

**Bachelor of Engineering in Chemical Engineering Examination 2017**  
(1<sup>st</sup> Year, 1<sup>st</sup> semester)  
**Inorganic Chemistry**

**Time 3 hours**

**Full Marks: 100**

**Answer any five questions**

- 1.a) What do you mean by conjugate acid base pair? Give example. 3
- b) Why second acid dissociation constant of a dibasic acid is always small than first acid dissociation constant? 3
- c) What do you understand by symbiosis? Give example. 3
- d) How can you separate  $\text{Cu}^{2+}$  and  $\text{Cd}^{2+}$  from their mixture? 3
- e) B–F bond distance in  $\text{BF}_3$  is shorter than B–F bond distance in  $\text{H}_3\text{N} \rightarrow \text{BF}_3$  adduct. Is this statement true? Give explanation in support of your answer. 3
- f) Define hard acids and hard bases. Give examples. 5
2. a) How can you calculate pH of a very dilute solution of a strong acid? What is the pH of  $10^{-7}$  (M) HCl solution? 5
- b) What is the relation between hydrolysis constant and acid dissociation constant? Calculate pH of a solution containing 25 mL of 0.01 (M) acetic acid and 25 mL of 0.01 (M) KOH.  $K_a$  of acetic acid is  $1.75 \times 10^{-5}$ . 5
- c) Derive the expression of pH when a salt of weak acid and weak base is hydrolyzed. 5
- d) Arrange the following in their increasing acidity order and explain elaborately:  
HF, HCl, HBr and HI 5
- 3 (a) Which one has higher ion-conduction value in aqueous phase among the following ions and why?  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Li}^{3+}$ ,  $\text{H}^+$  [2]
- (b) Write the canonical forms of  $\text{N}_3^-$  and  $\text{N}_2\text{O}_5$  and account their stability. [2]
- (c) Account the stability order of aluminum halides,  $\text{Al}_2\text{F}_6$ ,  $\text{Al}_2\text{Cl}_6$ ,  $\text{Al}_2\text{Br}_6$ , and  $\text{Al}_2\text{I}_6$  with proper justification. [2]
- (d) Explain why: (any three) [2×3=6]
- i) Trimethyl amine  $(\text{CH}_3)_3\text{N}$  and Trisilyl amine  $(\text{SiH}_3)_3\text{N}$  have nearly similar formula but they have different structures.
- ii)  $\text{ClF}_3$  exists whereas  $\text{FCl}_3$  does not.
- iii) Sn(+II) is strongly reducing but Pb(+IV) is strongly oxidizing.
- iv) Colouration behaviors of  $\text{HgCl}_2$ ,  $\text{HgBr}_2$ , and  $\text{HgI}_2$  are different.

- (e) Discuss the effect of ozone layer on human health. [2]
- (f) Write a note on 'Mercury toxicity'. [2]
- (g) Why carbon monoxide is a deadly poisonous gas? Explain your answer. [2]
- (h) Why EDTA is called flexidentate ligand? Draw the structure of  $\text{Ca}^{2+}$ -EDTA complex. [2]

4(a) Write the structure and bonding of the followings: (any two) [2×2=4]

i)  $\text{P}_4\text{O}_{10}$  ii)  $\text{B}_3\text{N}_3\text{H}_6$  iii)  $\text{SbF}_6^{3-}$

(b) Explain why: (any three) [2×3=6]

i)  $\text{KHF}_2$  exists but  $\text{KCl}_2$ ,  $\text{KBr}_2$ , and  $\text{KI}_2$  doesn't exist.

ii)  $\text{CCl}_4$  does not undergoes hydrolysis whereas  $\text{SiCl}_4$ .

iii)  $\text{N}_2$  is inert but  $\text{CO}$  is highly reactive, though both have 14 electrons.

iv) Bond length of B-F bonds in  $\text{BF}_3$  is  $1.3\text{\AA}$  and is less than the sum of the covalent radii.

(c) What is pesticide? Which class of pesticide is deadly poisonous to human health? [2]

(d) What is photochemical smog? How is it formed? [2]

(e) What are the parameters needed to check for water to be 'drinking water'? [3]

(f) Find the oxidation state and spin only magnetic moment ( $\mu_s$ ) of the following complexes: [3]

i)  $[\text{Fe}(\text{CN})_6]^{3-}$  ii)  $\text{Ni}(\text{CO})_4$  iii)  $[\text{CoCl}_4]^{2-}$  iv)  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  v)  $\text{Ni}(\text{DMG})_2$  vi)  $\text{Cu}(\text{OAc})_2 \cdot \text{H}_2\text{O}$

5. (a) (i) Draw the Walsh Diagram for Linear and bent  $\text{H}_3$  system and hence show that  $\text{H}_3^+$  is angular and  $\text{H}_3^-$  is linear. 5

or (ii) Find the energy of the bonding, non-bonding and antibonding orbitals in linear  $\text{H}_3$  systems.

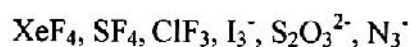
(b) (i) Draw the Walsh Diagram for Linear and bent  $\text{AH}_2$  system and hence show that  $\text{H}_2\text{O}$  is angular and  $\text{BeH}_2$  is linear. 5

or (ii) Draw the MO energy level diagram for  $\text{BeH}_2$ .

(c) (i) Draw the MO energy level diagram for CO and hence explain that Metal-Carbon bond is stabilized by  $\sigma$ - $\pi$  synergic effect in transition metal carbonyls. 5

or (ii) Two atomic orbitals,  $\chi_A$  and  $\chi_B$ , undergo out of phase overlap to form the bonding and antibonding MOs. Find out the energies of both bonding and antibonding MOs.

(d) Comment on the structures and shapes of the following chemical species. Draw their structures. Write the hybridization of the central atoms (any five): 5



6. (a) Draw the shapes of Bohr-Sommerfeld orbits for  $n=4$  and label them. 3

(b) (i) Calculate the wave length of the 3<sup>rd</sup> line in the Balmer series of  $\text{He}^+$  spectrum 3

or (ii) Draw molecular orbital energy level diagram of HF and hence comment on its polarity

(c) Write the electronic configuration of  $\text{Fe}^{2+}$ , Ag, Cr and Cu (any two) 3

(d) (i)  $\text{He}_2$  does not exist. Comment. 3

or (ii)  $\text{Be}_2$  may exist at very low temperature. Comment

(e) Calculate the radius of  $\text{Ne}^{9+}$  ion using Bohr's theory 3

(f) Draw the MO energy level diagram for  $\text{B}_2$  and hence explain its magnetism. 3

(g) (i) Find the ground state term symbol for  ${}^7\text{N}$  2

or (ii) Show that Bohr's 2<sup>nd</sup> postulate involving the quantization of the angular momentum can be derived from de Broglie's hypothesis.