Lab: Intermolecular Attractions Lab

AP Chemistry Unit 7

Lab 1: Floating Oil Droplet

Introduction: A lab that incorporates density, surface tension, and intermolecular attraction. Lamp oil is placed in a beaker of less dense alcohol. Water is gradually added until the oil droplets float in the middle of the beaker.

Key Concepts:

- Density
- Surface Tension
- Polarity

Procedure:

1. Place 200 ml of isopropyl alcohol in a 500 ml hydrometer cylinder or tall-form beaker.

2. Use graduated Beral-type pipet to place 2-3 ml of red oil into the isopropyl alcohol. Note: Droplets of red oil will form on the bottom of the cylinder

3. Use a wash bottle to slowly add distilled or deionized water to the cylinder. Adding the distilled water down the side of the beaker. Do not mix the solution. As the water is added, the oil droplets will clump together and start to float.

4. Continue to adding water until the droplets float in the middle of the cylinder.

Questions:

1. Complete the worksheet questions

2. Discus with your lab partners what happened between the oil, alcohol and water using the key terms density, surface tension, and intermolecular attraction.

3. Write a conclusion that everyone has agreed upon. Then compare this to the discussion answers at the end of the lab.

Lab 2: Capillarity

Introduction: The ability of water and ethyl alcohol to rise in a glass tube is observed and compared by measuring the height each attains in a capillary tube.

Key Concepts

- **Adhesive forces**
- **Cohesive forces**
- **Surface tension**

Procedure:

1. Place the Petri dish on an overhead projector. Use a wash bottle to add distilled water to fill the dish about 1/4 full.
2. Place the capillary tube in the Petri dish below the surface. Observe the water rise in the tube.
3. Hold your index finger over the top of the capillary tube.
4. Raise the tube out of the dish and place it sideways along the ruler. Adjust the tube's position to reveal the heights of the water in the column, in millimeters. Note this value.
5. Repeat steps 1 thru 4 for anhydrous ethyl alcohol. Note this value

Questions:

1. What is causing the solution to rise up in the tubing?
2. How does the height compare for distilled water vs anhydrous ethyl alcohol.
3. Complete the worksheet questions
4. Discus with your lab partners ability of water and ethyl alcohol to rise in a glass tube using the key terms adhesive, cohesive, and surface tension
5. Write a conclusion that everyone has agreed upon. (diagrams are encouraged) Then compare this to the discussion answers at the end of the lab.

Lab 3: Vanishing Volume

Introduction: 50 ml portions of deionized water and anhydrous ethyl alcohol are mixed together in a 100 ml graduated cylinder to produce a volume less than 100 ml

Key Concepts

- Intermolecular forces - Hydrogen bonding
- Polar molecules

Procedure:

1. Carefully measure out exactly 50 ml of water in a 100 ml graduated cylinder.

2. Carefully measure out exactly 50 ml of anhydrous ethyl alcohol into a second 100 ml graduated cylinder.

3. Pour the water from the first graduated cylinder into the graduated cylinder containing the ethyl alcohol.

4. Stir the mixture of alcohol and water with a stirring rod and wait about one minute for the bubbles to come out of the solution.

5. Observe that the final volume of the liquid in the cylinder is less than 100 ml

Questions:

1. What type of molecules are water and ethyl alcohol molecules?

2. What type of intermolecular forces occur between the two in the solution?

3. Discus with your lab partners what happened to the vanishing volume?

4. Would you have loss volume if you have combined 50 ml of water to 50 ml of water or 50 ml of ethyl alcohol? Explain

5. Write a conclusion that everyone has agreed upon. Then compare this to the discussion answers at the end of the lab.

Lab 4: Bubble Shapes

Introduction: Forms made of straws and twist ties are dipped in a soap solution and withdrawn to create beautiful geometric shapes of bubbles.

Key Concepts

- **Hydrophilic**
- **Surface tension**
- **Hydrophobic**

Procedure:

To make one liter of bubble solution mix 100ml of dishwashing liquid with 50 ml of glycerin in a 1000 ml beaker. Add this to 850 ml of distilled water. The mixture should be stirred, otherwise excessive amounts of suds will be produced. This solution can be stored and reused.

1. Submerge a model in the bucket containing the soap solution.

2. Pull the model out in one smooth motion. Note: It may take several "dips" in order to achieve the internal geometric soap patterns arranged as desired.

Notes:

- Hold the model over the large tray - it will drip. A wet surface from broken bubbles will be very slippery.

- The colors observed on a soap bubble are the result of thin film interference and changing thickness of the film due to the draining liquid. As the thickness of the soap film changes, the distance of the light travels changes, and the differential interference reflects different colors in the soap film. The swirling colors observed are a result of uneven thickness in the soap film.

Questions:

1. Read the discussion answers about the soap bubbles and discuss the type of hydrocarbon chain in detergent molecule, using the key concepts.

Preparation of Geometric Shapes

Use scissors to cut the twist ties in half and the coffee stirrers into 3-inch lengths.

Creating a three-way junction:

1. Place two twist ties on top of one another, fold them into a V-shape, and insert the twist ties together into one end of a coffee stirrer (see Figure 1).
2. Bend each twist tie backwards in opposite directions to form a T-shape (see Figure 2).
3. Place a third twist tie across the top of the other two twist ties, and insert the ends into two coffee stirrers (see Figures 3 and 4).

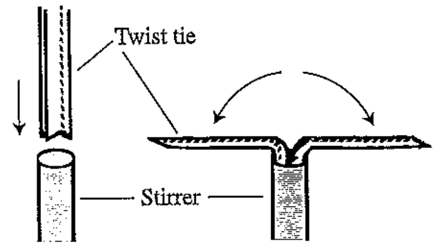


Figure 1. **Figure 2.**

Creating a four-way junction:

4. Repeat steps 1 and 2 twice to create two additional T-shaped assemblies.
5. Arrange the two T shapes on top of one another to form a cross shape (see Figure 5).
6. Slide a coffee stirrer over each of the exposed twist ties to create the cross shape (see Figure 6).

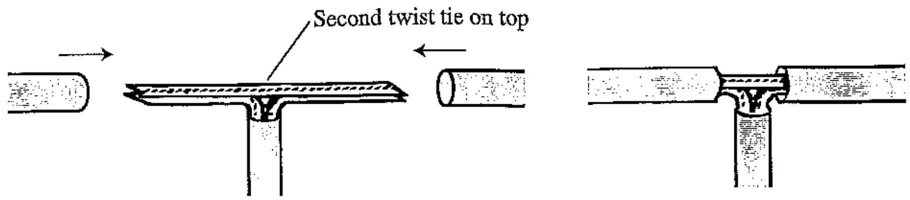


Figure 3. **Figure 4.**

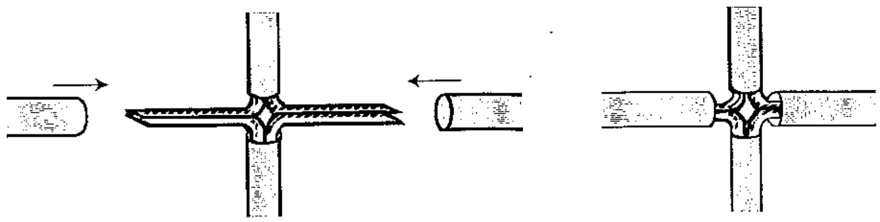


Figure 5. **Figure 6.**

Creating a five-way junction:

7. Repeat steps 1–3.
8. With a new stirrer, repeat steps 1–2.
9. Insert one twist tie into a new coffee stirrer.
10. Insert one of the twist ties from step 7 into the stirrer from step 9 to obtain the assembly shown in Figure 7.
11. Place the two exposed twist tie ends into the assembly created in step 8, creating a five-way juncture (see Figure 8).
12. Combine three-, four-, and five-way junctions as needed to build one of the model structures shown below.
13. Wrap an extra twist tie around one edge of the structure and then back up around itself in order to create a handle for dipping the model.

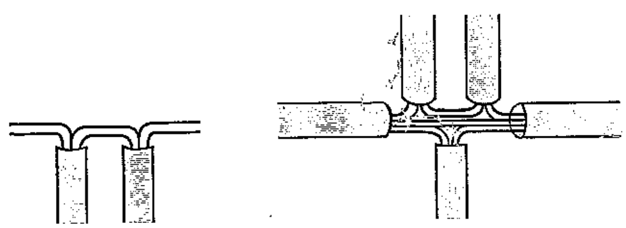
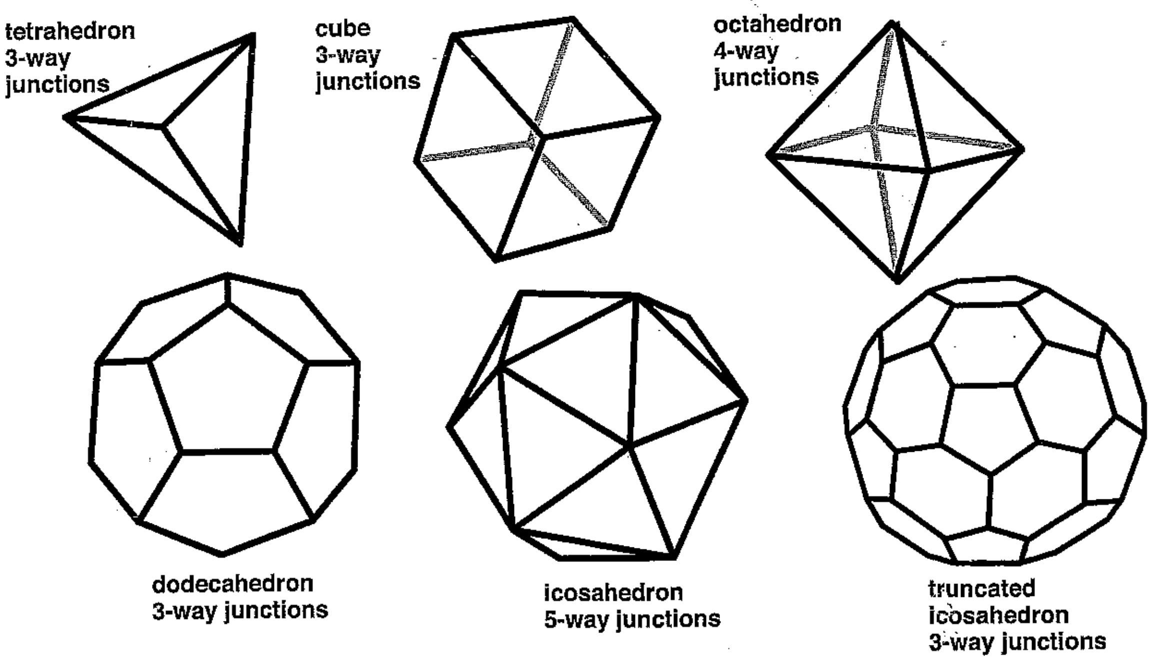


Figure 7. **Figure 8.**

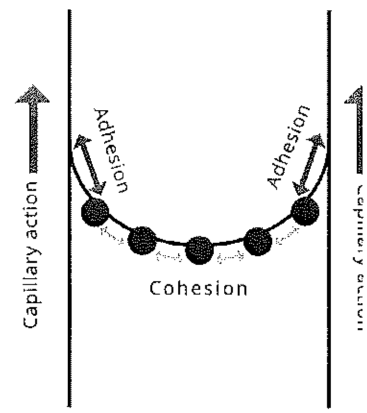


Discussion Answers

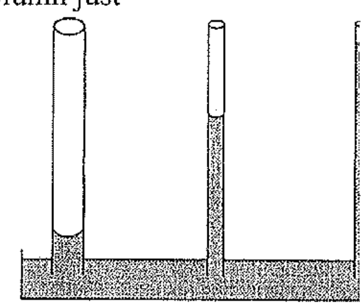
Lab 1: Floating Oil Droplet

The density of the lamp oil is greater than that of the isopropyl alcohol. Since the oil molecules are non-polar and the isopropyl alcohol is polar, the oil will not dissolve and instead forms droplets that sink to the bottom of the cylinder. When water, with a higher density than either isopropyl alcohol or lamp oil, is added, it forms a solution at the bottom of the beaker. The density of this solution is great than that of isopropyl alcohol alone. As more water is added, that the solution density increases. When enough is added to just match the density of the lamp oil, the droplets will float around the middle of the cylinder.

Lab 2: Capillarity



Cohesive forces are the electrostatic forces that hold molecules together. In water, these are primarily hydrogen bonding and dipole -dipole attractions. ***Adhesive forces*** are electrostatic forces between molecules of different substance. In the interaction of glass tube with water, the adhesive forces between the polar water molecules and the polar Si-O bonds at the surface of the glass are greater than the cohesive forces between the water molecules.

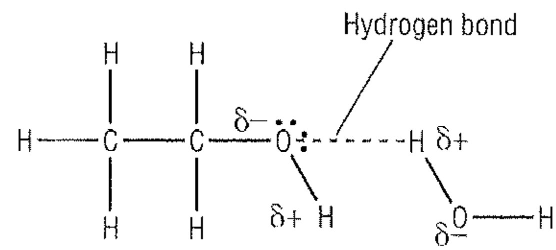


The water is pulled up the sides of the tubing until the weight of the water column just balances the total adhesive forces between the glass and water molecules. The smaller the diameter of the tubing is, the greater the height of the column.

The water molecules at the surface away from the glass wall are attracted inward and form a downwardly-curving surface, familiar to all the meniscus formed in burets, pipets, and other glass apparatus.

Lab 3: Vanishing Volume

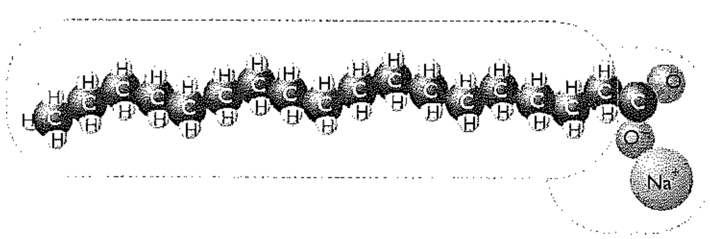
When 50 ml of water is added to 50 ml of water or when 50 ml of alcohol is added to 50 ml of alcohol, the final volume will always be 100 ml, as expected. When water is added to the alcohol, the final volume is about 10% less than the original volume of the two liquids. The "vanishing volume" is due to the differences in packing of the solvent molecules in the mixture versus the pure substances. Molecules of ethyl alcohol actually pack together more closely with water molecules than with other alcohol molecules due to hydrogen bonding. The solvent molecules form a highly-laced, 3-dimensional network held together by strong hydrogen bonds. Each alcohol molecule is able to form as many as three hydrogen bonds with neighboring water or alcohol molecules. The result is an intricate lattice or network of molecules strongly attracted to one another.



Hydrogen bonding is especially strong form of dipole-dipole interaction. A dipole-dipole interaction is the attraction of the positive end of one polar molecule for the negative end of another polar molecule. In hydrogen bonding, a hydrogen atom serves as a bridge between two electronegative atom (nitrogen, oxygen, or fluorine)

Lab 4: Bubble Shapes

A detergent molecule is a long chain of hydrocarbons with two distinct "ends". At one end is a nonpolar hydrocarbon group and at the other is a polar group with oxygen atoms. The nonpolar end is not attracted to water, or is said to be ***hydrophobic***. Polar end is very attracted to water, or ***hydrophilic***.



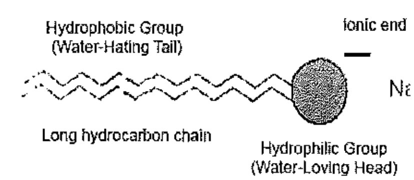
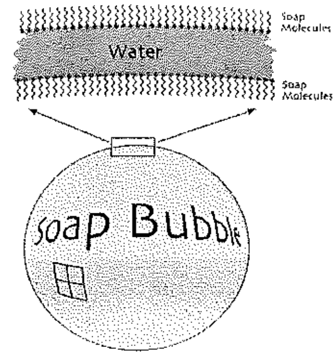


Fig 3. A detergent or soap molecule

When dissolved in water, detergent molecules will form a "sandwich" around the surface layer water molecules. The hydrophilic ends of the detergent molecules face the water molecules and the hydrophobic ends face away from the water molecules.



When the solution forms a bubble, it forms a three-layer sphere of detergent-water detergent molecules. When the geometric frames are dipped in the solution, minimum surface areas are produced. The different frames will generate a variety of shapes. In all cases, the intersection of surfaces will be an edge, the three planes intersect, or a point, if four surfaces intersect.