Undergraduate Programme, 2025
Semester-II (UGNEP)
Chemistry Major
Paper: MJCH03: Gr. A&B
Inorganic (Theory)

Time: Three Hours **Full Marks: 80**

(Use separate answer scripts for each group)

Questions are of value as indicated in the margin

Group –A (Marks: 40)
(Inorganic Chemistry)

*Answer **any four** of the following questions*

1. (a) Define disproportionation and comproportionation reactions with suitable examples
   (b) Metallic aluminium turns sodium nitrate into ammonia in the presence of sodium hydroxide. Balance the reaction involved by the ion-electron method.
   (c) Differentiate between an electrolytic cell and a galvanic cell. Give an example in each case.
   (d) Describe briefly: (i) Dry cell and (ii) Storage cell.
   (e) What is the standard electrode potential? Mention the factors controlling it. (1+1)×5=10

2. (a) Write the basic assumptions of the Liquid Drop Model.
   (b) Write the semi-empirical mass formula, mentioning the name of each energy term.
   (c) What are magic numbers, and why are they important in nuclear chemistry?
   (d) Write the nuclear configurations of $^{39}_{19}K$. 3+3+2+2=10

3. (a) What is the EMF of a cell? Derive the Nernst equation for the EMF of a chemical cell.
   (b) The standard EMF of a Daniell is 1.1V at 25°C. Calculate the equilibrium constant of the reaction occurring in that Daniell cell at 25°C. Also, calculate the standard free energy change and the electrical work done by the cell.
   (c) What do you mean by Latimer diagram? Give an example. Mention the utility of the Latimer diagram. (1+2)+(1+1+1)+(1+1+2)=10

4. (a) What is the life of a radioactive element? Write its expression.
   (b) The $^{3}_{1}H$ isotope of hydrogen, tritium, has a half-life of 12.33 yr. It is produced in the upper atmosphere by cosmic rays and brought to Earth by rain. As an application, determine approximately the age of a bottle of wine whose $^{3}_{1}H$ radiation is about $\frac{1}{10}$ that present in new wine.
   (c) Write the Soddy-Fajan group displacement law (s) with an example (s).
   (d) Arrange alpha (α), beta (β), gamma (γ) radiations according to their (i) penetrating and (ii) ionizing power. 2+3+3+2=10

5. (a) How do the following two compounds differ in their aqueous solutions in terms of the ions present: $KAl(SO_4)_2.12H_2O$ and $CuSO_4.4NH_3$
   (b) How do the following compounds differ during their reaction with $AgNO_3$ and why?
   i) $CoCl_3.\ 6NH_3$ ii) $CoCl_3.\ 5NH_3$; iii) $CoCl_3.\ 4NH_3$ 4 +6 = 10

6. (a) Write the three geometrical possibilities for a complex of coordination number six, and which one exists in the said complex. Explain.

(b) If you add $CuSO_4$ in concentrated NH_3 and, on other occasions, in dilute NH_3, where do you find a Cu-complex, and why?
(c) What do you mean by ligands, and give an example of a bidentate ligand? 4 + 4 + 2 = 10

Group –B (Marks: 40)
(Physical Chemistry)

Unit-I

Answer **any two** questions

1. (a) How many independent variables are required to define a state of a thermodynamic system with one component? Explain the answer with a suitable example. Generalize the answer for a thermodynamic system with N components. If the composition of this system is kept fixed then how many independent variables are required to define the state of the same? 2+3+1
   (b) What is the caloric theory? Is it true? Justify the answer. 1+3

2. (a) Define reversible and irreversible processes with suitable examples. What are the differences between the two processes? Both the processes are real. Comment on the statement. 4+2+1
   (b) A finite transformation of a system may be a reversible or an irreversible one. Comment on the statement with suitable examples. 3

3. (a) Prove that $PV\gamma=C$ for adiabatic reversible expansion of an ideal gas. compare this result with the isothermal reversible expansion of the same. Give answer using the P-V plot. Point out significant differences (if any) with explanation. 4+3
   (b) One mole of an ideal gas having and initially at 25^0C and 100 KPa, is compressed adiabatically using a constant pressure equal to the final pressure until the temperature of the gas reaches 325K . Calculate the final pressure. 3

4. State and prove the Clausius inequality. What is the significance of this relation? Apply this relation for spontaneous transformation of an isolated system and characterize the entropy. What is the Clausius statement on the entropy of an isolated system. Justify the relations, $ds\geq 0$ with suitable examples. 1+2+2+1+4

Unit-II

Answer **any two** questions

5. (a) Discuss how the equivalent conductance of weak and strong electrolytes varies with dilution. 2+2
   (b) A conductivity cell filled with 0.1M solution of KCl at 25 ^{0} C has a measured resistance of 24.96 ohm. Calculate the cell constant if the specific conductance of 0.1M KCl solution be 0.011639 ohm $^{-1}$ cm $^{-1}$ and conductivity water of L s = 7.5×10^{-8} ohm $^{-1}$ cm $^{-1}$ is used to make up the solution. When the cell is filled with a 0.001M solution of acetic acid, the cell resistance becomes 1982 ohm. Calculate the molar conductivity of acetic acid at this concentration. 3
   (c) Explain how by a graphical method the equivalent conductance of a weak electrolyte at infinite dilution can be determined. 3

6. (a) Discuss how the factors like viscosity, dielectric constant and temperature affect the electrophoretic effect and the relaxation effect. 3
   (b) Briefly discuss Debye-Falkenhagen effect and Wien's effect as evidence of Debye-Hückel ion atmosphere model. 2+2
   (c) Derive the following relation related to the terminal speed of an ion in an electrolyte solution:
   $\nu = \nu_T (1 - e^{-6\pi\eta r t/m})$. 3

7. (a) Deduce the following relation known as the Walden's rule
   $\Lambda_m \eta = |e|F(\nu_+ z_+^2/r_+ + \nu_- z_-^2/r_-)/6\pi$. Comment on this relation. Discuss when we observe departures from the above relation. 3+2+1
   (b) H^+ ions do not exhibit abnormal mobility in acetone solvent–comment on the statement. 2
   (c) Define ionic mobility. What is its unit? 1+1

8. (a) Prove that the equivalent conductance of an ion is proportional to its mobility where the proportionality constant is Faraday. 3
   (b) Define transport number. For a single electrolyte solution show that
   $t_+ = i_+/(i_+ + i_-) = \nu_+/(\nu_+ + \nu_-) = u_+/(u_+ + u_-) = \lambda_+/(\lambda_+ + \lambda_-)$. 1+3
   (c) Discuss the nature of the conductometric titration curve when acetic acid is titrated against ammonium hydroxide. 3

Undergraduate Programme 2025

Multidisciplinary Course in Chemistry: MDCH 01

[*Chemistry in Everyday Life*]

Time: Three Hours **Full Marks: 60**

Questions are of value as indicated in the margin.
Answer all questions from Group A and any three questions from Groups B, C, and D.

Group A

(Multiple Choice Type Questions)

Choose the correct alternatives of the following: **[15 × 1 = 15]**

1. (i) The enzyme responsible for enzymic browning is
(A) Peroxidase (B) Catalase (C) Phenolase (D) Amylase

(ii) Which of the following is an example of a viscosity modifying emulgent?
(A) Sodium Phosphate (B) Carboxymethyl Cellulose
(C) Sodium Nitrate (D) Sodium Stearoyl Lactylate.

(iii) Mixing usually aims to make:
(A) A Solid Product (B) A Homogeneous Mixture
(C) A Frozen Item (D) A Dry Powder

(iv) The wire used in electrical heaters is made up of
(A) Copper (B) Platinum (C) Aluminium (D) Nichrome

(v) Water molecule is?
(A) Circular (B) Linear (C) V-Shaped (D) Square Planar.

(vi) Which of the following is the effect of high BOD?
(A) More birth of aquatic plants (B) More birth of fishes
(C) Higher dissolved oxygen (D) Lower dissolved oxygen

(vii) The temperature range of the troposphere is:
(A) –2°C to 92°C (B) –56°C to –2°C
(C) 15°C to –56°C (D) –92°C to 1200°C

(viii) At DO below 3 mg/L, water at normal temperature is
(A) Heavily Polluted (B) Moderately Polluted
(C) Little Polluted (D) Nearly Pure

(ix) Which one of the following dissolves more rapidly in blood haemoglobin than oxygen?
(A) SO_2 (B) CO (C) NO (D) O_3

(x) Coal induced smog was formed by the interaction SO_2 smoke and water to form H_2SO_4 and more than 4000 people died in December 1952 in
(A) London, England (B) Los Angeles, California (C) Donora, USA (D) Bhopal, India.

(xi) Chloramphenicol palmitate is
(A) Drug (B) Broad Spectrum Analgesic (C) Antipyretic (D) Prodrug.

(xii) Polyethylene is
(A) An Elastomer (B) A Fiber (C) A Thermoplastic (D) A Thermoset.

(xiii) Graft copolymer is defined as when
(A) Two or more monomers are randomly distributed in the polymer chain;
(B) It possesses two regularly alternating monomer residues,
(C) Two or more homopolymer subunits linked by covalent bonds;

(D) Segmented copolymers with a linear backbone of one monomer and randomly distributed branches of another composite.

(xiv) Natural rubber has following repeating units:
(A) Ethylene (B) Propylene (C) Isoprene (D) Butadiene

(xv) Keratin does not contain following interaction:
(A) Salt Bridge (B) H-Bond (C) Triazine Bond (D) Disulphide Bond

Group B

(Short Answer Type Questions)

(*Answer any three questions*) **[3 × 5 = 15]**

2. (a) What do you mean by *N-P-K* ratio of a fertiliser? Describe the industrial synthesis of diammonium phosphate (DAP). Write down two major disadvantages of the excessive use of chemical fertilisers. (1.5+1.5+2)
(b) Write the sources of the metals Cadmium, Mercury, and Lead in water and their adverse effects on the human body. (5)
(c) Write short note on the following topics: (a) Earth's Albedo and Radiation Balance, (b) The Effects of Global Warming on weather change, farming, and sea levels. (2.5+2.5)
(d) Differentiate between BOD and COD. The 5-day biochemical oxygen demand (BOD) of a wastewater sample at 20°C is measured to be 210 mg/L. (i) Calculate the ultimate BOD and the BOD after 10 days at 20°C. (ii) If the same sample were incubated at 30°C, what would be the 5-day BOD value? (Given: $k_1 = 0.23$/day, $\theta = 1.047$) (2 + 3)
(e) Define greenhouse effect. Discuss different types of vibrations possible in CO_2 and how this gas increases the surface temperature of our Earth. What do you mean by atmospheric window? (1.5+2.5+1)

Group C

(Short Answer Type Questions)

(*Answer any three questions*) **[3 × 5 = 15]**

3. (a) Write short notes on the following topics: (i) Thermoplastic, (ii) Block copolymer, (iii) Random copolymer (2+1.5+1.5)
(b) Define polymer and oligomer. Define number average and weight average molecular weight and poly dispersity index (2+3)
(c) Classify dyes based on application and discuss their function with suitable examples. (2+3)
(d) What is a prodrug? Explain the difference between a drug and prodrug with examples. What is an allosteric site? (1.5+1.5+2.0)
(e) Why soap is used to clean our skin? How do soaps function? What are the components of a cream? (2.0+2.0+1.0)

Group D

(Short Answer Type Questions)

(*Answer any three questions*) **[3 × 5 = 15]**

4. (a) What do you mean by blending and mixing in food processing? How does a microwave oven operate? Mention one harmful effect of microwave heating on food? 2.0+2.0+1.0
(b) What is enzymic browning? How can enzymic browning be prevented? What are the advantages and disadvantages of enzymic browning? 2.0+1.0+2.0
(c) What is an electric heater? Explain its working principle briefly. What are the different types of heat transfer? 2.0+2.0+1.0
(d) What is an emulsion? Give two examples. What are the uses of emulsion? 2.0+2.0+1.0
(e) Briefly discuss on conduction, convection and radiation modes of heat transfer. 5.0

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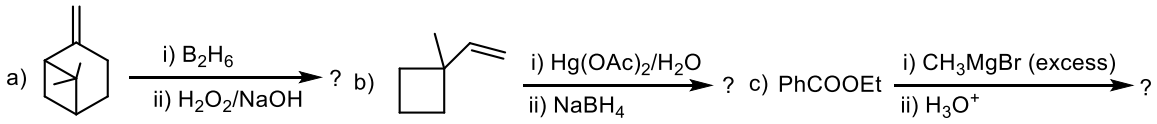
Four Year Undergraduate Programme - Chemistry (Major), 2025
Semester-II
Course: MJCH04: Gr. A
(Organic Chemistry)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Answer **four** questions taking any **two** questions from **Group A** and **two** questions from **Group B.**

Group A

1. (a) Describe a simple chemical test that can serve to distinguish between *n*-butanol and *tert*-butanol. 2
(b) How do you convert 1-propene into *n*-propanol? 2
(c) A concentrated aqueous solution of HBr reacts with EtOH to give EtBr, but a concentrated aqueous solution of NaBr does not. Explain. 2
(d) Predict the major product in each case (any two): 2+2



2. (a) Dehydration of *n*-BuOH with acid gives 1- and 2-butene. Explain this, and state which product predominates and why? 2
(b) Demonstrate the pinacol-pinacolone rearrangement with a suitable example. 2
(c) Optically active *sec*-butyl alcohol retains its activity indefinitely in contact with aqueous base, but is rapidly converted into optically inactive (racemic) *sec*-butyl alcohol by dilute sulphuric acid. How do you account for these facts? Suggest a detailed mechanism or mechanisms for the racemisation by dilute acid. 4
(d) "Urea (NH_2CONH_2) is a mono-acidic base" - do you agree with this statement? Give an explanation in support of your answer. 2

3. Write short notes on the following name reactions 2.5 x 4
(a) Appel Reaction. (b) Grignard reaction (focusing on alcohol synthesis). (c) Mitsunobu reaction. (d) Ritter reaction.

Group B

4. Define each term, and give an example (with reaction conditions and stereochemistry if applicable) 2 x5
(a) Alkoxymercuration. (b) Halohydrin. (c) Oxidative cleavage. (d) peroxide effect.
(e) Concerted reaction

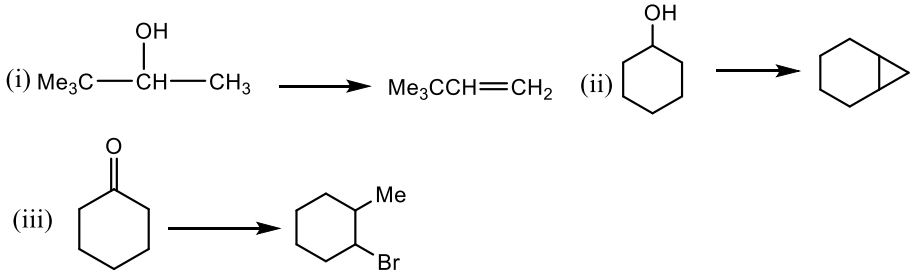
5. Show how you would accomplish the following synthetic transformations. Show all intermediates. 2x 5

(a) 1-butyne to *trans* 2-hexene. (b) *trans* -2-hexene to *cis*-2-hexene. (c) 1-hexyne to 2-hexanone. (d) cyclohexene to *trans*-cyclohexane-1,2-diol.

(e) cyclohexene to 3-bromocyclohexene.

6. (a) Provide an explanation for the fact that the *threo*- and the *erythro*-isomers of 2-deuterio-1,2-diphenylethyl acetate on pyrolysis give a predominance of the *trans*-isomer of stilbene and 1-deuteriostilbene respectively. 4

(b) Carryout the following transformations showing all the reaction intermediates. 2x3



Use separate answer script for each group

Undergraduate Examination, 2025
Semester-II (NEP-Minor)
Course: MNCH 01
Chemistry (Theory)

Time: Two Hours **Full Marks: 40**

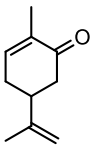
Group A (Organic Chemistry)

Questions are of value as indicated in the margin.
Answer any ***two*** questions

1. Write down the expected products of the following: 10x1=10

a) CH_3-CH=CH_2 $\xrightarrow{H_2O/H^+}$?

$\xrightarrow[ii)\ H_2O_2]{i)\ B_2H_6/THF}$?

b) 

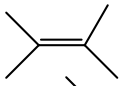
Wilkinson Catalyst → ?

Ni/H_2 → ?

c) 

i) I2/AgOA
Dry AcOH
ii) H_3O^+ → ?

i) I2/AgOA
Wet AcOH
ii) H3O$^+$ → ?

d) 

KMnO4
H_2SO_4 → ?

KMnO4
NaOH → ?

e) Me-C≡C-Me $\xrightarrow{\text{Birch reduction}}$?

Lindlar's catalyst → ?

2. Explain the following with suitable examples 2.5x4=10

   i) Inductive effect ii) Resonance effect iii) Hyperconjugation iv) Oxymercuration and Demercuration in an alkene

3. (a) Draw the possible conformations of the cyclohexane molecule. 3
   (b) What do you mean by the terms 'equatorial hydrogen' and 'axial hydrogen'? 3
   (c) What do you mean by ring inversion (flipping) of cyclohexane? 4

4. Write short notes on 2.5 x 4=10
   (a) Chirality of a molecule
   (b) Optically active compound with no chiral centre
   (c) Fischer projection formula
   (d) Conformations of the butane molecule

Ref. No.**VB/EXAM/REG/06/UGNEP/Programme Chemistry/Sem-II/39159/2025**

Paper Setter

Moderator

Group-B (Physical Chemistry)

Questions are of value as indicated in the margin.
Answer any ***two*** questions

1. a) State Boyle's law of the gaseous state. Draw the P-V isotherm at two different temperatures T_1 and T_2, where $T_2 > T_1$. 2+2

   b) Derive the equation of state from the gas laws. Define ideal gases. 2+1

   c) Calculate the pressure exerted on the walls of a 3-litre flask when 7 gms of Nitrogen are introduced into the same at 27 °C. 3

2. a) State any three (3) postulates of the kinetic theory of gases. 3

   b) Draw the graphical representation of the Maxwell distribution function of molecular velocity at temperatures T_1 and T_2, where $T_1 > T_2$. Define the most probable velocity in the graph. 2+1

   c) Derive the volume correction of van der Waal's equation for real gases. 4

3. a) Explain why real gases deviate from the ideal gas law. 4

   b) Define the surface tension of liquids. Briefly explain the reason behind the occurrence of surface tension. 1+2

   c) What is the viscosity of a fluid flow? What is the coefficient of viscosity? What is the unit of the coefficient of viscosity? 1+1+1

Undergraduate Programme, 2025
Semester-II (UGNEP)
Chemistry Major
Paper: SECCH02AT
Environment and its Segments (Theory)

Time: Two Hours **Full Marks: 20**

Questions are of value as indicated in the margin.

Answer any four of the following questions

1. (a) "The use of hydrohaloalkane in cooling system is a better alternative than pure haloalkane"-Justify the fact. (b) Write a brief note on O_3 layer depletion. 2.5×2 = 5

2. (a) Write the importance of the biogeochemical cycle. Write a brief discussion on the Nitrogen cycle. 1+4=5

3. How can you account for the global warming agents and the global warming potential? 5

4. Discuss two sources of water pollution. 2.5×2 = 5

5. Write a short discussion on photochemical smog. (b) Is MIC gas considered as dangerous for human consumption? Justify your response. 2+3 = 5

6. What is enrichment in water pollution? Write the cause and its consequences. 1+(2+2) = 5

Four Year Undergraduate Programme, 2025 Examination

Semester-II
Chemistry (Major)
Paper: [SECCH02C] - Physical Chemistry-I: Thermodynamics (Theory)

Time: 3 hours Full Marks:60

Answer any six questions

1. Justify the relation, $df=(\partial f/\partial x)_y dx+(\partial f/\partial y)_x dy$ with a suitable example. Using it, derive the cyclic rule and apply it for an ideal gas. What is the physical meaning of this relation? Using it discuss a method to determine $(\partial U/\partial V)_T$ experimentally for an gas. 3+1.5+1.5+4

2. (a) Classify the stationary states of a closed system. Describe the principle to identify the relevant stationary states. What is the basic difference for the stationary states? 1+3+1

(c) In an adiabatic expansion of one mole of an ideal gas from an initial temperature of 25^OC, the work produced is 1200J. If molar heat capacity at constant volume is 1.5R, calculate the final temperature, Q, W, ΔU and ΔH. 2+0.5+0.5+0.5 1..5

3. Comment on the following statements 2.5x4
(a) People prefer to think that internal energy of a pure thermodynamics system is a function of temperature and volume.
(b) With a good approximation, the internal energy of a pure thermodynamic system can be assumed as a function of temperature only.
(c) People prefer to think that enthalpy of a pure thermodynamics system is a function of temperature and pressure.
(d) dQ/dT at constant volume may lie between -∞ to +∞.

4. Define heat capacities of a system based on the first law of thermodynamics. Find the relation between the two. Interprete the relation. Apply the relation for an ideal gas. 4+3+2+1

5. One mole of an ideal gas with molar heat capacity 5/2R at constant volume, is subjected to two successive changes in state.

(i) From 25^OC and 100kPa pressure, the gas is expanded isothermally against a constant pressure of 20kPa to twice the initial volume.

(ii) After undergoing the change in (i) the gas is cooled at constant volume from 25^OC to -25^OC. Calculate Q, W, ΔU, and ΔH for the changes in (i) and (ii) and for the overall change (i) + (ii). 4+4+2

6. (a) Describe the principle used for an adiabatic calorimeter to determine heat of a reaction at constant pressure or volume. 4+3

(b) Discuss applicability of the relation, $dH=(\partial H/\partial T)_p dT+(\partial H/\partial P)_T dP$ for phase change of a pure system or a chemical reaction at constant temperature and pressure. 3

7. (a) Find the relation between Q_P and Q_V and interpret it. 4

(b) One mole of an ideal gas having molar heat capacity 25 J/K mol, is transformed at constant volume from 0^0 C to 75^0 C. Calculate Q, W, ΔU and ΔH . If the gas is a van der Waals one with the same molar heat capacity then qualitatively predict these quantities (with reason) in terms of greater, lesser or equal. 1+0.5+0.5+2+2

8. (a) An ideal adiabatic wall is impossible. Comment on the statement. 4

(b) From the data at 25^0C :

$O_2(g) \rightarrow 2O(g)$, $\Delta H^0=498.34$kJ/mol.rec , $Fe(s) \rightarrow Fe(g)$, $\Delta H^0=416.3$kJ/mol.rec and $\Delta H^0{}_f(FeO,s)=-272$kJ/mol.rec .

(i) Compute the ΔH^0 at 25^0C for the reaction, $Fe(g) + O(g) \rightarrow FeO(s)$

(ii) Assuming that gases are ideal, calculate ΔU^0 for this reaction. 4+2

9. (a) Discuss different kinds of equilibrium with examples. They are independent. Comment on the statement. What are the criteria in terms of these to satisfy an equilibrium state of a thermodynamic system. 4.5+4.5+1