LAB EXERCISE 4.5.1

Boiling Points and Intermolecular Forces

Inquiry Skills

○ Questioning	○ Planning	● Analyzing
● Hypothesizing	○ Conducting	● Evaluating
● Predicting	○ Recording	● Communicating

In all liquids, intermolecular forces are important, but these forces become negligible in the gas state for the conditions at which liquids boil. Therefore, we are looking at a situation where intermolecular forces must be overcome by adding energy, but no new bonds are formed. The temperature at which a liquid boils reflects the strength of the intermolecular forces present among the molecules. Higher temperatures mean more energy has been added and the intermolecular forces must have been stronger.

Purpose

The purpose of this lab exercise is to test the theory and rules for London and dipole−dipole forces.

Question

What is the trend in boiling points of the hydrogen compounds of elements in groups 14-17?

Hypothesis/Prediction

(a) Based upon dipole−dipole and London forces, write a prediction for the trend in boiling points within and between groups. Your prediction could include a general sketch of a graph of boiling point versus number of electrons per molecule. Provide your reasoning.

Analysis

(b) Complete a graph of the evidence by plotting boiling point versus number of electrons per molecule.

(c) Answer the Question.

Evidence

Table 1 Boiling Points of the Hydrogen Compounds of Elements in Groups 14–17

Group	Hydrogen compound	Boiling point (°C)
14	$CH_{4(g)}$	−162
	$SiH_{4(g)}$	−112
	$GeH_{4(g)}$	−89
	$SnH_{4(g)}$	−52
15	$NH_{3(g)}$	−33
	$PH_{3(g)}$	−87
	$AsH_{3(g)}$	−55
	$SbH_{3(g)}$	−17
16	$H_2O_{(l)}$	100
	$H_2S_{(g)}$	−61
	$H_2Se_{(g)}$	−42
	$H_2Te_{(g)}$	−2
17	$HF_{(g)}$	20
	$HCl_{(g)}$	−85
	$HBr_{(g)}$	−67
	$HI_{(g)}$	−36

Evaluation

(d) Assuming that the evidence is valid, evaluate the Prediction and the concept of intermolecular forces used to make the prediction.

(e) Are there any anomalies (unexpected evidence) in the evidence presented? Suggest an explanation.