ACIDS AND BASES

Unique Properties of Dry Ice

OVERVIEW: Students observe properties of dry ice. For example, whether dry ice can change the color of a basic solution that contains an indicator

OBJECTIVE: To review basic principles of matter and how this relates to every day objects. Develop concepts and nature of acids and bases and relate this to common household items.

GRADE LEVEL: 6-7

OHIO STANDARDS: PS7

Grade 7 Physical Science: The properties of matter are determined by the arrangement of atoms.

TIME: 30-45 minutes

VOCABULARY: acid, base, organic, inorganic, indicator, pH, hydrogen ion, molecule, CO_2, dry ice

MATERIALS: (per group of 5-6 students)

*Block of dry ice

*8 Beakers—600 ml tall with wide mouth

*1 Graduated cylinder-10ml

*1 stirring rod

*Gloves.—cotton and latex

*Safety glasses

*Indicator Solutions

*pH paper

*Balloons

*1 pint Ammonia

* 1 pint Vinegar

DEVELOPED BY:

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IMPORTANT:

Read all instructions before proceeding

INDICATOR SOLUTIONS:

100-250 ml of one or more of the following:

*Grape juice concentrate

*Cherry Juice

*Beet Juice

*Red Cabbage Juice

VARIATION: 10-15 ml of one of the following:

Thymolphthalein solution: (To prepare 100 ml of stock solution, dissolve 0.04g of thymolphthalein in 50 ml of 95% ethyl alcohol (ethanol) and dilute the resulting solution to 100ml with water. Alternatively, "Disappearing Ink" which is sold in toy stores can be used).

Phenolphthalein solution (To prepare 10ml stock solution, dissolve 0.05g phenolphthalein in 50 ml of 95% ethyl alcohol and dilute the resulting solution to 100ml with water. Alternatively, crush two or three EX-Lax tablets and cover with rubbing alcohol and mix.
Allow to stand until the undissolved portion of the tablet settles. The resulting solution contains the extracted phenolphthalein from the tablet).

Phenol red (phenolsulfonephthalein) solution (To prepare 100ml of stock solution dissolve 0.04g of red powder in 11ml of 0.1M sodium hydroxide and dilute the resulting solution to 100ml with water. Alternatively, this is available in the swimming pool maintenance department in most hardware stores).

Bromothymol blue (3'3" - dibromthymolsulfone-phthalein) solution (To prepare 100 ml of stock solution, dissolve 0.04g of bromo-thymol blue powder in 6.4 ml of 0.01M sodium hydroxide and dilute the resulting solution to 100ml with water).

Methyl red solution (To prepare 100ml of stock solution, dissolve 0.02g of methyl red in 60ml of 95% ethyl alcohol and dilute the resulting solution to 100ml with water).

Yamada's universal indicator (To prepare 200ml of stock solution, dissolve 0.005g thymol blue, 0.012g methyl red, 0.060g bromo-thymol blue, and 0.10g phenolphthalein in 100ml of ethyl alcohol. Add 0.01M sodium hydroxide until the solution is green and dilute the resulting solution to 200ml water).

PROCEDURE:

1. Engineer/Scientist discusses background and reason for being with the class.

    A. Ask students the definition of chemistry.

    Chemistry is the study of matter.

    B. Ask students for the definition of matter.

    Matter is anything that has mass (or weight) and occupies space).

    C. We can study matter in several ways—by its FORM and by its REACTIONS

2. Have a student blow up and tie a balloon. Ask what causes a balloon to expand, what is air made of, relate this to molecules that make up air. Discuss the nature of air (78%N_2, 21% o_2, <0.03% CO_2) and how the different molecules are used (plants vs. animals). Relate how additional molecules entering the balloon fill volume which causes the walls to expand. Use room walls review what would happen if the room was stuffed with molecules (students) and what would happen if the walls were stationary or elastic. Ask if there are any other ways to blow a balloon up.

3. When we talk about form, we mean something is a solid, liquid, or gas. Whether it is solid, liquid, or gas, matter is the same substance, only the form has changed. Bring out the dry ice. Why is it called dry ice? (Because it changes from a solid to a gas without becoming liquid first.) What is its chemical name? (CO_2 or carbon dioxide) Have a student open second balloon and drop a piece of dry ice in the balloon and tie it. Ask students why the balloon is expanding.

EXPLAIN: The nature of dry ice (CO_2), going from solid to gas, compare molecular arrangement in solids to liquids and gasses, the effect of temperature on molecular motion and states of matter. Discuss how dry ice is made (by-product of ammonia process) and the uses for the material (refrigeration, carbonation, fir extinguisher).

Talk about the freezing point of CO_2 (-78C/-109.9F). You may have to explain Celsius and Fahrenheit to get the students to understand how cold that is. Talk about how it "burns" skin by freezing the water in the cells.

4. Discuss how we try to explain chemistry by grouping things into categories (liquids, solids, metals, organic, inorganice…) two important groups re acids and bases. Define acids (substance which in water releases charged hydrogen ions) and bases (substance which in water releases groups of oxygen and hydrogen atoms called hydroxide ions).
5. Matter can be studied by its reactions. The reactions that we are focusing on today are acid-base reactions. Set up 8 beakers (2 beakers for each indicator) containing 50ml of tap water and 5ml of indicator. Discuss nature of indicators (relate to food coloring) and how these are used in labs for testing. Ensure that solutions are basic prior to starting. If not, add ammonia (3-5 ml) to the beaker.
6. Add pieces of dry ice to one beaker in each pair of beakers. Explain nature of vapors coming off beakers and how this is used in movies and on stage. Ask students to observe any changes taking place in solutions.
7. Explain why the colors are changing and how the color relates to the pH of the solution (acidic or b basic). Are there other ways of determining this? Use a roll of pH paper if no color indicator is available. Then show how this material is used by testing ammonia and vinegar solutions.
8. Add base back to acidic solution and show how color returns to starting point (if it does?) and check against pH paper.
9. Vinegar solution may be added to the beakers to return the solution to acidic.

<u>SUMMARY:</u> Discuss nature of acids and bases (corrosion, cleaning agents, weak vs. strong, hazardous nature) and how they can affect us (burns, acid rain).

<u>EXPLANATION:</u>

An acid-base indicator is a molecule that changes color as it gains a proton (as the solution becomes more acidic) or loses a proton (as a solution becomes more basic). Acidic solutions have pH values below 7, basic solutions have pH values above 7, and neutral solutions have a pH of 7.

In this demonstration, each of the solutions is neutral initially. Therefore, the indicator color is that of a basic solution. When carbon dioxide dissolves in water, it makes the solution acidic.

The acidity of the carbon dioxide firs t neutralizes the basic solution, then the excess $C0_2$ causes the solution to become acidic, resulting in a color change.

<u>SAFETY:</u>

1. The temperature of dry ice is –78C. Contact with exposed skin can cause frostbite and blisters. Gloves must be worn.
2. Ammonia solution or its vapors can damage eyes. Wear safety glasses and use only in well-ventilated areas.

SUGGESTIONS:

1. For more hands-on approach, provide balloons to all students and set up experiment of adding dry ice, water of varying amounts.

2. ACIDS:

   A. Common Acids: Citric, Acetic, Hydrochloric, and Sulfuric

   B. Definition: It is a substance which in water releases hydrogen ions. If you can get more technical, it forms hydronium ions with water. Water is H_20. The hydronium ion is H_30+.

   C. Now explain how $C0_2$ in water forms carbonic acid ($HC0_c-$ and H_30+) to make the water acidic. Explain that carbonic acid is used in soda pop. Take the other beaker of bromothymol blue and DI (deionized) water and put a piece of $C0_2$ in it. The indicator should turn green. Show them that $C0_2$ is in their breath by having them blow with a straw into a beaker of bromothymol blue and DI water.

3. BASES:

   A. Common Bases : Tums, sodium hydroxide, and ammonium hydroxide

   B. Definition: Substances which in water release hydroxide (OH-) ions.

   C. Pick up the ammonia bottle and describe ammonia. (A gas with a pungent odor.)

   Explain how it is bubbled through water and forms NH_4^+ and OH^- and turns the water basic.

4. pH:

   A. Definition: A scale that measures the amount of hydronium ions in a sample.

   B. This would be a great time to let the students us pH Paper.

5. INDICATORS:

   A. Definition: Compound that changes color as it gains or loses a portion (H^+) or as it becomes acidic or basic.

   B. Now change the color of the indicators with vinegar. Talk about some reactions being reversible. Change the indicator colors back with a base.

ACID

Acids produce H+ ions in aqueous solutions

(It forms hydronium ions H)

PROPERTIES OF ACIDS

*Acids are electron pair donors

*Acids taste sour

*Their aqueous solutions conduct electric current

*When they react with bases they form salts and water

*They have a pH below 7

*Turn litmus red

COMMON ACIDS

*Citric acid (In certain fruits and vegetables)

*Ascorbic acid (Vitamin C)

*Carbonic acid (Carbonation of soft drinks)

*Lactic acid (In buttermilk)

BASE

In water release groups of oxygen and hydrogen atoms called hydroxide ions

PROPERTIES OF BASES

*Taste bitter

*Feel slippery or soapy

*Their aqueous solutions conduct an electric current

*React with acids to form salts and water

*Turn litmus blue

*Have a pH above 7

COMMON BASES

*Detergent

*Soap

*Lye (NaOH)

*Household ammonia