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

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

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

$$H_2S + 2FeCl_3 \rightarrow 2FeCl_2 + 2HCl + S$$

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, $E^{\circ}_{Cu^{2+}/Cu} = 0{\cdot}34$ V and $E^{\circ}_{Ag^+/Ag} = -0{\cdot}80$ V. Justify your answer. 2

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

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

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
$K(s) = 102{\cdot}5 \text{ kJ mol}^{-1}$

(ii) Dissociation energy of
$Cl_2 = 230{\cdot}5 \text{ kJ mol}^{-1}$

(iii) Ionization energy of
$K(g) = 450{\cdot}6 \text{ kJ mol}^{-1}$

(iv) Electron affinity of
$Cl(g) = -350{\cdot}2 \text{ kJ mol}^{-1}$

(v) Heat of formation of
$KCl = -420{\cdot}4 \text{ kJ mol}^{-1}$

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

(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 $K_2Cr_2O_7$. 3

(b) Predict the feasibility of the following reactions : 2

(i) $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$

(ii) $2Ag + 2H^+ \rightarrow 2Ag^+ + H_2$

Given

Electrode	*Standard electrode potential*
Zn^{2+}/Zn	–0·76 V
Ag^+/Ag	+0·80 V
$2H^+/H_2$	0·00 V

(c) Define oxidation number. How does oxidation number differ from valency? 1

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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) C_6H_6

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

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 $m\,s^{-1}$. 3

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. 1½

(c) Write the expression for reduced equation of state and explain the terms. 1½

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 $0{\cdot}80\ g\ cm^{-3}$ and $0{\cdot}96\ g\ cm^{-3}$. Find the surface tension of organic liquid, if that of water is $7{\cdot}2\times10^{-2}\ N m^{-1}$. 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

(c) What do you mean by stoichiometric defect? 2

23. (a) Draw the different types of unit cell which are defined as $\alpha = \beta = \gamma = 90°$ 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} *M* Na_2SO_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

(*Continued*)

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. ($K_a = 1{\cdot}2 \times 10^{-3}$) 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

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