Laboratory 10 Evaporation and Intermolecular Forces

Abstract

The temperatures of five substances were measured at their maximum and minimum temperatures to calculate evaporation rate. After comparing their intermolecular forces, temperature change, and molar mass it was found that there is a relationship between the three. Hydrogen bonds were found to have the strongest bond, with a strong relationship between molar mass and intermolecular forces. Following, dipole-dipole intermolecular forces have the second strongest bond, then London dispersions have the weakest bond.

Introduction

The five substances' temperature change, through evaporation, are being compared in order to observe the difference of intermolecular strengths between hydrogen bonds, dipole-dipole bonds, and London dispersion forces. Intermolecular forces are the different attractions between certain molecules within a bond. Hydrogen bonds are formed between hydrogen and one of three elements (fluorine, oxygen, and nitrogen). Dipole-dipole bonds are between elements that do not have an even dispersion of electrons and result with polar bonds. London dispersion are temporary bonds.

Experimental

First, n-pentane, 1-propanol, 1-butanol, 1-pentanol, and 2-pentanone are obtained. The longer-lite probe, connected to the logger lite software, was covered with a small piece of paper towel and tightened with a rubber band. After the probe was covered, it was dipped into the first solution (n-pentane) for thirty seconds and the temperature was recorded. After the probe is taken out, the temperature is observed until it reaches a minimum. Then the minimum is recorded. Once all maximum and minimum temperatures were taken for the five solutions, the minimum is subtracted from the maximum in order to calculate the change in temperature.

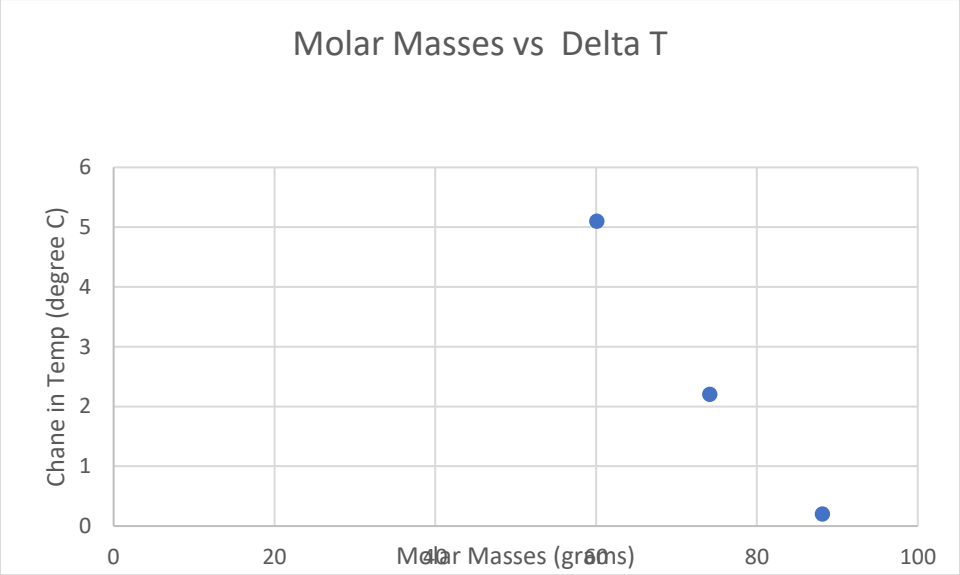
Results

The results from the table below show that the alcohols had the slower rate of evaporation; 1-pentanol had the smallest change in temperature, however it has the greatest molar mass. Following, 1-butanol had the second smallest change followed by 1-propanol. n-pentane had the greatest change in temperature followed by 2-pentanone.

Table 1

Substance	Molar Mass (grams/mole)	Boiling Points (°C)	Inter-Molecular Forces	Change in Temperature (°C)
n-pentane	72	36	London Dispersion	16.8
1-propanol	60	97	Hydrogen Bond	5.1
1-butanol	74	118	Hydrogen Bond	2.2
1-pentanol	88	138	London Dispersion, and Hydrogen	.2
2-pentanone	86	101	Dipole-Dipole	6.8

Graph 1



Discussion

Due to all three alcohols having the slowest evaporation rate, it is concluded that their intermolecular force, hydrogen bond, is stronger. After observing the graph above, the greater in molar mass for hydrogen bonds means that they are more likely to have a lower evaporation rate. Therefore, it takes longer to separate the forces. Based off of evaporation rate, it can be concluded that the dipole-dipole bond, 2-pentanone, is the second strongest intermolecular force. Since n-pentane had the fastest rate of evaporation, or weakest bond between atoms, it can be assumed that London dispersion molecules are the weakest among the three types of intermolecular forces. Based off of the findings in this experiment, it can be predicted that methanol would have a temperature of about 7.5 degree Celsius, due to its molar mass of about 32.04 grams per mole. In addition, Hexanol ($C_6H_{13}OH$) would have a temperature change between 0 and .2, due to its molar mass of about 102.18 grams per mole.

Conclusion

To conclude, hydrogen bonds are the strongest intermolecular force, and have increasing strength with increasing molar mass. Then dipole-dipole bonds are the second strongest, followed by London dispersion forces, which are the weakest due to their temporary bond characteristic.