

1M/CHE-100 (Th) Syllabus-2023

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(Nov-Dec)

FYUP : 1st Semester Examination

MAJOR

CHEMISTRY

Part-A (Theory)

(Introductory Chemistry—I)

CHE-100

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

UNIT—I

(Inorganic Chemistry—I)

(Marks : 18)

1. (a) Write down the Schrödinger wave equation for an electron propagating in three dimension in space and explain the term involved.

2

(2)

- (b) Calculate the uncertainty in the position of the electron if uncertainty in its velocity is 0.001%. Given $m = 9.1 \times 10^{-31}$ kg, velocity = 300 ms^{-1} . ($h = 6.6 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$). 2
- (c) Why is 4s orbital lower in energy than 3d orbital? 1
- (d) State Hund's rule of maximum multiplicity. 1
- (e) Consider the following species :
 N^{3-} , O^{2-} , F^- , Na^+ , Mg^{2+} and Al^{3+}
- (i) What is common in them?
- (ii) Arrange them in the order of increasing ionic radii. 2
- (f) The electron gain enthalpy value of inert gas is zero. Why? 1
- (g) Give reason why the electron affinity of fluorine is less than that of chlorine. 1

OR

2. (a) State the Heisenberg's uncertainty principle and write its mathematical form. 2

(3)

(b) What do you mean by quantum numbers? Name the different types of quantum number and their significance. 2

(c) Calculate the effective nuclear charge felt by $2p$ electron of a nitrogen atom. 1

(d) Describe the following orbital in terms of their corresponding $(n + l)$ value : 1

$3s$ and $5p$

(e) Among the second period elements, the actual ionization enthalpies are in the order :



Explain why—

(i) Be has higher $\Delta_i H$ than B?

(ii) O has lower $\Delta_i H$ than N? 2

(f) Write the electronic configuration of Cr (24) and Cu (29). 1

(g) State one pair of diagonally related element in the periodic table and mention one similarity in their chemical behaviour. 1

3. (a) What is Born-Haber cycle? Calculate the lattice energy of NaCl crystal from the following data by using Born-Haber cycle : 2

(i) Sublimation energy (S)
 $= 108.7 \text{ kJ mol}^{-1}$

(ii) Dissociation energy for Cl_2 (D)
 $= 225.9 \text{ kJ mol}^{-1}$

(iii) Ionization energy of Na(g) (I)
 $= 484.5 \text{ kJ mol}^{-1}$

(iv) Electron affinity of Cl(g) (E)
 $= -351.4 \text{ kJ mol}^{-1}$

(v) Heat of formation of NaCl (ΔH_f)
 $= -414.2 \text{ kJ mol}^{-1}$

- (b) Consider the chlorides NaCl, MgCl_2 and AlCl_3 : 2

(i) Which cation among Na^+ , Mg^{2+} and Al^{3+} has the highest polarizing power? Explain briefly.

(ii) Based on polarizing power and polarizability of Cl^- , arrange the compound in order of increasing covalent character. Also predict which compound will have the highest melting point.

(5)

- (c) Write down the postulate of valence bond theory. 2
- (d) On the basis of hybridization, discuss the geometry and hybridization state of the central atom. 2
- (i) H_3O^+
- (ii) PCl_3

OR

4. (a) Discuss the geometry of the molecule on the basis of VSEPR theory : 2
- (i) BF_3
- (ii) SF_6
- (b) State the hybridization of the central atom in NH_3 molecule and explain how it leads to its shape, bond angle and typical N—H bond length. 2
- (c) Compare the relative stability of the following species on the basis of MO theory and indicate their magnetic properties : 2
- O_2, O_2^+
- (d) The dipole moment of hydrogen halide decreases from HF to HI. Explain the trend. 1
- (e) Write down two factors affecting the polarizing power of the cation. 1

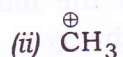
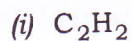
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UNIT—II

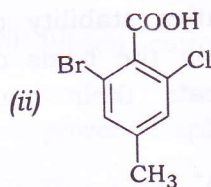
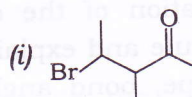
(Organic Chemistry—I)

(Marks : 19)

5. (a) Draw the molecular orbital picture of the following molecules emphasizing the type of hybridization, shape and bond angles : $1\frac{1}{2} \times 2 = 3$



- (b) Give the IUPAC names of the following : $1 \times 2 = 2$

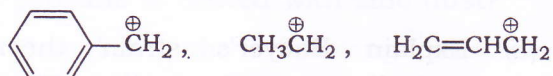


- (c) *p*-hydroxybenzoic acid is more soluble in water compared to its *ortho*-isomer. Explain with structures. $1\frac{1}{2}$

(7)

- (d) Arrange the following carbocations in their increasing order of stability. Give reasons.

1½



OR

6. (a) Explain why the bond angle of methyl carbanion is less than that of methane although both are sp^3 -hybridized.

2

- (b) *n*-butyl alcohol and diethyl ether have the same molecular formula $\text{C}_4\text{H}_{10}\text{O}$, but the boiling point of *n*-butyl alcohol is 118°C and that of diethyl ether is 34.6°C . Account for the difference in boiling point.

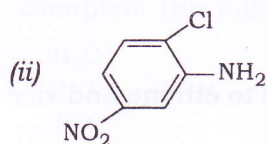
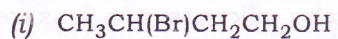
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- (c) What are electrophiles and nucleophiles? Give one example for each.

2

- (d) Give the IUPAC name of the following compounds :

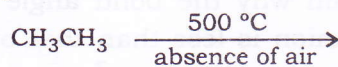
1×2=2



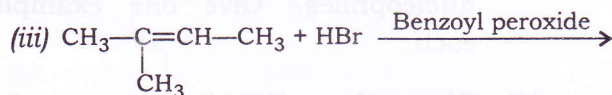
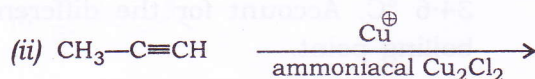
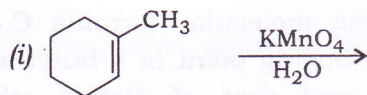
7. (a) What is the advantage of preparing an alkane by Corey-House reaction? Illustrate with a suitable example. 2

- (b) Explain Baeyer's strain theory of cycloalkanes and mention one of its limitations. 1½

- (c) Complete the following reaction : 1



- (d) Complete the following reactions : 1×3=3



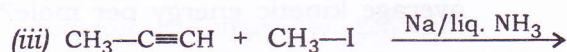
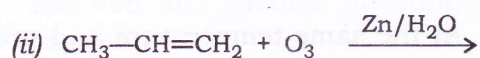
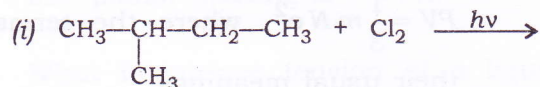
- (e) Explain why alkynes are less reactive than alkenes towards electrophilic addition. 1½
- (f) Convert ethene to ethyne and vice versa. 2

(9)

OR

8. (a) What happens when 1,3-dibromopropane is heated with zinc dust? 1

(b) Complete the following reactions
(any two) : 1×2=2



(c) Explain why hydrogen undergoes *cis*-addition to an alkene. 1½

(d) What happens when—

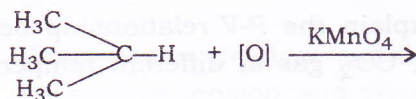
(i) cyclopropane is treated with HBr;

(ii) ethane is treated with conc. HNO_3
at 450°C ? 1×2=2

(e) How can you convert ethane into *n*-butane? 1½

(f) How can you obtain 1-butanol and 2-butanol from 1-butene? 1+1=2

(g) Complete the following reaction : 1



(10)

UNIT—III

(Physical Chemistry—I)

(Marks : 19)

9. (a) Derive the kinetic gas equation $PV = \frac{1}{3} m N \overline{c^2}$, where the terms have their usual meanings. 3
- (b) At the same temperature and pressure, which of the gases will have higher average kinetic energy per mole?
 H_2, O_2, CH_4, SF_6
Give reasons for your answer. 1+1=2
- (c) Under what conditions does a real gas approach ideal behaviour? Explain using van der Waals' equation of state. 2
- (d) Explain Frenkel and Schottky defects in crystal. $1\frac{1}{2}+1\frac{1}{2}=3$

OR

10. (a) Explain the variation of the compressibility factor with pressure at a given temperature. $3\frac{1}{2}$
- (b) Explain the P-V relationship behaviour for CO_2 gas at different temperatures. $3\frac{1}{2}$

- (c) Calculate the angle at which second-order reflection will occur in an X-ray spectrometer, when X-rays of wavelength $1.54 \text{ \AA}$ are diffracted by the atoms of a crystal. Given that the interplanar spacing is $4.04 \text{ \AA}$. 3

11. (a) What is surface tension of a liquid? Mention the factors affecting surface tension. 1+1=2
- (b) Volatile liquids must have lower surface tension and viscosity. Explain. 2
- (c) The reaction $A+B \rightarrow P$ is first-order with respect to both A and B. A and B have the same initial concentration. Derive the integrated rate expression. 3
- (d) The half-life for a reaction at two initial concentrations of 0.1 mol L^{-1} and 0.4 mol L^{-1} are 200 seconds and 50 seconds respectively. What is the order of the reaction? 2

OR

12. (a) Define vapour pressure. Explain the effect of temperature on vapour pressure. 1+1=2
- (b) What is the effect of addition of NaCl on surface tension and viscosity? 1+1=2

(12)

- (c) Give the Stoichiometric equation for the reaction of the rate law expression

$$\frac{dx}{dt} = k(a-2x)^2(b-x)$$

where a and b are the initial concentrations of A and B respectively. 2

- (d) The rate constant for the second-order neutralization of nitropropane by a base is given by

$$\log k = -\frac{3163}{T} + 11.899$$

The initial concentration of acid and of base were both 0.005 M. Calculate

- (i) E_a (in joules) and (ii) $t_{1/2}$ (in minutes) at 25 °C.

$$1\frac{1}{2} + 1\frac{1}{2} = 3$$
