Birla Institute of Technology and Science, Pilani (Rajasthan)
First Semester 2023-24, 20th December, 2023
Comprehensive Examination (Open Book) Part -II
CHEM F214; Inorganic Chemistry I

Time: 2 hours 20 Mins **Max. Marks: 56**

Q.1(a) Arrange the following compounds according to the increasing order of lattice energy and explain: CaO, LiCl, KBr, KCl. **[1+3]**
(b) pK_a of HI, HBr, HCl and HF are -10, -9, -7, 3 respectively. Provide the reason behind the trend observed for acidity. To differentiate the acids like HI, HBr, HCl, which solvent is better, H_2O or CH_3COOH and why? **[2+2]**
(c) In which complex ion amongst $[Co(NH_3)_6]^{3+}$ and $[Co(H_2O)_6]^{3+}$, the ionic radius of Co^{3+} is higher? Justify your answer. **[2]**
(d) Write down the balanced reduction reaction of O_2 in aqueous acid. Calculate the emf for this reaction when p_{O2} = 0.2 bar and pH = 7 (E^0 = 1.229 V; 2.303RT/F = 0.0591V at 298 K) **[1+3]**

Q. 2 (a) R_2Sn exists in dimeric form in solid state. The bond order between Sn-Sn bond is 1.46. Comment on hybridization, hence on the structure of the compound with one-line justification. **[1+1+1]**
(b) Orthocarbonic acid, $C(OH)_4$ and orthonitric acid, $ON(OH)_3$ are unknown rather $O=C(OH)_2$ and $O_2N(OH)$ form, whereas orthosilicic acid $Si(OH)_4$ forms. Why does such difference exist? **[3]**
(c) The bond energies of BrF, BrF_3 and BrF_5 follow the order as $BrF>BrF_3>BrF_5$. Provide the justification. Why does not BrF_7 form whereas IF_7 is a stable compound? **[2+2]**
(d) (i) Stilbite is a natural zeolite of formula $Na_4Ca_8Al_{20}Si_{52}O_{144}.56H_2O$. Can it be converted to $Ca_{12}Al_{l2}Si_{52}O_{144}.56H_2O$? Justify you answer. (ii) How can be any zeolite made more acidic in nature? **[2+2]**

Q. 3(a) From the perspective of structure and bonding, several polyhalides are analogous to $[py\text{-}I\text{-}Py]^+$ (py = pyridine). Name such two polyhalides and describe their bonding with a help of MO diagram (consider only the valence orbitals of interest) **[1+3]**
(b) Draw all of the structural isomers of P_4H_6. Assume that inversion at phosphorous is slow and draw all possible stereoisomers. **[4]**
(c) Predict the products (A, B, C) of the following reactions.
$[CH_3NH_3]Cl + BCl_3 \rightarrow A + B$
$A + CH_3MgBr \rightarrow C$ **[3]**
(d) Find out the bond order of Mo-Mo bond in $Mo_2(MeCO_2)_4$ complex. In the σ bonding between two Mo atoms which orbitals are in use and why? **[1+2]**

Q.4(a) Compare the aromaticity of trimeric phosphazene, borazine with that of benzene and explain. Arrange them in the order of increasing aromaticity. In trimeric phosphazene, $P_3N_3Cl_6$, **justify** the orbitals utilized in π bonding (in-plane) from N and P atoms with mention of the orbital utilized. Amongst in-plane and perpendicular π bonding, which one do you think stabilize the molecule more? Explain **[3+2+2]**
(b) Consider a $[B_{11}H_{14}]^-$ species. identify the number of framework electrons and B-H-B bonds. With the help of Wade's rule, find out the its structure. **[1+1+2]**
(c) Between infinite single chain of formula $[SiO_3]_n^{2n-}$ and infinite double chain of formula $[Si_4O_{11}]_n^{6n-}$ and a sheet or layer structure, $[Si_2O_5]_n^{2n-}$ what is fundamental difference in terms of the number of shared oxygen atoms? **[3]**

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