

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  $\text{PF}_5$  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  $\text{PF}_5$  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  $\text{B}_6\text{H}_{10}$  (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)  $\text{B}_6\text{H}_{10}$  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  $\text{B}_2\text{H}_6$  and  $\text{Ga}_2\text{Cl}_6$  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]**

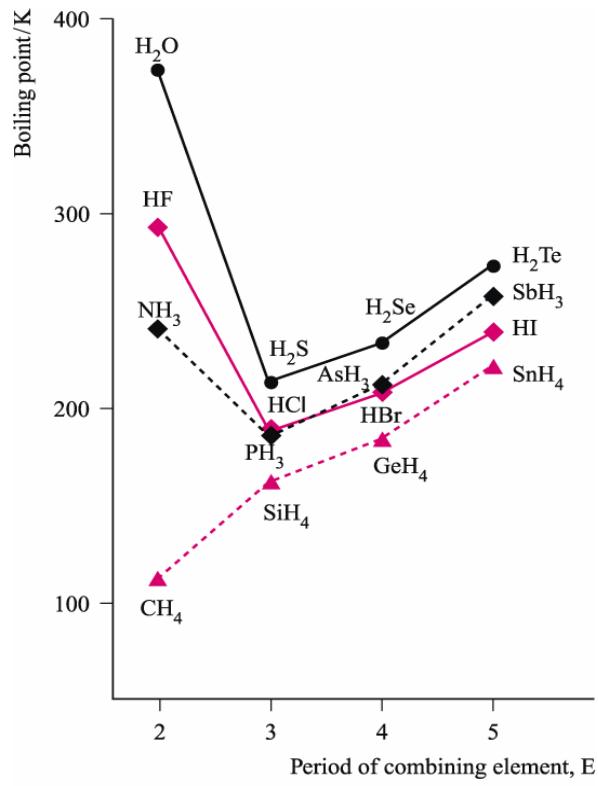
(a) Use appropriate arguments to explain why  $\text{Li}_2\text{O}$  is the only stable oxide of lithium while  $\text{K}_2\text{O}$ ,  $\text{K}_2\text{O}_2$  and  $\text{KO}_2$  are possible for potassium.[10]

(b) Explain the following observation:  $\text{Cl}_3\text{BNMe}_3$  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  $\text{Mes}_2\text{BNMe}_2$  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)

