

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, H₂O or CH₃COOH and why? [2+2]

(c) In which complex ion amongst [Co(NH₃)₆]³⁺ and [Co(H₂O)₆]³⁺, the ionic radius of Co³⁺ is higher? Justify your answer. [2]

(d) Write down the balanced reduction reaction of O₂ in aqueous acid. Calculate the emf for this reaction when $p_{O_2} = 0.2$ bar and pH = 7 ($E^0 = 1.229$ V; $2.303RT/F = 0.0591$ V at 298 K) [1+3]

Q. 2 (a) R₂Sn 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 O₂N(OH) form, whereas orthosilicic acid Si(OH)₄ forms. Why does such difference exist? [3]

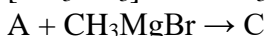
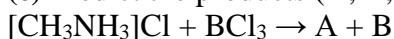
(c) The bond energies of BrF, BrF₃ and BrF₅ follow the order as BrF > BrF₃ > BrF₅. Provide the justification. Why does not BrF₇ form whereas IF₇ is a stable compound? [2+2]

(d) (i) Stilbite is a natural zeolite of formula Na₄Ca₈Al₂₀Si₅₂O₁₄₄.56H₂O. Can it be converted to Ca₁₂Al₁₂Si₅₂O₁₄₄.56H₂O? Justify your 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-I-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 P₄H₆. Assume that inversion at phosphorous is slow and draw all possible stereoisomers. [4]

(c) Predict the products (A, B, C) of the following reactions.



[3]

(d) Find out the bond order of Mo-Mo bond in Mo₂(MeCO₂)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, P₃N₃Cl₆, **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 [B₁₁H₁₄]⁻ 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 [SiO₃]_n²ⁿ⁻ and infinite double chain of formula [Si₄O₁₁]_n⁶ⁿ⁻ and a sheet or layer structure, [Si₂O₅]_n²ⁿ⁻ what is fundamental difference in terms of the number of shared oxygen atoms? [3]

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