

CHOICE BASED CREDIT SYSTEM

M.Sc. CHEMISTRY FIRST SEMESTER DEGREE EXAMINATION JANUARY 2023

Inorganic Chemistry - I

Duration: 3 Hours

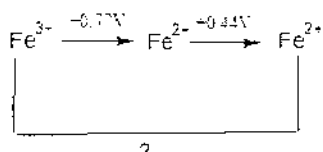
Max Marks: 70

PART - A

1. Answer any TEN of the following :

(10×2= 20 Marks)

- a) Give the hybridisation in ClF_3
- b) What are octahedral and tetrahedral voids?
- c) Mention the type of hybridisation in PH_3 .
- d) Strong oxidising agents do not exist in liquid ammonia. Justify.
- e) Write the conjugate acids for each of the following:
 - i) OH^-
 - ii) HCO_3^-
 - iii) HS^-
 - iv) NH_3
- f) What is amphoteric species? Illustrate with an example.
- g) Define titration curve.
- h) Differentiate between accuracy and precision.
- i) What is masking of ions in complexometric titration? Give an example.
- j) What are Frost Diagrams?
- k) Water can act as oxidising and reducing agent based on the metals/metal ions: Justify.
- l) From the following Latimer diagram of Fe, calculate skip potential



PART - B

Answer any Five questions selecting at least one question from each unit (5×10= 50 Marks)

UNIT - I

2. a) Draw the molecular orbital diagram of CO .
 b) Indicate the different states of hybridisation and deduce the geometry of the following isolated molecules:
 - i) XeF_4
 - ii) SF_6 (5+5)
3. a) What are the conditions necessary for the formation of molecular orbitals?
 Explain why O_2 is paramagnetic and O_2^{2-} is diamagnetic with the help of neat MO diagram.
 b) Discuss the geometry of ICl_4^- (6+4)

UNIT - II

4. a) Explain Lewis acid-base theory with an appropriate example.
b) Discuss the following in liq. SO_2
i) Metathetical reaction ii) Solvolysis reaction
c) PCl_5 is a better Lewis acid than PCl_3 . Why? (4+3+3)
5. a) Discuss the concept of HSAB principle.
b) Write a note on Lux-Flood concept of acid and base. (6+4)

UNIT - III

6. a) Explain the steps involved in the gravimetric analysis.
b) Write a note on relative supersaturation using Von Weimarn equation and explain its significance. (6+4)
7. a) Explain co-precipitation and post-precipitation in gravimetric analysis.
b) Write a note on metal ion indicator with suitable examples. (6+4)

UNIT - IV

8. a) Differentiate between i) Mineral and ore ii) Calcination & roasting
b) Write short note on hydrometallurgy. (6+4)
9. a) What is Ellingham Diagram? Explain its applications.
b) Ellingham diagram consists of straight lines and the lines point upwards. Justify. (6+4)

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Organic Chemistry - I

Duration:3 Hours

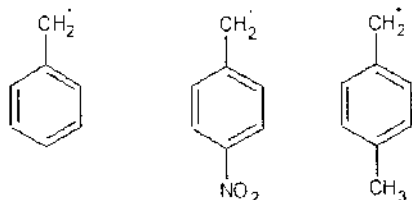
Max Marks:70

PART - A

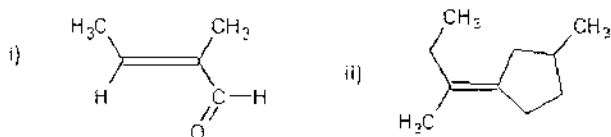
1. Answer any TEN of the following :

(10×2= 20 Marks)

- Define resonance. Write any two characteristics of resonance hybrid structure.
- Define intramolecular hydrogen bonding. Give an example.
- What are non-benzenoid aromatic compounds? Give an example.
- Explain S_N1 reaction with an example.
- Arrange the following in increasing order of their stability. Give reason.



- Define anchimeric assistance. Give an example.
- Assign E, Z notation for the following compounds:



- Give the Newmann projection formula of eclipsed and staggered conformation of n-butane.
- What is Fischer projection formula? Give an example.
- Write any two differences between Amylose and Amylopectin.
- What are hemiacetals? Give an example.
- Give the reaction for the formation of fructosazone.

PART - B

Answer any Five questions selecting at least one question from each unit (5×10= 50 Marks)

UNIT - I

2. a) Write note on the following:
- i) Baker Nathan effect
 - ii) Crown ethers
 - iii) Inclusion and fluxional molecules
- b) Differentiate between hyperconjugation and resonance with suitable examples. (6+4)
3. a) Explain how does inductive effect help in explaining the relative strengths of acids and bases? Give examples.
- b) Define cross-conjugation. Show benzophenone and p-quinone undergoes cross-conjugation. (6+4)

UNIT - II

4. a) Write a note on the determination of reaction mechanism by identification of product with suitable examples.
- b) Discuss the generation and reactions of arynes. (5+5)
5. a) Explain the structure, stability and generation of carbocations.
- b) Write a note on the reactions of nitrenes. (6+4)

UNIT - III

6. a) Discuss the conformational analysis and stability of cyclohexane.
- b) Explain the stereochemistry of nitrogen and phosphorus compounds. (6+4)
7. a) Explain Cram's and Prelog's rule taking suitable examples.
- b) Discuss the optical activity in
- (i) Allenes
 - (ii) Spiranes
- (6+4)

UNIT - IV

8. a) What are terminal deoxy sugars? Explain synthesis of α -Rhamnose.
- b) Explain the synthesis of acetal and ketal derivatives of β -D-glucose. (6+4)
9. a) Elucidate the structure of fructose.
- b) Explain the configuration of aldopentoses. (6+4)

**CHOICE BASED FIRST SEMESTER M.Sc. Chemistry DEGREE EXAMINATION
JANUARY 2023****Physical Chemistry Theory - I**

Duration:3 Hours

Max Marks:70

PART - A

1. Answer any TEN of the following :

(10×2= 20 Marks)

- a). State Le Chatelier's principle. Name the factors influencing state of equilibrium.
- b). In a certain process, 600 J of work is done on a system which gives off 250 J of heat. Calculate the internal energy.
- c). 2 distinguishable particles are distributed in 3 containers with no restrictions. Find the thermodynamic probability.
- d). What is non-equilibrium state? Give the criteria for a non-equilibrium state.
- e). Electronic partition function is generally equal to the degeneracy of ground electronic state. Why?
- f). State the linear law in irreversible thermodynamics.
- g). Explain Arrhenius energy and Arrhenius pre-exponential factor
- h). A first order reaction is 50 % completed in 10 mins. Calculate the time required for it to be completed 87.5%
- i). Explain primary salt effect
- j). Give the Schrodinger's wave equation for the energy of the particle confined to a 3-D box..
- k). Write the expression for wave function of a particle confined to a 1-D box.
- l). How Planks idea of quantisation is used to explain Black body radiation?

PART - B

Answer any Five questions selecting at least one question from each unit (5×10= 50 Marks)

UNIT - I

2. a) Describe B-E statistics.
b) Explain probability theorem and Liouville's theorem. (6+4)
3. a) Derive an expression for fugacity of a gas? Discuss the determination of fugacity by approximate calculation method.
b) Explain the variation of chemical potential with pressure and temperature. (6+4)

UNIT - II

4. a) Discuss the Einstein theory of heat capacity of solids.
b) Give the derivation for the expressions of enthalpy and entropy in terms of partition function. (5+5)
5. a) Derive the expression for internal energy and heat capacity in terms of partition function.
b) Deduce the relation between molar and molecular partition function. (5+5)

UNIT - III

6. a) Derive the rate expression for opposing reactions
b) Explain Marcus theory of electron transfer (5+5)
7. a) Describe the continuous flow method for the study of fast reactions
b) Discuss Lindemann theory of unimolecular reactions. (5+5)

UNIT - IV

8. a) What are operators? Explain any 3 operators and describe the rules for writing operators corresponding to any property.
b) Which of the following pair of operators commute?
i) x and d/dx ii) d/dx and $[(d^2/dx^2) + 2(d/dx)]$ (6+4)
9. a) Discuss the application of Huckel Molecular orbital theory to ethylene molecule.
b) Discuss the application of Schrodinger's wave equation for a rigid rotator and deduce the expression for its energy. (5+5)

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M.Sc. CHEMISTRY FIRST SEMESTER DEGREE EXAMINATION JANUARY 2023

Analytical Chemistry

Duration:3 Hours

Max Marks:70

PART - A

1. Answer any SEVEN of the following : (2×7= 14)

- a) The distribution coefficient of an organic compound A for benzene and water is 10. Find the amount of A extracted if 1.0 g of it dissolved in 100ml of water is equilibrated in a separatory funnel with 100 ml benzene.
- b) Write the different stationary phases used in HPLC.
- c) Give examples of a strongly and weakly basic anion-exchange resin.
- d) Differentiate between Total consumption and premix burner used in AAS.
- e) State Beer-Lambert's law.
- f) Explain the principle of Flame Photometry.
- g) How to determine the isothermal crystallization rates of high polymers using DTA?
- h) An electron of mass 9.11×10^{-31} kg moves at nearly the speed of light. Using a velocity of 3.00×10^8 m/s. Calculate the wavelength of the electron.
- i) Write the temperature range of DSC analysis and mention any two limitations of DSC.

PART - B

Answer any Four questions selecting at least one question from each unit.

(14×4 = 56)

UNIT - I

- 2)
 - a) Describe how batch extraction of liquids takes place.
 - b) Give the criteria for selection of solvents during solvent extraction process.
 - c) Two metals A and B form chelates with dithiazone and extracted with chloroform. What should be the ratio of their distribution ratios so that 90% of B remains in the aqueous phase and 90% of A goes to the organic? Assume equal volumes of organic and aqueous phases. (5+5+4)

- 3) a) Write in brief on principle and application of TLC.
b) Describe the various developmental techniques in paper chromatography.
c) Describe two-dimensional paper chromatography with reference to methodology and uses. (5+5+4)

UNIT - II

- 4) a) Describe in detail how quantitative analysis is done in Emission Spectroscopy.
b) Write a short note on the different excitation sources used in Emission Spectroscopy.
c) Describe the types of electrodes which can be used in AES. (5+5+4)
- 5) a) State and explain the factors affecting measurement in turbidimetry.
b) Explain the principle and procedure used to determine sulphate by turbidimetry.
c) Draw the schematic diagram for a turbidimeter and explain its various parts. (5+5+4)

UNIT - III

- 6) a) Give a detailed note on thermogravimetric analysis.
b) Describe the TGA-thermogram of calcium oxalate hydrate.
c) Explain the factors affecting the TG curve. (5+5+4)
- 7) a) What information can be retrieved from SEM analysis? Explain why nonmetal samples are trickier to use in SEM?
b) Illustrate the conversion of electrons into a digital image in SEM.
c) Discuss the principle of SEM. (5+5+4)

CHOICE BASED CREDIT SYSTEM

M.Sc. CHEMISTRY THIRD SEMESTER DEGREE EXAMINATION JANUARY 2023

Inorganic Chemistry Theory III

Duration:3 Hours

Max Marks:70

PART - A

1. Answer any TEN of the following : (10×2= 20 Marks)

- Find the symmetry elements in the following molecule and write their point groups:
i) HOCl ii) H₂S
- Write the matrix representation for identity and centre of inversion symmetry elements.
- Explain S_n symmetry operation with an example.
- What relationship exists between Δ (the crystal field splitting) and the pairing energy (P) in determining whether a given complex will be high spin or low spin?
- What are the conditions to be satisfied by ligands to act as chelating agents?
- Explain why both the low spin [Fe(CN)₆]⁴⁻ and [Fe(H₂O)₆]³⁺ are colourless.
- Draw the Orgel diagram of CrCl₄²⁻ ion.
- Calculate the number of microstates in d⁷ system.
- In [Co(NH₃)₅I]²⁺, the charge transfer bands largely obscure the d-d bands. Explain.
- Give examples to explain one electron transfer reaction.
- Justify why S_N¹(CB) mechanism is applied for base hydrolysis and not S_N¹ or S_N².
- The rates of aquation of the complexes increases in the following order: Give reason.
[Co(NH₃)₅Cl]²⁺ > [Co(en)(NH₃)₂Cl]²⁺ > [Co(en)₂(NH₃)Cl]²⁺ > [Co(tetraene)Cl]²⁺

PART - B

Answer any Five questions selecting at least one question from each unit

(5×10= 50 Marks)

UNIT - I

- Find the IR, Raman and total modes of vibrations in o-dichlorobenzene by using C_{2v} character table.

C _{2v}	E	C _{2z}	σ _{xz}	σ _{yz}		
A ₁	1	1	1	1	z	x ² , y ² ,z ²
A ₂	1	1	-1	-1	R _z	xy
B ₁	1	-1	1	-1	x, R _y	xz
B ₂	1	-1	-1	1	y, R _x	yz

- Explain irreducible representations and list their properties.

(5+5)

3. a) Find the vibrational and Raman active modes for IF_5 with the help of the following character table:

C_{4v}	E	$2C_2(z)$	C_2	$2\sigma_v$	$2\sigma_d$	linear functions, rotations	quadratic functions
A_1	+1	+1	+1	+1	+1	z	x^2+y^2, z^2
A_2	+1	+1	+1	-1	-1	R_z	-
B_1	+1	-1	+1	-1	-1	-	x^2-y^2
B_2	+1	-1	+1	-1	+1	-	xy
E	+2	0	-2	0	0	(x, y) (R_x, R_y)	(xz, yz)

- b) Write the transformation matrix for p-orbital of 1,3-butadiene for the proper axis of rotation C_2^z and the reflection plane σ_{xy} (5+5)

UNIT - II

4. a) Explain with the help of the molecular orbital theory why Cl^- acts as a weak ligand whereas CN^- acts as a strong ligand in octahedral transition metal complexes.
b) Explain the variation of heats of hydration divalent metal cations of the first transition series using CFT. (6+4)
5. a) What is crystal field theory? How does it differ from the valence bond theory?
b) $[\text{NiCl}_4]^{2-}$ ion is paramagnetic tetrahedral but $[\text{PdCl}_4]^{2-}$ and $[\text{PtCl}_4]^{2-}$ ions are diamagnetic square planar : Give reason.
c) How will you account for the non existence of tetrahedral complexes with low spin configurations.? (4+3+3)

UNIT - III

6. a) Write short notes on ferro and antiferromagnetism with examples.
b) What is Curie temperature? Why iron obey Curie Weiss law? Explain. (6+4)
7. a) Which complex among the following shows orbital contribution to the magnetic moment? Explain.
 $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
b) Given that the value of the spin-orbit coupling constant λ , is -316 cm^{-1} for Ni^{2+} , and Δ_{oct} is 8500 cm^{-1} . Calculate μ_{eff} for $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$. (Note: for 3F & 4F terms $\alpha = 4$, for $2D$ & $5D$, $\alpha = 2$ and 6S term $\alpha = 0$). (5+5)

UNIT - IV

8. a) Explain the applications of Trans effect series.
b) Explain polarisation theory to explain trans effect. (5+5)
9. a) What do you understand by labile and inert complexes? Explain on the basis of crystal field theory, the cause of lability and inertness of octahedral complexes.
b) Explain the formation of different types of intermediates in S_N^1 mechanism. (5+5)

CHOICE BASED CREDIT SYSTEM

M.Sc. CHEMISTRY THIRD SEMESTER DEGREE EXAMINATION JANUARY 2023

Techniques & Applications of Spectroscopy

Duration:3 Hours

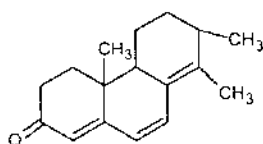
Max Marks:70

PART - A

1. Answer any TEN of the following :

(10×2= 20 Marks)

- a) In the infrared spectrum of the polymeric complex $\text{Na}_2[(\text{CN})_5]_x$, two CN stretching frequencies occur: Explain.
- b) Find out λ_{max} for the following ketone.



- c) How will you note the progress of oxidation of 2-propanol to propanone in infrared spectroscopy?
- d) Predict the structure of an organic compound having the molecular formula $\text{C}_2\text{H}_4\text{O}$ having the following PMR data: Doublet, δ 2.2 ppm, 3H; Quartet, δ 9.8 ppm, 1H.
- e) Identify the number of ^{13}C NMR resonance in 1,3-dichlorobenzene and 1-bromo-4-chlorobenzene.
- f) Mention the reference compound used in NMR. List out its advantages.
- g) Determine the index of hydrogen deficiency for :
 (i) $\text{C}_8\text{H}_7\text{NO}$ (ii) $\text{C}_5\text{H}_3\text{ClN}_4$ (iii) $\text{C}_3\text{H}_7\text{NO}_3$ (iv) $\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2$
- h) Write fragmentation modes of methylcyclopentane.
- i) How is spectrometry different from spectroscopic techniques?
- j) An irradiated sample of MgO has a strong ESR line at 0.163T when the spectrometer is operating at 9.4 GHz. What is the g value of the line?
- k) Predict the number of ESR lines for methyl radical.
- l) Which nuclei possess nuclear quadrupole and why?

PART - B

Answer any Five questions selecting at least one question from each unit (5×10= 50 Marks)

UNIT - I

2. a) Explain the following terms
 i) Bathochromic shift ii) Hypsochromic shift iii) Chromophore
 b) Explain the principle and instrumentation of electronic spectroscopy. (6+4)

3. a) Discuss how the inductive and the mesomeric effects influence the carbonyl absorption frequency with suitable examples.
- b) Arrange benzaldehyde, p-methoxy benzaldehyde and p-nitrobenzaldehyde in their order of increasing wave number of carbonyl absorption in the infrared spectra.
- c) How will you distinguish propanal and propanone with the help of infrared spectra. (4+3+3)

UNIT - II

4. a) Explain the diamagnetic circulation of electrons in case of aromatic compounds and in alkenes.
- b) Write a note on spin-spin coupling in proton NMR spectroscopy taking suitable example.
- c) Explain shielding and desheilding of a nucleus in PMR spectroscopy. (4+3+3)
5. a) Explain decoupling techniques in ^{13}C NMR spectroscopy.
- b) Find the ^{19}F NMR and ^1H NMR spectrum of 1-bromo-3,4,5-trifluorobenzene. (6+4)

UNIT - III

6. a) Explain the theory of magnetic sector analyser and deduce the formula relating path of an ion and its m/z value.
- b) Discuss ionisation techniques in mass spectrometry. (6+4)
7. a) Compound with molecular formula $\text{C}_3\text{H}_6\text{O}_2$ shows the following spectral data:
 IR (cm^{-1}): 2900, 1727
 ^1H NMR (δ , ppm): 1.30 (t, 3H), 4.25 (q, 2H), 8.05 (s, 1H)
 ^{13}C NMR proton decoupled (δ , ppm): 14, 60, 161
 Deduce the structure of the compound.
- b) Compound with molecular formula $\text{C}_9\text{H}_{10}\text{O}_2$ shows the following spectral data: IR (cm^{-1}): 1745, 1225, 749, 697
 ^1H NMR (δ , ppm): 1.96 (s, 3H), 5.0 (s, 2H), 7.22 (s, 5H)
 Deduce the structure of the compound.
- c) Explain the factors affecting the fragmentation patterns. (4+3+3)

UNIT - IV

8. a) Illustrate Mossbauer nuclides with examples.
- b) Discuss the principle and theory of Mossbauer Spectroscopy. (5+5)
9. a) Write a note on quadrupole interactions and nuclear Zeeman splitting in Mossbauer spectroscopy.
- b) Discuss the instrumentation of Mossbauer Spectroscopy and explain how the spectrum is obtained. (5+5)

CHOICE BASED CREDIT SYSTEM

M.Sc. CHEMISTRY THIRD SEMESTER DEGREE EXAMINATION JANUARY 2023

Organic Chemistry Theory - III

Duration: 3 Hours

Max Marks: 70

PART - A

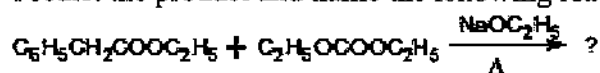
1. Answer any TEN of the following :

(10×2= 20 Marks)

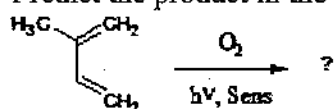
a) What is Sharpless asymmetric epoxidation reaction? Give an example.

b) What is Chichibabin reaction? Give any one synthetic application.

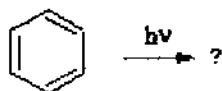
c) Predict the product and name the following reaction:



d) Predict the product in the following:



e) Predict the products in the following:



f) What is meant by photosensitization?

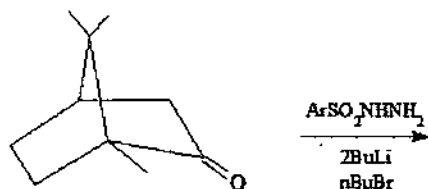
g) State the characteristics of Pericyclic reactions.

h) Define conrotatory and disrotatory process.

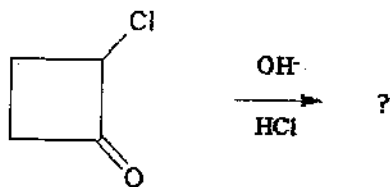
i) Explain Cope rearrangement with an example.

j) Give the reaction for conversion of Camphor to α - Campholide.

k) Predict the product and name the reaction:



1) Predict the product and name the reaction:

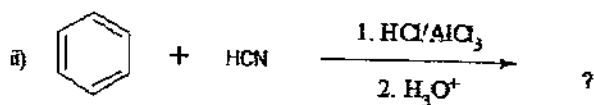
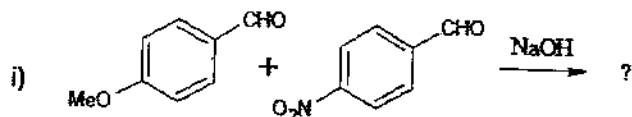


PART - B

Answer any Five questions selecting at least one question from each unit (5×10= 50 Marks)

UNIT - I

2. a) Predict the products and propose the mechanism for the following:



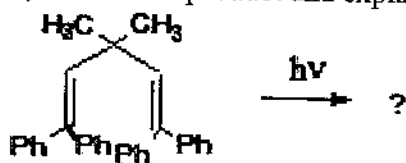
b) Discuss crossed Cannizzaro reaction with suitable example. (6+4)

3. a) Discuss the mechanism and synthetic applications of Stobbe condensation.

b) Write a note on Darzen reaction taking suitable example. (5+5)

UNIT - II

4. a) Predict the product and explain the mechanism for the following reaction:



b) Write a note on Photo Fries rearrangement and its advantages over thermal reaction. (6+4)

5. a) Explain the following terms: i) Phosphorescence ii) Photosensitisation
iii) Intersystem crossing

b) Discuss the mechanism of Norrish type I reaction. (6+4)

UNIT - III

6. a) Using FMO approach, predict whether the suprafacial [2+2] cycloaddition is thermal or photochemical.

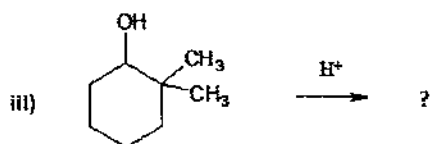
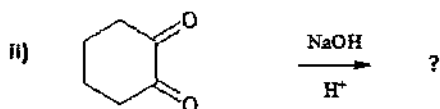
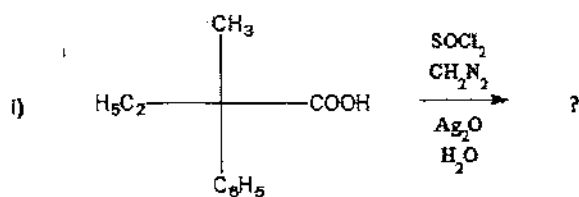
b) Draw Woodward Hoffmann correlation diagram for [4+2] cycloaddition. (5+5)

7. a) Explain sigmatropic rearrangement taking the example of 1,5 - shift of hydrogen atom.

b) Write an account on sigmatropic rearrangements. (5+5)

UNIT - IV

8. a) Predict the products



b) What is Arndt-Eistert reaction? Explain with an example: (6+4)

9. a) Predict the mechanism for the conversion of propanamide to ethyl amine.

b) Explain the reaction and mechanism of Curtius rearrangement. (5+5)

CHOICE BASED CREDIT SYSTEM

M.Sc. CHEMISTRY THIRD SEMESTER DEGREE EXAMINATION JANUARY 2023

Environmental Chemistry

Duration:3 Hours

Max Marks:70

PART - A

1. Answer any SEVEN of the following : (2×7= 14)

- a) What are the sources and sinks of carbon dioxide?
- b) Give different measurements of noise.
- c) What do you understand by the term Los Angeles Smog?
- d) Why is chlorine added to swimming pools?
- e) How does water turbidity affect one's health?
- f) Mention any four elements responsible for the concentration of seawater.
- g) Define eutrophication.
- h) What is meant by humus?
- i) Name two types of microbe that aid in the composting process. Give an example for each.

PART - B

Answer any Four questions selecting at least one question from each unit.

(14×4 = 56)

UNIT - I

- 2) Give the source and effects of the following air pollutants: i) SO₂ ii) CO
- 3) Explain major sources of air pollution.

UNIT - II

- 4)
 - a) Explain the significance of bleaching powder in water treatment.
 - b) Describe the benefits of deionized water over distilled water.
 - c) Can potassium permanganate be used to purify water? Explain. (5+5+4)
- 5)
 - a) Write a note on the degree of hardness of the water.
 - b) Discuss the benefits of alkaline water.
 - c) Describe any four ways to eliminate water hardness. (5+5+4)

UNIT - III

- 6) a) What is herbicide? Describe the harmful effects of herbicides.
b) Describe the significance of micro and macronutrients present in the soil.
How do these improve soil fertility? (7+7)
- 7) a) Write a note on heavy metals that affect the soil.
b) How does industrial pollution affect the soil? Illustrate with examples.
b) Describe the consequences of soil pollution. (5+5+4)
