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Breath and Base Reaction

Preparer's Version

Introduction

Acid-base reactions are fundamental to understanding various chemical processes, both in the laboratory and in real-world applications. In the context of a chemistry demonstration, blowing exhaled carbon dioxide through a straw into a basic solution containing an indicator like a universal indicator or phenolphthalein results in a visually striking color change as the solution acidifies. This demonstration effectively illustrates several core concepts in acid-base chemistry.

Safety Hazards

- Personal Protective Equipment
  - Safety glasses/goggles
  - Nitrile gloves
  - Chemical & flame retardant lab coat
- Physical Hazards
  - Sodium hydroxide may be corrosive to metals.
  - Phenolphthalein is a highly flammable liquid and vapor.
  - Universal indicator is a highly flammable liquid and vapor.
- Chemical Hazards
  - Sodium hydroxide may cause severe skin burns and eye damage.
  - Phenolphthalein causes serious eye irritation, drowsiness and dizziness, may cause cancer, and is suspected of causing genetic defects and damage to fertility or the unborn child.

Materials

- 500 mL Erlenmeyer flask
- 1M Sodium hydroxide
- 250 mL of DI water
- Phenolphthalein OR Universal indicator
- Disposable droppers
- Straws
- Stopper

Safety Data Sheet(s)

- Sodium hydroxide
- Phenolphthalein
- Universal Indicator

Procedure

1. Measure 1.999 g of sodium hydroxide and add it to 50 mL of deionized water. Stir until thoroughly dissolved.
2. Using gloves, add the water to the flask.
3. Add one to two drops of sodium hydroxide solution to the flask.
    a. *Note: The basic water mixture can be pre-made instead of doing it on stage upon request.*
4. Add about 5 drops of your indicator of choice into the flask. The solution should be pink if you chose phenolphthalein and blue/purple if you chose universal indicator.
5. Use the straws and exhale slowly into the solution until the color changes.
    a. *IMPORTANT: Be careful not to blow too hard and to wear goggles! Liquid splashing on the skin could be dangerous.*
6. When the reaction is complete, the solution will turn colorless (if using phenolphthalein) or yellow/orange (if using universal indicator).

Tips & Tricks

- Be careful to not make the water too basic, or else it'll be impossible to turn it with your breath!
- Use either smoothie straws or several regular drink straws to allow for more air.

Clean-Up Procedures

1. Stopper the flask until it is back in the lab.
2. Neutralize the solution using weak acid/weak base.
    a. If using phenolphthalein, use pH paper to detect whether or not it's neutral. The indicator does not change color at a pH of 7, so you'll need to test it in another way.
    b. If using universal indicator, aim for a neutral green for a pH of approximately 7.
    c. When the solution is acidic, you can use either dilute sodium hydroxide (0.01M or 0.1M works well, but be careful not to overshoot) or baking soda. When the solution is basic, you can use dilute acetic acid (0.5M or 1M works well).
3. Pour into an acid/base waste stream with other compatible substances.
4. Rinse the labware thoroughly with deionized water at least three times, emptying the runoff into the waste stream.
5. Clean thoroughly with laboratory detergent.