The University of Texas at Austin
Department of Chemistry
College of Natural Sciences

Bending Liquids

Performer's Version

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)

Procedure

1. A member of the Demonstrations team will set up the burettes, funnels, and beakers – each of which will be clearly labeled and all burettes will be closed (stopcock parallel to the floor/in the horizontal position).
2. Depending on your preference, a member of the Demos team can pour each liquid into the closed burettes and remove the funnels, or you can opt to do so yourself.
3. Press the button on the static wand to ensure that it works. You should hear a quiet buzzing.
4. Turn the stopcock on the first burette until it is in the vertical position (perpendicular to the floor). This should allow the liquid to flow into the beaker below.
5. Hold the static wand near the stream of liquid and push the button to produce static electricity. Hold the wand close to the stream, but avoid touching the liquid. Hexanes will not bend; ethanol will bend slightly; water will bend dramatically.
6. Repeat for the other liquids.
   a. *Note: The order of liquids is ultimately up to you. It is suggested that you either go in order of increasing reactivity to the electric field, or decreasing reactivity to the electric field. This would mean either Hexanes → Ethanol → Water, or Water → Ethanol → Hexanes.*

Pedagogy & Supplemental Information

The polarity of a compound is extremely important for understanding its chemical and physical properties. 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. When the relative electronegativities of two atoms covalently bonded together are evenly matched, the distribution of negative charges in the bond is equally spread between those atoms. When the relative electronegativities of two atoms covalently bonded together are *not* so evenly matched, we get something a little different.

A polar bond is formed when there is a significant difference between the electronegativities of two atoms bonded together; if bonding electrons are the rope in a game of tug-of-war between these atoms, having different electronegativities means that one atom will pull way more strongly than the other, thereby pulling those electrons closer to it than to the other atom. With this unequal pull comes an unequal sharing of electrons – and that results in an asymmetrical distribution of electrons (and therefore their negative charge) across the bond. The ultimate results of significant electronegativity differences producing a polar bond are partial charges; the more electronegative atom, pulling negative charge closer towards itself, will be *partially* negative. On the other hand, the less electronegative atom inevitably becomes partially positive. The equal and opposite directionality of these partial charges are called *dipoles*.

For molecules that have polar bonds, but are entirely symmetrical in three dimensions, any dipoles caused by unequal distributions of charges across the bond cancel out; equal but opposite forces negate one another. For molecules that are not entirely symmetrical, the dipoles do not cancel one another out, and the molecule is characterized as a polar molecule – one with permanent dipole moments that determine the molecule’s behavior and chemical properties.

Static wands create a small imbalance of charges on their surface, and the partial charges in polar liquids can respond to it. The partial positive charges of the liquid will be attracted to the negative charge produced by the static wand, and vice versa. Nonpolar liquids, however, have no partial charges; all dipoles cancel out and therefore there are no net attractions or repulsions to the electric field produced. This responsiveness to an electric field visually manifests as the liquid bending when the static wand is near – or *not* bending, for nonpolar liquids!