**CHEM 132 Lab #2**

**Exploring Intermolecular Forces**

Background

**Intramolecular forces** are forces acting on atoms **within** ionic crystals or molecules. Intramolecular forces are responsible for many macroscopic properties such as electrical conductivity, hardness, and luster. Other properties of matter such as boiling point, vapor pressure, and surface tension are best explained by the forces action **between** molecules (**intermolecular forces**). In this experiment the surface tension of three liquids (water, isopropyl alcohol and glycerol) will be compared in order to assess the strength of their intermolecular forces. Also their boiling points and solubility in water will be tested.

Materials:

3 Erlenmeyer flasks with stoppers, 3 petri dishes, pepper shaker, 3 plastic pipets, 5+ paper clips, liquid detergent, wax paper, 3 pennies, forceps

3 100 ml beakers containing: water, isopropyl alcohol and glycerol (aka glycerin)

Procedure:

In this experimental you will be comparing three liquids, isopropyl alcohol, water and glycerol.

**Part 1:** **Surface tension and vortex**.

When a liquid is swirled, a vortex is developed in which the surface level of the center of the liquid is substantially below the surface level of the perimeter. The greater the surface tension, the longer the vortex will remain after you have stopped swirling the container.

1. Fill one 125 ml Erlenmeyer flask half-full with isopropyl alcohol, another with water, and yet another with glycerol. (**Remember to fill the flasks only half-full**). Stopper the flasks to prevent vapors from polluting the room. Try to swirl each flask with the same intensity and record the time it takes for the vortex to disappear.

Which liquid appears to have greater surface tension and greater intermolecular forces? Record your answer for Part 1.



**Reuse these 3 chemicals for the rest of experiment.**

**Part 2: Surface tension and droplet shape**:

1. Using an eyedropper or pipet, transfer one drop of each fluid to a sheet of wax paper. The liquid with greater surface tension will maintain a higher profile and will not spread out as much as the one with lower surface tension.
2. Which liquid appears to have the greater surface tension and greater intermolecular forces? Record your answer for Part 2.



**Part 3: Surface tension and impenetrability**:

Liquids with strong intermolecular bonding will be less penetrable than those with weaker intermolecular bonding.

1. Try to float a paper clip on water, isopropyl alcohol, and glycerol by gradually lowering a dry paper clip into each liquid on a cradle fashioned from another paper clip (Figure 3). It may be best to use a small beaker and some forceps for this procedure.
2. Which liquid appears to have the greater surface tension and greater intermolecular forces? Record your answer for Part 3.



**Part 4: Visualization of surface tension**:

The surface of a liquid with strong hydrogen bonding will exhibit great tension much like the head of a drum that has been pulled tight. If a drumstick ruptures the head of a drum, the sides recoil under the tension. In a similar manner, if a chemical ruptures the surface tension of a fluid, the "skin" of the liquid will recoil away from the point where the chemical was applied.

1. Fill one Petri dish with water, another with isopropyl alcohol, and the third with glycerin. Sprinkle crushed pepper on the surface of both. The pepper will be more likely to float on the fluid with greater surface tension (Figure 4).
2. Cover the tip of a paper clip with liquid dish soap and hold over the center of each Petri dish until a drop of soap falls into the liquid. If the surface of the liquid is under tension, the pepper will recoil towards the sides immediately (see picture).
3. Which liquid appears to have the greater surface tension and greater intermolecular forces? Record your conclusion for Part 4.



**Part 5: Measure the boiling point** for each of the three liquids by placing the 3 samples (already in 3 separate beakers) on a hot plate. Which one has the highest boiling point and which one has the lowest boiling point? Record your conclusion for Part 5.

**Part 6: Check the solubility in each other and in water** for each of your three liquids.

Record your conclusion for Part 6.

**Return the chemicals to their original bottles.**

**Data Sheet**: Intermolecular Forces

Part 1: Surface tension and vortex

Part 2: Surface tension and droplet shape

Part 3: Surface tension and impenetrability

Part 4: Visualization of surface tension

Part 5: Boiling points

Part 6: Solubility in each other

 Solubility in water

7. Are all of the above chemicals polar? Rank these chemicals from least polar to most polar and justify your answer based on all your observations above.

8. What type of intermolecular forces (LDF, D-D, H-bonds) would you expect for each molecule? Create a table similar to the one you used in Prelab.

9. Which of the liquids you tested (isopropyl alcohol, water and glycerol), displayed the greatest surface tension (greatest intermolecular forces)? Why? Be specific.

10. Which of the liquids you tested (isopropyl alcohol, water and glycerol), boiled most easily? Why? Be specific.

11. You may have noticed mosquitoes, water spiders, and other insects walking on the surface of a pond. Why don't they sink?

Prelab: Intermolecular Forces

1. Predict whether the following molecules are polar or nonpolar and explain your reasoning.
2. oxygen difluoride, OF2
3. methane, CH4
4. carbon disulfide, CS2
5. fluoromethane, CH3 F
6. hydrogen peroxide, H2O2
7. ammonia, NH3

2. The weakest attraction between molecules are collectively called Van der Waals forces. For each of the above substances, list the kinds of attractive forces between molecules that are **expected***.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Molecule** | **LDF** | **Dipole-dipole** | **H-Bonds** |
| Oxygen difluoride |  |  |  |
| Methane |  |  |  |
| Carbon disulfide |  |  |  |
| Fluoromethane |  |  |  |
| Hydroqen peroxide |  |  |  |
| Ammonia |  |  |  |

3. What two conditions are necessary for molecules to be polar?

4. If water had a linear molecular shape, would the molecule be polar or nonpolar? Explain your answer.

5. When will hydrogen bonding occur? Give an example of a liquid other than water, in which this type of force is important.