid or base. This behavior labels them as indicators. There are reference tables that describe the nature of the color change, and gives the pH at which the color change occurs for many man made indicators.

pH is the percent of hydrogen ions, sometimes referred to as hydronium (H_3O^+), in a solution. Acids are associated with high levels of hydrogen ions in solution. Bases are associated with low levels of hydrogen, but high levels of hydroxide ions in solution. The compound water has equal quantities of both, making it neutral. pH is calculated from the concentration of the hydrogen ion, written $[H^+]$. pOH is calculated from the concentration of hydroxide, written $[OH^-]$. For strong acids and bases, their molarity will be the concentration of the relative ion. If equation 1 or 2 below is applied to the concentration, the pH or pOH can be found Equations 3 and 4 below allow you to go from pH or pOH to the ion's concentration. This concentration tells you how many ions are available for other reactions.

Eq 1: $pH = -\log[H^+]$ Eq 3: $[H^+] = 10^{-pH}$

Eq 2: $pOH = -\log [OH^-]$ Eq 4: $[OH^-] = 10^{-pOH}$

On the pH scale, acids have low pH's and bases have high pH's (a quirk of the log function used to calculate pH). On the pOH scale, acids have high pOH's and bases have low pOH's. You can see they are opposites. This leads to the relationship of $pOH + pH = 14$. Knowing one, allows you to calculate the other. Even though scientists discuss and calculate both the pH and pOH, society focuses on pH.

In this laboratory you will estimate, measure, and calculate the pH of several household substances by using a natural indicator you will make in part one. You will then use your results to help determine the color/pH range of your indicator.

Acid/Base Vocabulary
pH
pOH
concentration
molarity
indicator
hydronium ion
hydrogen ion
hydroxide ion
acid
base

Possible Apparatus:

stove
400 mL beakers
test tube rack(s)
knife
blender
pots/pans
~ 20 test tubes
stir rod
droppers
spatula/spoons/scoopula

Materials:

0.10 M HCl
0.10 M NaOH
pH paper
distilled, de-ionized water
10 household samples
wash bottles

Possible Indicators:

colorful veggies (red cabbage, beets)
highly colored (red) flower petals
highly colored fruit (blueberries, strawberries, cherries)
leaves/ grass/ bark

NOTE: EACH GROUP WILL BE RESPONSIBLE FOR BRINGING IN THEIR OWN PREPARED INDICATOR AND SAMPLES TO TEST ON LAB DAY

Procedures:

Part I: Extracting the Indicator (to be done at home)

1. For beets, red cabbage or flowers:
   a. Clean the indicator. If necessary, cut or break into pieces to increase speed of making indicator.
   b. Place in proper container (see step 2). Add just enough drinking or distilled (not tap even if it is filtered) water to make about 2cups of solution. OR cover the item with water, which ever is more.
2. a. For flowers or beets: Boil until the solution is a deep color. Beets-short time, flowers-long time.

b. For fruit: let defrost; pour off juice; mush solids to collect more juice, just the juice. Don't blend in blender- will be too thick.

c. For red cabbage: use blender to puree (with drinking or distilled water as in step one) until see rich color.

3. Once the solution is made: remove large pieces; filter out small pieces; if necessary, add water to make ~ 2 cups (but not too much- you want to keep the deep color); label (with substance, your name and period) and save for testing of samples. If you make it more than 2 hours in advance (but not more than 24 hours), it must be kept cold or it will spoil. Bring into class before school starts for storage.

Part II: Preparation of Standards

1. Put ~ 2mL of 0.10 M HCl into a labeled test tube (eyeball it).
2. Add from 5 drops to 2-3 droppers full of the natural indicator. If the color is not pronounced, it may be necessary to add more indicator. Note: you may need to add the standard to the indicator to get good color results. In that case, add just a little standard at a time until a pronounced result is seen. If you find this method works best, test your other standards and samples (Part III) the same way. If it is never obvious either way, note this and do the best you can with your results.
3. Repeat procedures 1 and 2 with 0.10 M NaOH, and distilled water.
4. Set the acid test tube at the left end of the test tube racks, distilled water in the middle, and base at right end. You have just set up a pH scale- these are your extremes and neutral. These are your standards that you will use to compare your household samples to help determine their pH. DO NOT THROW THEM AWAY UNTIL YOU HAVE FINISHED PART III OF THE LAB.

Part III: Testing of Common Household Substances

1. For each substance to be tested: label each test tube with a china marker, then obtain about 1/8 teaspoon of the substance to be tested. Test your sample as you did the standard to see what color you get. Compare the color of the substance with your standards, and other samples, to determine if the substance is acidic, basic, or neutral. Record observations. Note: if your sample is thick, or dry, you may need to add distilled water to dilute it so you can see the color better. When figuring out color, be sure to think about what color your sample is, and how that may affect results. If you dilute it, you have changed its pH, slightly.
2. Place all samples in the rack in color (pH) order as you go to help see the color progression from acid to base. You should end up with some sort of rainbow effect (ROYGBIV). Some will be all colors, others variations on the same color.
3. On your data table, you will have to guess pH's at this point. Fill in your guess pH's before moving on to part IV. This portion of the table must be shown to the instructor before moving on.

Part IV: Using pH paper

Use pH paper to test the pH of your household samples. Obtain the paper from the teacher. Be sure to fill in the actual pH for these on your data table. Use this information to re-evaluate your household substance pH's. When you do your write-up be sure to address this issue and any other difficulties or cool things you discovered.

Sample Data Table:

substance	color	A/B/N	pH(guess)	pH(research)	pH(from paper)	observations
HCl						
NaOH						
H_2O						
samples (list them all- about 10 more lines)						

Calculations:

1. Calculate actual pH, $[H^+]$, and $[OH^-]$ for your standards. Hint: look at molarities as discussed in class. Be sure to show an example calculation for $[H^+]$, $[OH^-]$, and pH. Create a new table to display these answers.
2. All samples should have a guess pH (according to your indicator), pH according to research findings (be sure to site sources) and pH from the pH paper.

Analysis:

1. Recap and discuss your group findings (calculations, things found out in lab and things to be discussed in your presentation).
2. Include a table (labeled "Individual Contributions") of all your group members (including yourself) and rank each member on a scale of 0 (low) to 5 (high) in the following categories:
    a. Contributions to group
    b. Topic knowledge
    c. Attendance at all group meetings (in and out of class)
    d. Participation in presentation (this means helping to prepare, organize and participate in)
    e. Materials contribution (for lab and presentation)

Concluding Questions:

1. How/why was it possible (or not) to rank your samples from most acidic to most basic?
2. Why would some substances make better indicators than others?
3. What do you say about your indicator and/or your ability to estimate pH well?
4. Liquid, paper, and electronic meters are three possible methods of testing pH. Research about electronic pH meters. Based on your experiences with the liquid and paper and your research, which do you think is most accurate and why?

Presentation of Results:

As a lab group, you will present your results. Your presentation should last no longer than 5 min (don't stretch it, it's ok if it's shorter). You need to discuss:
1- what your indicator was and how you prepared it and got your results (a.k.a. your methods)
2- the color range of the indicator for samples, and its own color change/pH range
3- pH of samples you tested (the guesses, research, and real- how close or far apart), any surprises?
4- general conclusions about the usefulness of your indicator and its indicating range(s)
In addition, you need to have a large, colorful visual display, which ranks your tested substances FROM most acidic TO most basic (like a pH scale). Draw with colors, label each item, state their pH's (guess and real). Get creative. The prettier, the better...

How this is your Quarter Project:

You will conduct the lab next class and present your results the following class. On presentation day, you will turn in your lab report and vocabulary for this unit. Be prepared to present when called upon. Remember volunteers always get bonus points.

You will receive grades as follows:

group grades- poster and presentation
individual grades- individual contributions, lab report, vocabulary

This project will take us through the end of the semester. You will also turn in your semester essay (review given next period). There is not much time left, so this strict schedule will be adhered to. There is no time for review, so you will need to come in before or after school for questions.

Natural Indicator Report Rubric

Title 1 2

Prelab 10 15

Data Table 5 10 15

Calculations =______/12

Analysis =______/13

Conclusions =______/8

Questions =______/4

Organized 1 2 3 4 5

Score:_______/74

Natural Indicator Report Rubric

Title 1 2

Prelab 10 15

Data Table 5 10 15

Calculations =______/12

Analysis =______/13

Conclusions =______/8

Questions =______/4

Organized 1 2 3 4 5

Score:__________/74

Natural Indicator Report Rubric

Title 1 2

Prelab 10 15

Data Table 5 10 15

Calculations =______/12

Analysis =______/13

Conclusions =______/8

Questions =______/4

Organized 1 2 3 4 5

Score:__________/74

Natural Indicator Report Rubric

Title 1 2

Prelab 10 15

Data Table 5 10 15

Calculations =______/12

Analysis =______/13

Conclusions =______/8

Questions =______/4

Organized 1 2 3 4 5

Score:__________/74

Natural Indicator Report Rubric

Title 1 2

Prelab 10 15

Data Table 5 10 15

Calculations =______/12

Analysis =______/13

Conclusions =______/8

Questions =______/4

Organized 1 2 3 4 5

Score:__________/74

Natural Indicator Report Rubric

Title 1 2

Prelab 10 15

Data Table 5 10 15

Calculations =______/12

Analysis =______/13

Conclusions =______/8

Questions =______/4

Organized 1 2 3 4 5

Score:__________/74

Natural Indicator Grading Rubric (74 pts total)

- **Title:** 2pts if in area below shaded region, 1pt if have one only in shaded region
- **Prelab:** 10pts if have no stamp; 15 pts if have stamp
- **Data Table (15pts):** 5pt if any data present or if empty table; 10pts if some data in table; 15pts if carefully labeled table with data
- **Calculations (12 pts):**
  1. **calc of pH, H^+ and OH^- (3pts- 1pt each)**
     a. **pH:** show use of log button
     b. **$[H^+]$:** show use of the 10^{-x} button
     c. **$[OH^-]$:** show use of the 14 – pH and then 10^{-x} button OR $1x10^{-14}/[H+]$
  2. **proper data in data table (9pts): 1pt for each box (-1/2 if doesn't agree, -1 if blank)**

Item	$[H^+]$	$[OH^-]$	pH
HCl	0.1	$1x10^{-13}$	1
NaOH	$1x10^{-13}$	0.1	13
Water	$1x10^{-7}$	$1x10^{-7}$	7

- **Analysis (13 pts):**
  1. **discussion of findings and presentation information** – 3pts for discussion
  2. **group member ranking table -** 10pts for doing, 5 if left off self or only half done, 0 if empty table… don't worry about actual scores

- **Conclusions (8pts):** 2pts for any writing + 2 more pts for discussion about how good/bad the indicator was + 2 more pts for recap of colors + 2 more pts for their results vs. research or guess

- **Questions (may be incorporated into conclusions look carefully)(4pts- 1pt each):**
  1. **Ranking samples Acid to Base….** Color change
  2. **Why some are better indicators…** more dramatic color changes in pH ranges.
  3. **Indicator's ability…**if say good colors should say good indicator. If poor colors, poor indicator.
  4. **Most accurate pH measurer…** pH meter because it gives an electronic reading based on the conduction of electricity.

- **Organization (5pts):** 1pt for each of the following: Organization, Neatness, Legibility, no write through from one carbonless paper to another, you did not have to ask for assistance