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**University Examinations 2016/2017**

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE CHEMISTRY

**SCH 3303: INTRODUCTION TO GROUP THEORY**

**DATE: December, 2016 TIME: HOURS**

**INSTRUCTIONS:** *Answer questions* ***one*** *and any other* ***two*** *questions .Character tables attached*

**QUESTION ONE - (30 MARKS)**

1. Distinguish between; (4 Marks)
2. Reducible representation and irreducible representation
3. Symmetry elements an symmetry operation
4. Identify symmetry elements present in each of the following molecules; (6 Marks) 

 

 

1. Use knowledge of group theory to classify each of the following molecules as chiral or achiral. (6 Marks)
2. Staggered 1, 2 – dichloroethane
3. Ammonia molecule
4. CBr Cl F H
5. Using group theory , classify each of the following molecules as polar or non polar.

(6 Marks)



 



1. Define a mathematical group and list four rules that qualifies it as such. (5 Marks)
2. Name a symmetry operation that corresponds to each of the following 2 x 2 transformation matrices. (3 Marks)
3. $\left[\begin{matrix}Cos θ&Sin – θ\\Sin θ&Cos θ\end{matrix}\right]$
4. $\left[\begin{matrix}1&0\\0&1\end{matrix}\right]$
5. $\left[\begin{matrix}1&0\\0&-1\end{matrix}\right]$

**QUESTION TWO (20 MARKS)**

1. (i) What is meant by the term “point group”? (2 Marks)

(ii) What distinguishes Cn point group from Dn point group? (2 Marks)

1. (i) State rearrangement theorem. (1 Mark)

(ii) Construct group multiplication table for point group C2V ensuring that rearrangement theorem is obeyed. (4 Marks)

(iii) Use the group multiplication table constructed in b(ii) above to determine the following; (3 Marks)

1. $ExC\_{2}$
2. $Exσv(xz)$
3. $σv(xz) X σV(yz)$
4. Using group theory, determine the hybridization of Boron in Boron Brifluoride (BF3)

(9 Marks)

**QUESTION THREE (20 MARKS)**

1. State VSEPR theory. (1 Mark)
2. Use VSEPR theory to determine the geometry and structure for each of the following molecules and hence assign point group to each one of them. (12 Marks)
3. $COCl\_{2}$
4. $SF\_{6}$
5. $M\_{n}O\_{4}^{-}$
6. (i) What is a character table? (½ Mark)

(ii) Label all the parts of character table given below. (2$½ $Marks)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| $$C\_{2}V$$ | E | $$C\_{2}$$ | $$σv\_{(XZ)}$$ | $$σ\_{V}(yz)$$ |  |  |
| $$A\_{1}$$$$A\_{2}$$$$B\_{1}$$$$B\_{2}$$ | 1111 | 11-1-1 | 1-11-1 | 1-1-11 | ZRzX,RyY, R | $$x^{2},y^{2},z^{2}$$x yx zy z |

(iii) What is the order of the group in table above? (½ Mark)

1. Find the irreducible representation of NH3 (C3V). Use SN, $S\_{1}$,$ S\_{2}$ , $S\_{3}$ as the basis (3½Marks)

**QUESTION FOUR (20 MARKS)**

1. Analysis of the x, y, z coordinates of each atom in SO2 gives the following representation;

$C\_{2}V $ E C2 $δV\left(xz\right)$ $δv\left(yz\right)$

Γ 9 -1 3 1

1. Classify the irreducible representation into translation rofation and vibration modes. (10 Marks)
2. With explanation, identify the vibration modes that are; (6 Marks)
3. Infrared active
4. Raman active
5. Can a tetrahedral molecule such as CH4 have a triply degenerate orbitals? What is the minimum number of atoms from which a molecule can be built that does not display triple degeneracy? (4 Marks)