

CHEM 111 Challenge Problem One

A common physical property of a liquid is the normal boiling point, BP. It is useful in identifying an unknown liquid. More importantly the magnitude of the BP is related to the intermolecular forces in the liquid. Consider each of the following series of closely related compounds.

A. ethane, fluoroethane, chloroethane, bromoethane, iodoethane.

B. methane, ethane, propane, butane, pentane

For each of the series:

1. Using the VSEPR approach draw the molecular structure for the compounds (give shape and bond angles). Indicate if the molecule is polar or non-polar.
2. Indicate the intermolecular forces for the compounds in the liquid state.
3. Look up the normal boiling points of the compounds using your textbook, CRC Handbook, Merck Index, or another printed reference source or an electronic source such as that of the National Institutes for Standards and Technology (NIST) at <http://webbook.nist.gov>.
4. Using CurveExpert prepare a graph of boiling point (in K) vs. molecular weight (molar mass). Fit the data with a linear spline.
5. Discuss whether your graphs indicate that there is a regular relationship between molecular weight and boiling point, why these two quantities might be related and why there are differences between the A and B series of compounds. Your discussion should include the structures of all the compounds and make reference to the predominant intermolecular forces present in the compounds in each series and their relative strengths.
6. Using the graph for series A calculate the BP of ethanol and acetic acid. Compare the calculated values with the experimental values and discuss any anomalous results in terms of intermolecular forces.
7. Based on the data you gathered is molecular weight by itself a good predictor of boiling point? Why or why not?