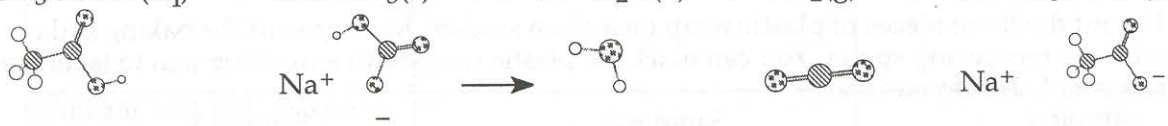
Bridging the Gap I Name _____
Sodium Bicarbonate, $NaHCO_3$, and Vinegar
Heat Effects and Production of CO_2

This exercise will deal with the reaction between vinegar and baking soda. Vinegar is a mixture that is roughly 95% water and 5 % acetic acid, CH_3COOH. Baking soda is pure sodium bicarbonate, $NaHCO_3$. The reaction is shown below.

Acetic acid		Baking soda		Water		Carbon dioxide		Sodium acetate
$CH_3COOH(aq)$	+	$NaHCO_3(s)$	$\longrightarrow$	$H_2O(l)$	+	$CO_2(g)$	+	$Na^+CH_3COO^-(aq)$



Heat Effects

One part of this activity is to observe the heat effect that accompanies the reaction. This will allow you to decide if the reaction is exothermic or endothermic. When a reaction is exothermic the reaction releases energy in the form of heat or light to the surroundings. A fire is a reaction that produces both heat and light. Sometimes this energy release is only in the form of heat. The surroundings gain energy (from the reaction) and become warmer. You can observe this by touching the container. When a reaction is endothermic the reaction draws energy from the surroundings. In this case the surroundings lose energy and create a "cooling" sensation if you touch the reaction container.

Production of Carbon Dioxide, $CO_2(g)$

This part of the exercise is to observe the reaction between vinegar and baking soda and note the amount of gas, CO_2, produced.

Equipment and materials

A box of Ziploc® sandwich bags (or equivalent), a roll of Saran® or other plastic wrap, a bottle of plain white vinegar, a box of baking soda (typically Arm and Hammer®), a 1/4 cup measuring cup, 1/8 and 1/4 teaspoon measuring spoons, scissors, marking pen, and transparent tape or stick on labels.

Procedure

1. Label three Ziploc® bags as 1 , 2, and 3. Fold back the top of the open Ziploc® bag back so the bag stay open. Do this with all three bags. Set the bags in a bowl or cup so they stand up and don't spill.

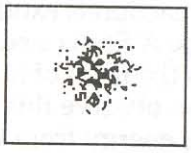
2. Add 1/4 cup of vinegar to each one of the three Ziploc® bags.

3. Open the box of baking soda and stir the contents so that samples are not taken only from the surface which may have reacted or decomposed.

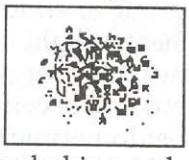
4. Cut three pieces of plastic wrap about 3x3 inches each. These will be used to wrap the sodium bicarbonate (baking soda).

5 Layout the three pieces of plastic wrap on a clean surface. Measure out the baking soda with the measuring spoon. You can mark the plastic wrap with a marking pen to label the samples 1, 2, 3 if you wish.

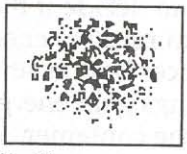
Sample 1
1/8 teaspoon
of baking soda



Sample 2
1/4 teaspoon
of baking soda



Sample 3
1/2 teaspoon
of baking soda



6. Fold up the plastic wrap around the baking soda samples. This will allow you prevent the mixing of the vinegar with the baking soda until you are ready for the reaction to occur.

7. Carefully place "Sample 1" of the wrapped sodium bicarbonate into the bag labeled "1". Try to "float " the wrapped sample on the surface of the vinegar. Carefully seal the bag. Be sure the bag is sealed completely, but do not allow the two reactants to mix yet..

8. From the outside of the sealed Ziploc® bag put your fingers on the package of baking soda. Rub the package with your fingers so the it opens up. Shake the Ziploc® bag so the contents mix. Immediately, some bubbles should form. Watch what happens. Touch the outside of the bag to sense its temperature. Record your observations on the Concept Report Sheet. KEEP this bag sealed and set it aside.

9. Repeat steps 7 and 8 with the other Ziploc® bags.

10. Estimate the amount of gas produced in each bag by carefully rolling the top of the bag down so the gas is trapped in the bottom of the bag. Stop rolling when you meet resistance. The skin of the bag will tighten and look like a balloon. Estimate the relative volumes of the three bags. (1/4 of a bag full, 1/2 bag full, etc.)

11. Flush the contents of the bags down the drain with a steady flow of water.

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Observations

Record the heat effects and volume changes you observed when you mixed the sodium bicarbonate with the vinegar.

Mixture	Gas volume observation (A fourth of a bag, etc.)	Temperature observation (No effect, warmer, cooler)
Vinegar and 1/8 teaspoon of baking soda		
Vinegar and 1/4 teaspoon of baking soda		
Vinegar and 1/2 teaspoon of baking soda		

Analysis and Conclusions

1. Is the reaction exothermic or is it endothermic? Justify your answer based on your observations.

2. What happened to the volume of the gas in the Ziploc® bag when you increased the amount of sodium bicarbonate used? Why do you think this happened?

3. Write the overall reaction between vinegar and sodium bicarbonate. Circle the reaction product you believe causes the observed volume changes?

4. What do you think would happen if you continued to add larger and larger amounts of baking soda? Do you think the volume would continue to increase or would there be some limit? Why?