QUESTION BANK

CHP -4102

Section I

A] Multiple choice questions.

1) Square pyramidal MX_4 molecule belongs to C_{4v} point group and symmetry elements are E, $2C_4$, C_2, $2\sigma v$, $2\sigma d$ the trace for the reducible representation is-
   a) 5 1 1 1 3
   b) 5 1 1 1 1
   c) 1 1 1 1 1
   d) 4 1 1 1 3
2) The point group of $[M(CO)_3L_3]$ is-
   a) C_{2v}
   b) C_{3v}
   c) Oh
   d) D_{3h}
3) Point group of Cyclohexane is -
   a) Chair form is D_{3d}
   b) Boat form is C_{3v}
   c) Both chair and boat form is C_{2v}
   d) Boat form is D_{3d}
4) In which of the following pairs both the molecules will give pure rotational spectra-
   a) CH_4 and $CHCl_3$
   b) CH_2Cl_2 and CCl_4
   c) CH_2Cl_2 and $CHCl_3$
   d) $CH_4$and CCl_4

5) The character table for C_{2v} point group is given below. In cis butadiene molecule the vibrational modes belonging to A_2irreducibla representation are IR inactive. The remaining are-

C_{2v}	E	C_2	σ_v	σ'_y	
A_1	1	1	1	1	Z, x^2,y^2,z
A_2	1	1	-1	-1	R_z, xy
B_1	1	-1	1	-1	X, R_y, xz

B_2	1	-1	-1	1	Y, R_x, yz

a) $7A_1 + 5B_1 + 8B_2$
b) $9A_1 + 4B_1 + 7B_2$
c) $7A_1 + 3B_1 + 7B_2$
d) $9A_1 + 3B_1 + 8B_2$

6) SF_4 is consistent with the point group symmetry-
a) C_{3v}
b) C_{4v}
c) T_d
d) C_{2v}

7) The point group of NOCl is-
a) C_3
b) C_{3v}
c) D_3
d) C_{2v}

8) Which of the following is not the point group of ferrocene –
a) D_{5h}
b) D_{5d}
c) C_{4v}
d) None of the above

9) The order of C_{3v} point group is-
a) 3
b) 6
c) 9
d) 12

10) Which of the following is non abelian group-
a) C_{2v}
b) C_{3v}
c) C_{4v}
d) None of the above

B] Short answer questions

1) Define improper axis of rotation.
2) Enlist all the symmetry elements of H_2O molecule.
3) What is the difference between symmetry and symmetry operation?
4) Give the definition of symmetry elements.
5) What is inversion centre? Give example.

6) Explain equivalent atoms with suitable example.
7) What are the conditions for mathematical group?
8) Define abelian group.
9) What is mean by order of a group?
10) What is matrix? Give the matrix representation of C_2^z.

C] Short answer questions

1) Write down the associative operation of S_3axis.
2) How do you distinguish between Cnv and Cnh point group?
3) Using molecular geometry give the product $\sigma_v^1 \times \sigma_v^2$ operation in NH_3molecule?
4) Find out the product $\sigma_v(xz) \times \sigma_v(xy)$ symmetry operations by matrix multiplication method.
5) Identify and draw different types of planes present in CO_3^{2-} ion.
6) What are the symmetry criterion for a molecule to posses permanent dipole?
7) Classify cisplatin in the appropriate point group. Justify your answer.
8) When n is odd, $S_n^{2n} = E$, prove this.
9) How will you distinguish between Cis and trans isomer of 1,2- dichloroethylene using plane of symmetry?
10) Mention the symmetry elements, order and classes of D_4h point group.
11) Identify and draw the different types of planes in NO_3^- ion.
12) Give the equation of direct product.
13) What is point group of $[Co(en)_3]^{2+}$?
14) What are the point group symmetry for cyclopropane and benzene?
15) Find improper axis of rotation in following molecules?
    i) CCl_4
    ii) C_2H_4 (eclipsed)

D] Long answer type questions

1) What are the conditions of mathematical group? Show C_2v forms a mathematical group.
2) Sketch and describe all the S_4 operations in trans-$[Co(NH_3)_4Cl_2]$
3) For PF_5 molecule find out reducible representation for which sigma bonds form the basis and find out which of the orbitals from the P atom will be offered for sigma bonding?

D_{3h}	E	$2C_3$	3C2	σ_h	$2S_3$	$3\sigma_v$		
A_1'	1	1	1	1	1	1		X^2+y^2 , z^2
A_2'	1	1	-1	1	1	-1	R_z	
E'	2	-1	0	2	-1	0	(x , y)	(x^2-y^2, xy)
A_1''	1	1	1	-1	-1	-1		
A_2''	1	1	-1	-1	-1	1	Z	
E''	2	-1	0	-2	1	0	(R_x, R_y)	(xz, yz)

4) Define abelian group. Explain an abelian group with example.
5) Using great orthogonalitytheorem derive the character table for D_2 point group.
6) Find the normalized SALC using projection operator of E_u irreducible representation on σ_1 of the $[PtCl_4]^{2-}$ / $[Cu(NH_3)_4]^{2+}$ complex ion.

D_{4h}	E	$2C_4$	C_2	$2C_2'$	$2C_2''$	I	$2S_4$	σ_h	$2\sigma_v$	$2\sigma_d$
E_u	2	0	-2	0	0	-2	0	2	0	0

7) Prove that C_{3v} point group is Non-Abelian point group.
8) Derive the transformation matrix for the axis of rotation and mention the matrix for C_2^z rotation.
9) Find out the normalized SALC using projection operator of A_g irreducible representation on σ_1 orbital of the B_2H_6 molecule which belongs to D_{2h} point group.

D_{2h}	E	C_2^z	C_2^y	C_2^x	I	$\sigma(xy)$	$\sigma(xz)$	$\sigma(yz)$
A_g	1	1	1	1	1	1	1	1

10) Derive the character table for H_2O_2 trans molecule.
11) Sketch and describe all the symmetry elements in $[Ni(CN)_5]^{3-}$ complex.
12) Explain all symmetry elements and classify it into appropriate point group : Eclipsed ferrocene.
13) Give the matrices for σ^{xy} and C_2^z and find out the product of them. Give the matrix representation for improper axis of rotation.
14) Write short note on symmetry elements and symmetry operations.
15) Give point group of Allene and describe symmetry elements, symmetry operations of it.
16) Write short note on great orthogonality theorem and its consequences and derive the character table for C_{2h} using great orthogonality theorem.
17) Give the point group for following molecules.
    i) H_2O_2 (cis)
    ii) $[TiCl_4]^{2-}$
    iii) ferrocene (staggered)

iv) $C_2H_4Cl_2$

iv) HCl

v) $XeOF_4$

vi) $C_2H_2Cl_2$

vii) B_2H_6

viii) CH_4

ix) Cyclooctatetraene

x) SF_5Cl

xi) 1,2- Dichlorobenzene

18) Prove that all irreducible representations of abelian groups must be one dimensional

19) Write the matrices describing the effect on a point (x,y,z) of reflections vertical planes which lie halfway between the xz and yz planes by matrix methods determine hat operations result when each of these reflections is followed by reflection in the xy plane.

20) The character table of the irreducible representation A_1 in C_{3v} point group is given below.

	E	$2C_3$	$3\sigma_v$
A_1	1	1	1

Identify one irreducible representation orthogonal to A_1 among the following

	E	$2C_3$	$3\sigma_v$
T_1	1	-1	1
T_2	2	-1	0
T_3	2	0	1
T_4	1	-1	-1

21) Give the point group for H_3BO_3 molecule and give its symmetry elements, classes, order

22) Construct the character table for C_{3v} point group with proper explanation.

Section II

A) Objective questions

1) Borax is used in preparing-

a) soda glass

b) pyrex glass

c) opal glass

d) Portland cement

2) Hydrogen will not reduce –
a) Heated cupric oxide
b) Heated ferric oxide
c) Heated stannic oxide
d) Heated aluminium oxide

3) The ratio of ortho hydrogen:para hydrogen-
a) Decrease with increase of temperature
b) Increase with increase of temperature
c) Is independent of temperature
d) at highest at 100^0 C and then decreases

4) Alkali metal in liquid ammonia are blue in colour because –
a) They contain alkali metal cations
b) the free electron is trapped in solvent cages
c) an ion pair is formed
d) An amide ion is formed

5) The Si-O-Si bond angle in $Me_3Si\text{-}O\text{-}SiMe_3$ is –
a) ~120^0
b) ~180^0
c) ~90^0
d) ~109^0

6) Which of the following an arachnoborane
a) $[B_6H_6]^{2-}$
a) $[B_5H_9]$
b) $[B_2H_6]$
d) $[B_6H_{12}]$

7) C_{60} has –
a) 14 pentagons and 18 hexagons
b) 12 pentagons and 20 hexagons
c) 10 pentagons and 20 hexagons
d) 12 pentagons and 18 hexagons

8) Inorganic graphite is –
a) $B_3N_3H_6$
b) B_3N_3
c) SiC

d) P_4S_3

9) White phosphrous belongs to the –
a) closo system
b) Nido system
c) Arachno system
d) Hypo system

10) Which of the following alkali metal cations forms the most stable cryptate[2 2 2]-
a) Li^+
b) Na^+
c) K^+
d) Rb^+

B) Answer in one sentence

1) Give the account of the hydrides of boron
2) Among the following elements the one that acts as a major component in semiconductor is – a) carbon b) silicon c) gallium d) arsenic
3) Draw the structures $[B_5H_9]$, $[B_4H_9]$, N_2O_5, P_4O_{10}
4) Define electron deficient compounds
5) Define electron rich compounds

C) Short Answer Questions

1) What are the metallic hydrides ? Mention their properties.
2) Explain the alkali metal solution in ammonia used as a good reducing agent ?
3) Diborane is best soft lewis acid. Explain
4) Explain any two reactions of $COCl_2$.
5) What are nitrides of boron ?
6) What are the electron rich compound?
7) Explain the Oxoanions of nitrogen.
8) Draw the structure of B_5H_9
9) Explain the Nitrogen Oxyacids.
10) Draw the structure of Diborane.
11) Difference between Diamond and Graphite.
12) Give the classification of electron deficient and electron rich hydrides
13) Give an account of Borazine

D) Shorts Notes

1) Write a short note on Interhalogen Cmpound
2) Short Note on aluminosilicate
3) Pseudohalogens
4) Give an account of Borazole
5) Short note on Intercalation compounds
6) Short note on Carbon Nanotubes
7) Applications of carbon Nanotubes
8) Write a note on π- acidity.
9) Applications of Crown Ether
10) Write a note on Coordination compounds of alkali metals?
11) Short notes on zeolits
12) How many types of bonds are involved in the bonding of boranes? Give the structural features of B_4H_{10}, B_5H_9, B_5H_{11}, B_6H_{10} , $B_{10}H_{14}$ what is the STYX number write the STYX number of above boranes
13) Give the structure of Diborane and write a short note on it.

E) Long Answer Questions

1) Give an account reactions of BX_3
2) Write a note on solutions of alkali metals in liquid ammonia.
3) Give an account of Oxyanions of Nitrogens.
4) Short note on Fullerene.
5) Give the reactions of – 1) $COCl_2$ 2) CO_2 3) PCl_5 4) CH_3X 5) C_2H_5Br
6) What is Grignard Reagent? How it is prepared Properly? Uses of it.
7) Synthesis and properties of Saline Carbides.
8) Define Interhalogen Compounds? Give their classification. Explain preparation, bonding and structure of XY_5 type of Interhalogen compound.
9) What are the silicons ? How they are prepared? Give two important properties and uses of silicons?
10) Discuss structural aspects of different types of Silicate.
11) Write down the classification and synthesis of structure of Organometallic compounds of Li , Mg , Br.
12) Explain with one example each of Closo , Nido, Arachno Carborane. Explain Wade's rule.
13) Distinguish between Geminal and Vicinal dihalides.
14) Explain Allotropes of carbon
15) Complete the following reactions
    i) $XeF_2 + NO \rightarrow$
    ii) $RLi + R'CHO \rightarrow$
    iii) $Be(CH_3)_2 + CH_3OH \rightarrow$
    iv) $B_3N_3H_3Cl_3 + NaBH_4 \rightarrow$? + $NaCl + BH_3$

v) $6RGeCl_3 + Li \rightarrow$? + LiCl

vi) $BeCl_2 + RMgCl + (C_2H_5)_2O \rightarrow$? + $MgCl_2$

16) Draw the structure of following- XeF_2, XeF_4 , $XeOF_4$, XeO_2F_2 , XeO_3, $[XeO_6]^{4-}$, XeO_4

17) Draw the structure of following –

B_5H_9 , N_2O_5 , IF_7 , Diborane , Triborane , BrF_5, $S_4N_4F_4$, S_2F_{10}

18) Draw the structure of following –

B_4H_{10}, N_2O_5 , $TeCl_4$, $[B_3O_3(OH)_5]^{2-}$, $(NPCl_2)n$