Acid Base Properties of Household Materials

Recommended for Chapter(s): 7

Demo #029

Materials NOT in box

1. Safety goggles.
2. Cabbage juice. If you need help preparing your cabbage juice please e-mail Darby (feldwinn@chem.ucsb.edu) 2 days before your demonstration.
3. Lemon Juice. In fridge in demonstration room.

Procedure

1. (Prep) Pour ~ 80 mL of water into eleven 150 mL beakers
2. (Prep) Put a ¼ of a red cabbage head into a blender ~1½ c of water. You can also do this in front of the class. They are usually amazed at how easy it is to make an indicator. The 1000 mL beaker and the 600 mL beaker are for cabbage waste (gets thrown in the trash) and cabbage juice. If you decided to blend cabbage in front of class. The strainer is used to separate the cabbage juice from the solid cabbage.
3. Pour ~10 mL cabbage juice in with all of the waters. All of the mixtures will be purple. Ask students if water is an acid or base (neutral). Therefore, if the solution is purple it is neutral.
4. Ask students if HCl is an acid or a base (acid). Pour 20 mL of either the HCl solutions into one of the beakers. It will turn red. Therefore if the solution is red we know it is an acid.
5. Ask students if NaOH is an acid or a base. (base) Pour, 20 mL of either the NaOH solutions into one of the beakers. It will turn greenish yellow. Therefore, if the solution is greenish yellow we know it is a base.
6. Ask students to predict whether they think each of the household substances (bleach, ammonia, milk of magnesia (antacid), lemon juice, Coke, Drain-O, baking soda, and vinegar) is acid basic or neutral. After they make their predictions, put a small amount of each into each of the beakers and from the color or the solutions have them determine if the substance is an acid or base.

Safety

1. Wear safety goggles.
2. Do not mix the bleach (or Drano (the Drano contains bleach)) and the ammonia. Toxic Cl_2 gas is produced if you do this.

Clean Up

1. Pour the HCl and NaOH solutions into appropriate waste bottle.
2. Pour the ammonia solution into the appropriate waste bottle.
3. Pour the bleach and Drano solution into the appropriate waste bottle.
4. Pour all other solutions into the last waste bottle.
5. Return the materials to the cart in the demonstration library room.

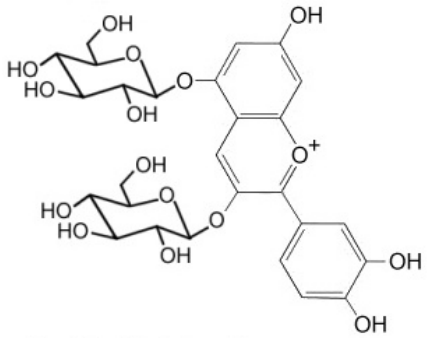
Stockroom Notes

1. Pour solutions in waste beakers down the drain with plenty of water.
    a. Note: Make sure to not dump the bleach/Drano and the ammonia down the drain at the same time or you will make toxic Cl_2 gas.
2. Refill any solutions that need refilling.
3. Put clean glassware into the box.
4. Return items to demonstration tub.
5. Return tub to the demonstration library.
    a. When storing this demo leave the ammonia outside of the box.
    b. Return the lemon juice to the fridge in the demonstration room.
    c. Return goggles to the goggle box.

Discussion

Red cabbage juice has a class of chemicals called anthocyanins in them. At low pH (acidic conditions) they will have the chemical structure seen below.

As the pH of the system rises the hydrogen in the hydroxide groups can come off into solution and be replaced with a sugar as seen below.



Cyanidin-3,5-diglucoside

Although this molecule has two hydrogens replaced with glucose, other sugars can attach in the substitution. The higher the pH, the more hydrogens will be replaced by sugars. As the hydrogens are replaced, the energy that the molecule absorbs changes, causing the solution to change color.

The picture below shows the color of cabbage juice at different pH levels.

The table below shows the household materials tested in this demonstration and the colors that they turn when added to cabbage juice.

Substance	Acid or Base	Color
0.1 M HCl	Acid	Dark pink
0.1 M NaOH	Base	Green
Bleach (NaOCl) – sodium hypochlorite	Base	Green → White
Ammonia (NH_3)	Base	Dark Green
Milk of Magnesia (antacid) ($Mg(OH)_2$) – magnesium hydroxide	Base	Bluish Green
Lemon Juice ($C_6H_8O_7$) – citric acid	Acid	Pink
Drano (NaOH) – sodium hydroxide * The Drano contains bleach this is why it turns white in the end	Base	Green → White
Coca-Cola Acids in Coke: ($C_6H_8O_{7)}$ – citric ($H_3PO_{4)}$ – phosphoric ($H_2CO_{3)}$ – carbonic from CO_2	Acid	Reddish Purple
Vinegar ($HC_2H_3O_2$) – acetic acid	Acid	Pink
Baking Soda ($NaHCO_3$) – sodium bicarbonate	Base	Dark Blue

Materials for demo 029

1. 0.1 M NaOH
2. 0.1 M HCl
3. Bleach
4. Ammonia
5. Milk of magnesia
6. Coke
7. Drano
8. Vinegar
9. Baking Soda
10. Eleven 150 mL Beakers
11. One 1000 mL Beaker
12. One 600 mL Beaker
13. Water container
14. Waste container
15. Blender
16. Strainer
17. Six Glass stirring rods