

2019/TDC/ODD/SEM/CHMHCC-101T/130

TDC (CBCS) Odd Semester Exam., 2019

CHEMISTRY

(1st Semester)

Course No. : CHMHCC-101T

(Atomic Structure and Chemical Bonding)

Full Marks : 50

Pass Marks : 20

Time : 3 hours

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

SECTION—A

(Marks : 20)

Answer **ten** questions, taking **two** from each Unit

UNIT—I

1. Mention two important postulates of Bohr's theory. 1+1=2
2. Calculate the uncertainty in the position of an electron, if the uncertainty in velocity is 0.1% of velocity of light. 2
3. State and explain Aufbau principle. 2

(2)

UNIT—II

4. What do you mean by ionic radii? Explain why the size of Na^+ ion is smaller than that of Na atom. 1+1=2
5. Justify with suitable example that van der Waals' radius is greater than covalent radius. 2
6. Discuss the variation of atomic radii from left to right in a period and down a group for main group elements. 2

UNIT—III

7. With the help of MOT, show that He_2 molecule does not exist but He_2^+ exists. 1+1=2
8. Draw the resonating structures of carbonate ion and nitrate ion. 1+1=2
9. (a) Write the bond orders of H_2^+ and H_2^- . 1
(b) Draw the Lewis structures of PO_4^{3-} and CO. 1

(3)

UNIT—IV

10. Dipole moments of CO_2 and SO_2 are zero and 1.60 D respectively. Explain the observation. 2
11. If Na^{\oplus} and Cu^{\oplus} have similar sizes, which one will show more polarizability? Explain. 2
12. Electronegativities of H and F are 2.1 and 4.0 respectively. Calculate the percentage of ionic character in the H—F bond. 2

UNIT—V

13. Identify the oxidizing and reducing agents and the atoms undergoing oxidation and reduction in the following reaction : 2

$$\text{H}_2\text{S} + 2\text{FeCl}_3 \rightarrow 2\text{FeCl}_2 + 2\text{HCl} + \text{S}$$
14. HNO_3 can act as oxidizing agent only while HNO_2 can act as both oxidizing and reducing agents. Explain. 2
15. Can we use a copper vessel to store 1 M AgNO_3 solution? Given, $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = 0.34 \text{ V}$ and $E^\circ_{\text{Ag}^+/\text{Ag}} = -0.80 \text{ V}$. Justify your answer. 2

(4)

SECTION—B

(Marks : 30)

Answer **five** questions, taking **one** from each Unit

UNIT—I

16. (a) Write three-dimensional Schrödinger wave equation in Cartesian coordinates and explain the significance of terms. What are the significances of ψ and ψ^2 ?
2+2=4
- (b) Calculate the energy of the emitted radiation in wave number when the electron of hydrogen atom jumps from the third level to the first level. 2
17. (a) Derive de Broglie equation and show that it is in accordance with Bohr's atomic theory. 2
- (b) Draw the radial probability distribution curves for 1s and 2s electrons. 2
- (c) Two particles A and B are in motion. If the wavelength associated with the particle A is 5×10^{-8} m, calculate the wavelength of particle B, if its momentum is half of A. 2

(5)

UNIT—II

18. (a) Define electronegativity. Give a short account of Pauling's scale of electronegativity. 1+2=3
- (b) Arrange the following in the increasing order of size : 1
 Al^{3+} , F^- , Na^+ , O^{2-} , Mg^{2+}
- (c) Explain why the electron affinity of F is lower than that of Cl although the electronegativity of F is higher than that of Cl. 2
19. (a) Define effective nuclear charge and shielding effect. Calculate the effective nuclear charges for Cu^+ and Cu. 2+2=4
- (b) Define ionization potential. Mention the factors that govern the magnitude of ionization potential. 2

UNIT—III

20. (a) Draw and explain the MO energy level diagram of NO molecule. Comment on its bond order and magnetic properties. 3
- (b) Explain the structures of NH_3 and ClF_3 on the basis of VSEPR theory. 3

(6)

21. (a) What is radius ratio rule? How does it help to predict the structure of ionic compound? 2
- (b) Predict the structure and coordination number of the cation in MgO, where the radii of cation and anion are 65 pm and 140 pm respectively. 2
- (c) Calculate the lattice energy of KCl from the following data : 2
- (i) Sublimation energy of
 $K(s) = 102.5 \text{ kJ mol}^{-1}$
- (ii) Dissociation energy of
 $Cl_2 = 230.5 \text{ kJ mol}^{-1}$
- (iii) Ionization energy of
 $K(g) = 450.6 \text{ kJ mol}^{-1}$
- (iv) Electron affinity of
 $Cl(g) = -350.2 \text{ kJ mol}^{-1}$
- (v) Heat of formation of
 $KCl = -420.4 \text{ kJ mol}^{-1}$

UNIT—IV

22. (a) With the help of band theory, explain the terms—conductors, semiconductors and insulators. 3
- (b) "NaCl is soluble in water whereas AgCl is insoluble in it." Explain. 2

(7)

- (c) Which point defect in a crystal does not alter the density of the solid? 1
23. (a) What do you understand by the imperfection in ionic solid? Name the types of imperfections which occur in ionic solids. 3
- (b) Discuss the nature and relative strength of Debye and London forces. 2
- (c) Why does white zinc oxide become yellow on heating? 1

UNIT—V

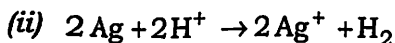
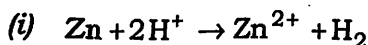
24. (a) Balance the following redox reactions by ion electron method : 3
- (i) $Cr_2O_7^{2-} + Fe^{2+} + H^+ \rightarrow$
 $Fe^{3+} + Cr^{3+} + H_2O$
- (ii) $Zn + NaOH + NaNO_2 \rightarrow$
 $NH_3 + Na_2ZnO_2 + H_2O$
- (b) Why is the colour of copper sulphate solution discharge when iron rod dipped into it? 1
- (c) Of the two substances, $K_2Cr_2O_7$ and $KMnO_4$, which one is used as primary standard and why is it so? 2

25. (a) Explain the principle and write the reactions involved in the estimation of Fe^{2+} ion by $\text{K}_2\text{Cr}_2\text{O}_7$.

3

- (b) Predict the feasibility of the following reactions :

2



Given

<i>Electrode</i>	<i>Standard electrode potential</i>
$\text{Zn}^{2+} / \text{Zn}$	-0.76 V
Ag^+ / Ag	+0.80 V
$2\text{H}^+ / \text{H}_2$	0.00 V

- (c) Define oxidation number. How does oxidation number differ from valency?

1

2019/TDC/ODD/SEM/CHMHCC-102T/131

TDC (CBCS) Odd Semester Exam., 2019

CHEMISTRY

(1st Semester)

Course No. : CHMHCC-102T

(States of Matter and Ionic Equilibrium)

Full Marks : 50

Pass Marks : 20

Time : 3 hours

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

SECTION—A

(Marks : 20)

Answer **ten** questions, taking **two** from each Unit

UNIT—I

1. Show that the mean free path of a gas at constant volume is directly proportional to temperature. 2
2. Calculate various degrees of freedom for the following : 2
 - (a) HCl
 - (b) C₆H₆

(2)

3. Prove that the molecular velocity of any gas is proportional to the square root of absolute temperature. 2

UNIT—II

4. Write the dimension and significance of van der Waals' constant a . 2
5. Calculate the value of critical compressibility factor Z_c . 2
6. Write the Dieterici equation and explain the terms. 2

UNIT—III

7. What are cohesion and adhesion forces? 2
8. Explain the term 'cybotactic group'. 2
9. What is viscosity of a liquid? How does viscosity vary with temperature? 2

UNIT—IV

10. Write the cell parameters for the most unsymmetric unit cell. 2

(3)

11. Explain the term 'F-centre'. 2
12. What do you mean by the term 'plane of symmetry'? 2

UNIT—V

13. Write the solubility product expression for aluminium sulphide. 2
14. Calculate the pH of 10^{-9} M HCl solution. 2
15. "Aqueous CuSO_4 solution is acidic or alkaline." Explain the statement. 2

SECTION—B

(Marks : 30)

Answer **five** questions, taking **one** from each Unit

UNIT—I

16. (a) Deduce the kinetic gas equation. 3
- (b) Calculate the temperature at which the root mean square velocity, the average velocity and the most probable velocity of oxygen gas are all equal to 1500 ms^{-1} . 3

(4)

17. (a) Find out the number of molecules of an ideal gas per litre at (i) 300 K and 1 atm pressure and (ii) 400 K and 2 atm pressure. 2
- (b) What is the effect of temperature and pressure on the coefficient of viscosity? 2
- (c) Deduce an expression for mean free path relating to temperature. 2

UNIT—II

18. (a) Derive the van der Waals' equation for real gas. 3
- (b) One mole of SO_2 gas occupies a volume of 350 mL at 27°C and 50 atm pressure. Calculate the compressibility factor of the gas. Comment on the type of deviation shown by the gas from ideal behaviour. 2+1=3
19. (a) Show that for a van der Waals' gas, the Boyle temperature is $T_B = \frac{a}{Rb}$. 3
- (b) Mention the difference between real and ideal gases. $1\frac{1}{2}$
- (c) Write the expression for reduced equation of state and explain the terms. $1\frac{1}{2}$

(5)

UNIT—III

20. (a) Describe the process of determination of a liquid using Ostwald's viscometer. 3
- (b) Equal volume of an organic liquid and water gave 55 drops and 25 drops respectively. The densities of liquid and water are 0.80 g cm^{-3} and 0.96 g cm^{-3} . Find the surface tension of organic liquid, if that of water is $7.2 \times 10^{-2}\text{ Nm}^{-1}$. 3
21. (a) What is radial distribution function? How is it used for elucidation of structure of liquid? 2+2=4
- (b) What do you mean by 'free volume' in a liquid? 2

UNIT—IV

22. (a) Write the difference between symmetry element and symmetry operation. 2
- (b) Explain the following terms : 2
- (i) Primitive unit cell
- (ii) Non-primitive unit cell

(6)

- (c) What do you mean by stoichiometric defect? 2
23. (a) Draw the different types of unit cell which are defined as $\alpha = \beta = \gamma = 90^\circ$ and $a = b = c$. 3
- (b) Write the symmetry operations for any two of the following molecules : 3
- (i) H_2O
 (ii) CO_2
 (iii) NH_3
 (iv) O_2

UNIT—V

24. (a) Mention two limitations of pH scale. 2
- (b) Explain the common ion effect with reference to wet test for basic radical in Gr-III(A). 2
- (c) 10 mL of $10^{-3} \text{ M Na}_2\text{SO}_4$ is mixed with 20 mL of 10^{-4} M BaCl_2 . Predict whether barium sulphate will precipitate or not if its solubility product is 10^{-7} . 2

(7)

25. (a) Calculate the pH of a mixture obtained by mixing 30 mL of 0.25 M CH_3COOH and 60 mL of 0.65 M CH_3COONa . ($K_a = 1.2 \times 10^{-3}$) 3
- (b) Derive the expression for the hydrolysis constant, degree of hydrolysis and pH for hydrolysis of a salt of strong acid and weak base. 3
