



I Semester B.Sc. Examination, Oct./Nov. 2015
(Semester Scheme) (New Syllabus) (2014-15 Onwards)
CHEMISTRY (Paper – I)

Time : 3 Hours

Max. Marks : 60

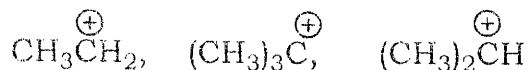
- Instructions :** a) Use SI Units.
 b) Write *neat* labeled diagrams and chemical equations wherever necessary.

PART – A

Answer all the questions :

(6×1=6)

1. a) State Heisenberg's uncertainty principle.
- b) Define pericyclic reaction.
- c) What is RMS velocity ?
- d) Zero group elements have very high ionization energy. Give reason.
- e) Arrange the following carbocation in the increasing order of their stability :



- f) Give the relationship between inversion temperature and Van der Waals constants.

PART – B

Answer any three questions of the following :

(3×6=18)

2. a) Explain the significance of the Azimuthal quantum number. Give all the values for l and m when $n = 3$. 4
- b) How does electron affinity vary along a period and down a group ? 2
3. a) Write a note on Slater's rule. 4
- b) Define covalent and Van der Waal's radii. 2
4. a) What is electronegativity ? How is it calculated by Pauling's method ? 4
- b) State and explain Hund's rule of maximum multiplicity. 2
5. a) Radius of cation is smaller than that of the corresponding atom. Give reason. 2
- b) Explain the factors which influences the ionization potential. 4

P.T.O.



PART – C

Answer **any three** questions of the following :

(3×6=18)

6. a) What is inductive effect ? Using this how do you explain chloro acetic acid is stronger acid than acetic acid. 3
b) Define homolytic and heterolytic cleavage with examples. 3
7. a) Discuss the effect of solvent on SN^1 and SN^2 reactions. 3
b) Explain 1, 2 and 1, 4 addition reactions of bromine to 1, 3 butadiene. 3
8. a) Discuss E_1 mechanism taking t-butyl bromide as an example. 4
b) Explain steric effect with suitable example. 2
9. a) State and explain the mechanism of Anti-Markownikoff's rule. 4
b) What is pinacol-pinacolone rearrangement ? 2

PART – D

Answer **any three** questions of the following :

(3×6=18)

10. a) What is adsorption ? Discuss the influence of temperature and pressure on the adsorption of gas on a solid. 4
b) Define most probable velocity and give its mathematical expression. 2
11. a) State law of corresponding state. Derive the reduced equation of states. 4
b) Calculate the RMS velocity of hydrogen molecule at $27^\circ C$ [$R = 8.314 \text{ J K}^{-1} \text{ Mol}^{-1}$]. 2
12. a) Explain Maxwell-Boltzmann distribution of molecular velocities. 3
b) Describe the mechanism of heterogeneous catalyst. 3
13. a) Write a note on Andrew's work on liquefaction of carbon dioxide. 3
b) Elucidate lock and key mechanism of enzyme catalyzed reactions. 3
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III Semester B.Sc. Examination, October/November 2015
(Semester Scheme)
CHEMISTRY (Paper – III)
(2014-15 Onwards)

Time : 3 Hours

Max. Marks : 60

Instruction : Write balanced equations and neat diagrams wherever necessary.

PART – A

Answer all the questions :

(6×1=6)

- a) What are active methylene compounds ?
b) State first law of thermodynamics.
c) Write the structure of silica.
d) What type of compounds undergo Cannizzaro reaction ?
e) Define viscosity.
f) What are insulators ?

PART – B

Answer any three of the following :

(3×6=18)

- a) Discuss the structure of XeO_3 molecule. 4
b) Explain the ionisation of acetic acid in liq. ammonia. 2
- a) Explain Pearson's concept of hard and soft acids and bases. Give examples. 4
b) Write a short note on super conductors. 2
- a) How is diborane prepared ? Explain the nature of bonds in diborane. 4
b) Explain acid base reaction in liquid SO_2 . 2
- a) What are silicates ? Write the structure of ortho silicates, pyro silicates and cyclic silicates. 4
b) What are n-and p-type semiconductors ? 2



PART – C

Answer **any three** questions :

(3×6=18)

6. a) How will you convert : 4
- i) Acetoacetic ester into antipyrine
 - ii) Malonic ester into barbituric acid ?
- b) Write the mechanism for the reaction between carbonyl compound and phenylhydrazine. 2
7. a) Arrange the following in the increasing order of their acidity : 2
- 2-chloro propionic acid, 2-fluoro propionic acid and propionic acid. Give reason.
- b) Give the mechanism of Canizzaro's reaction. 4
8. a) Explain the effect of heat on lactic acid. 2
- b) What is Keto-enol tautomerism ? Give example. 2
- c) Give the synthesis of citric acid. 2
9. a) Explain : 4
- i) Arndt-Eistert reaction
 - ii) Rosenmund's reaction.
- b) Write the IUPAC name for : 2
- i) $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{COOH}$
 - ii) $\text{CH}_3 - \text{CO} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_2 - \text{CH}_3$.

PART – D

Answer **any three** questions :

(3×6=18)

10. a) What is an emulsion ? Mention different types of emulsions. Give examples for each. 4
- b) Explain the effect of temperature on surface tension. 2



11. a) Derive an expression for the calculation of the entropy change of an ideal gas when the temperature changes from T_1 to T_2 and the volume changes from V_1 to V_2 . 4
- b) The water flow time for an Ostwald viscometer is 59.2 sec. at 25°C . If 46.2 sec. are required for the same volume of ethyl benzene (density = 0.867 g cm^{-3}) to flow through capillary, calculate its absolute viscosity at 25°C , that of water being 0.00895 poise at the same temperature. 2
12. a) State and explain Carnot's theorem. 2
- b) Calculate the maximum efficiency of a steam engine operating between 110°C and 25°C . 2
- c) How do you prepare colloids by double decomposition methods? 2
13. a) Write short notes on : , 4
- i) Plank's radiation law
- ii) Compton effect.
- b) Explain why C_p is always greater than C_v . 2
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IV Semester B.Sc. Examination, April/May 2015
(Semester Scheme)
CHEMISTRY
Paper – IV (2008 to 2013)

Time : 3 Hours

Max. Marks : 60

- Instructions :** 1) *Use SI Units.*
2) *Draw neat labelled diagrams and equations wherever necessary.*

PART – A

Answer **all** the questions :

(6×1=6)

1. a) What is an amphoteric solvent ?
- b) Write the auto-ionisation reaction of liquid ammonia.
- c) Name the reducing agent used in Clemmensen's reduction.
- d) Write the structure of Indole.
- e) Give the unit of second order rate constant.
- f) Define centre of symmetry.

PART – B

Answer **any three** of the following :

(3×6=18)

2. a) Discuss acid-base reaction and complex formation reaction in liquid SO₂ with examples. 4
- b) Differentiate nuclear fusion and nuclear fission reactions. 2
3. a) What is meant by pH range of an indicator ? 2
- b) What are isotopes and isotones ? 2
- c) Calculate the binding energy of helium nucleus in MeV, mass defect of He is 0.02912 amu. 2
4. a) Explain the action of methyl orange indicator in acid-base titrations. 4
- b) List out any two advantages of liquid ammonia. 2

P.T.O.



5. a) What is the principle of nuclear reactor ? Sketch the diagrammatic view of a nuclear reactor and label it. 4
- b) Write notes on : (2+2+2)
- i) Universal indicator's
 - ii) Behaviour of metals in liquid NH_3 .
 - iii) Adsorption indicators.
6. a) Write a note on pH titration curves. 4
- b) Give an example for solvolysis in liquid ammonia. 2

PART – C

- Answer **any three** of the following : (3×6=18)
7. a) What are heterocyclic compounds ? Classify them with examples. 4
- b) Write a note on resonance energy. 2
8. a) Explain the mechanism of halogenation of benzene. 3
- b) Discuss Skraup's method of synthesising quinoline. 3
9. a) What are the postulates of Baeyer's strain theory. 2
- b) Explain Friedel-Craft's alkylation and acylation of benzene. 4
10. a) What are cyclo alkanes ? How is cyclopentane synthesized by Freud's method ? 3
- b) Discuss the aromaticity of pyrrole. 3
11. a) How is pyridine prepared from acetylene ? 2
- b) Explain the orienting influence on benzaldehyde and toluene during electrophilic substitution reactions. 4



PART – D

Answer **any three** of the following :

(3×6=18)

12. a) Discuss the principle and experimental technique involved in spectrophotometric kinetic study of oxidation of indigo-carminine by chloramine-T. 4
- b) What is mesomorphic state ? 2
13. a) Enumerate the elements of symmetry present in a cube. 4
- b) Differentiate symmetry elements and symmetry operations. 2
14. a) Decomposition of a gas is of second order reaction calculate the half-life of the reaction when $a = 4 \times 10^{-2}$ mole/litre and $k = 0.4162 \text{ lit mol}^{-1} \text{ min}^{-1}$. 2
- b) Derive expression for second order rate constant when $a = b$. 4
15. a) What are nano-materials ? 2
- b) How is the Avogadro's number determined using X-ray diffraction method ? Explain in detail. 4
16. a) How is the order of a reaction determined by differential method ? 3
- b) Sketch the unit cells of three types of cubic lattices and name them. 3
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V Semester B.Sc. Examination, Oct./Nov. 2015
(Semester Scheme) (2008 Onwards)

CHEMISTRY

Paper – V : Inorganic Chemistry

Time : 3 Hours

Max. Marks : 60

Instruction: Write equations and neat diagrams wherever necessary.

PART – A

Answer all the questions.

(10×1=10)

1. a) d-block elements form coloured compounds. Give reason.
- b) Why actinides have greater tendency to form complexes than lanthanides ?
- c) Write the IUPAC name of $[\text{CoCl}_2(\text{en})_2]^+$ ion.
- d) Define coordination sphere.
- e) Give an example for bridged complex.
- f) Name the isomerism exhibited by $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$.
- g) Define precision.
- h) What are high spin complexes ?
- i) Write the structure of 1, 10-phenanthro line.
- j) What are spectrochemical series ?

PART – B

Answer any five questions.

(5×4=20)

2. Explain the formation, geometry and magnetic property of $[\text{Ni}(\text{CN})_4]^{2-}$ on the basis of valence bond theory. 4
3. Write the conditions for the precipitation in gravimetric analysis. 4
4. Explain any two physical methods to study the formation of complexes. 4
5. Discuss the geometrical isomerism in square planar complexes. 4
6. Explain :
 - i) hydrate isomerism
 - ii) linkage isomerism. 4

P.T.O.



7. a) Calculate the magnetic moment of a high spin complex in which metal ion having d_6 configuration. 2
b) Write the limitations of VBT. 2
8. Explain the following properties with respect to lanthanides.
i) oxidation states
ii) magnetic properties. 4

PART - C

Answer any five questions.

(5×6=30)

9. a) Explain the magnetic properties of $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{CN})_6]^{3-}$ based on CFT. 4
b) Transition elements shows variable oxidation states. Why? 2
10. a) Outline the important features of CFT. 3
b) Describe the splitting of d-orbitals in tetrahedral complexes. 3
11. a) Explain the classification of ligands with suitable examples. 4
b) Which complex has larger crystal field splitting $[\text{Co}(\text{CN})_6]^{3-}$ or $[\text{Co}(\text{NH}_3)_6]^{3+}$? Why? 2
12. a) Explain the advantages of organic precipitants over inorganic precipitants. 4
b) Write the structure and use of EDTA in volumetric estimation of zinc. 2
13. a) Discuss the following with respect to transition elements
i) Complex formation
ii) Spectral properties. 4
b) What are outer orbital complexes? Give an example. 2
14. a) What are errors? Explain the types of errors. 4
b) What are chelates? Give an example. 2
15. a) What is lanthanide contraction? Mention their consequences. 4
b) Calculate CFSE value for d^5 low spin octahedral complex. 2
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V Semester B.Sc. Examination, Oct./Nov. 2015
(Semester Scheme)
(2008 Onwards)
CHEMISTRY
Paper – VI : Organic Chemistry

Time : 3 Hours

Max. Marks : 60

Instruction : Write equations and structures wherever necessary.

PART – A

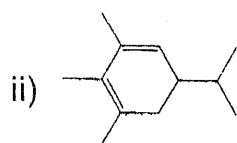
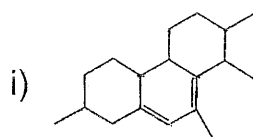
1. Answer **all** the questions : (10×1=10)
- a) Write the structure of methyl orange.
 - b) Mention the applications of buna S.
 - c) How does a red shift differ from a blue shift ?
 - d) Which disease caused by the deficiency of vitamin E ?
 - e) What is Barton reaction ?
 - f) Define iodine value.
 - g) Give an example for plant wax.
 - h) What is chemotherapy ?
 - i) Name the product formed by the photo-oxidation of benzaldehyde.
 - j) Identify the types of signals ¹H NMR spectrum of acetophenone.

PART – B

- Answer **any five** questions : (5×4=20)
- 2. What are merits and demerits of soaps and detergents ? 4
 - 3. Outline the synthesis of nylon –6, 6 and give its uses. 4
 - 4. Write notes on : 4
 - i) Saponification value
 - ii) Thermosetting resins.



5. Explain Norrish type I reaction. 4
6. Making use of Woodward-Hoffmann's rules, calculate the λ_{\max} of the following molecules : 4



7. Write short notes on : 4
- i) IR spectroscopy and
- ii) Vitamin – A
8. Give the synthesis of Phenolphthalein. 4

PART – C

Answer **any five** questions of the following : (5×6=30)

9. a) Describe the primary and secondary processes involved in a photo chemical reaction. 4
- b) Mention the mode of action of chloroquine. 2
10. a) How do you prove the presence of 4
- i) OH groups and
- ii) Six membered rings in the molecule of alizarin.
- b) What are the uses of neoprene ? 2
11. a) Outline the procedure for the manufacture of soap by hot process. 3
- b) What are chromophores and auxochromes ? Give examples. 3



12. a) Explain chemical shift with examples. 3
b) Write the structure of vitamin – C and mention its occurrence. 3
13. a) Discuss the photochemistry of cis-trans isomerism of conjugated dienes. 4
b) What is step growth polymerization ? 2
14. a) How do you synthesize
i) Paracetamol
ii) Malachite green. 4
b) A compound with molecular formula C_3H_6O gives the following 1H NMR spectrum :
Singlet at δ 2.35 for 6 H, give the structural formula. 2
15. a) Write notes on :
i) Developed dye
ii) Acid value. 4
b) Mention the IR frequency range for carbonyl and alcoholic groups. 2
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V Semester B.Sc. Examination, October/November 2015
(Semester Scheme)
CHEMISTRY
Physical Chemistry (Paper – VII) (2008 Onwards)

Time : 3 Hours

Max. Marks : 60

- Instructions :** i) Write chemical equations and neat diagrams wherever necessary.
ii) Use **SI Units**.

PART – A

Answer all the questions.

(10×1 = 10)

1. a) What is bioluminescence ?
b) What happens to absorption of light with increasing concentration of solution ?
c) Show that the sum of the transport numbers of cation and anion is unity.
d) Define Gray.
e) Give an example for an acidic buffer.
f) What is energy yield ?
g) Name any two methods to prevent corrosion.
h) Define standard electrode potential.
i) Why is KCl used in salt bridges ?
j) Give an example for a fuel cell.

PART – B

Answer any five of the following :

(5×4 = 20)

2. Discuss the electrochemical reaction occurring in corrosion of a metal. 4
3. A cell is made up of zinc electrode and copper electrode, E° for Zinc and Copper electrodes are -0.76 V and $+0.37$ V respectively.
 - a) Represent the cell.
 - b) Give the electrode reaction.
 - c) Write the cell reaction.
 - d) Calculate the emf of the cell. 4



4. Define quantum yield. What are the reasons for high quantum yield ? 4
5. Draw and explain the conductometric titration curve of mixture of HCl and CH_3COOH against NaOH. 4
6. What are buffer solutions ? Derive Hendersons equation for an acid buffer. 4
7. What is electrochemical series ? Explain its importance. 4
8. Describe the radiolysis of acetic acid. 4

PART – C

Answer **any five** of the following :

(5×6 = 30)

9. a) State Kohlrausch's law of independent migration of ion. How do you calculate molar conductance of ammonium hydroxide at infinite dilution. 4
- b) Explain mechanism of phosphorescence. 2
10. a) What are concentration cells ? Explain the application of concentration cell in the determination of valency of ions. 3
- b) Molar conductance at infinite dilution of Na^+ and Cl^- ions are 50.0×10^{-3} mho's and 76.34×10^{-3} mho's respectively. Calculate the transport number of Na^+ and Cl^- ions. 3
11. a) Explain the construction of lead storage cell. Write the discharging and charging reactions. 4
- b) What is corrosion and give an example. 2
12. a) What is molar extinction coefficient ? How do you determine molar extinction coefficient graphically ? 3
- b) Discuss qualitatively the Debye-Huckel-Onsager theory. 3



13. a) How is the pH of a solution determined using glass electrode ? Give the advantages of the glass electrode. 4
- b) Write a note on uranyl oxalate actinometer. 2
14. a) How is the ionic product of water determined by conductance measurements ? 3
- b) E° of Daniel cell is 1.1 V. Calculate ΔG° and K for the cell reaction at 25°C . 3
15. a) Discuss the role of buffer in maintaining pH in sugar industry. 2
- b) How does the molar conductance vary with dilution ? 2
- c) Write the characteristics of reversible cells. 2
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VI Semester B.Sc. Examination, October/November 2015
(Semester Scheme) (2008 Onwards)
CHEMISTRY
Paper – VIII : Inorganic Chemistry

Time : 3 Hours

Max. Marks : 60

Instruction : Write equations and neat diagrams wherever necessary.

PART – A

1. Answer **all** questions : (10×1 = 10)
- a) What are phosphazenes ?
 - b) Name the metal extracted by electrometallurgy.
 - c) Name the tracer elements in biological systems.
 - d) What are metal carbonyls ?
 - e) Write the composition of LPG.
 - f) Define calorific value of a fuel.
 - g) What is annealing ?
 - h) Water gas is also called as Blue gas. Why ?
 - i) What are Ceramics ?
 - j) What are fluorocarbons ?

PART – B

- Answer **any five** questions : (5×4 = 20)
- 2. a) Describe the production of water gas. 2
 - b) Ceramics are used as insulators. Give reason. 2
 - 3. a) Calculate the EAN of Ni in $Ni(Co)_4$. 2
 - b) Explain the role of trace elements in biological system. 2
 - 4. What are the constituents of a common paint ? Mention the function of each constituent. 4

P.T.O.



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| 5. a) Write a short note on glazing of ceramic articles. | 2 |
| b) Write the cyclic structure of triphosphazene. | 2 |
| 6. How is tungsten powder produced from wolframite ? | 4 |
| 7. Discuss the role of Na and Ca in biological systems. | 4 |
| 8. What are refractories ? How are they classified ? Give an example for each type. | 4 |

PART - C

Answer **any five** questions :

(5×6 = 30)

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|--|---|
| 9. a) Explain the nature of M-CO bonding in mononuclear carbonyls. | 3 |
| b) How is alundum manufactured ? | 3 |
| 10. a) Explain switching phenomenon in chalcogenide glasses. | 4 |
| b) How is Lithophone manufactured ? | 2 |
| 11. a) Describe the extraction of thorium from monazite sand. | 4 |
| b) Mention the applications of phosphorus based polymers. | 2 |
| 12. a) Give the differences between inorganic and organic polymers. | 4 |
| b) Write the separation of Ag and Cu from Au by quartation process. | 2 |
| 13. a) What are organometallic compounds ? Discuss the properties of organo lithium compounds. | 4 |
| b) Mention the raw materials used in the production of ceramic wares. | 2 |
| 14. a) Give the composition and one use of optical glass. | 2 |
| b) Mention the requirements of a good explosive. | 4 |
| 15. a) Write a note on the preparation and properties of $(\text{SN})_x$. | 4 |
| b) Write a short note on Kuroll's salts. | 2 |



VI Semester B.Sc. Examination, Oct./Nov. 2015
(Semester Scheme)
CHEMISTRY
Organic Chemistry (Paper – IX)
(2008 onwards)

Time : 3 Hours

Max. Marks : 60

Instruction : Write chemical equations and neat structures wherever necessary.

PART – A

Answer all the questions :

(10×1=10)

1. a) Define plane of symmetry.
- b) Give an example of a trisaccharide.
- c) Name one α -amino acid found in proteins.
- d) Mention the physiological importance of atropine.
- e) Mention the basic skeleton of terpenes.
- f) What are Sterols ?
- g) Write the structure of menthol.
- h) Write the Howarth structure of α -D(+)-Glucopyranose.
- i) Define optical activity.
- j) What are enzymes ?

PART – B

Answer any five questions :

(5×4=20)

2. What are steroidal hormones ? Write the structural formulae of testosterone. Mention its importance. 4
3. State isoprene rule. Give the classification of terpenes with an example each. 4



4. Elucidate the structure of Nicotine. 4
5. Write a short notes on : (2+2)
- i) isoelectric point and
 - ii) Zwitter ion state of amino acids.
6. Describe the determination of ring size of hexoses by methylation method. 4
7. What is optical resolution ? How are enantiomers resolved by chemical method ? 4
8. How do you convert D-Glucose to D-fructose ? 4

PART – C

- Answer **any five** questions : (5×6=30)
9. a) Write a note on physiological action of cholesterol. 2
- b) Elucidate the structure of citral. 4
10. Write the structural formulae and their importance of : (2+2+2)
- i) Cocaine
 - ii) Quinine
 - iii) Oestrone
11. a) What are nucleic acids ? Mention their types. 2
- b) Write a note on muta rotation. 2
- c) What are diastereomers ? Give an example. 2
12. a) Write a note on epimerisation. 2
- b) Give an account on classification of enzymes. 4
13. Write a short notes on : (2+4)
- i) R & S notation
 - ii) Chain elongation reaction and carbohydrates.
14. a) Write the partial structure of α -amylose. 2
- b) What are proteins ? Describe their classification based on molecular shape. 4
15. a) What is racemisation ? Illustrate with an example. 2
- b) Give the synthesis of amino acid by Gabriel phthalimide method. 4
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VI Semester B.Sc. Examination, Oct./Nov. 2015
(Semester Scheme)
CHEMISTRY
Physical Chemistry (Paper – X) (2008 Onwards)

Time : 3 Hours

Max. Marks : 60

Instruction: Draw neat and labelled diagrams and use SI units wherever necessary.

PART – A

1. Answer all the questions. (10×1=10)
- a) Write the mathematical expression of Planck's radiation law.
 - b) What is the characteristic property of a black body ?
 - c) Define zeta potential.
 - d) Mention the sign of DG for a spontaneous process.
 - e) Write the differential form of Clausius Clapeyron equation.
 - f) How are Gibb's free energy and Helmholtz free energy mathematically related to each other ?
 - g) Define zero point energy.
 - h) What is emission spectra ?
 - i) Why is the plot of molar polarization vs $\frac{1}{T}$ a horizontal line for the CO₂ molecule.
 - j) Write the equation to calculate the parachor.

PART – B

Answer any five of the following :

(5×4=20)

2. What are sols ? Give the differences between lyophilic and lyophobic sols. 4
3. a) Explain Tyndall effect. 2
b) Write Clausius Mossotti equation and mention the forms. 2
4. Derive the equation for the variation of Helmholtz free energy with volume and temperature. 4
5. Define parachor. How is the parachor study helpful in the structural elucidation of quinone molecule. 4



6. Derive the moment of inertia expression for a diatomic molecule as rigid rotator. 4
7. a) Mention the regions of electromagnetic radiation. 2
 b) 4 moles of an ideal gas expand isothermally from one litre to ten litres at 300 K. Calculate the free energy change of the gas $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$. 2
8. a) How does Raman spectrum originate? 2
 b) Write a note on Frank Condon principle. 2

PART – C

Answer any five of the following : (5×6=30)

9. a) Explain Compton effect. 2
 b) Write the Schrodinger wave equation. Mention the terms in it. 2
 c) What are the differences between, elastic and non-elastic collisions? 2
10. a) Discuss the stability of colloids. 3
 b) Mention applications of colloids. 3
11. a) Explain the use of dipole moment to predict the structure of AB_2 and AB_3 type. 4
 b) State the Born-Oppenheimer approximation. 2
12. a) Derive Clausius-Clapeyron equation. 4
 b) The IR spectrum of $^1\text{H}^{35}\text{Cl}$ consists of an intense line at $2.90 \times 10^3 \text{ cm}^{-1}$. Calculate the force constant of HCl given $c = 3 \times 10^8 \text{ m/sec}$ $N = 6.023 \times 10^{23} \text{ Mol}^{-1}$. 2
13. a) Define chemical potential. Write its mathematical expression. 2
 b) Derive the Gibbs-Helmholtz equation at constant volume. 4
14. a) Discuss the rotational spectrum of a diatomic rigid rotator molecule. 4
 b) Give any two applications of I.R. spectra. 2
15. a) Write the vibration energy expressions for a diatomic simple harmonic oscillator, draw the vibrational energy levels. 2
 b) What is the gross selection rule for a molecule to show (i) microwave spectrum and (ii) vibration spectra. 2
 c) The pure rotational (microwave) spectrum of the gaseous molecule CN consists of a series of equally spaced lines separated by 3.7978 cm^{-1} . Calculate the internuclear distance of the molecule, given $C^{12} = 12.011$ and $N^{14} = 14.0067$ and moment of inertia of the molecule = $1.4742 \times 10^{-46} \text{ kgm}^2$. 2