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

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### 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

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

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

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## 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 $\psi$ and $\psi^2$?

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 $5 \times 10^{-8}$ m, calculate the wavelength of particle $B$, if its momentum is half of $A$.

2

( *Continued* )

## UNIT—II

18. (a) Define electronegativity. Give a short account of Pauling's scale of electro-negativity. $1+2=3$

(b) Arrange the following in the increasing order of size : $\quad$ 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. $\quad$ 2

19. (a) Define effective nuclear charge and shielding effect. Calculate the effective nuclear charges for $Cu^+$ and Cu. $\quad 2+2=4$

(b) Define ionization potential. Mention the factors that govern the magnitude of ionization potential. $\quad$ 2

## UNIT—III

20. (a) Draw and explain the MO energy level diagram of NO molecule. Comment on its bond order and magnetic properties. $\quad$ 3

(b) Explain the structures of $NH_3$ and $ClF_3$ on the basis of VSEPR theory. $\quad$ 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

         ( Continued )

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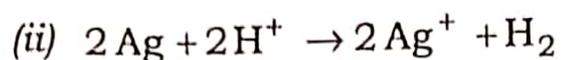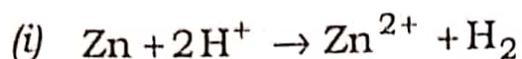
Given

| 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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