

University of Windsor
Chemistry and Biochemistry
Chemistry 59-450, Winter Term 2011

Mid-Term Examination

Do all questions in the exam booklets that have been provided.

Question #1 [20 points]

- (a) In the gas phase PF_5 has the structure that one would predict on the basis of VSEPR theory; describe and draw that structure. [5]
- (b) Use appropriate arguments and diagrams to explain how the bonding in PF_5 can be rationalized without having to assume the need for d-orbital participation. [15]

Question #2 [20 points]

- (a) Use Wade's rules to predict the structure of B_6H_{10} (show your work and be sure to indicate the cluster type and to make a reasonable drawing of the molecule - common parent polyhedra are illustrated at the end of this test). [10]
- (b) B_6H_{10} reacts with ethyne to produce a cluster with the composition $\text{C}_2\text{B}_4\text{H}_6$ and other products. Use Wade's rules to predict the cluster type of the carborane and draw each of the different possible isomers of the carborane cluster. [10]

Question #3 [20]

The dimeric compounds B_2H_6 and Ga_2Cl_6 have similar-looking 3-dimensional structures. (i) Draw Lewis-type structures for each molecule; (ii) draw the 3-dimensional structure of one of these molecules as accurately as possible and (iii) describe the similarities and differences between the bonding in each of these molecules using appropriate bonding models. [20]

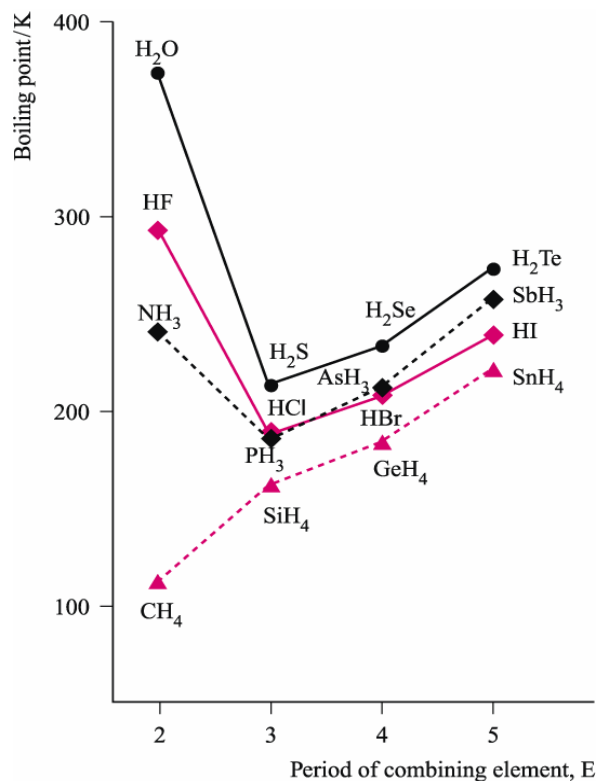
Question #4 [15]

- (a) Use appropriate arguments to explain why Li_2O is the only stable oxide of lithium while K_2O , K_2O_2 and KO_2 are possible for potassium. [10]
- (b) Explain the following observation: Cl_3BNMe_3 has a B-N distance of 1.575 D, while $\text{B}(\text{NMe}_2)_3$ has a B-N distance of 1.439 D and Me_2BNMe_2 has a B-N distance of 1.375 D. [5]

Question #5 [25]

(a) Explain the following observations regarding lithium compounds we examined in class: LiCl has a typical salt-type structure, $(C_5H_5)Li$ has a linear (column-like) structure and $(H_3C)Li$ has a cube-shaped cluster structure. [10]

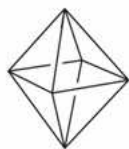
(b) Contrast and compare the trends and anomalies for the elements of **Groups 14 and 16** depicted in the following diagram. Be sure to explain in detail the reason(s) for any anomalous behaviour. [15]



(b)



$n = 5$
Trigonal
bipyramid



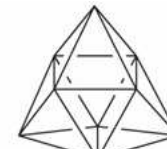
$n = 6$
Octahedron



$n = 7$
Pentagonal
bipyramid



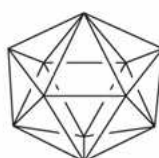
$n = 8$
Dodecahedron



$n = 9$
Tricapped
trigonal prism



$n = 10$
Bicapped
square-antiprism



$n = 11$
Octadecahedron



$n = 12$
Icosahedron