CH2101-Inorganic Chemistry-I

(The question paper must be submitted with the answer script)

End Semester Question paper **2018** **Marks-50**

MCQ (7 x1) =7

1. Sapphire is aluminium oxide. It crystallizes with aluminium ions in two-thirds of the octahedral holes in a closest packed array of oxide ions. Hence the simple formula is-
   (a) Al_2O_3
   (b) AlO_2
   (c) Al_4O_6
   (d) None of the above
2. As a ligand Cl^- is,
   (a) Only a σ-donor
   (b) Only a π-donor
   (c) Both a σ- and π-donor
   (d) A σ-donor and a π-acceptor
3. The structure obtained when all the tetrahedral holes are occupied in a fcc structure is like
   (a) NaCl
   (b) Al_2O_3
   (c) CaF_2
   (d) $TiCl_4$
4. In a close packed fcc arrangement of a lattice comprising of n atoms of a kind, the number of tetrahedral and octahedral holes present respectively are-
   A. 2n and 4n
   B. n and 4n
   C. 2n and n
   D. n and 2n
5. Among the given examples which one obeys the 18-electron rule-
   (a) $Mn(CO)_5$ (b) $Fe(CO)_5$
   (c) $V(CO)_6$ (d) $Cr(CO)_6$
6. Due to formation of Schottky defects the density of the crystal-
   (a) increases slightly
   (b) decreases slightly
   (c) remains unchanged
   (d) increases appreciably
7. The spinels$Co^{II}Fe^{III}_2O_4$ and Fe_3O_4 respectively are-
   (a) inverse and inverse spinel
   (b) normal and normal spinel
   (c) normal and inverse spinel
   (d) inverse and normal spinel

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8. Given below are two reactions: comment on what type of reactions they are? **2**

$$AgNO_3 + LiCl \longrightarrow AgCl + LiNO_3$$

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_20$$

9. The pK_a of acetic acid is 4.76, while that of chloroacetic acid is 2.86. What does it signify? **2**

Section –B (Answer any four)

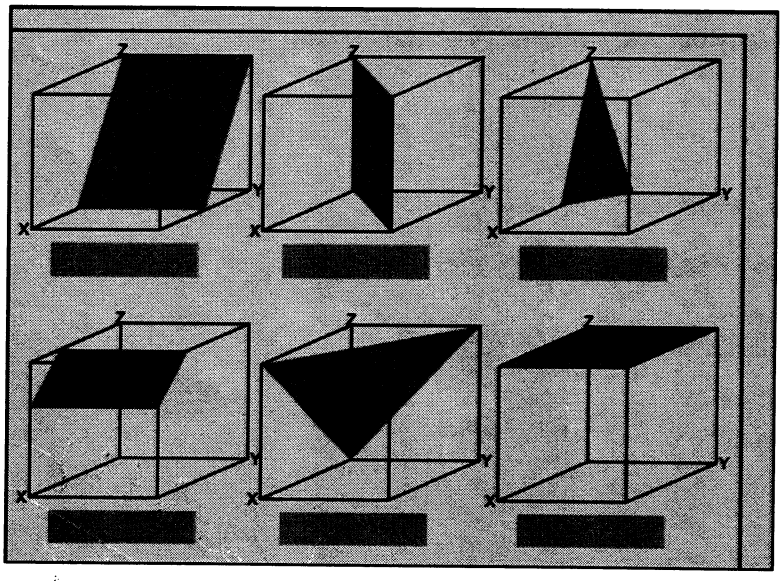
10. A solution is 10^{-3}M in $Cr_2O_7^{2-}$ and 10^{-2} M in Cr^{3+}. If the pH is 2.0 what is the potential of the half-reaction? $E^0(Cr_2O_7^{2-}, Cr^{III})$ =1.33 V **3**

11. You found that the reduction potential of $Fe^{3+} \rightarrow Fe^{2+}$ system increases on addition of PO_4^{3-} . Explain why so? $E^0(Fe^{III}/Fe^{II})$ = 0.769 V **3**

12. Explain the trend in reactivity— **3**

Metal ion:	Li(I)	Mg(II)	In(III)	Zr(IV)
Ionic radius (Å):	0.7	0.74	0.80	0.84
log $K_1(OH^-)$:	<0	2.6	10.0	14.6
log $K_1(F^-)$:	<0	1.82	4.6	9.8

13. Given below are few planes and their Miller indices. Assign the Miller indices to the correct planes. **3**



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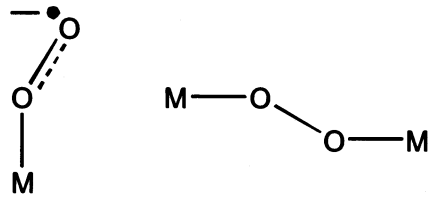
14. You have a CO ligand and the following metals - Mn^{I}, Ti^{IV} and Mn^{VII}. You see that the ligand CO only forms complex with Mn^{I} the others do not form isolable complexes in general why so? **3**

Section –C (Answer any two)

15. Metal nitrosyl can have both linear and bent structure. Explain when a metal nitrosyl bond will be bent and when will it be linear. Show the bonding with orbital overlap diagrams. **6**
16. If the following two metal oxygen bonds are found which orbitals may possibly be involved in their formation show with drawing using the concept of molecular orbitals. **6**



17. Find out the point group for the following molecules (If you write point group directly no marks will be awarded). **6**

(a) BH_3 (b) BrF_5 (c) Tris(oxalato)Fe^{III}

Section –D (Answer any two)

18. Using the MO diagram of carbon dioxide show whether the carbon center is electrophilic or nucleophilic. You may form the SALC by inspection using the respective character Table. **7.5**
19. Draw the MO diagram of BH_3 using projection operator method. (Use the right character Table from the ones given at the end of the question paper) **7.5**
20. Explain using MO diagram for octahedral complexes how pi-donor, sigma donor and pi-acceptor ligand would affect the splitting. Why do pi-acceptor ligands have the tendency to provide low spin complexes. **7.5**
21. Construct the MO diagram of ammonia using projection operator and the respective character Table. **7.5**

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C_{3v}	E	$2C_3$	$3\sigma_v$		
A_1	1	1	1	z	$x^2 + y^2, z^2$
A_2	1	1	-1	R_z	
E	2	-1	0	$(x, y), (R_x, R_y)$	$(x^2 - y^2, xy), (xz, yz)$

O_h	E	$8C_3$	$6C_2$	$6C_4$	$3C_2'$	i	$6S_4$	$3\sigma_h$	$8S_6$	$6\sigma_d$		
A_{1g}	1	1	1	1	1	1	1	1	1	1		$x^2+y^2+z^2(=r^2)$
A_{2g}	1	1	-1	-1	1	1	-1	1	1	-1		
E_g	2	-1	0	0	2	2	0	2	-1	0		$(3z^2-r^2, x^2-y^2)$
T_{1g}	3	0	-1	1	-1	3	1	-1	0	-1	(I_x, I_y, I_z)	
T_{2g}	3	0	1	-1	-1	3	-1	-1	0	1		(xy, yz, zx)
A_{1u}	1	1	1	1	1	-1	-1	-1	-1	-1		
A_{2u}	1	1	-1	-1	1	-1	1	-1	-1	1		
E_u	2	-1	0	0	2	-2	0	-2	1	0		
T_{1u}	3	0	-1	1	-1	-3	-1	1	0	1	(x, y, z)	
T_{2u}	3	0	1	-1	-1	-3	1	1	0	-1		

D_{3h}	E	$2C_3$	$3C_2$	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

D_{2h}	E	$C_2(z)$	$C_2(y)$	$C_2(x)$	i	$\sigma(xy)$	$\sigma(xz)$	$\sigma(yz)$	linear functions, rotations	quadratic functions	cubic functions
A_g	+1	+1	+1	+1	+1	+1	+1	+1	-	x^2, y^2, z^2	-
B_{1g}	+1	+1	-1	-1	+1	+1	-1	-1	R_z	xy	-
B_{2g}	+1	-1	+1	-1	+1	-1	+1	-1	R_y	xz	-
B_{3g}	+1	-1	-1	+1	+1	-1	-1	+1	R_x	yz	-
A_u	+1	+1	+1	+1	-1	-1	-1	-1	-	-	xyz
B_{1u}	+1	+1	-1	-1	-1	-1	+1	+1	z	-	z^3, y^2z, x^2z
B_{2u}	+1	-1	+1	-1	-1	+1	-1	+1	y	-	yz^2, y^3, x^2y
B_{3u}	+1	-1	-1	+1	-1	+1	+1	-1	x	-	xz^2, xy^2, x^3

D_{2d}	E	$2S_4$	C_2	$2C_2'$	$2\sigma_d$		
A_1	1	1	1	1	1		$x^2 + y^2, z^2$
A_2	1	1	1	−1	−1	R_z	
B_1	1	−1	1	1	−1		$x^2 - y^2$
B_2	1	−1	1	−1	1	z	xy
E	2	0	−2	0	0	(x, y); (R_x, R_y)	(xz, yz)