Beverage Tests

ID: 13607

Time required: 1 class period
Suggested Grade Levels: 6–8

Activity Overview

In this activity, students will use the CBL 2™ with a pH sensor to test the pH of common beverages. They will then choose a graph that will compare the drinks by their pH and use the results to identify mystery solutions.

Math Objectives:

- *Create graphs comparing pH levels*

Science Objectives:

- *Understand how to determine the pH of a liquid*
- *Classify a solution as an acid, a neutral, or a base*
- *Identify an unknown solution based on its pH*

Materials

- *TI-73 Explorer™*
- *CBL 2™*
- *pH sensor*
- *Distilled water for rinsing sensor*
- *Beaker or container for rinse water*
- *14 beverage samples (7 known to students and 7 unknown)*
- *SciAct06_BeverageTest_worksheet_TI73.doc*

Teacher Preparation

- *Use small plastic bathroom cups housed in egg cartons for the beverage samples.*
- *Students can provide a variety of popular beverages to test. Include tap water, milk, orange juice, lemonade, Kool-Aid, tea, soda, coffee, and so on. As a hypothesis, students can rank beverages from least to greatest by acidity; just predict acid, neutral, or base for each sample; or both.*

  ***Caution**: Be sure to consider that some students may be allergic to some beverages.*
- *Provide distilled water for rinsing the pH sensor between trials. Crook-necked bottles work well.*

Classroom Management

- Assign these student jobs for this lab:
  - Materials/setup person (sets up samples, sensor)
  - Tech person (operates CBL 2™ and TI-73)
  - Data recorder (reads pH readings from the TI-73 at each collection)
  - Runner (brings CBL 2 and TI-73 to the computer to print out graphs with TI-GRAPH LINK™ or TI™ Connect and brings **worksheets** to the teacher)
- Clear covered plastic shoeboxes will hold a CBL 2™, pH sensor, cups, rinsing bottle, and other equipment neatly at each station. If students are sharing one pH sensor, representatives from each lab group would bring test beverages in the cups to the sensor. Mounting the sensor on a ring stand is an option.

  Note: *pH sensor must remain in buffer solution bottle (packaged with the sensor) when not in use. If the sensor becomes completely dry, it will stop working.*
- Students can record pH readings as they are displayed on the TI-73 in their lab journals. This keeps them engaged throughout the data collection period and if they lose their data/graph later, they can still write up their lab report. Students can also access the data in the TI-73 lists after data collection. You can send the lists to all students' calculators using [APPS] **1:Link**.

  a. Press [APPS].

  b. Press [ENTER] to select **1:Link.**

  c. Select **4:List** and press [ENTER].

  d. Press [▼] to move the ▸ beside the list you wish to send. Press [ENTER].

  e. Repeat step **d** for each list you wish to send.

  f. Set the receiving unit by pressing [APPS] [ENTER] [▶] to select **RECEIVE**. Press [ENTER]. **Waiting…** displays on the TI-73 screen.

  g. On the sending unit, press [▶] to select **TRANSMIT** and press [ENTER].

  For more permanent storage of data, use TI-GRAPH LINK™ or TI™ Connect to save the lists in a computer folder.
- Students can assess each other using a teamwork rubric after the lab. Provide a checklist of positive and negative behaviors. Copy these on quarter sheets of paper.

Classroom Management

- Choosing an appropriate graph to answer a specific question can be explored by having different lab groups display data using different graphs. Compare a line plot of pH (1-variable), bar graph (categorical) and/or scatter plot (beverage number on the *x*-axis, pH on the *y*-axis) to a circle graph showing the percent of all tested beverages as being an acid, a neutral, or a base. Use the TI-73 to make all but the line plot.

- Students can print their graphs on the computer using TI-GRAPH LINK™ or TI™ Connect software and cable. One option is to paste the graph into a word processing program. Students can then write their lab report/conclusion with the graph.
- In a one-computer classroom, a student from each lab station can use TI-GRAPH LINK or TI Connect to print out copies of the graphs for each team member. Students then can incorporate these graphs into their lab reports.
- Middle school students are often learning initial graphing skills. Determining the scale for the axes is difficult for many. Therefore, the **worksheet** provides space for those students to hand plot the data points for each graph and write their conclusions.
- Since each group is getting only one value for each beverage, average all of their results and have the students record the results on the **worksheet**.
- As a homework assignment, ask students to find some of the beverages in their refrigerators at home and compare the taste of one of the more acidic beverages to one that is a base or a neutral.

  ***Caution**: Be sure that these taste tests are NOT conducted in the lab setting using the lab samples.*

  Students may describe acidic beverages as being sour and basic drinks as being bitter compared to water (neutral).

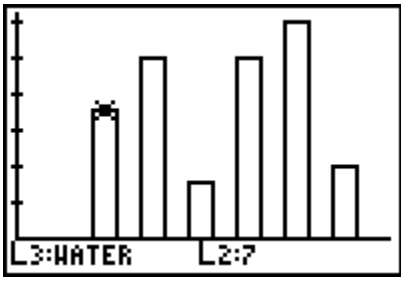
Application

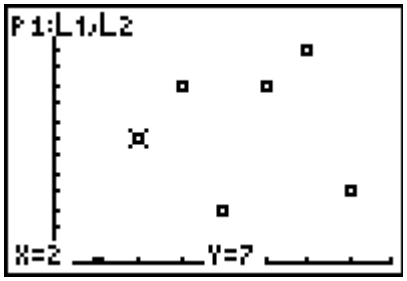
- Prepare up to five clear mystery liquids. Distilled water, flat lemon-lime soda, soapy solution (water and five drops of clear liquid soap), weak ammonia solution, and hydrogen peroxide work well. Provide a pH description of up to 10 common clear liquids, including the test solutions. Students will measure the pH and identify each liquid by its pH.

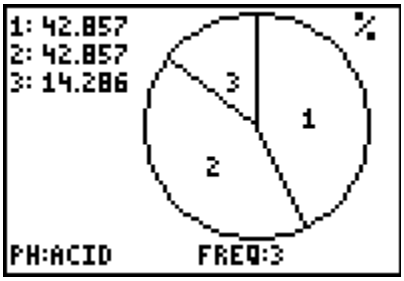
Extensions

- Set up an experiment testing different antacids. Use your pH readings to decide which would do the best job of neutralizing stomach acid.
- Collect different soil samples from your area. Mix a set amount in 2 oz. of distilled water. Test the pH of each solution. Which soil sample would be best for growing grass? Flowers? Compare pH results from the CBL 2 to those from a commercial lawn pH meter.

Selected Answers – Worksheet







14. Students will classify acidic beverages with vinegar (pH < 7), basic beverages (pH > 7) with ammonia, and neutral liquids (pH = 7) with water. Some students may use pH to describe most beverages as being a weaker acid or base compared to vinegar and ammonia.

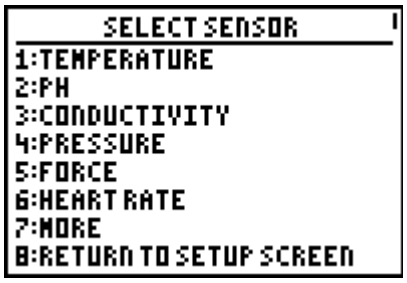
The Problem

Are most of the beverages you drink each day acids, neutral, or bases?

Hypothesis

Before testing, answer the questions on the **worksheet** pages to predict the pH of the beverages.

Collecting the Data



1. Collect the beverage samples.
2. Plug the pH sensor into Channel 1 (**CH 1**) on the CBL 2 using the DIN adapter, if necessary.
3. Start the DATAMATE program.
4. The Main Screen is displayed. If **CH 1:PH** is displayed at the top of the screen, go to step 9. If **CH 1:PH** is not displayed, go to step 5.
5. Select **1:SETUP**.
6. Select **CH 1**. Select **2:PH**.
7. Select **MODE**, and then select **3:EVENTS WITH ENTRY**.
8. Select **1:OK** to return to the Main Screen.
9. Before measuring the pH of your first sample, rinse the pH sensor as demonstrated by your teacher. Repeat this process each time you are ready to measure a new sample.
10. When you are ready to begin, select **2:START**. The screen displays **PRESS ENTER TO COLLECT OR STO TO STOP**.
11. Place the pH sensor in the sample and gently swirl the container around the bottom of the pH sensor. When the pH reading is steady, press [ENTER].
12. The program asks you to enter a value. This value is the number of your sample, NOT the pH value. Type the number for this sample (for example, if this is the first sample, type **1** and press [ENTER]. Record the sample name beside the number in the table on the **worksheet**. The program returns to the data collection screen, ready for your next sample.
13. Repeat steps 9 through 12 for each sample, using the number for the sample when the program asks for a value after you have the pH. After you enter the first sample number, the last number you used is displayed at the bottom of the screen.
14. After you have collected the pH value for your last sample, press [STO▶]. A plot of your data, or a scatter plot, is displayed, showing the pH value for all of your samples. Use [◀] and [▶] to move to each data point and record the values in the table on the **worksheet**.

15. To exit from the DATAMATE program, press ENTER to return to the Main Screen. Select **6:QUIT** and press ENTER.

16. To display the lists showing the results, press LIST. The sample numbers for the beverages are stored in **L1**. The pH values are stored in **L2**.

17. To add the names of the liquids to **L3**:

a. Highlight the first element in the list.

b. Press 2nd [TEXT].

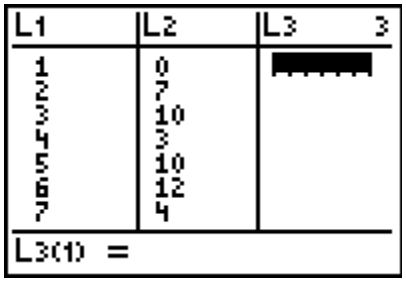
c. Press ▶ or ▼ to move to the letters in the name, pressing ENTER after each one.

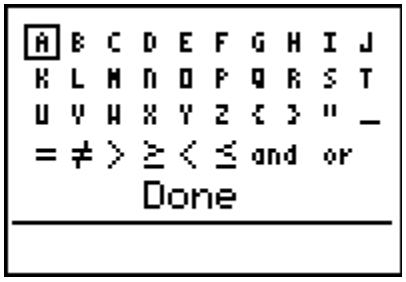
Note: *The first name must be enclosed in quotation marks to tell the TI-73 that all additional elements of the list will be names.*

d. When the name is finished, move to **Done** and press ENTER.

e. Press ENTER again to paste the name in the list.

f. When you finish working with the lists, press 2nd [QUIT] to return to the Home screen.





Graphing the Data

Review the pH values on three different graphs—a bar graph, a circle graph, and a scatter plot. Record the graphs on the **worksheet**.

Before each graph, press 2nd [PLOT] **4:PlotsOff** ENTER to turn off all stat plots.

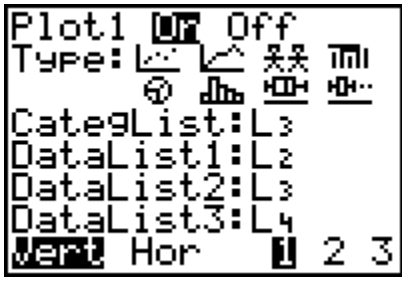
Bar Graph

1. Press 2nd [PLOT] ENTER to select **Plot1**.

2. Press ENTER to select **On** (to turn on **Plot1**).

3. Select (the bar graph) for **Type**.

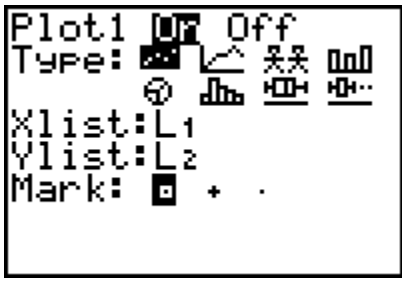
4. Plot **L3** (beverage names) as the categorical list and **L2** as DataList1 (pH values).



5. Press ZOOM **7:ZoomStat** to set the window and display the graph.

6. Press ZOOM to display the beverages with their pH values.

Scatter Plot

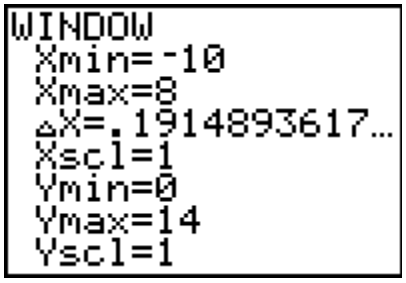


1. Press 2nd [PLOT] ENTER to select **Plot1**.

2. Press ENTER to select **On** (to turn on **Plot1**).

3. Select (the scatter plot) for **Type**.

4. Plot the beverage numbers (**L1**) on the *x*-axis and the pH values (**L2**) on the *y*-axis.



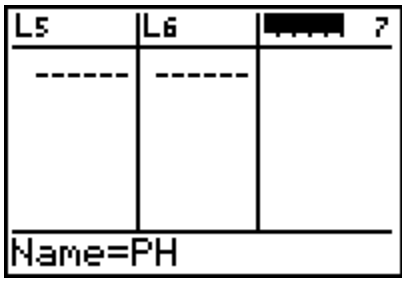
6. Press WINDOW to set the window values as shown. **Xmax** must be 1 more than the number of samples. The 0 through 14 for the *y*-range represents the pH scale.

7. Press GRAPH to display the plot. Press DRAW **3:HORIZONTAL** to place a horizontal line at pH = 7.

8. On the **worksheet**, discuss the meaning of the location of the points relative to the line.

Circle Graph

1. To make a circle graph displaying the number or percentage of all tested beverages that are acids, neutral, or bases, you must first enter the lists.

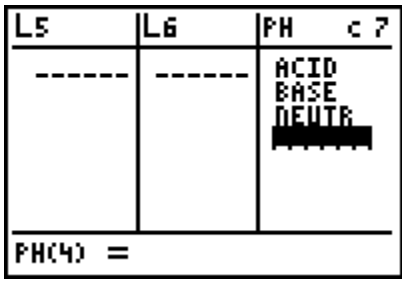


a. Press LIST to display the List Editor.

b. Press ▲ ◀ to move to the first unnamed list.

c. Press 2nd [TEXT].

d. Name the list **PH** by selecting from the list, pressing ENTER after each letter, and then selecting **Done** to return to the List Editor.



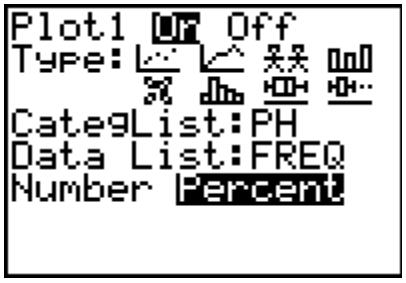
e. Press ENTER to place the name at the top of the list.

f. Using 2nd [TEXT], enter the categories **ACID**, **BASE**, **NEUTR** (limit of 5 text spaces). Put the first element of the list in quotes.

g. Press ▶ to move to the header of the next unnamed list. Name this list **FREQ** for the frequency of the type of beverages.

h. Press ▼. Enter the number of beverages that fall within each category.

2. Plot the categorical list **PH** and the numerical list of beverage frequencies **FREQ** as a circle graph. To set up the plot:



a. Press 2nd [PLOT] ENTER to select **Plot1**.

b. Press ENTER to select **On** (to turn on **Plot1**).

c. Select (the pie chart or circle graph) for **Type**.

d. Press ▼ 2nd [STAT] to specify the categorical list. Press ▼ to highlight **PH** and press ENTER.

f. Press 2nd [STAT] to specify the data list. Press ▼ to highlight **FREQ** and press ENTER.

g. Press ▶ ENTER to select **Percent**.

h. Press ZOOM **7:ZoomStat** to display the graph.

Data Analysis

Using the data you collected and the graphs, answer the questions on the **worksheet** to analyze your results.

Application

Use five clear liquid samples and a pH description of different clear liquids provided by your teacher.

1. Measure the pH of five clear mystery solutions.

2. Record the results. Then classify each one as being an acid, a neutral, or a base.

3. Identify each liquid from its pH description.

4. Choose a graph that will compare the liquids by pH.

5. Write a conclusion of your results using data to justify.