PG/IIIS/CEM-303/19

M.Sc. 3rd Semester Examination, 2019

CHEMISTRY

PAPER –CEM-303

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

(*Physical Special*)

Answer **all** questions

1. Answer any *four* questions : 2 × 4

(*a*) Define spectral energy density of a black body radiation.

(*b*) State the principle of microscopic reversibility.

(*c*) Define Hall mobility.

(*d*) Why the crystalline substances are anisotropic *in nature* ?

(*e*) Define 'geometric structure factor' of a crystal.

(*f*) What is an 'exciton' ?

(*g*) Define a 'R_2' center.

(*h*) Why the conductivity of a semiconductor increases with increase in temperature ?

2. Answer any *four* questions : 4 × 4

(*a*) How does mercury (Hg) become super-conductor below 4·2 K ? 4

(*b*) Why a structured band is obtained when KBr is heated in excess Bromine gas ? 4

(*c*) Define quantities α and β for exchanges between suitable ensembles and derive the relation between these. 1 + 3

(*d*) Obtain the expression for the entropy production due to flow of matter. 4

(*e*) Explain what is meant by phenomenological co-efficients and discuss the significance of the cross co-efficients Lij. 2 + 2

(*f*) Obtain the concentration of Frenkel defect in a crystal. 4

(*g*) Explain the working principle of *n-p* junction of a semiconductor. 4

(*h*) Crystalline KF has the NaCl type of structure. Given that the density of KF (S) is 2·481 g cm^{-3} at 20 °C, calculate the unit cell length and the nearest-neighbour distance in KF (S). 4

3. Answer any *two* questions : 8 × 2

(*a*) Derive an expression of ideal gas equation given by Einstein. 8

(*b*) (*i*) Define Grand Partition Function for bosons and hence derive Bose-Einstein distribution law.

(*ii*) Calculate the rotational contribution to the molar entropy of a homonuclear diatomic gaseous molecule with moment of inertia = $4{\cdot}60 \times 10^{-48}$ kgm^2. 1 + 4 +

(*c*) Obtain the expression for the rate of entropy production for a process where the application of an electric field $\Delta\phi$ causes a pressure difference Δp utilising this expression define streaming potential and electro-osmosis in terms of the phenomenological co-efficients. 5 + 3

(*d*) Distinguish between body centered cubic (BCC) lattice and face centered cubic (FCC) lattice with the help of Geometrical Structure Factor. 8

(*Inorganic Special*)

Answer **all** questions

GROUP–A (a)

1. Answer any *two* of the following questions : 2 × 2

(*a*) Draw the active site structure of electron carrier protein cytochrome C.

(*b*) Draw and discuss the active site structure of enzyme catalase.

(*c*) Draw the active site structure of Chlorophyll.

GROUP–A (b)

2. Answer any *two* of the following questions : 4 × 2

(*a*) Which enzyme is responsible for the uric acid synthesis ? Outline mechanism involved in this conversion.

(*b*) "Poisonous superoxide required an enzyme to convert O_2 and H_2O_2" mention the name of the enzyme and draw its active site structure.

(*c*) Write short notes on photosynthetic electron transfer chain reaction.

GROUP–A (c)

Answer any **one** of the following questions : 8 × 1

3. (*a*) Where Carboxy peptidase is found ? Write down the active site structure and discuss the mechanism involve in the hydrolysis of peptide. 4

(*b*) Write down the mechanism of Nitrogen fixation by nitrogense enzyme. 4

4. (*a*) Draw the active site structure of the enzyme sulphite oxidase and outline the steps involved in the conversion of sulphite to sulphate. 4

(*b*) Discuss the reduction of nitrate by the enzyme nitrate reductase with proper mechanism. 2

(*c*) Discuss the reaction and reaction mechanism involved in cobalamin catalyzed reaction. 2

GROUP–B (a)

5. Answer any *two* of the following questions : 2 × 2

(*a*) Generally the photo-excitation of metal carbonyl compounds increases the weakness of metal-CO bond. Explain.

(*b*) The parity selection rule for radiationless transition is precisely opposite of the selection rule for radiative transitions. Explain.

(*c*) What do you mean by DOSENCO state ?

GROUP–B (b)

6. Answer any *two* of the following questions : 4 × 2

(*a*) Derive the expression for Stern-Volmer equation.

(*b*) Write short note on "bimolecular quenching of fluorescence".

(*c*) Write the practical criteria which must be fulfill for developing a "photochemical energy-storage cycle".

GROUP–B (c)

7. Answer any *one* of the following questions : 8 × 1

(*a*) Write short notes on : 4 + 4

(*i*) Radiationless transitions

(*ii*) Stimulated Absorption.

(*b*) (*i*) Write the mechanisms of quenching via "photo induced electron transfer (PET)" and "resonance energy transfer (RET)" processes. 5

(*ii*) Write the expression for calculating fluorescence quantum yield. Mention each terms involved in this expression. 3

(*Organic Special*)

Answer **Q. Nos. 1 & 2** and any **two** from **Q. Nos. 3, 4, 5, 6**

1. Answer any *four* questions : 2 × 4

(*a*) Define hydrophobic effect.

(*b*) Write four principles of green chemistry.

(*c*) What is aromatic-aromatic (π-π) interaction ?

(*d*) Show schematically the potential energy diagram for two interacting π-atoms as a function of their orientation.

(*e*) Give four examples of Low Molecular Mass Organogelators.

(*f*) What is bell-shaped pH-vs Rate profile ? In which enzyme is it observed ?

(*g*) What are 'salting in' and 'salting out' agents ?

(*h*) What is the vertical distance of separation between adjacent base pairs in DNA double helix ?

2. Answer any *four* questions : 4 × 4

(*a*) How can one study the morphology of a supramolecular gel ?

(*b*) Design, synthesize and explain the mode of complexation of barbital.

(*c*) Give an example of Host-Guest complexation utilizing aromatic-aromatic interaction. How triterpenoids can be termed as "renewable nano"s ?

(*d*) Charge transfer transitions observed for EDA complexes are a consequence not a cause of the more general π-π interaction. Explain.

(*e*) How can water act as a better solvent than common organic solvents for a simple Diels-Alder reaction ? Illustrate with examples.

(*f*) Design a receptor for urea, synthesize and show the mode of their complexation.

(*g*) How can one design a receptor for mono-potassium salt of maleic acid ?

(*h*) How can one modify the barbiturate receptor for the design of a protease enzyme mimic ?

3. (*a*) What are cyclodextrins ?

(*b*) p-chlorination of anisole is preferred in water in the presence of β-CD with rate acceleration. How do you explain this observation ?

(*c*) Describe the use of a cyclodextrin derivative as a Ribonuclease enzyme mimic. 2 + 3 + 3

4. (*a*) Define Ramachandran plot.

(*b*) Locate the following secondary structural element of proteins in Ramachandran plot : α-helix, parallel β-pleated sheet, antiparallel β-pleated sheet, 3·10 helix.

(*c*) Compare the structural features of protein α-helix and DNA double helix. 2 + 3 + 3

5. (*a*) What is self-replication ?

(*b*) Write briefly the significance of such studies.

(*c*) Propose a self-replicating scheme based on a model compound and explain how a simple template molecule can amplify. 2 + 2 + 4

6. (*a*) Write the significance of multiple recognition sites in the selection of substrates during host-guest complexation.

(*b*) Design a suitable chiral host for complexing L-Trp and show the mode of its complexation.

(*c*) How can one use such a receptor for resolution of racemic mixture ? 2 + 4 + 2