SCH3U3 Period # 2 / Room 311

“Evaporation and Intermolecular Forces”

Given: Oct. 21, 2019

Due: Oct. 23, 2019

Lab Partners:

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Purpose:

Forces within a molecule are known as intramolecular forces and hold the molecule together from the inside. Forces from molecules that attract one another are called intermolecular forces, which come in two types: Van der Waals forces (which includes dipole-dipole forces) and hydrogen bonds, as shown in the table below:

Intermolecular Force	Relative Strength	Found between
Van der Waals	Weakest, temporary	All atoms and molecules
Dipole-dipole	medium	Polar molecules
Hydrogen bond	strongest	Atoms in which H is bonded to N, O, F

The intermolecular forces of a molecule influence a liquid's surface tension and evaporation rate through similar mechanisms. This lab seeks to explore the relationships between surface tension and evaporation rate with the intermolecular forces of water, acetone, and ethanol.

Materials:

- Labquest
- Vernier Temperature Probes
- tissue/gauze/filter paper
- plastic sheet
- 3 pipets
- Masking tape
- acetone
- water
- ethanol (ethyl alcohol)

Procedure:

Please refer to the "Lab – Evaporation and Intermolecular Forces" handout

Observations:

Table 1.1

Probe	**Liquid**	**Relative Height**	**Relative Width**	**T_i (℃)**	**T_f (℃)**	**$\Delta T = T_f - T_i$ (℃)**
1	Water	High (0.3 cm)	High (0.8 cm)	27.1	25.6	2.5
2	Acetone	Med (0.1 cm)	Low (1 cm)	26.0	6.8	19.2
3	Ethanol	Low (0.1 cm)	Med (1.1 cm)	26.9	18.4	8.5

Analysis:

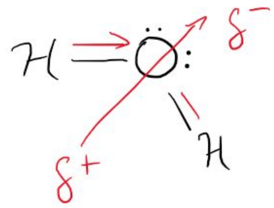
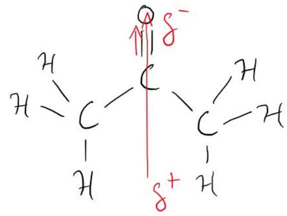
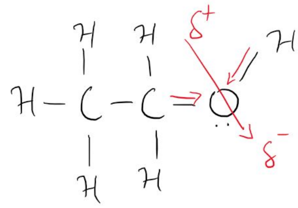
1. Use the information in your data table to list the three liquids in order of increasing intermolecular forces. For each liquid, indicate the relative surface tension and rate of evaporation.

Table 1.2

	Relative Intermolecular Force Strength	Relative Surface Tension	Relative Rate of Evaporation (High, Medium, Low)
Weak IMF	Acetone	Low	High
↓	Ethanol	Medium	Medium
Strong IMF	Water	High	Low

2. Draw the structures for each liquid. List the types of intermolecular forces present within each liquid. Draw all arrows needed on each diagram.

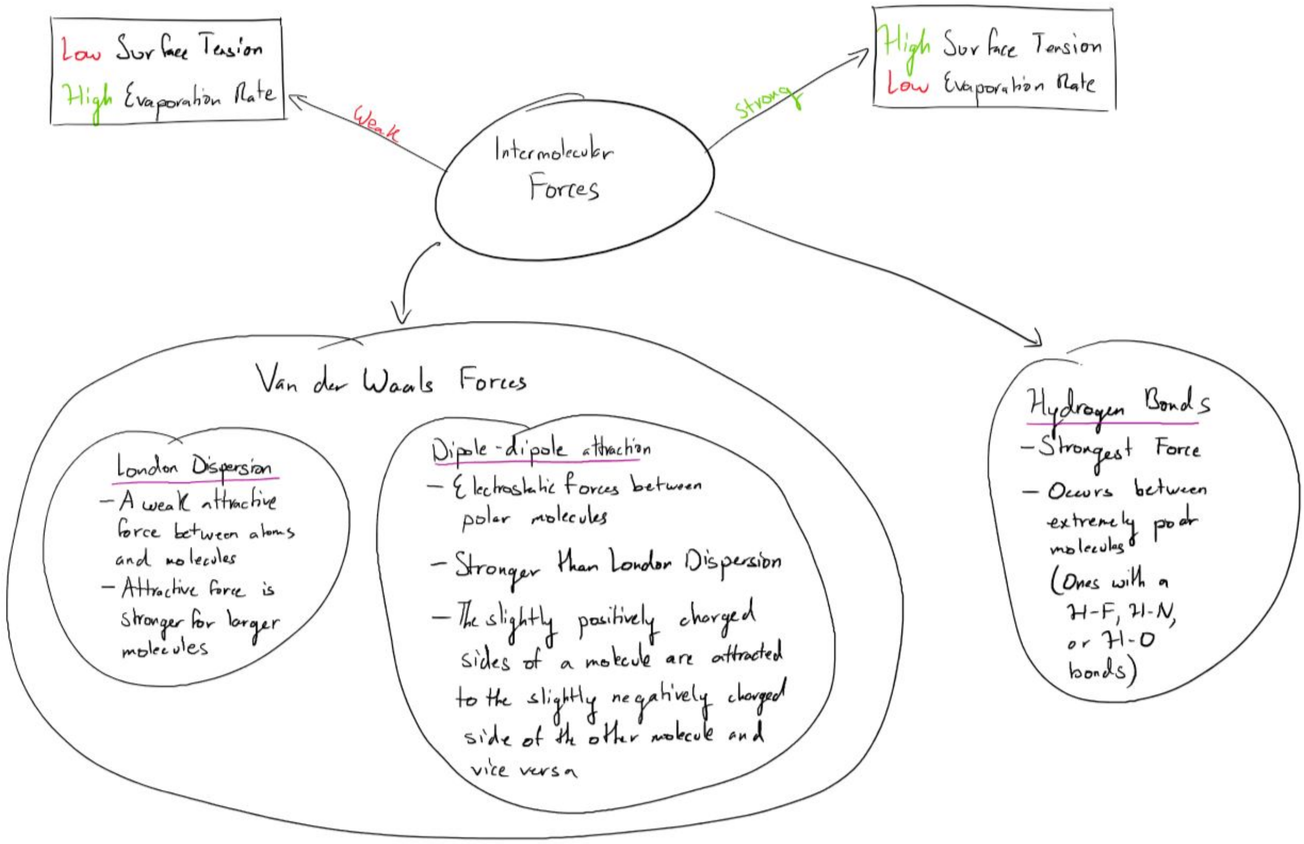
Table 1.3

	Water	Acetone (CH_3COCH_3)	Ethanol (CH_3CH_2OH)
Structure			
Forces Present	London dispersion Dipole-dipole forces Hydrogen bonds	London dispersion Dipole-dipole forces	London dispersion Dipole-dipole forces Hydrogen bonds

3. Explain the trends for surface tension and evaporation rate using the intermolecular forces.

The strength of a molecule’s intermolecular forces dictates how strongly the molecules attract each other, which can affect its surface tension and the evaporation rate. Surface tension is strongly correlated with a molecule’s intermolecular forces as high intermolecular forces imply that the molecules will be to pull themselves very close to each other, resulting in the liquid shrinking into the minimum surface area possible, but the highest surface tension. Conversely, low intermolecular forces imply that the molecule is not very good at attracting its neighbours, causing the liquid to spread out, resulting in lower surface tension. Evaporation rate, the rate at which molecules can change from a liquid state to a gaseous state, is also strongly correlated with a molecule’s intermolecular forces, as high intermolecular forces imply that the molecule is strongly attracting its neighbours, requiring more energy for molecules to evaporate, resulting in a lower evaporation rate. Conversely, low intermolecular forces imply that the molecule does not strongly attract its neighbours, requiring much less energy for molecules to evaporate, resulting in a higher evaporation rate.

4. Draw a concept map to summarize the relationships between intermolecular forces, surface tension, and rate of evaporation. Include a definition of intermolecular forces. London dispersion forces, dipole – dipole attraction and H-bonding.



Conclusion:

As shown in table 1.2, it was found that a molecule’s intermolecular forces are positively correlated with surface tension; higher intermolecular forces correlate with higher surface tension and lower intermolecular forces correlate with lower surface tension. It was also found that a molecule’s intermolecular forces are negatively correlated with evaporation rate; higher intermolecular forces correlate with a lower evaporation rate and lower intermolecular forces correlate with a higher evaporation rate. Intermolecular forces dictate the strength of the attraction between molecules, and, by extension, the surface tension and the difficulty a molecule would face to transition to its gaseous state (evaporation rate). Three sources of error in this lab include: inaccuracy in measurement from the ruler, uncertainty in the measurement by the temperature probes, and an inconsistent amount of each liquid being measured. The ruler only offers markings for every 0.1 cm, but greater precision was needed to measure the height of ethanol and acetone drops. The temperature probes have inherent uncertainty from covering the probe with an inconsistent amount of filter paper, which may have affected the temperatures recorded by the probe. Finally, although one drop of each liquid was measured for its height and width, the volume of the drop can vary, introducing uncertainty in the measurements of height and width.