2025

(Nov–Dec)

FYUP : 5th Semester Examination

MAJOR

CHEMISTRY

(Chemistry–IV)

CHE–300

Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

PART—A

(Inorganic)

(*Marks* : 37)

1. *(a)* With the help of a suitable example, explain 'equivalent configuration' and 'equivalent atoms'. 2

(b) Assign point groups to the following molecules : 1½×4=6

(i) $XeOF_4$

(ii) Ferrocene (staggered)

(iii) *Trans*-$[PtCl_2(NH_3)_2]$

(iv) Borazole

(c) List down all the symmetry elements and symmetry operations of $Cr(CO)_6$. 2+2=4

(d) With the help of a suitable example, explain centre of inversion, proper axis and rotation-reflection axis. 1+1+2=4

(e) Draw the flowchart for assigning point groups to different molecules. 3

OR

2. (a) Assign point groups to the following molecules : 1½×4=6

(i) SbF_5

(ii) *Cis*-N_2F_2

(iii) $MnO_4^{\ominus}$

(iv) $H_2C{=}C{=}CH_2$

(b) Using a suitable example, define what is meant by 'symmetry element' and 'symmetry operation'. 2+2=4

(c) Clearly depict and identify the symmetry planes present in $PtCl_4^{2-}$. 2

(d) What is meant by product of symmetry? Explain using a suitable example. 2

(e) What symmetry elements are present in the following molecular point groups? 3

(i) C_s

(ii) $C_{\alpha v}$

(iii) T_d

(f) How many symmetry operations can be generated from an S_5 improper axis of rotation? 2

3. (a) How do metals occur in nature? Write down the steps involved in the extraction of metals from their ores. 1+2=3

(b) Explain the following terms : ½×4=2

(i) Minerals

(ii) Ores

(iii) Gangue

(iv) Flux

(c) What kind of ores do the following metals exist as in nature? ½×4=2

(i) Mercury

(ii) Aluminium

(iii) Zinc

(iv) Iron

(d) Predict the products and balance the following reactions : 1+1=2

(i) $Cr_2O_3 + Al \longrightarrow$

(ii) $Mn_3O_4 + Al \longrightarrow$

(e) Explain how aluminium is extracted from bauxite ore. 3

(f) Mention two general properties of inorganic polymers. Give three points of difference between inorganic and organic polymers. 1+1=2

(g) What are homo-atomic and hetero-atomic polymers? Give one example of each type. 2

(h) What are silicones? How are they obtained and why are they considered valuable? Mention one important use of silicones. ½×4=2

(Continued)

OR

4. (a) Explain with the help of a neat and labelled diagram how copper is purified from copper matte. 2

(b) What is zone refining? 2

(c) Explain how metals are purified using Parke's process. 3

(d) Explain how iron is extracted from haematite ore. 3

(e) Complete and balance the following reaction : 2

$$Ni + CO \xrightarrow{?} ? \xrightarrow{?} ?$$
(s) (g)

(f) Describe one method for the preparation of tetrasulphur tetranitride (S_4N_4) and draw its structure. Write the reaction of S_4N_4. 2½

(g) Why is phosphonitrilic chloride $(NPCl_2)_n$ called 'inorganic rubber' ? 1

(h) How is cyclic $(NPCl_2)_3$ prepared? Draw its structure and explain the bonding in it. 1+½+1=2½

(Turn Over)

PART—B

(Physical)

(*Marks* : 38)

5. *(a)* Write the frequency equation for a diatomic molecule assuming it behaves as a simple harmonic oscillator. Obtain the vibrational energy levels for such a molecule and define zero point energy. 2+3+1=6

(b) Which of the following molecules will be microwave active? 2

H_2, Cl_2, HCl, H_2O

(c) Explain the following in short : 2+2=4

(i) Additive properties

(ii) Constitutive properties

(d) Write the Clausius-Mosotti equation for a non-polar molecule and explain the meaning of the terms involved. 2+1=3

(e) The microwave spectrum of HBr molecule shows equidistant lines separated by 16·94 cm^{-1}. Calculate the bond length of the molecule if atomic masses of H and Br are 1·008 and 80 a.m.u. respectively. 4

OR

6. *(a)* Define surface tension. Describe the capillary rise method for determining the surface tension of a liquid. 1+3=4

(b) Explain the following : 3+3=6

(i) Anharmonicity

(ii) Induced polarization

(c) Describe the different types of spectroscopy involved in the different regions of the electromagnetic spectrum. 5

(d) What are degrees of freedom? Calculate the total degrees of freedom present in the following : 1+1½+1½=4

(i) CO_2

(ii) H_2O

7. *(a)* Differentiate between thermal and photochemical reactions. 4

(b) Discuss the photodecomposition of hydrogen iodide molecule. 3

(c) Derive the Michaelis-Menten equation for an enzyme-catalyzed reaction. 6

(d) Explain the following in short : 3+3=6

(i) Opposite reaction

(ii) Parallel reaction

OR

8. (a) With the help of Jablonski diagram, explain the following phenomena : 5

(i) Fluorescence

(ii) Phosphorescence

(b) What are photosensitized reactions? Give example. 2

(c) What are consecutive reactions? Obtain the rate expression for such reactions. 2+4=6

(d) Explain the following in short : 3+3=6

(i) Transition state theory

(ii) Chain reaction of decomposition of acetaldehyde

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