Substance 4
CH_4

Unit 6: Bonding & Intermolecular Forces

Free Response Review #1

Directions: The suggested time is about 15 minutes for answering the constructed response section of the chemistry test. The parts within a question may not have equal weight. For calculations, show all your work in the spaces provided after each part. Pay particular attention to the proper use of units. Be sure your final answer is rounded to the correct number of significant figures. Make sure your work is legible. Illegible work will receive a grade of zero.

Question 1 [10 POINTS] Three substances are listed below. Use your knowledge of chemical bonding and molecular structure to answer the questions that follow.

Substance 1	Substance 2	Substance 3
KBr	NH_3	BF_3

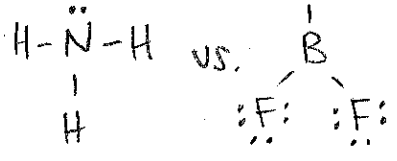
A. Describe, in terms of valence electrons, how the chemical bonds form in substance 1. **[2 POINTS]**

The ionic bond in KBr forms when K gives its valence e^- to Br, forming the ions K^+ and Br^-, which are held together by Coulombic (electrostatic) attraction.

B. Describe, in terms of valence electrons, how the chemical bonds form in substance 2. **[2 POINTS]**

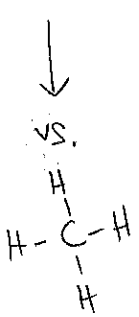
The covalent bonds in NH_3 form when N and H each share 1 valence e^- w/ each other, forming a single bond between them.

C. Are the molecular geometries for substances 2 and 3 the same? Explain. **[2 POINTS]**



Nope! Both molecules have 3 bonds around their central atom, but NH_3 has a lone pair on its central atom, while BF_3 does not. NH_3 = trigonal pyramidal
BF_3 = trigonal planar

D. Would you predict the H—N—H bond angle in substance 2 is larger than, smaller than, or equal to the H—C—H bond angle in substance ~~2~~ Substance 4 (CH_4)? Explain. **[2 POINTS]**



The H-N-H bond will be smaller than the H-C-H bond, b/c the lone pair on NH_3 repulses more strongly than the bonded e^- pairs in CH_4, decreasing the bond angle.

E. Substance 2 has a boiling point of −33.3°C, whereas substance 3's boiling point is −161.5°C. Account for the difference in boiling points between the two compounds in terms of intermolecular forces. **[2 POINTS]**

IMFs (NH_3) = LDFs, dipole-dipole, hydrogen bonding (polar + "FON"!)
IMFs (BF_3) = LDFs only (non-polar)
The stronger IMFs in NH_3 mean a greater attraction between molecules, so more energy is required to separate molecules from a liquid into a gas in NH_3 than BF_3.