Comparing the Strength of Intermolecular Forces

Station 1 – comparing liquids with hydrogen bonding

There are 3 flasks with different liquids: C_2H_5OH (ethanol), $C_2H_4(OH)_2$ (ethylene glycol), and $C_3H_5(OH)_3$ (glycerin). **DO NOT** remove the stoppers from the flasks. Test them by swirling the contents and comparing the time it takes for the fluid motion to stop and the difficulty you have in moving the fluid quickly. Also shake the flask and observe how long it takes for the bubbles to disappear.

Observations:

Letter of flask	***Results of swirling***	***Results of shaking***

1. Draw a structural formula for each of the 3 compounds. (don't guess, look them up)

2. How can you determine by looking at the formula if a molecule can form hydrogen bonds to adjacent molecules?

3. How many hydrogen bonds are in each compound:

ethanol = _____ glycerin = _____ ethylene glycol = _____

4. Identify the liquid in each flask and give your reason. Your reason should relate your observations to the number of hydrogen bonds.

A= _____

B = _____

C = _____

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Station 2 – comparing molecules with only dispersion or London forces

You have a sample of C_3H_8 (propane), C_6H_{14} (hexane), and $C_{18}H_{38}$ (paraffin). Observe the samples and compare the strength of the dispersion forces between the molecules.

Letter on sample	***State (phase) of sample***	***Relative strength of intermolecular forces***

1. Draw a structural formula for each of the molecules:

2. Identify each of the samples by letter and give your reason. Your reason should relate your observations to the intermolecular forces.

X = _____

Y = _____

Z = _____

3. In general you can say that as the _____ of the molecule increases the dispersion forces will increase.

4. What causes dispersion forces?

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Station 3 – surface tension and strength of van der Waal forces

There are 2 test tubes with plastic pipettes at this station. Place one drop of each of the liquids on a piece of plastic. $C_{12}H_{26}$ (oil) and H_2O (water).

Observation:

1. Look at each droplet from the side. Draw a picture of the drops made by each liquid.

2. Draw the structural formula for each of the liquids at this station.

3. Identify the types of intermolecular forces found for each of the liquids and relate these to the shape of the drop as seen from the side. Include the terms cohesive and adhesive forces properly in your explanations.

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Station 4 – using rate of evaporation to compare attraction between molecules

At the same time, place one drop of each of the 3 liquids on the counter and observe the time it takes each to evaporate. The liquids are water, C_3H_7OH (rubbing alcohol), and CH_3COCH_3 (acetone or nail polish remover). Indicate the relative time it takes each to evaporate – fastest, medium, slowest.

Letter of liquid	Ranking of rate of evaporation

1. Draw a structural formula for each of the 3 liquids and identify the intermolecular forces present in each liquid.

2. Identify the liquids and give a reason for your choice. Your reason should relate your observations to the intermolecular forces.

E = _____

F = _____

G = _____

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Station 5 – Using Viscosity to Compare the Attraction between Molecules

You will find 3 test tubes at this station. Each test tube is capped and has a small plastic bead in it. Each test tube has a different liquid in it. For each liquid, follow these steps:

1. Hold the tube upright until the bead is at the bottom.
2. Quickly turn the tube upside down so that the bead is at the top.
3. Measure the time recorded for the bead to fall to the other end of the tube.
4. Repeat two more times and determine the average time for each liquid.

Liquid	Trial 1	Trial 2	Trial 3	Avg. Time

1. Compare the forces of attraction between molecules for the 3 liquids. Which has the strongest forces? _____ Which has the weakest forces? _____

2. Polymer chemists use a test just like the one at this station to determine the molecular weight of polymers they manufacture. Using this test, which liquid (assume they are all nonpolar molecules) has the largest molecules? Explain by relating your observations to the IMF's present in the liquids.

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Station 6 – How many drops of water can you place on a penny?

Place a penny on a dry piece of paper towel and add water drop by drop. Count how many drops can be added before the penny can hold no more water. Observe the shape of the water on the penny and carefully observe what happens when the penny can hold no more water.

Draw a *side* view picture of the penny with water and describe what you observed when the penny could hold no more water.

1. How many drops of water could your penny hold?

2. What are some reasons other members of the class may have a different number?

3. Would you expect similar results if oil were used (see results for station 3)? Give a reason for your response that is related to IMFs and the molecular structure for both oil and water.