Lab 10: Evaporation and intermolecular forces

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Abstract:

 In Lab 10: Evaporation and intermolecular forces, the temperature changes caused by the evaporation of several liquids were studied. The liquids that were used were n-pentane, 1-propanol, 1-butanol, 1-pentanol, and 2-pentanone. Also, the temperature changes were related to the strength of intermolecular forces of attraction. 1-pentanol has the strongest intermolecular force, and n-pentane has the weakest.

Introduction:

 The purpose of this lab was to learn about the different strengths of intermolecular forces related to specific molecules. This allowed us to compare the strengths IMF’s of different molecules, and to see which was the strongest and which was the weakest. The three types of intermolecular forces that was discovered were London Dispersion Forces, Dipole-Dipole, and Hydrogen Bonding. Every molecule has an LDF, and this is the weakest IMF of the three. This is because it is a temporary force that results from temporary dipoles. A Dipole-Dipole force is the next strongest force, and it is the force between the polar and non-polar ends of two molecules. Finally, a Hydrogen bond is a bond between a hydrogen element and one of the elements N, O, or F. I hypothesize that the largest molecule will have the lowest delta-T, resulting in the strongest intermolecular force. By using a thermometer, knowing the Lewis dot structures, and molar masses of a molecule, the IMF’s can be identified.

Experimental:

 The materials needed for this experiment were a Vernier temperature probe that plugged into a laptop, filter paper squares, tape, rubber bands, and the five liquids. The five liquids that were studied were n-pentane, 1-propanol, 1-butanol, 1-pentanol, and 2-pentanone. To begin this experiment the Logger Light software had to be downloaded onto the laptop and the temperature probe had to be attached. Secondly, a pieced of filer paper was wrapped around the temperature probe and was secured by a rubber band. The probe was then inserted into one of the liquids. Once the probe was in the liquids for 30 seconds, the data was collected by digitally monitoring the temperature for 15seconds. The probe was then taken out and taped on the edge of the lap counter. Once the temperature reached a minimum the data collection stopped. Both a minimum and maximum temperature were recorded. The T1 was then subtracted from the T2 to find the change in temperature. The station was cleaned, and the probe was put away. All of these steps except the last one was repeated for all other liquids.

Results and Discussion:

 Once the experiment concluded, it was found that n-pentane had the highest Delta T at 24.9°C, and 1-pentanol had the lowest Delta T at 1.1°C. All five liquids were used and observed, but the liquids with the highest and lowest Delta T gave information for Intermolecular Force Attraction. The table below represents the characteristics of each compound.

Table 1:

|  |  |  |  |
| --- | --- | --- | --- |
| Substance  | Molar Mass (g) | Delta T (°C) | Boiling Point (°C) |
| n-pentane | 72 | 24.9 | 36 |
| 1-propanol | 60 | 8.3 | 97 |
| 1-butanol | 74 | 3.7 | 118 |
| 1-pentanol | 88 | 1.1 | 138 |
| 2-pentanone | 86 | 9 | 101 |

The chart below represents the three alcohols that were used during the experiment. This graph shows the molar mass and the Delta T of each substance. The numbers used in Table 1 can be used to compare to find the substances in Chart 1. The three substances in Chart 1 are 1-propanol, 1-butanol, and 1-pentanol.

N-pentane and 1-butanol have nearly the same molar masses, but significantly different Δ*T* values. This is because 1-butanol is smaller because of the hydrogen bonding it has. This included a small Δ*T* and resulted in a higher attraction.

Of all of the substances 1-pentanol had the strongest IMF because it is the largest molecule. This meant that it had the smallest Δ*T.* On the other hand, n-pentane had the weakest IMF because it had the largest Δ*T.*

Chart 1 included three alcohols that were used in the experiment. This chart helped predict the Δ*T* value for methanol and hexanol. The molar mass and boiling point for methanol are 32g and 148 °C. The molar mass and boiling point of hexanol is 102g and 314 °C. Based on Chart 1, Hexanol would have a lower Δ*T* than 1-pentanol, and methanol would have a higher Δ*T* than 1-propanol. The would mean that if hexanol was added to our substance list, it would have the strongest IMF because it has the smallest Δ*T.* This also means that if methanol was added to our substance list it would have the weakest IMF because it has the largest Δ*T.*

The IMF’s that were present in n-pentane, 1-pentanol, and 2-pentanone were London dispersion forces, dipole, dipole forces, and hydrogen bonds. From weakest to strongest: London dispersion forces, dipole, dipole forces, and hydrogen bonds

Conclusion:

 This experiment concluded that a substance with a small Δ*T* will have a stronger intermolecular force attraction, than a substance with a larger Δ*T.* Also, out of the five substances, three of them were alcohols and if methanol and hexanol were added to the substance list, they would be the opposite of each other. Hexanol had a high IMF while methanol had a low IMF. The hypothesis I stated at the beginning was correct. 1-pentanol had the strongest IMF because it is the largest molecule and it had the smallest Δ*T.* So, that means that a substance with a high Δ*T* will have a weak IMF.