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# Pink Panther Breath—Microscale

## Properties of Ammonia

## Introduction

Students can do this well-known demonstration themselves on a very small scale, using the world's smallest test tubes.

## Concepts

- Scientific method
- Gas-liquid miscibility
- Gas diffusion

## Materials (for each lab group)

Ammonium hydroxide, $NH_4OH$, 3 M, 3 mL
Phenolphthalein indicator solution, 1%, 1 mL
Water, distilled or deionized
Beaker, 500-mL
Orthodontic rubber bands
Permanent marker
Pipets, Beral-type, thin-stem, 2
Test tube, 6 × 50 mm

## *Safety Precautions*

*Ammonium hydroxide liquids and vapors are extremely irritating—especially to eyes. Dispense in a hood and ensure an eye wash is accessible. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.*

## Preparation

1. Fill a 500-mL beaker with 400-mL of distilled or deionized water.
2. Using a graduated Beral-type pipet add 8 drops of phenolphthalein indicator solution to the water and stir.
3. Fill enough thin stem pipets for each lab group.
4. Using a permanent market label these pipets with a number 1.
5. Fill a second set of pipets with 3 M ammonium hydroxide solution. Label these pipets with a number 2.

## Procedure

1. Place 1–2 drops of ammonium hydroxide (pipet 2) into one well of an 8-well reaction strip.
2. Place an orthodontic rubber band around the 6 × 50 mm test tube about 1 cm from the top.
3. Using a Beral-pipet, fill the test tube with the contents of pipet 1. *Note:* Make sure the test tube is completely full with a convex meniscus.
4. Invert the test tube and set it over the well that contains the ammonium hydroxide solution (see Figure 1).

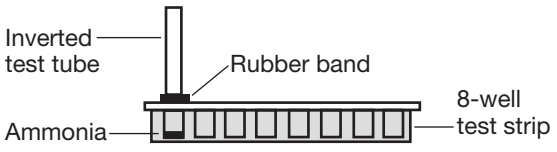


**Figure 1.**

## Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. If there is any ammonia left in the reaction strip allow it to evaporate in a hood. The solution containing water and dissolved ammonia gas may be neutralized according to Flinn Suggested Disposal Method #10.

## Discussion

Gas diffusion refers to the mixing of different gases throughout an enclosed space due to the random molecular movement of gas particles. This microscale experiment takes advantage of the solubility equilibrium for ammonia gas and water and the acid–base properties of ammonia to demonstrate the diffusion of gases.

Ammonium hydroxide is a concentrated solution of ammonia gas ($NH_3$) dissolved in water. It is a pungent liquid with a strong ammonia odor due to the high vapor pressure of ammonia gas over the solution (Equation 1). The vapor pressure of ammonia and the amount of ammonia dissolved in water depend on temperature and pressure.

$$NH_3(g) \rightleftarrows NH_3(aq) \qquad \textit{Equation 1}$$

Dissolved ammonia behaves as a weak Brönsted base, reacting with water to form ammonium ($NH_4^+$) and hydroxide ($OH^-$) ions, as shown by the reversible acid–base reaction summarized in Equation 2.

$$NH_3(aq) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq) \qquad \textit{Equation 2}$$

In this activity, a test tube completely filled with water containing phenolphthalein indicator is inverted and placed over ammonium hydroxide solution in a microscale well plate. (The high surface tension of water "holds it" in place and prevents the water from spilling out of the inverted test tube.) Ammonia gas molecules in equilibrium with the ammonium hydroxide solution diffuse and mix with air and dissolve in the indicator solution. Evidence is provided by the observation of pink "tendrils" due to the phenolphthalein color change. Phenolphthalein is an acid–base indicator that is colorless in acidic or weakly basic solutions (pH <8), red at pH values >10, and intermediate pink colors in the transition range from pH 8–10. The solubility of ammonia gas is extremely high—approximately 400 liters of ammonia will dissolve in one liter of water at room temperature. (As with any gas, the solubility of ammonia in water decreases as the temperature increases.)

## Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

***Unifying Concepts and Processes: Grades K–12***
Systems, order, and organization
Evidence, models, and explanation
***Content Standards: Grades 5–8***
Content Standard B: Physical Science, properties and changes of properties in matter
***Content Standards: Grades 9–12***
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions

## Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of *Pink Panther Breath—Microscale* activity, presented by John Little is available in *Properties of Ammonia*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

## Materials for *Pink Panther Breath—Microscale* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|---|---|
| GP6060 | Test Tubes, 6 × 50 mm |
| A0193 | Ammonium Hydroxide, 3 M, 500 mL |
| AP1724 | Reaction Strips, 8-well |
| P0019 | Phenolphthalein Indicator Solution, 1%, 100 mL |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.