Polarity and Properties Lab

PURPOSE:
To investigate polar and non-polar molecules and the affect of polarity on molecular properties.

STATION 1:
“Oil and water do not mix.” We all know that. As a metaphor, it is often used to explain why relationships between opposites are difficult. In this lab you will trace this metaphor back to its source—the nature of oil and water, solutes and solvents, and why some substances do not dissolve in or mix well with others. We will be looking at the polarity of substances and attractions (or “weak bonds”) between molecules and how those influence solubility.

Background
A solution is a homogeneous mixture of two or more substances. The word homogeneous means _____________________________________________________________.

The composition or concentration of a solution can be changed by changing the amount of the solute (the minor component) dissolved in a given amount of the solvent (the major component).

Solubility is a characteristic property of a pure substance and can be used to help identify different substances. Thus, a chemistry handbook will usually report the solubility of a substance in different solvents along with other physical properties such as melting point, density, etc.

When a solute dissolves in a solvent, the attractive forces acting between solute particles and those between solvent molecules must be broken and replaced by new attractive forces between the solute and solvent. The nature and strength of the attractive forces among solute and solvent particles influences whether a solute will dissolve in a solvent.

Covalent compounds consist of molecules, rather than ions. The physical properties of a molecular compound, including its solubility, depend on the polarity of the molecules. The polarity of a compound determines the types of intermolecular attractive forces between molecules and is an important factor influencing the solubility of solutes and solvents.

At this station you will use water, paint thinner, and isopropyl alcohol as solvents.

Carbon tetrachloride (a carcinogen) has properties very similar to that of paint thinner; methyl alcohol (CH₄O) has properties very similar to isopropyl alcohol. We will use the safer solvents in this lab, but you can understand what is going on by looking at the Lewis Dot diagrams for the more dangerous (but easier to draw) compounds.
1) Draw the Lewis Dot structure for water, carbon tetrachloride, and methyl alcohol. Then use the periodic table of electronegativities to determine if each bond is polar or non-polar, and determine whether the molecule is polar or non-polar.

2) List the 3 solvents in order of increasing polarity.

3) Draw the Lewis Dot diagrams for for iodine (I₂) and copper (II) chloride, the solutes for this lab.

   Copper II chloride is a(n) (circle one) ionic covalent compound.

   Iodine is a(n) (circle one) ionic covalent compound.

Procedure
Part I: Solubility of Solids

1) Obtain six test tubes. Put water into two test tubes, isopropyl alcohol into two, and paint thinner into the last two.

2) Put a small amount (less than a matchhead-sized piece) of iodine into each test tube. Swirl or tap. Swirl some more.

3) Judge by the color of the liquid whether the solid is insoluble, partially soluble, or very soluble.

4) Record all data in the table provided.

5) Empty the test tubes into the proper places and wash with soap and water.

   NO PAINT THINNER GOES DOWN THE DRAIN!!!

6) Obtain enough copper II chloride crystals to fill the tip of a scoopula. Put this much of the solid into each of the 3 test tubes.

7) Judge by the color of the liquid whether the solid is insoluble, soluble, or very soluble.
8) Record all data.

9) Empty the test tubes into the proper places and wash with soap and water.

    NO PAINT THINNER GOES DOWN THE DRAIN!!!

Part II: Mixing Liquids

1) Put 10 mL of water into 1 test tube, then add 10 mL of paint thinner. Swirl or tap the test tube. Do they mix or separate? Record observations.

2) Put 10 mL of water into a 2\textsuperscript{nd} test tube, then add 10 mL of alcohol. Swirl or tap the test tube. Do they mix or separate? Record observations.

3) Put 10 mL of paint thinner into a 3\textsuperscript{rd} test tube, then add 10 mL of alcohol. Swirl or tap the test tube. Do they mix or separate? Record observations.

4) Test tube #2 can be poured down the sink. Test tubes #1 & #3 must go into the waste beaker.

    NO PAINT THINNER GOES DOWN THE DRAIN!!!

QUESTIONS:

1) Polar/Ionic solids dissolve in (circle one) polar non-polar liquids.

2) Non-polar solids dissolve in (circle one) polar non-polar liquids.

3) Polar liquids (circle one) mix do not mix with non-polar liquids.

4) Using what you have learned from this lab, explain why oil and water don’t mix. Be sure to include the term polarity or polar in your explanation.
STATION 2
Viscosity is a measure of how resistant a liquid is to flow, or how “thick” a liquid is. Liquid water has a low viscosity; shampoo has a higher viscosity.
There are three test tubes, each one filled with a different covalent liquid. The Lewis Dot diagrams for those compounds are below.
1) For each compound, determine if it contains any polar bonds and label them appropriately.
2) Use the magnet provided to **slowly** raise the metal ball within each liquid, then watch it fall.

Which liquid has the **lowest** viscosity? ____________

Which liquid has the **highest** viscosity? ____________

3) Molecules with more polar bonds are (circle one) **more** **less** viscous. Why do you think that is?

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

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STATION 3
1) Place a **small** pile of shaving cream on the lab bench (the size of ¼ of your fist). Then add 2-3 drops of 2 colors of food coloring.

2) Use a toothpick to swirl the colors. **Don't swirl them too much**! You want to be able to see the individual colors as separate lines when you are done.

3) Place the blank side of the index card on the shaving cream and **lightly** tap it down so that all parts of the card are in contact with the shaving cream.

4) Carefully lift up the card and use the plastic ruler to scrape off the excess shaving cream.

5) Scrape your shaving cream pile into the trash can.

Questions
1) The dye and the index card had (circle one) **the same** **opposite** polarities.
STATION 4

1) Look at your Lewis Dot diagrams from station 1.

Water is a (circle one) polar non-polar molecule

2) Rub the glass stirring rod with the fleece or wool fabric provided. When you do that you are building up a charge on the rod.

3) Turn on the sink to a low stream. Then hold the rod near the water, but not in the stream. What do you see?

Question

1) Use what you know about charges and polar and non-polar molecules to explain your observations in station 4.

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STATION 5 (demo)

1) Below are the Lewis Dot diagrams for acetone (nail polish remover) and ethyl alcohol. You can redraw the Lewis Dot diagram for water below. Use your Periodic Table of electronegativities to determine the polar nature of each bond, and note it on the diagrams.

acetone

\[
\begin{array}{ccc}
    & H & O & H \\
    H & C & C & C & H \\
    H & & & H \\
\end{array}
\]
2) I will place a dropperful of each liquid on the front lab bench and we will watch them evaporate.

3) List the liquids from first to evaporate to last to evaporate:
   a) ____________________________
   b) ____________________________
   c) ____________________________

Questions
1) The first liquid to evaporate had (circle one) the most the fewest polar bonds.
2) Use what you know about intermolecular attractions to explain this.
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
Conclusion Questions

1) What is a polar bond?

__________________________________________________________________
__________________________________________________________________

2) List 3 properties affected by the polarity of a molecule.
   a) ___________________________________________________________
   b) ___________________________________________________________
   c) ___________________________________________________________

3) Polar compounds have (circle one) stronger weaker attractions between molecules. That means that they will evaporate at higher lower temperatures and they will be more less viscous. This is because of the attractions between the polar regions of each molecule.