3 (Sem–4/CBCS) CHE HC 1

2023

CHEMISTRY

(Honours Core)

Paper : CHE–HC–4016

(Inorganic Chemistry–III)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following : 1×7=7

(i) The compound which exhibits Jahn-Teller distortion is

(a) $[Mn(H_2O)_6]^{2+}$

(b) $[Mn(H_2O)_6]^{3+}$

(c) $[Cr(H_2O)_6]^{3+}$

(d) $[Fe(CN)_6]^{4-}$

(Choose the correct answer)

Contd.

(ii) Which metal helps in blood clotting ?

(iii) For which of the following ions, colour is not due to a d-d transition ?

(a) CrO_4^{2-}

(b) $Cu(NH_3)_4^{2+}$

(c) $Ti(H_2O)_6^{3+}$

(d) CoF_6^{3-}

(Choose the correct answer)

(iv) What is the main iron storage protein in biological system ?

(v) What type of isomerism is exhibited by the complex $[Co(NH_3)_5NO_2]^{2+}$?

(vi) Draw the structure of the following complex :
Tri-μ-hydroxo bis
[triammine chromium(III)]

(vii) Which metal deficiency causes pernicious anemia ?

2. Answer the following : 2×4=8

(i) Explain why Ce^{+3} and Tb^{+3} are colourless but show strong absorption in UV region.

(ii) How does mercury cause toxicity in living system ?

(iii) Why do transition metals show variable oxidation states ?

(iv) Determine the crystal field splitting energy Δ_0 of a d^6 complex having $10\ Dq = 25{,}000\ cm^{-1}$ and $P = 15{,}000\ cm^{-1}$. Consider low spin complex.

3. Answer ***any three*** questions from the following : 5×3=15

(i) Using crystal field theory explain the difference in magnetic property of $[CoF_6]^{3-}$ and $[Co(CN)_6]^{3-}$.

(ii) Comment on the spectral and magnetic properties of actinide elements compared to lanthanides.

(iii) What is Na/K pump ? Write the mechanism of action of Na/K pump.

(iv) Given below is the Latimer diagram of manganese in acidic medium : 2+3=5

$$MnO_4^- \xrightarrow{+0.56} MnO_4^{2-} \xrightarrow{+2.26} MnO_2 \xrightarrow{+0.95} Mn^{3+} \xrightarrow{+1.15} Mn^{2+} \xrightarrow{-1.19} Mn$$

(a) Which species are likely to disproportionate and why ?

(b) Calculate standard reduction potential for the couple MnO_4^{2-}/Mn^{3+}

(v) Discuss the mechanism of binding of dioxygen with hemoglobin.

4. Answer ***any three*** questions from the following : 10×3=30

(i) Explain the bonding of $[Co(NH_3)_6]^{3+}$ with the help of molecular orbital theory. Draw the energy level diagram and also predict the magnetic property of the complex. 6+3+1=10

(ii) (a) Explain the evidences in favour of the covalency of metal-ligand bonding in complexes. 5

(b) What inferences can be drawn from the following reactions ? 5

$$[Ni(CN)_4]^{2-} + 4^*CN^- \longrightarrow [Ni(^*CN)_4]^{2-} + 4CN^- \text{ (very fast) } t_{1/2} = 30 \text{ sec}$$

$$[Mn(CN)_6]^{3-} + 6^*CN^- \longrightarrow [Mn(^*CN)_6]^{3-} + 6CN^- \text{ (slow) } t_{1/2} = 1 \text{ hr}$$

$$[Cr(CN)_6]^{3-} + 6^*CN^- \longrightarrow [Cr(^*CN)_6]^{3-} + 6CN^- \text{ (slowest) } t_{1/2} = 24 \text{ days}$$

(iii) Write about the use of chelating compounds in medicinal chemistry.

(iv) Answer the following questions regarding oxidation states exhibited by the first transition series elements :

(a) List the oxidation states shown by each element indicating the unstable states within bracket.

(b) All the elements except scandium exhibits $a+2$ oxidation state whereas scandium exhibits a+3 oxidation state only. Explain.

(c) Why do the elements at each end of the series exhibit minimum number of oxidation states and those in the middle show a maximum number of oxidation states ?

(d) Why are the higher oxidation states stabilised by oxide or fluoride ? 3+2+3+2=10

(v) What is lanthanide contraction and what is its cause ? Discuss the separation of lanthanides using ion exchange method. Explain why La^{3+} is colourless but Lu^{4+} is orange red. 1+2+5+2=10

(vi) What special feature of Zn^{2+} makes it an excellent candidate for different enzymes ? Write the structure and function of carbonic anhydrase enzyme with suitable diagram. 2+2+6=10
