TDC (CBCS) Odd Semester Exam., 2020
held in March, 2021

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

1. Answer any *ten* of the following questions : 2×10=20

(a) Mention two important limitations of Bohr's theory. 1+1=2

(b) State and explain Pauli's exclusion principle. 2

(c) Calculate the wavelength of 1000 kg rocket moving with a velocity of 3000 km per hour ($\mu = 6.626 \times 10^{-34}$ Js). 2

(d) State and explain Aufbau principle. 2

(e) Mention four important characteristics of *d*-block elements. ½×4=2

(f) What are meant by tetrahedral and octahedral covalent radii? 1+1=2

(g) Explain why ionisation energy of neon is more than that of fluorine. 2

(h) van der Waals' radius is greater than covalent radius. Justify. 2

(i) Draw the Lewis dot structures of

(i) PO_4^{3-}, (ii) O_2^{2-}, (iii) SO_4^{2-}, (iv) H_2O_2 ½×4=2

(j) Mention two important postulates of valence bond theory for covalent bond. 1+1=2

(k) Explain why LiCl is soluble in organic solvents. 2

(l) He_2 does not exist but He_2^+ does. Explain. 2

(m) Explain why H_2O is a liquid but H_2S is a gas. 2

(n) Metals show lustre and malleable and ductile. Explain. 2

(o) Mention two important characteristics of van der Waals' forces. 2

(p) The dipole moments of CO_2 and H_2O are different. Explain. 2

(q) What do you mean by primary and secondary standard substances? Give examples of each type. 2

(r) What is meant by standard electrode potential? Give examples. 2

(s) Which of the following species do not show disproportionation reaction and why? 2

ClO^-, ClO_2^-, ClO_3^- and ClO_4^-

(t) What is meant by formal electrode potential? 2

SECTION—B

Answer *any* **five** questions

2. (a) State and explain Heisenberg's uncertainty principle. 2

(b) State and explain normalised wave function. 2

(c) Explain the shapes of 2*s* and 2*p* orbitals in the light of angular wave function. 2

3. *(a)* What are quantum numbers? Explain the significances of each quantum number. 2

(b) Calculate the uncertainty in the velocity of an electron, if the uncertainty in its position is of the order of ±10 pm. The mass of electron is $9 \cdot 11 \times 10^{-31}$ kg. 2

(c) State and explain orthogonal wave function. 2

4. *(a)* Define electron gain enthalpy. Discuss the variation of electron gain enthalpy in group and period in *s*- and *p*-block elements of the periodic table. 1+2=3

(b) State Slater rules. Calculate the effective nuclear charge of 3*d* electron in Zn. 1+2=3

5. *(a)* Calculate the C—F bond length if covalent radius of C = 0·77 Å, F = 0·72 Å, $\chi_C = 2 \cdot 5$, $\chi_F = 4 \cdot 0$. 2

(b) Explain why halogens have highest electron gain enthalpies. 2

(c) Explain the variation of electro-negativity with partial charge, hybridization and bond order. 2

6. *(a)* Draw the MO energy level diagram of CO molecule. Comment on its bond order and magnetic properties. 3

(b) Calculate the lattice energy of NaCl with the help of following data : 3

Electronic charge = $4 \cdot 8 \times 10^{-10}$ e.s.u.
Born exponent = 9
Madelung constant for NaCl = 1·748
Ionic radius of Na^+ = 0·95 Å
Ionic radius of Cl^- = 1·81 Å

7. *(a)* Discuss the structure of IF_7, NH_3 and $BeCl_2$ with the help of VSEPR theory. 3

(b) Distinguish between bonding and anti-bonding molecular orbitals. What is meant by resonance energy? 2+1=3

8. *(a)* What is meant by H-bonding? What are its different types? Cite suitable examples. Explain why water has maximum density at and minimum volume at 4 °C. 1+2+1=4

(b) Explain dipole-dipole interaction with suitable examples. 2

9. *(a)* What is meant by intrinsic semi-conductor? What are its different types? Explain with examples. 3

(b) State and explain Fajan's rules with suitable examples. 3

10. *(a)* Balance the following reactions by ion-electron method : 1½×2=3

(i) $KMnO_4 + FeSO_4 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + MnSO_4 + K_2SO_4 + H_2O$

(ii) $Br_2 + NaOH \rightarrow NaBr + NaBrO_3 + H_2O$

(b) Explain the principle and write the redox reactions involved in volumetric quantification of Fe^{2+} by $KMnO_4$. 3

11. *(a)* Determine the cell e.m.f. at 25 °C for

$$Fe(s) + Cd^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cd(s)$$

where

$$[Cd^{2+}] = 1 \cdot 0\ M \text{ and } [Fe^{2+}] = 0 \cdot 1\ M$$

and

$$E^\circ_{Fe^{2+}/Fe} = -0 \cdot 44\ V$$

$$E^\circ_{Cd^{2+}/Cd} = -0 \cdot 40\ V$$ 3

(b) *(i)* Write the cell reaction and calculate the standard e.m.f. E° of the cell

$$Zn(s)\,|Zn^{2+}(aq)\,||Cd^{2+}(aq)\,|Cd$$

Given

$$E^\circ_{Zn^{2+}/Zn} = -0 \cdot 76V \text{ and } E^\circ_{Cd^{2+}/Cd} = -0 \cdot 4\,V$$

(ii) Calculate the oxidation no. of S in $H_2S_2O_5$ and $H_2S_2O_8$. 2+1=3

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