FYUG Odd Semester Exam., 2024

CHEMISTRY

(1st Semester)

Course No. : CHMDSM–101T

(Fundamentals of Chemistry—I)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* from the following : 2×2=4

   (a) (i) Which quantum number determines the size of an orbital? 1

   (ii) How many orbitals are possible in a sub-shell for which $l = 2$? 1

   (b) (i) How many unpaired electrons are present in nitrogen atom? 1

   (ii) "Macroscopic bodies have no de Broglie wavelength." Justify. 1

(Turn Over)

(c) (i) What is meant by degenerate orbital? 1

(ii) Calculate the product of uncertainty in position and velocity of an electron of mass 9.1×10^{-31} kg. 1

2. (a) Write the possible quantum numbers for an electron present in $3p$ orbital. 2

(b) Write the stable electronic configuration of chromium ($Z = 24$). 1

(c) Write the expression for the time independent Schrödinger wave equation in one dimension. 1

(d) Write the significance of ψ and ψ^2 with respect to Schrödinger wave equation in one dimension. 2

(e) What do you mean by exchange energy? 2

(f) What is meant by the term 'dual nature of electrons'? 2

OR

3. (a) Explain how Pauli's exclusion principle rules out the existence of more than two electrons in an orbital. 3

(b) The mass of a moving electron is 9.11×10^{-31} kg and its wavelength is 727 pm. Find out its velocity. 3

(c) Write the electronic configurations of N and O; and explain with reasons which of them has more stable configuration. 4

UNIT—II

4. Answer any *two* from the following : 2×2=4

(a) (i) Which of the following molecules possess(es) regular geometry?

NH_3, H_2O, CH_4, H_2S 1

(ii) Fill in the blank :   1

Bonding MO has energy _____ than anti-bonding MO.

(b) (i) Identify the hybridization state of carbon in $CHCl_3$ and CO_2.   1

(ii) Which of the following hybridizations lead(s) to (1) a square planar and (2) an octahedral shape?

sp^3, sp^2d, sp^3d, sp^3d^2 1

(c) Which has shorter bond length—H_2 or $H_2^{\oplus}$? Justify your answer.   1+1=2

5. (a) How does the VSEPR theory explain the following?   4

(i) Pyramidal structure of ammonia

(ii) Distorted trigonal bipyramidal structure of SF_4

(b) What is meant by bonding and anti-bonding molecular orbital? Explain taking example of H_2.   3

(c) What is resonance energy? Write its significance.   3

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OR

6. *(a)* Draw the resonance structure of the following :   1+1=2

     (i) CO_3^{2-} ion

     (ii) NO_3^- ion

(b) What do you mean by LCAO? Write the three conditions of LCAO to form MO.   3

(c) On the basis of VSEPR theory, explain the structure of PCl_5.   2

(d) Arrange N_2, $N_2^{\oplus}$ and $N_2^{\ominus}$ in order of increasing stability.   3

UNIT—III

7. Answer any *two* from the following :   2×2=4

(a) Write two important postulates of kinetic molecular theory of gases.   2

(b)   *(i)* Write down the van der Waals' equation of state for *n* moles of a gas.   1

     (ii) Write the SI unit of van der Waals' constants *a* and *b*.   1

(c) Justify Boyle's law on the basis of kinetic theory of gas.   2

8. *(a)* What are the causes of deviation of real gases from ideal behaviour?   3

(b) How does mean free path of a gas molecule change with *(i)* temperature and *(ii)* pressure?   2

(c) State the conditions under which a gas shows ideal behaviour.   3

(d) Calculate the RMS velocity of molecules of nitrogen gas at 280 K in SI unit.   2

OR

9. (a) Derive the kinetic gas equation in terms of density.   3

(b) Show from kinetic gas equation that kinetic energy of gas molecules is directly proportional to temperature in Kelvin scale.   2

(c) Derive a relationship between the most probable velocity and average velocity of a gas.   2

(d) Calculate the most probable velocity of CO_2 molecule at 27 °C.   2

(e) Will the average kinetic energy of a mole of CO_2 and a mole of H_2 gas at 300 K be same? Justify.   1

UNIT—IV

10. Answer any *two* from the following :   2×2=4

(a) What is surface tension of a liquid? Write its SI unit.   1+1=2

(b) Define unit cell and give an example.   2

(c) Define coefficient of viscosity. What is its SI unit?   1+1=2

11. (a) Under what condition surface tension of a liquid becomes zero?   1

(b) Why does water have a concave meniscus?   1½

(c) What are ionic crystals? Write a few important characteristics of ionic crystals.   1+2=3

(d) What are the different types of unit cells in crystal systems? Explain them.   3

(e) A cubic solid is made up of two atoms A and B. Atoms A are present at the corners and B at the centre of the body. What is the formula of the unit cell?   1½
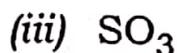
OR

12. (a) Why are ionic solids conducting in the molten state and not in the solid state?   2

(b) What is a lattice point? Write its significance.   2

(c) What do you mean by point defects in a crystal?   1

(d) How is density of a crystal affected by (i) Schottky defect and (ii) Frenkel defect?   2

(e) What is crystal lattice?   1

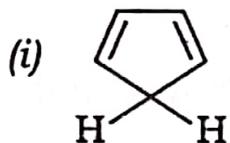(f) Calculate the number of points present in the bcc unit cell.   2

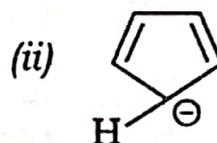## UNIT—V

13. Answer any *two* from the following : $\qquad$ 2×2=4

(a) Pick up electrophiles and nucleophiles from the following : ½×4=2

    (i) $\overset{\ominus}{C}Cl_3$

    (ii) BF_3

    (iii) SO_3

    (iv) CH_3OH

(b) Which of the following is aromatic? Give reason. ½+1½=2

    (i) [cyclopentadiene with CH₂ (H, H)]   *Or*   (ii) [cyclopentadienyl anion with H and ⊖]

(c) Which of the following is a stronger base? Justify your choice. ½+1½=2
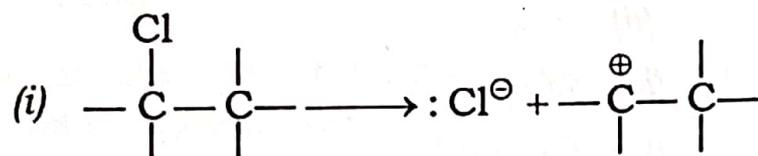
    (i) $CH_3—NH_2$ *Or*   (ii) [phenyl]$—NH_2$
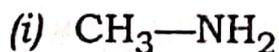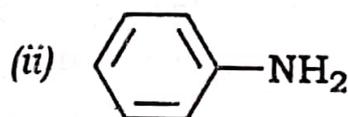
14. (a) What are carbocations? Compare the stability of the following pairs of carbocations and give reasons for your choice : 1+1+2=4

    (i) $(CH_3)_2\overset{\oplus}{C}H$ and $(CH_3)_3\overset{\oplus}{C}$

    (ii) $CH_3CH_2\overset{\oplus}{C}H_2$ and $CH_2=CH—\overset{\oplus}{C}H_2$
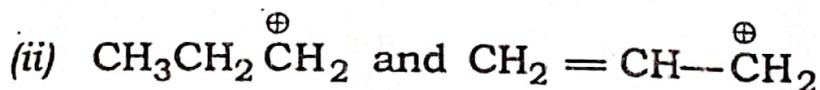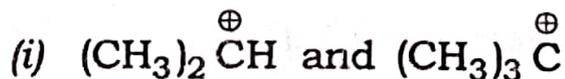
(b) What are ambident nucleophiles? Give one example to illustrate. 1+1=2

(c) Explain the term 'resonance hybrid'. 2

(d) Use curved arrows to show the electron flow in each of the following. Identify the type of bond cleavage in each type : 1+1=2

(i)

$$-\overset{\overset{\displaystyle Cl}{|}}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}- \longrightarrow \; :Cl^{\ominus} + -\overset{\oplus}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$$

(ii) $CH_3OOC_2H_5 \longrightarrow CH_3\dot{O} + C_2H_5\dot{O}$

OR

15. (a) Why is hyperconjugation called 'no bond resonance'? 2

(b) Explain Hückel's rule of aromaticity with an example. 4

(c) Methanoic acid is more acidic than ethanoic acid. Justify this observaton. 2

(d) Write the types of electrons involved in the following processes : ½×4=2

   (i) Inductive effect

   (ii) Resonance

   (iii) Hyperconjugation

   (iv) Electromeric effect

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