

1/CHE-100 (Th) Syllabus-2023

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(December)

FYUP : 1st Semester Examination

MINOR

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) Derive de Broglie's equation. Calculate the wavelength of an electron moving with a velocity of $2.5 \times 10^7 \text{ m-s}^{-1}$.

($h = 6.63 \times 10^{-34} \text{ J-s}$, mass of an electron = $9.11 \times 10^{-31} \text{ kg}$) $1\frac{1}{2} + 1\frac{1}{2} = 3$

(2)

- (b) Calculate the effective nuclear charge felt by 1s and 2p electrons of a nitrogen atom. 2
- (c) Write down the electronic configurations of P and S. Compare the stability of their electronic configurations. 2
- (d) Arrange the following sets of atoms/ions according to their increasing atomic/ionic radii : 2
- (i) Li, K, Rb, Na
- (ii) Mn^{2+} , Mn^{7+} , Mn^{5+} , Mn^{3+}
- (e) State Hund's rule of maximum multiplicity. 1

OR

2. (a) Predict the shapes of 2s and 2p orbitals by applying probability distribution curve. 3
- (b) Calculate the uncertainty of velocity of an electron if the uncertainty of its position is 5×10^{-10} m. ($h = 6.63 \times 10^{-34}$ J-s, mass of an electron = 9.11×10^{-31} kg) 2

(3)

- (c) Explain why the first ionization energy $(\text{IE})_1$ of Be is $899.3 \text{ kJ mol}^{-1}$ and that of B is $800.1 \text{ kJ mol}^{-1}$. 2
- (d) What is diagonal relationship? Why do Li and Mg show diagonal relationship? 2
- (e) From the following sets of values of quantum numbers, identify which one is correct : 1
- (i) $n = 1; l = 0, 1; m_e = +1, 0, -1$
- (ii) $n = 2; l = 0, 1; m_e = +1, 0, -1$
- (iii) $n = 3; l = 0, 1, 2; m_e = +1, 0, -1$

3. (a) On the basis of hybridization, discuss the geometry and hybridization states of the central atom, and draw the orbital structures of the following molecules : $1\frac{1}{2} + 1\frac{1}{2} = 3$



- (b) Point out two limitations of valence bond theory. 2

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(4)

- (c) What is Born-Haber cycle? Draw the Born-Haber cycle for the formation of NaCl and mention the terms involved. 2
- (d) Account for the fact that the dipole moment of NH_3 is 1.49 D and that of CH_4 is 0 D. 1

OR

4. (a) On the basis of molecular orbital (MO) theory, write down the molecular orbital configurations of N_2 and N_2^{2+} . Calculate the bond orders and mention the nature of the bonds in each case. 3
- (b) Predict the shapes of the following molecules using VSEPR theory : 2
- (i) SF_4
- (ii) SF_6
- (c) Write down the factors affecting polarizability of the anion. Arrange the following in increasing order of polarizability : 2
- LiF , LiBr , LiCl , LiI
- (d) Between LiF and CaF_2 , which will have higher value of lattice energy and why? 1

(5)

UNIT—II

(Organic Chemistry—I)

(Marks : 19)

5. (a) Give the IUPAC names of the following : 1×2=2
- (i) $\text{O}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{Cl}$
- (ii) $\text{CH}_3-\underset{\text{CH}_2\text{OH}}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3$
- (b) Arrange the following in order of decreasing acid strength. Give reason : 2
- CH_3COOH , Cl_3CCOOH ,
 Cl_2CHCOOH , ClCH_2COOH
- (c) Carboxylic acids show much higher boiling points compared to alcohols of comparable molecular mass. Explain. 2
- (d) Which of the following is more acidic and why? 2
- $\text{CH}=\text{CH}$, $\text{CH}_3-\text{C}\equiv\text{CH}$

(6)

OR

6. (a) *o*-nitrophenol is less soluble than its *p*-isomer. Explain giving suitable reasons. 2
- (b) Taking suitable examples, explain why hyperconjugation is also called 'no-bond' resonance. 2
- (c) Classify the following as electrophiles or nucleophiles : $\frac{1}{2} \times 4 = 2$
- (i) SnCl_4
- (ii) R_3N
- (iii) $\text{NO}_2^{\oplus}$
- (iv) $\text{NH}_2^{\ominus}$
- (d) Allyl carbocation is more stable and less reactive than simple carbocation. Explain. 2

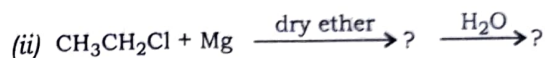
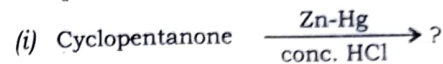
7. (a) Why does cyclopropane undergo ring opening more easily than cyclobutane or cyclopentane? $1\frac{1}{2}$
- (b) HBr gives anti-Markownikoff's addition reaction in presence of peroxide but not HCl and HI. Explain. $1\frac{1}{2}$

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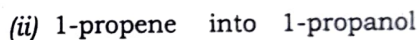
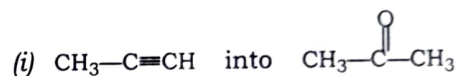
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- (c) Complete the following reactions : $1 \times 2 = 2$



- (d) How will you carry out the following conversions? Give suitable reactions : $1+1=2$

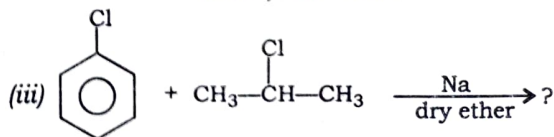
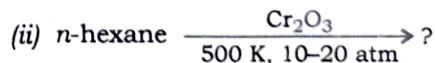
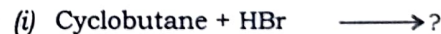


- (e) Write a suitable mechanism for the preparation of $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ by Corey-House method. 2

- (f) What happens when water is dropped over calcium carbide and the gas so produced is bubbled through dilute H_2SO_4 containing HgSO_4 ? Write chemical equations. $1+1=2$

OR

8. (a) Write the product of the following reactions : $1 \times 3 = 3$

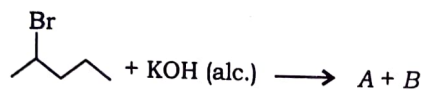


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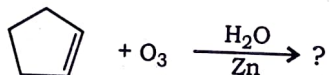
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(8)

- (b) Write the postulates of Bayer's strain theory. 2
- (c) Identify the products in the following reaction. Also, indicate the major product : 1½



- (d) Which is more reactive towards the addition of HBr, ethylene or propylene? Explain. 1
- (e) Write the product(s) with mechanism for the following reaction : 2



- (f) How is propanone obtained from propyne? Give reaction. 1½

(9)

UNIT—III

(Physical Chemistry—I)

(Marks : 19)

9. (a) Derive van der Waals' equation for n moles of a gas and write down the units of van der Waals' constants. 2+1=3
- (b) Calculate the average kinetic energy of a hydrogen molecule at 0 °C. Given, $R = 8.314 \times 10^{-7}$ erg K⁻¹mol⁻¹. 2
- (c) What are the reasons for the deviation of real gases from ideal behaviour? 2
- (d) Derive Bragg's equation. 3

OR

10. (a) Give the assumptions of the kinetic theory of gases. 3
- (b) Starting from kinetic gas equation, derive (i) Avogadro's law and (ii) Charles' law. 2+2=4
- (c) Explain Schottky and Frenkel defects in crystals. 3

(10)

11. (a) Define the following :

2

(i) Vapour pressure

(ii) Refractive index

(b) How does the viscosity of a liquid change with temperature?

2

(c) Derive an expression for the rate constant of a second-order reaction when the initial concentration is the same.

2

(d) Show that for a first-order reaction, the time required for 99.9% completion is three times the time required for 90% completion.

3

OR

12. (a) What is surface tension of a liquid?

Give the unit of surface tension. 1+1=2

(b) What are the important factors that affect the vapour pressure?

2

(c) Show that the half-life of a first-order reaction is independent of the reactant concentration.

2

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(11)

(d) If the rate constant of a reaction is $2.0 \text{ mol}^{-1} \text{ L s}^{-1}$ at 700 K and $32 \text{ mol}^{-1} \text{ L s}^{-1}$ at 800 K, what is the activation energy?

3
