UNIVERSITY OF RUHUNA
BACHELOR OF SCIENCE GENERAL DEGREE LEVEL I (SEMESTER II)
EXAMINATIONS – JANUARY 2022

SUBJECT: CHEMISTRY

COURSE UNIT: CHE 1212 (Descriptive Inorganic Chemistry -I) TIME: **Two (02)** hours

Answer **four (04)** questions only by selecting at least **one (01)** from each sections **A**, **B** and **C**.

Section – A

(01) Answer **all** parts

(a) Phosphorus forms two common oxides, phosphorus(III) oxide (P_4O_6), and phosphorus(V) oxide (P_4O_{10}).

(i) Draw the structures of the two common oxides of phosphorous.

(ii) Write balanced equations for the reactions occur when P_4O_6 reacts with

(I) hot water

(II) cold water

(iii) Draw the structures of the products formed in part (ii) above.

(iv) Give balanced chemical equation for the preparation of P_4O_{10} from apatite and sand.

(v) Briefly explain how you would prepare a pure sample of phosphorous starting from P_4O_{10}.

(vi) Giving chemical equations explain how PCl_5 can be oxidized by P_4O_{10}.

(50 marks)

(b) Hydrogen is the lightest element and it is given a separate position in the periodic table.

(i) Briefly discuss why hydrogen cannot be grouped with alkali metals and halogens.

(ii) Giving necessary chemical equations, briefly explain the chemistry involved in the preparation of pure hydrogen from coke. (30 marks)

(c) Write short notes on the following

(i) Hydrogen economy

(ii) Hydrogen gap

(iii) Ortho and Para hydrogen

(iv) Exchange reactions of deuterium

(20 marks)

(02) Answer **all** parts

(a) The Lewis theory concerning acids and bases was introduced in 1923 by the U.S. chemist Gilbert N. Lewis.

(i) Explain what is meant by a Lewis acid and a Lewis base.

(ii) Identify the Lewis acids and bases in the following reactions

(I) $BF_3 + CH_3NH_2 \rightarrow$

(II) $Co + CO \rightarrow$

(III) $Ag^+ + Cl^- \rightarrow$

(IV) $BF_3 + F^- \rightarrow$

(iii) Briefly discuss the limitations of the Lewis theory.

(30 marks)

(b) Draw the structures of the following

(i) Borazine

(ii) $Al(BH_4)_3$

(iii) Inosilicates (Single Chain Silicates)

(iv) trimetaphosphoric acid

(20 marks)

(c) Discuss the differences of the following reactions

(i) Reactions of F_2 with dilute NaOH vs. concentrated NaOH

(ii) Reactions of Br_2 with cold diluted NaOH vs. hot NaOH

(iii) Reactions of F_2 with liquid water vs. Steam

(iv) Reduction of $SICl_4$ with $LiAlH_4$ vs. reduction of Si_2Cl_6 with $LiAlH_4$

(v) Reaction of $AlCl_3$ with limited LiH vs. excess LiH

(50 marks)

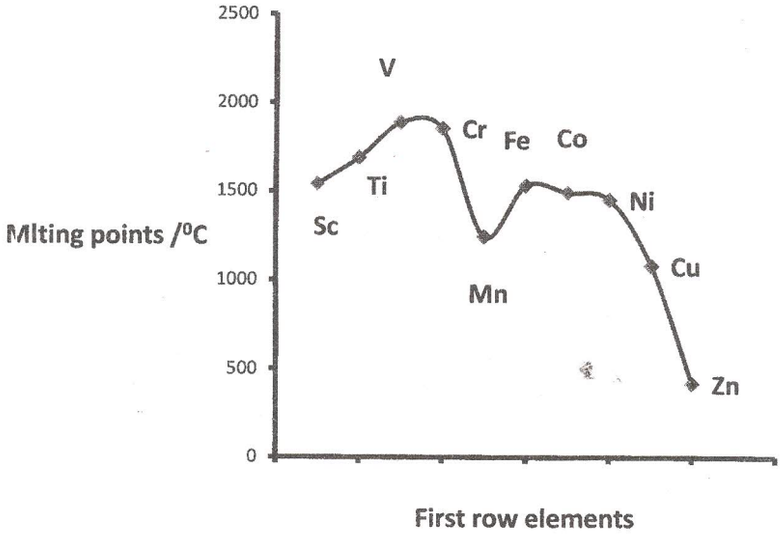
Section – B

(03) Answer **all** parts.

(a) Transition metals resemble main group metals in many ways. However, there are differences between them as well. Support this statement by giving appropriate examples.

(20 marks)

(b) Variation of melting points of the first transition metal series is shown in the following figure.



(i) Explain the above variation of melting points of first row transition elements.

(ii) Justify the unusual behavior of Cr and Mn

(iii) Giving reasons, predict the melting points of second and third transition series in comparison to first row .

(30 marks)

(c) Consider the following equations and standard reduction potential values.

$Mn^{2+} + 2e \longrightarrow Mn \quad E^0 = -1.18\ V$

$Co^{2+} + 2e \longrightarrow Co \quad E^0 = -0.28\ V$

(i) Select the best reducing agent from Mn^{2+} and Co^{2+}

(ii) Explain why reduction potential values are different for the two metals

(20 marks)

(d) Paramagnetism arises from spin and orbital motions of unpaired electrons.

(i) Calculate the spin only magnetic moment for the complex $[Cr(H_2O)_6]Cl_2$

(ii) Discuss whether an orbital contribution to the magnetic moment is expected or not for the above complex.

(30 marks)

(04) Answer **all** parts.

(a) Giving balanced chemical equations explain how you would extract pure Cr from naturally occurring chromite, $FeCr_2O_4$.

(20 marks)

(b) Naturally occurring mineral rutile is heated with coke and chlorine gas to produce colourless liquid **A** and a toxic gas **B**. The liquid **A** is distilled off and reacted with pure oxygen flame at 1500 ^{0}C to yield a commercially important metal oxide $\mathbf{MO_2}$ and a gas $\mathbf{X_2}$ with a strong pungent odor.

(i) Identify the chemical formulae of **A**, **B**, $\mathbf{MO_2}$ and $\mathbf{X_2}$

(ii) Write balanced chemical equations for the formation of above species.

(iii) Name two structural forms of the oxide $\mathbf{MO_2}$.

(iv) Propose an experiment to identify the amount of each structural forms of $\mathbf{MO_2}$ produced.

(v) Consider paper, textile and paint industries. Select the preferred structural form of $\mathbf{MO_2}$ for each of these industries. Give reasons for your selection.

(56 marks)

(c) Fe is the most important transition element in plants and animals. It forms many complexes including hemoglobin.

(i) Sketch the coordination environment at the oxygen binding site of hemoglobin molecule.

(ii) Briefly explain the positive cooperative effect of oxygen binding in hemoglobin.

(24 marks)

Section – C

(05) Answer **all** parts.

(a) What are the geometries and coordination numbers of the central atom of following complexes?

(i) $K[CuCl_2]$

(ii) $(NH_4)_2[Ni(CN)_4]$

(iii) $Na_2[MnCl_4]$

(iv) $[CoCl_2(en)_2]Cl$ (20 marks)

(b) For each of the following coordination complexes determine the oxidation state.

(i) $[Fe(CO)_4]^{2-}$
(ii) $[Co(CN)_5H]^{3-}$
(iii) $[Fe(H_2O)_5(NCS)]^{2+}$
(iv) $[Ni(en)_3]Cl_2$ (16 marks)

(c) Using IUPAC norms write the formulae for the following:

(i) tetrahydroxozincate(II) ion

(ii) diamminedichloridoplatinum(II)

(iii) potassium tetracyanidonickelate(II)

(iv) pentaamminenitrito-O-cobalt(III)

(v) tris(ethane-1,2-diammine)cobalt(III) ion

(25 marks)

(d) Draw all the possible isomers for the complex $[Cr(en)_2(CN)_2]^+$ and identify the type of isomerism

(18 marks)

(e) Palladium(II) tends to form complexes with a coordination number of 4. One such complex (**A**) was originally formulated as $PdCl_2 \cdot 3NH_3$.

(i) Suggest an appropriate coordination complex formulation for this compound **A**.

(ii) Suppose an aqueous solution of the compound **A** is treated with excess $AgNO_3(aq)$. How many moles of AgCl(s) are formed per mole of A? write the balanced chemical reaction for the reaction of **A** with $AgNO_3(aq)$ solution.

(21 marks)

(06) Answer **all** parts.

(a) Identify the geometries and hybridization of following coordination complexes.

(i) $[Ag(NH_3)_2]^+$

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

(iii) $[Cu(NH_3)_4]^{2+}$

(12 marks)

(b) Which of the following complexes are chiral?

(i) $[Cr(ox)_3]^{3-}$

(ii) *cis*-$[PtCl_2(en)]$

(iii) *cis*-$[RhCl_2(NH_3)_4]^+$

(10 marks)

(c) What is the coordination entity formed when an excess amount of aqueous KCN is added to an aqueous solution of copper sulphate? Why is it that no precipitate of copper sulphide is obtained when $H_2S(g)$ is passed through this solution?

(17 marks)

(d) Identify the factors affecting the Crystal Field Stabilization Energy (CFSE) and briefly explain how they affect CFSE.

(21 marks)

(e) $[Fe(CN)_6]^{4-}$ and $[Fe(H_2O)_6]^{2+}$ are of different colours in dilute solutions. Why?

(20 marks)

(f) $[Ni(CN)_4]^{2-}$ is diamagnetic and square planar in geometry. Explain the statement using Valence Bond Theory

(20 marks)

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PERIODIC TABLE OF ELEMENTS