

B.S.C 5th sem

Roll No.

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NGSQ/D-25

613

CHEMISTRY-V

Paper-B23-CHE-501

Time allowed : 3 Hours]

[Maximum Marks : 50

Note : Attempt five questions in all, selecting one question from each unit. Question No. 1 is compulsory. All questions carry equal marks.

Compulsory Question

1. Attempt all questions:

(i) Is $[\text{NiCl}_4]^{2-}$ paramagnetic or diamagnetic?

Comment.

2

(ii) What is reduced phase rule?

1½

(iii) State third law of thermodynamics.

1½

(iv) What is Hamiltonian operator?

1

(v) Why vibrational degree of freedom is different for CO_2 and H_2O , however both are triatomic molecules?

2

(vi) Compare the basicity of Pyridine and Pyrrole.

2

UNIT-I

2. (a) What is EAN? How does EAN help in predicting the formula of several coordination compounds?

3

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P.T.O.

- (b) Draw all possible isomers of $[\text{Co}(\text{en})\text{Cl}_4]$. 2
- (c) Give IUPAC name of followings:
- (i) $[\text{Co}(\text{en})_3][\text{Cr}(\text{CN})_6]$.
- (ii) $[\text{Pt}(\text{NH}_3)(\text{H}_2\text{O})\text{Cl}_2]$. 2
- (d) Write the limitations of VSEPR theory. 3
3. (a) With the help of labelled diagrams, describe the crystal field splitting of the d-orbitals of a transition metal ion, which placed in tetrahedral field. 3
- (b) Explain the effect of nature of ligands and geometry of complex on magnitude of crystal field splitting. 3
- (c) Give the relationship between magnetic susceptibility and magnetic moment of transition metal ion. 2
- (d) Why Cu(I) is diamagnetic while Cu(II) is paramagnetic in nature? 2

UNIT-II

4. (a) State Nernst heat theorem. 3
- (b) How the absolute entropy of a gas can be evaluated from third law of thermodynamics? 4
- (c) Calculate free energy change accompanying the compression of 1.0 mole of CO_2 at 57°C from 5.0 atm to 50.0 atm. Assume that CO_2 behaves like an ideal gas. 3

5. (a) Derive phase rule and define all the terms involved. 3
- (b) Draw a labelled phase diagram of Pb-Ag system and discuss its important features. 4
- (c) What is triple point? Write its value for water system. 3

UNIT-III

6. (a) Derive Plank's radiation law for spectral distribution of black body radiations. 4
- (b) Evaluate the followings:
- (i) $\left[x^2, \frac{x^2}{dx} \right]$
- (ii) $\left(x + \frac{x}{dx} \right)^2$. 3
- (c) Write postulates of quantum mechanics. 3
7. (a) Derive the energy expression for a particle moving in one dimensional box of length 'a' and mass 'm'. 3
- (b) Write a note on degree of freedom. Calculate the vibrational degree of freedom of following molecules:
- (i) C_2H_2 (ii) CO_2
- (iii) H_2O (iv) $CHCl_3$. 4

- (c) Write a note on rotational spectra of diatomic molecules. How it is helpful in calculating the bond length of diatomic molecules? 3

UNIT-IV

8. (a) Write down the structure of products that may be formed when Claisen or Claisen type condensation is carried out on ethyl acetate and ethyl formate pair. 3½
- (b) Why are α -Hydrogens of carbonyl compounds usually acidic as compared to the hydrogen of an ordinary C-H bond? 3
- (c) How is diethylmalonate prepared in the laboratory? Starting from diethylmalonate, how will you synthesize 2-methylbutane-1,3-diol? 3½
9. (a) Explain molecular orbital structure and aromatic character of Furan and Pyridine. 2
- (b) Discuss Paal-Knorr synthesis for preparation of Pyrrole derivative. 3
- (c) Write any one reaction for synthesis of thiophene. 2
- (d) Write the product of following reactions: 3
- (i) Pyridine $\xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) LiAlH}_4 / \text{ether}}$
- (ii) Pyridine $\xrightarrow{\text{Ni / H}_2, 473\text{K}}$

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MODERN PHYSICS

Paper-B23-PHY-501

Time allowed : 3 Hours]

[Maximum Marks : 50

Note : Attempt five questions in all, selecting one question from each unit. Question No. 1 is compulsory. All questions carry equal marks. Use of Scientific (non-programmable) calculator is allowed.

Compulsory Question

1. Attempt all questions:

5×2=10

(i) A photon and an electron have energy of 1 keV. Calculate their wavelengths.

(ii) Explain the difference between Photoelectric and Compton Effect.

(iii) What are symmetry operations? Name some types of symmetry operations.

(iv) What is the Raman Effect?

(v) Define the terms Nuclear magneton and Bohr Magneton.

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UNIT-I

2. (a) What do you understand about wave particle dualism? Derive formula for the de-Broglie wavelength of a particle in terms of kinetic energy. 7
- (b) The wavelength of a photon is $1.5 \text{ \AA}$. It collides with an electron and its wavelength after collision is $2.0 \text{ \AA}$. Calculate energy of scattered electron. 3
3. (a) Define Phase velocity, Group velocity and Particle velocity. Derive relation between these for a relativistic particle. 5
- (b) Describe Heisenberg's uncertainty principle for position and momentum and describe an experiment (thought) to show that $\Delta x \Delta p_x \geq h/2$. 5

UNIT-II

4. (a) What is a Bravais lattice? Explain different types of Bravais lattices in two dimensions. 6
- (b) Draw (110), (111) planes and [110], [111] directions in a simple cubic crystal. 4
5. (a) Explain the concept of Miller Indices. Deduce formula for the distance between adjacent planes of a simple cubic lattice. 5
- (b) What are reciprocal lattice vectors? Show that the reciprocal lattice of a body centred cubic (bcc) lattice is face centred cubic (fcc) lattice. 5

UNIT-III

6. (a) Discuss the main features of Sommerfeld's orbits. What are its shortcomings? 6
- (b) Find S, L and J values that correspond to each of the following states: 1P_1 , 2P_2 , $^2P_{3/2}$, and $^2D_{3/2}$. 4
7. (a). What is LS coupling? Calculate the terms arising in LS coupling in two valence electrons atoms when one electron is in *s* subshell and other in *p* subshell. 5
- (b) What do you understand about the Anomalous Zeeman effect? Explain observed splitting of D_1 and D_2 lines of Na in a weak magnetic field. 5

UNIT-IV

8. (a) What is proton-neutron hypothesis? How does it account for the failures of proton-electron hypothesis? 6
- (b) Write a short note on any two of following:
- (i) Nuclear Size (ii) Nuclear Mass
- (iii) Nuclear Density. 4
9. (a) Discuss the processes by which heavy charged particles interact with matter and hence derive an expression of their stopping power. 7
- (b) Explain some basic properties of elementary particles Baryons and Mesons. 3

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NGSM/D-25

PHYSICS

(Thermodynamics and Statistical Physics)

Paper : B23-PHY-301

(CC-3/MCC-4)

Time : Three Hours]

[Maximum Marks : 50

Note : Attempt *five* questions in all. Question No. 1 is compulsory. Select *one* question from each unit. All questions carry equal marks. Use of scientific (non-programmable) calculator is allowed.

1. (a) What is third law of thermodynamics? Write its mathematical form also.
- (b) Draw the P-T phase diagram of CO_2 .
- (c) If the r.m.s. speed of hydrogen at N.T.P. is 1840 m/s, calculate the speed of oxygen molecule at N.T.P. Molecular weight of hydrogen and oxygen are 2 gm and 32 gm respectively.
- (d) What is a degenerate gas? (2.5×4=10)

UNIT-I

2. (a) State and prove Carnot's theorem. (3)
(b) What is Joule-Thomson porous plug experiment?
Explain its theory with diagram. (7)
3. (a) Define Kelvin absolute scale of temperature.
Show that this scale agrees with the ideal gas scale. (4)
(b) Define entropy. Discuss its physical significance.
Derive an expression for the change in entropy in terms of temperature and pressure. (6)

UNIT-II

4. (a) Drive the Clausius-Clapeyron heat equation
$$dP/dT = L/T(V_2 - V_1),$$

where letters have their usual meanings. Also discuss the significance of equation. (6)
(b) Define and explain the thermodynamic functions,
(i) Enthalpy and (ii) Helmholtz free energy. (4)
5. (a) Using Maxwell's thermodynamic relations derive relationship between two molar specific heats for a perfect gas. (5)
(b) Derive Stefan-Boltzmann Law using Maxwell's relations. Also explain the law. (5)

UNIT-III

6. (a) Show that entropy of a system is proportional to logarithm of probability of that system. (5)
- (b) For a distribution of N distinguishable particles in two compartments of equal size, derive the expression for the probability for maximum and minimum probable macrostates. (5)
7. (a) Discuss the basic assumptions of statistical mechanics. (2)
- (b) Show that probability distribution function of gas molecules in the speed range v to $v + dv$ is given by
- $$P(v)dv = 4\pi(m/2\pi KT)^{3/2} v^2 \exp(-mv^2/2KT)dv.$$
- Also discuss the significance of function. (8)

UNIT-IV

8. (a) Derive Planck's law for black body radiation using Bose-Einstein distribution law. (5)
- (b) What is Fermi gas? Derive an expression for the energy of a Fermi gas at absolute zero. (5)
9. (a) Derive Bose-Einstein's distribution formula and explain the phenomenon of Bose-Einstein condensation. (8)
- (b) Explain the concept of zero point energy. (2)

SEQUENCES & SERIES

Paper-B23-MAT-501

Time allowed : 3 Hours]

[Maximum Marks : 50

Note : Attempt five questions in all, selecting one question from each unit. Question No. 1 is compulsory. All questions carry equal marks.

Compulsory Question

1. Attempt all questions:

(i) Find the supremum and infimum of the set:

$$\left\{ 1 + \frac{(-1)^n}{n}, n \in \mathbb{N} \right\}.$$

(ii) Write interior of set of rational numbers.

(iii) Give an example of a set which has two limit points.

(iv) Discuss the convergence of the series:

$$\sum_{n=1}^{\infty} \tan^{-1} \frac{1}{n}.$$

(v) Test the absolute convergence of infinite series:

$$\sum_{n=1}^{\infty} (-1)^{n-1} \frac{1}{n}.$$

UNIT-I

2. (a) Define smallest members and infimum of a set. Give examples. Also prove that the smallest member of a set, if it exists, must be the infimum of the set.
(b) Prove that the union of an arbitrary family of open sets is an open set.
3. (a) State and prove Bolzano Weierstrass Theorem for sets.
(b) Define a compact set. Prove that union of a finite family of compact sets is compact.

UNIT-II

4. (a) Prove that denumerable union of denumerable sets is denumerable.
(b) Prove that every convergent sequence is bounded but not conversely.
5. (a) Prove that the sequence $\langle a_n \rangle$ defined by $a_1 = \sqrt{2}$, $a_{n+1} = \sqrt{2 + a_n}$ converges to the positive root of the equation $x^2 - x - 2 = 0$.
(b) Prove that the sequence $\langle a_n \rangle$ where
$$a_n = 1 + \frac{1}{4} + \frac{1}{7} + \dots + \frac{1}{3n-2}$$
 is not convergent, while $\langle b_n \rangle$ defined as
$$b_n = \frac{1}{n} \cdot a_n$$
 converges to 0.

UNIT-III

6. (a) Examine the convergence of the series $\sum_{n=3}^{\infty} x^{\log n}$.

(b) Test the convergence of the series

$$x + \frac{2^2 \cdot x^2}{2!} + \frac{3^3 \cdot x^3}{3!} + \frac{4^4 \cdot x^4}{4!} + \dots$$

7. (a) State and prove Gauss Test.

(b) Using Cauchy's Integral Test, test the behavior of the series:

$$\sum_{n=2}^{\infty} \frac{1}{n(\log n)^p}, p > 0.$$

UNIT-IV

8. (a) State and prove Leibnitz's Test.

(b) Test the convergence and absolute convergence of the series:

$$\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{n^p}, p > 0.$$

9. (a) Test the convergence of the series

$$\sum_{n=1}^{\infty} \frac{\cos nx}{n^p}, p > 0.$$

(b) Show that the Cauchy product of the convergent series:

$$\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{\sqrt{n}} \text{ with itself is not convergent.}$$

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NGSM/D-25

CHEMISTRY

(Chemistry-III)

Paper : B-23-CHE-301

Time : Three Hours]

[Maximum Marks : 50

Note : (i) Question paper contains 9 questions in all, out of which students will be required to attempt five questions.

(ii) Question No. 1 will be compulsory and students will be required to attempt *one* question from each Section. All questions carry equal marks.

Compulsory Question

1. (a) Explain structure and properties of diborane. 2
- (b) What do you mean by standard Hydrogen electrode? 2
- (c) How Kolbe's electrolysis help in synthesis of alkynes. 1.5
- (d) What happens when acetylene is passed through ammonical solution of silver nitrate? 1
- (e) E and Z stands for. 2
- (f) Why racemisation is not 100% in case of S_N1 reactions? 1.5

SECTION-A

2. (a) Write salient features of M^{2+} oxides (M belongs to 2nd group of Periodic table). 3
- (b) Explain the trends of solubility of hydroxides (M^{2+}) along down the group. 3
- (c) Draw and explain the structure and properties of $(BeCl_2)_2$ Dimer. 2
- (d) Explain method of preparation, chemical bonding and properties of borazine. 2
3. (a) Draw and explain $d\pi-p\pi$ bonding. 3
- (b) Draw and explain various types of silicates. 4
- (c) Write a note on the chemical reactivity of noble gases. 3

SECTION-B

4. (a) Define following :
- (i) Specific Conductance.
- (ii) Equivalent Conductance.
- (iii) Effect of dilution on specific and molar conductance. 3
- (b) If the equivalent conductance at infinite dilution of NaCl, HCl and CH_3COONa are 126.4, 426.1 and $91.0 \text{ Ohm}^{-1} \text{ cm}^2 \text{ eq}^{-1}$ respectively. What will be equivalent conductance at infinite dilution for acetic acid? 4
- (c) Write Henderson-Hassel equation and its applications. 3

5. (a) Write the conditions of a cell to be reversible cell. 3
- (b) Write a note on Calomel electrode. 3
- (c) Calculate the K_{sp} of AgI by forming a proper cell.

Given $E^0_{I/AgI(s)/Ag} = -0.151 \text{ V}$ and $E^0_{Ag^+/Ag} = 0.7991 \text{ V}$.

4

SECTION-C

6. (a) Explain structure and bonding in alkynes. 2
- (b) Write any two methods for preparation of acetylene. 2
- (c) Explain mechanism of nucleophilic addition reactions of alkynes. 3
- (d) What will be the products obtained when Br_2 reacted to alkynes (1:1 molar) and when Br_2 taken in excess. Explain mechanism for it. 3
7. (a) Explain stereoisomerism with example. 2
- (b) What are enantiomers? How they differ from distereoisomers, explain with example. 2
- (c) Write a Note on Newman projection formulae. 2
- (d) Give an example of Cis-Trans isomerism. 2
- (e) Explain the rules for priority of atoms in a molecule to assign its 'R' or 'S' configuration.

2

SECTION-D

8. (a) Explain Huckel' rule. Why cyclopropenyl cation is aromatic while cyclo propene is not aromatic? 4
- (b) Write mechanism and potential energy diagram of sulphonation of Benzene. 3
- (c) In the organic synthesis, Friedal-Craft's acylation is preferred over Friedal-Craft's alkylation. 3
9. (a) Explain the hydrolysis of ethyl chloride is S_N2 reaction, but that of tertbutyl chloride is S_N1 reaction. 4
- (b) Write Sandmayer reaction. 3
- (c) Compare the reactivity of venyl halides versus alkyl halides. 3
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