

Module 7: Intermolecular Forces and Properties

Pre-Laboratory Questions

Read about intermolecular forces in your textbook, pages 186- 192. Construct a table comparing the following intermolecular forces: **dipole-dipole interactions, Hydrogen bonds and London Forces.**

Force	For polar or nonpolar molecules?	Examples of Molecules (indicate two or more)	Relative strength (strongest- weakest)	Boiling point effect (highest to lowest)

Answer the following questions. Make sure you also understand the reasoning for each one (although you do not need to write the reasoning here). Check your answers in your textbook in section 7.1.2:

- Order the following compounds of group 14 elements and hydrogen from lowest to highest boiling point: SiH_4 , CH_4 , GeH_4 , and SnH_4 .
- Order the following hydrocarbons from lowest to highest boiling point: C_3H_8 , C_4H_{10} and C_2H_6
- Predict which will have the higher boiling point: N_2 or CO
- Predict which will have the higher boiling point: ICl or Br_2
- Consider the compounds dimethyl ether (CH_3OCH_3), ethanol ($\text{CH}_2\text{CH}_2\text{OH}$) and propane ($\text{CH}_3\text{CH}_2\text{CH}_3$). Their boiling points, not necessarily in order are -42.1°C , -24.8°C , and 78.4°C . Match each compound with its boiling point.
- Ethane (CH_3CH_3) has a melting point of -183°C and a boiling point of -89°C . Would the melting and boiling points for methylamine (CH_3NH_2) be higher or lower? Why?

Procedure and Data

Watch the following video and answer the following questions. I suggest you use a split screen so that you can watch the experiment as you collect the data. I caught one mistake in this video regarding the kind of intermolecular force in nail polish remover. When you get to that part of the video, I will correct it in the data table I provide.

<https://www.youtube.com/watch?v=jrY4jlec7-Q>

Part 1: Evaporation

When molecules evaporate, the forces are broken which keep the molecules attached to other molecules in the beaker – when those forces are broken, the molecules escape the beaker. In this evaporation experiment, the experimenter placed 50 mL of three chemicals in beakers and allowed them to evaporate for four days. Then he rechecked their volume. Record the data in the table below:

Chemical	Volume before	Volume after (Zoom in and read the beakers)	Change in Volume (subtract)	Rank of evaporation 1 = most	Rank of IMF strength 1 = strongest
Fingernail polish remover (acetone*)					
Water					
Methylated Spirits (ethanol)					

*The speaker says that acetone has London Forces. TRUE – ALL molecules have London forces. What he did not mention is that it also has dipole-dipole forces.

In subsequent experiments, the experimenter will also test oil and glycerin. After you see those experiments, come back and answer this question: Why do you think the experimenter did NOT check the evaporation of oil and glycerin? Write your answer in the box below:

Part 2: Surface Tension

Surface tension is the attractive force exerted upon the surface molecules of a liquid by the molecules underneath. In this surface tension experiment, the experimenter drops the chemicals on pennies to see how many “stick” will together:

Chemical	Number of Drop on the penny before it bursts	Ranking of drops 1 = most	Ranking of surface tension 1 = greatest	Rank of IMF strength 1 = strongest
Oil				
Water				
Glycerin				
Fingernail polish remover (acetone*)				
Methylated Spirits (ethanol)				

*The speaker says that acetone has London Forces. TRUE – ALL molecules have London forces. What he did not mention is that it also has dipole-dipole forces.

Part 3: Solubility

This is an interesting experiment in which you see that “like dissolves like” (polar molecules dissolve in polar compounds and nonpolar molecules dissolve in nonpolar compounds). We will explore these topics in our last module, the module on solutions. You can skip this part of the experiment and jump to 8:13 in the video. (If you do watch the solubility tests, know that his data table is confusing; he puts a ✓ in the data box which seems to mean “tested”, not “soluble” or “insoluble”.

Part 4: Boiling Point

When molecules boil, the forces are broken which keep the molecules attached to other molecules in the beaker – when those forces are broken, the molecules escape the beaker. In this simulated boiling point experiment, the experimenter placed 50 mL of three chemicals in beakers and allowed them to evaporate for four days. Then he rechecked their volume. Record the data in the table below:

Chemical	Boiling Point	Rank of boiling point 1 = highest	Rank of IMF strength 1 = strongest
Water			
Oil			
Glycerin			
Nail Polish Remover			
Methylated Spirits (ethanol)			

Post-Laboratory Questions

1. Rank these chemicals (water, oil, glycerin, nail polish remover and methylated spirits) from strongest molecular force (1) to weakest (5):

- 1)
- 2)
- 3)
- 4)
- 5)

2. In which experiments did oil exhibit stronger intermolecular forces than water?

3. Would you be surprised to learn that oil can only make London Forces the weakest of all intermolecular forces. What conclusion can you draw about oil given that it behaves as if its intermolecular forces are stronger than water even though it can only form London forces and water can form hydrogen bonds?

4. Why do you think glycerin has stronger forces than either water or oil?