

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

2024

(April)

FYUP : 1st Semester Examination

MAJOR COURSE

CHEMISTRY : CHE-100

Part-A (Introductory Chemistry—I)

(Theory)

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) What is Heisenberg uncertainty principle? Calculate the uncertainty in velocity of an electron when the uncertainty of its position is 10^{-10} m.

$$(h = 6.6 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1} \text{ and}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}) \quad 3$$

(2)

- (b) Write down the Schrödinger wave equation in three-dimension and define all the terms involved. Write down the physical significances of ψ and ψ^2 . 3
- (c) Differentiate between electron gain enthalpy and electronegativity. 2
- (d) Give two similarities between Li and Mg. 2

OR

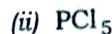
2. (a) For principal quantum number $n = 3$, write all the permissible values of l and m , and identify all the orbitals. 3
- (b) What is meant by 'dual character of matter'? Derive the de Broglie relation. 1+2=3
- (c) Define the modern periodic law. Write down the atomic number and electronic configuration of Cl. 2
- (d) Fluorine has a lower electron affinity than chlorine. Explain. 2
3. (a) Draw the molecular orbital energy-level diagram for O_2 molecule. Calculate the bond orders for O_2 , O_2^- and O_2^{2-} , and mention their magnetic behaviours. 3

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(3)

- (b) Predict the shapes of the following molecules using VSEPR theory : 2
- (i) H_3O^+
- (ii) BO_3^{3-}
- (c) Mention the hybridization states of phosphorus (P) in the following molecules :



Draw the orbital structures for both. 2

- (d) Explain why CO_2 molecule shows zero dipole moment. 1

OR

4. (a) What is lattice energy? Calculate the lattice energy of NaCl, when one mole of NaCl is prepared from 1 g atom of Na and 0.5 mole of Cl_2 gas from the given data : 3

$$\begin{aligned} \text{Enthalpy of formation of NaCl(s)} \\ = 381.8 \text{ kJ/mole} \end{aligned}$$

$$\begin{aligned} \text{Enthalpy of sublimation of Na} \\ = 108.5 \text{ kJ/mole} \end{aligned}$$

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(4)

Heat of dissociation of Cl_2
= 495.2 kJ/mole

Ionization energy of Na
= 495.2 kJ/mole

Electron affinity of Cl
= 348.3 kJ/mole

- (b) Mention the factors which affect the polarity of a molecule and hence its dipole moment. 2
- (c) Define 'polarizing power' and 'polarizability' of ions. Which ions will have higher polarizing power, K^+ or Li^+ ? Explain. 2
- (d) The hybridization state of Cl in ClF_3 is sp^3d as well as S in SF_4 , but their shapes are different. Explain. 1

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(5)

UNIT—II

(Organic Chemistry—I)

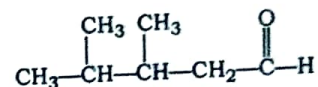
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5. (a) Draw the molecular orbital diagram of the following molecules and predict their hybridization and bond angle of each : $1\frac{1}{2} \times 2 = 3$

(i) CH_4

(ii) $\text{R}-\text{C}\equiv\text{N}$

- (b) Give the IUPAC name of the following : 1



- (c) Why is the boiling point of *p*-nitrophenol higher than that of *o*-nitrophenol, though they are isomers of each other? 2
- (d) Benzyl carbocation is more stable than ethyl carbocation. Explain. 2
- (e) How can an alkane be prepared using Corey-House synthesis? Give the chemical equation. $1\frac{1}{2}$

OR

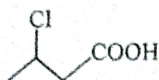
6. (a) Draw the hyperconjugation structure of toluene. 2

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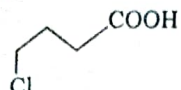
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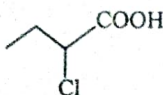
- (b) Arrange the following substituted carboxylic acids in order of decreasing acidity. Give suitable explanation : 2



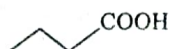
(I)



(II)

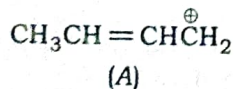


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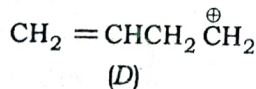


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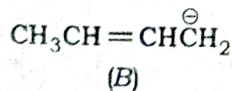
- (c) What are the types of reaction intermediates formed by homolytic and heterolytic bond fissions? Give examples. 2
- (d) The species A, B and C are more stable than D, E and F respectively. Give reasons for your answer : 2



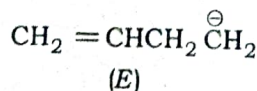
(A)



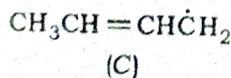
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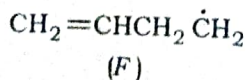
(B)



(E)



(C)

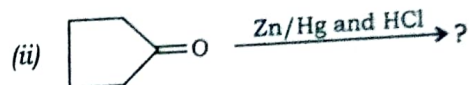
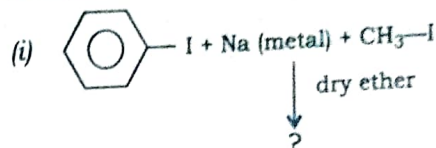


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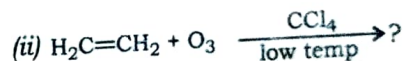
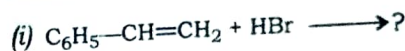
- (e) Write the mechanism for chlorination of methane. 1½

(7)

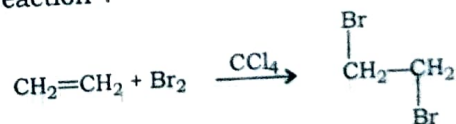
7. (a) Complete the following reactions by writing the correct products : 1×2=2



- (b) Give a brief account on the limitation of Bayer's strain theory. 1
- (c) Predict the products of the following reactions : 1×2=2



- (d) Give the mechanism of the following reaction :



Also explain why this addition leads to the formation of *trans*-addition product as major product. 2+1=3

- (e) Write the mechanism for the reaction of ethyne with HOCl . 1½

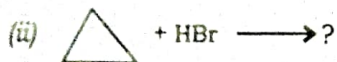
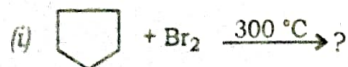
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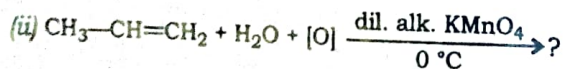
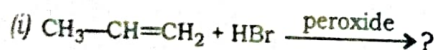
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8. (a) Give the Kolbe's synthesis of ethane with mechanism. $2\frac{1}{2}$

- (b) Complete the following reactions : $\frac{1}{2} \times 2 = 1$

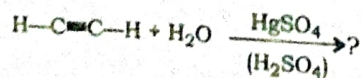


- (c) Predict the products for the following reactions. Give suitable mechanisms : $1\frac{1}{2} \times 2 = 3$



- (d) Compare the acid strengths of ethane, ethene and ethyne. $1\frac{1}{2}$

- (e) Complete the following reaction : $1\frac{1}{2}$



(9)

UNIT—III

(Physical Chemistry—I)

(Marks : 19)

9. (a) Write down the postulates of kinetic theory of gases. 3
- (b) Derive the Boyle's law from kinetic gas equation. 2
- (c) Define the following : $1 \times 2 = 2$
- (i) Root-mean-square velocity
- (ii) Compressibility factor
- (d) Calculate the angle at which a first-order reflection will occur when a beam of X-rays of wavelength $1.54 \text{ \AA}$ is diffracted by atomic planes of a crystal, given the interplanar distance is $4.04 \text{ \AA}$. 3

OR

10. (a) Derive the van der Waals' equation of state

$$\left(P + a \frac{n^2}{V^2} \right) (V - nb) = nRT \quad 4$$

(10)

- (b) Describe the deviation of a real gas from ideality with the help of a diagram. 3
- (c) Write short notes on the following : $1\frac{1}{2} \times 2 = 3$
- (i) Schottky defect
 - (ii) Frenkel defect
11. (a) Derive the integrated rate equation for a first-order reaction. 3
- (b) Give the differences between order and molecularity of a reaction. 2
- (c) Explain the following terms : $2 \times 2 = 4$
- (i) Surface tension
 - (ii) Refractive index

OR

12. (a) Discuss the effect of additive (sodium chloride) on surface tension and viscosity of a liquid. $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (b) What is the effect of catalyst on reaction rates? Explain. 3

(11)

- (c) A first-order reaction is 40% complete in 50 minutes. Calculate the value of the rate constant. In what time will the reaction be 80% complete? $1\frac{1}{2} + 1\frac{1}{2} = 3$

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