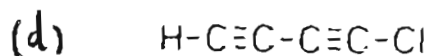
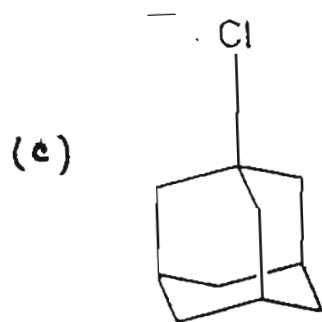
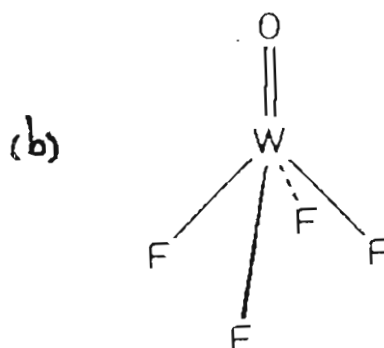
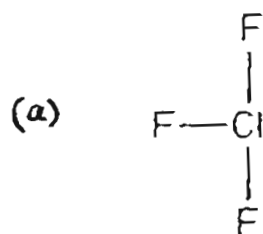


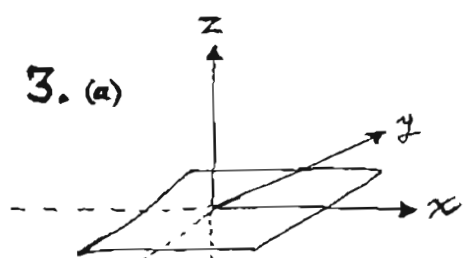
CHEM 3870  
**SAMPLE QUESTIONS**

There are 4 questions for a total of 40 marks  
The answers to each of the 4 questions are of equal value.

1. Classify the following molecules according to the point group to which they belong.



2. Using ordinary multiplication as the combining operation construct a group multiplication table for the set of elements  $i, -1, -i, \text{ and } 1$ . (Note:  $i = \sqrt{-1}$ ). Find any nontrivial subgroups of this group. Is the full group Abelian? Why? Is the full group cyclic? Divide the elements into classes.

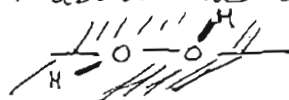


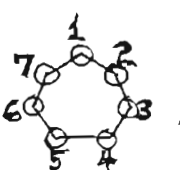
By considering the transformation of a general point  $(x, y, z)$ , show that

$$C_2(z) \sigma(xy) = \sigma(xy) C_2(z)$$

To what operation is the product of these two operations equivalent?

- (b) What does symmetry tell us about the possible optical activity of  $H_2O_2$ ? about the direction of the dipole moment in  $H_2O_2$ ?



4. (a) With reference to a regular heptagon,  ,

write out all the operations generated by an  $S_7$  axis. Express each operation in conventional notation. Divide these operations into classes.

(b) For  $\underline{\underline{A}} = \begin{pmatrix} 1 & 1 & 1 \\ 2 & 3 & 4 \\ 5 & 5 & 5 \end{pmatrix}$  and  $\underline{\underline{B}} = \begin{pmatrix} 2 & 2 & 2 \\ 1 & 1 & 1 \\ 3 & 3 & 3 \end{pmatrix}$

verify that  $\chi(\underline{\underline{A}} \underline{\underline{B}}) = \chi(\underline{\underline{B}} \underline{\underline{A}})$ .  
( $\chi$  = 'character' or 'trace'.)