The University of Texas at Austin
Department of Chemistry
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Bending Liquids

Preparer's Version

Introduction

Polarity all starts with a quintessential property of atoms – electronegativity. Electronegativity is often described as the relative pull a given atom has on the electrons "shared" in a covalent bond. A polar bond is formed when there is a significant difference between the electronegativities of two atoms bonded together; this leads to an asymmetrical distribution of electrons (and therefore their negative charge) across the bond. For molecules that are not entirely symmetrical, the molecule is characterized as a polar molecule – one with permanently unequal distributions of charges. Static wands create a small imbalance of charges on their surface, and any partial positive charges of a molecule will be attracted to the negative charge produced by the static wand, and vice versa. Polar molecules respond to static wands, but nonpolar ones do not respond. This responsiveness to an electric field visually manifests as a given liquid bending when the static wand is near – or *not* bending.

Safety Hazards

- Personal Protective Equipment:
  - Nitrile gloves
  - Safety glasses/goggles
  - Chemical & flame retardant lab coat
- Physical Hazards
  - Ethanol is a highly flammable, volatile liquid.
  - Hexanes is a highly flammable, volatile liquid.
- Chemical Hazards
  - Ethanol can cause serious eye irritation.
  - Hexanes may be fatal if swallowed and if it enters airways. Suspected of damaging fertility or an unborn child, and may cause damage to the nervous system from prolonged exposure through inhalation.
  - Iodine may cause damage to organs through prolonged or repeated exposure. Harmful if swallowed, in contact with skin or if inhaled.

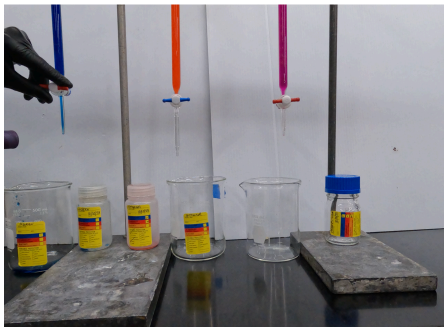
Materials

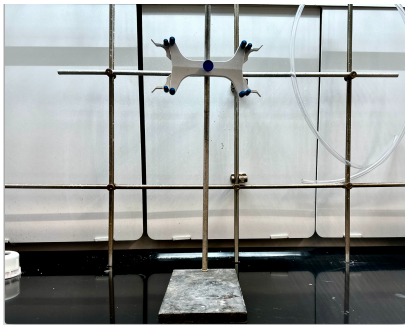
- 3 glass burettes
- 3 ring stands with single or double buret clamps
- 3 funnels
- 3 500 mL glass beakers
- 50 mL ethanol + red food coloring
- 50 mL deionized water + blue food coloring
- 50 mL hexanes
- ~0.2 g iodine crystals
- Static wand
- Paper towels and/or kim wipes

Safety Data Sheets

- Ethanol, 200 proof (Fisher)
- Hexanes (Sigma-Aldrich)
- Iodine (Fisher)

Set-Up Reference Photos





Procedure

1. Set up the burettes.
    a. On three separate ring stands, attach three single or double burette clamps.
    b. Ensure that the stopcock on each burette is in the horizontal, closed position (parallel to the floor). Test that there are no leaks with a very small amount of deionized water (no more than 5 mL). Empty the water from each burette by turning the stopcock to the vertical, open position (perpendicular to the floor) and return each stopcock to the horizontal, closed position. Label each one with its respective liquid (water, ethanol, hexanes + iodine)
    c. Place three 500 mL beakers beneath each burette, and label each one with its respective liquid (water, ethanol, hexanes + iodine).
    d. Place three funnels into the top of each burette. Label each one with its respective liquid (water, ethanol, hexanes + iodine)
2. Prepare all three solutions.
    a. Measure 50 mL of deionized water and pour into a small beaker. Add several drops of blue food coloring to the beaker, and swirl to mix until fully incorporated. You can also use a stir bar, but it isn't essential.
    b. Measure 50 mL of 200 proof ethanol and pour into a small beaker. Add several drops of red food coloring to the beaker, and swirl to mix until fully incorporated. You can also use a stir bar, but it isn't essential.
    c. Measure 50 mL of hexanes and pour into a small beaker. Place the beaker into a fume hood, and weigh ~0.2 grams of solid iodine (crystalline) with a metal scoopula or spatula. Carefully bring the iodine to the fume hood and pour into the beaker. Place a small magnetic stir bar into the beaker, and place it on a stir plate. Stir on low to medium speed until the iodine has fully dissolved.
        i. The mass of iodine doesn't need to be precise; you only need a small quantity of iodine to dye the hexanes visibly purple.
        ii. Keep the metal scoopula/spatula, weigh boat, and used magnetic stir bar and set them in a bin for special cleaning protocols.
3. If transporting the three liquids to a location outside of the lab, pour each into small glass bottles with tightly-fitted screw-on lids and label each one with its respective liquid (water, ethanol, hexanes + iodine). If performing the demo in the lab, parafilm the beakers and leave them inside of a fume hood until you're ready to pour into the burettes.
4. Assemble the static wand by connecting the two halves. Press the button to ensure the batteries work. You should hear a faint buzzing sound.
5. To perform the demonstration, hold the static wand close to the liquid stream of one burette each opening the stopcock to the vertical, open position. Do one liquid at a time. Water will bend dramatically, ethanol will bend moderately, and hexanes won't bend at all.

Tips & Tricks

- *Label all pieces of glassware with their corresponding liquid!* Water and ethanol will be cleaned differently from the hexanes + iodine, and it's important to keep them separated. This includes:
    - Each burette
    - Each funnel
    - Each small beaker containing original 50 mL sample of each liquid, and any graduated cylinders used to measure the 50 mL
    - Each 500 mL beaker placed to catch each liquid as it flows out of the burette.

Clean-Up Procedures

1. *For equipment/glassware used for water and ethanol:*

    a. Pour deionized water into the burette (with the stopcock in the horizontal, closed position). Close a gloved hand over the opening and tip, and tilt the burette side to side to run water across the inside. There should be no trace of food coloring (liquid is clear) or smell from ethanol. Empty the liquid from these burettes into their respective 500 mL beakers.
    b. For water and ethanol, rinse beakers and any used graduated cylinders using a squirt bottle of deionized water, collecting the run-off waste in their respective 500 mL beakers. There should be no trace of food coloring (liquid is clear) or smell from ethanol.

2. *For equipment/glassware used for hexanes + iodine:*

    a. Pour acetone into the burette (with the stopcock in the horizontal, closed position). Close a gloved hand over the opening and tip, and tilt the burette side to side to run acetone across the inside. There should be no trace of iodine (liquid is clear) or smell from hexanes. Empty the liquid from this burette into its respective 500 mL beaker.
    b. Rinse all other materials (funnel, metal scoopula/spatula, weigh boat, small beaker, any used graduated cylinders) thoroughly with acetone in a squirt bottle. All run-off from rinsing should be caught in the hexanes 500 mL beaker. When they have been thoroughly rinsed and no longer have any trace of iodine (liquid is clear) or smell from hexanes, proceed to the next step.

3. *With/Without a glassware washer:*

    a. If available, use a glassware washer with lab soap set to a clean cycle for glass (not plastic). Do not try to stand the burettes up – lay them down in the tray within the washer.
        i. *Note: any glassware that came in contact with hexanes, solid iodine, or the mixture of the two MUST be cleaned with acetone as described in Step 2b prior to placing it in a glassware washer*.
    b. If a glassware washer is not available to you, add laboratory soap to water in another beaker and clean all equipment thoroughly.
        i. *Note: any glassware that came in contact with hexanes, solid iodine, or the mixture of the two MUST be cleaned with acetone as described in Step 2b prior to placing it in a glassware washer*.

4. *Liquid Waste*:

    a. Record the final volume of each 500 mL beaker.
        i. In your waste log, be sure to record the initial volume of each liquid and mass of iodine. In addition, record the volume of water and acetone added to rinse the equipment.
    b. Empty each of the 500 mL beakers into the appropriate waste container.
        i. Water and ethanol (now heavily diluted), can be rinsed down the sink, and the beaker can be cleaned as described in Steps 1 & 3.
        ii. For the beaker with hexanes, iodine, and acetone, pour into a waste container designated for organic waste. Be sure to check that no other chemicals inside the carboy will result in a hazardous interaction with what you're adding) or begin an organic waste stream. Organics should never be mixed with inorganics.