# Intermolecular Forces Magic Trick

There's Magic in Chemistry

## Introduction

Surface tension is a force—a force powerful enough to prevent water from spilling out of an open jar when it is turned upside-down! A fine mesh screen hidden inside the lid of the jar provides hundreds of tiny surface tension "membranes" that, in addition to air pressure, will support the weight of the water.

## Concepts

- Intermolecular forces
- Surface tension

## Materials

Water, tap
Baby powder
Glue gun
Glue sticks
Jar, glass canning type, 1-qt
Laminated card, 4¼ inch square
Newspaper
Rubber cement
Scissors
Screening, fiberglass insect type

## *Safety Precautions*

*Although the materials in this lab are considered nonhazardous, follow all standard laboratory safety procedures. Perform the surface tension jar demonstration over a sink or large bucket. Wash hands thoroughly with soap and water before leaving the laboratory.*

## Part A. Newspaper Intermolecular Forces

## Preparation

1. Cut a 2-inch strip of newspaper from the length of a sheet of newsprint.
2. Coat one side of the strip of newspaper with rubber cement and allow it to dry.
3. Lightly coat the dry rubber cement with baby powder.

## Procedure

1. Show the uncoated side of the strip of prepared newspaper to the students.
2. Bring the bottom edge of the newspaper up so that the two coated sides face each other. *Note:* Keep the uncoated side toward the students.
3. Keep a finger between the top edges of the newspaper but lightly press the bottom folded area together.
4. Cut above the fold with sharp scissors.
5. Let the back edge of the newspaper fall; this will keep the uncoated side toward the students. The strip of newspaper will stay connected giving the illusion of an uncut strip of paper.
6. Repeat as desired.

## Part B. Canning Jar Surface Tension



Publication No. 91721
061616

## Preparation

1. Place a glass canning jar upside down on a piece of fiberglass insect screen.
2. Trace the mouth of the jar onto the screen.
3. Carefully cut out the circle of screen. *Note:* The circle of screen should be slightly smaller than the outside of the jar's rim.
4. Hot glue the screen to the top of the jar so that students cannot easily see the screen.

## Procedure

1. Pour tap water through the screen until the jar is about three-quarters full.
2. Place a laminated card over the top of the jar and hold the card down tightly with one hand. The water will form an adhesive seal with the laminated paper.
3. Quickly invert the jar 180° over a sink or other container, such as a plastic tub or bucket.
4. While holding the jar steady, remove your hand from the laminated card. The card will remain in place over the mouth of the jar! The water forms a tight adhesive seal and external air pressure holds the card in place.
5. Carefully slide the card out from under the jar with one hand while holding the jar steady with the other hand. A little water may spill out, but most of the water will stay in the jar! The mesh screen provides a surface for the formation of hundreds of tiny surface-tension "membranes" that, in addition to air pressure, will support the weight of the water.
6. Tilt the jar a few degrees to allow air to enter the jar. The water will immediately spill out of the jar—gravity still works!

## Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Newspaper may be disposed of in the regular trash, according to Flinn Suggested Disposal Method #26a.

## Tips

- Cut the strip of paper at a 45-degree angle to create a 90-degree turn.
- If the jar is inverted while the screen is uncovered, all of the water will pour out.
- To make the demo more dramatic, do not allow students to see the screen before inverting the jar—let them think the mouth of the jar is open. Alternatively, do the demonstration over a student's arm if they do not mind getting wet in the event that the surface tension is broken.

## Discussion

Intermolecular forces hold the strips of newspaper together. The scissors bring the molecules of rubber cement into contact establishing an intimate connection that the powder prevented. *Intermolecular forces* are the weak attractive forces between molecules in the liquid or solid state. A substance that vaporizes easily (has a high vapor pressure) has very weak attractive forces between molecules. A substance with very strong intermolecular forces has strong forces between molecules and thus does not vaporize easily (has a low vapor pressure). Although there can be a wide range in the strength of intermolecular attractive forces between molecules, intermolecular forces are always *significantly* weaker than the covalent bonds between atoms in a molecule.

Water is a unique liquid—the surface tension of water is substantially greater than that of alcohols and other liquids. Surface tension is a net attractive force that tends to "pull" adjacent surface molecules inward toward the rest of the liquid. Surface tension is a result of uneven attractive forces experienced by molecules at the surface of a liquid versus those in the rest of the liquid. Molecules in the liquid are bound to neighboring molecules all around them. Molecules at the surface, however, have no neighboring molecules above them. Because the forces acting on the surface molecules are not balanced in all directions, the surface molecules are drawn inward toward the rest of the liquid.

When the jar is first inverted, a small amount of water leaks out from the jar. This creates a slight partial vacuum in the space

above the water in the jar. The water in the jar also forms a tight adhesive "seal" with the card—in addition to forming strong intermolecular cohesive forces with other water molecules, water also forms strong adhesive forces to many other molecules or materials. External air pressure, acting in all directions, applies a net upward force on the card and the water and prevents the water from spilling out of the jar.

When the card is removed, the surface tension of water provides an additional force keeping the water in the inverted jar. The high surface tension of water arises because of strong hydrogen bonding among water molecules. As an analogy, the surface tension of water may be thought of as an invisible, "elastic" film that expands as needed to counteract the force of gravity and prevent the water from spilling out of the jar. The numerous tiny holes in the mesh screen provide a larger total surface area for the formation of thousands of invisible surface membranes.

When the jar is tilted, the forces become off-balanced and there is no longer a greater pressure on the outside of the jar. The surface tension "breaks" and the water spills out of the jar.

## Connecting to the National Standards

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

***Unifying Concepts and Processes: Grades K–12***
Evidence, models, and explanation
***Content Standards: Grades 5–8***
Content Standard B: Physical Science, properties and changes of properties in matter, motions and forces
***Content Standards: Grades 9–12***
Content Standard B: Physical Science, structure and properties of matter, motions and forces

## Flinn Scientific—Teaching Chemistry eLearning Video Series

A video of the *Intermolecular Forces Magic Trick* activity, presented by Mike Roadruck, is available in *There's Magic in Chemistry*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

## Materials for *Intermolecular Forces Magic Trick* are available from Flinn Scientific, Inc.

Some of the materials required to perform this activity are available in the *Surface Tension Jar—A Surface Tension Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

| Catalog No. | Description |
|---|---|
| AP6648 | Surface Tension Jar—A Surface Tension Demonstration |
| AP9011 | Glue Gun |
| AP9012 | Glue Sticks, Pkg/24 |

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