

This question paper contains 8 printed pages.]

Your Roll No

5162

B.Sc./B.Sc. (Hons.)/I/NS

J

CH-103 – CHEMISTRY

(NC – Admission of 2008 onwards)

Time : 3 Hours

Maximum Marks : 75

(Write your Roll No on the top immediately on receipt of this question paper)

(Use separate answer-sheets for Sections A, B and C each)

SECTION – A

(Inorganic Chemistry)

Attempt any **two** questions.

1. Explain briefly .

- (i) Despite the fact that the central atoms in NH_3 and H_2O are sp^3 hybridized, the HNH bond angle is 107° whereas HOH bond angle 104.5° 2½
- (ii) The electronic configuration $3\text{d}^54\text{s}^1$ has higher exchange energy than $3\text{d}^44\text{s}^2$. 2½

- (iii) The dipole moment value of NH_3 molecule is higher than that of NF_3 , though the N - H bond is less polar than the N - F bond 2½
- (iv) BaO is 2000 times more soluble than MgO, but BaSO_4 is insoluble, however MgSO_4 is quite soluble in water 2½
- (v) s-orbitals are spherically symmetrical 2½
2. (a) Write the time-independent Schrodinger wave equation for hydrogen atom and explain the physical significance of Ψ^2 . 2½
- (b) Sketch the radial probability curve for 3s, 3p and 3d orbitals on the same set of axes. 2½
- (c) What is the concept of multiplicity rule ? How do you justify the Hund's rule of maximum multiplicity ? 2½
- (d) Justify which of the following orbitals are not feasible :
- 1p, 5f, 3g, 2d 2½
- (e) Draw the shapes 3d orbitals, indicating the sign of wave function 2½
3. (a) Draw the molecular orbital energy level diagrams for C_2 and O_2 molecules and explain the following
- (i) Oxygen is paramagnetic
- (ii) C_2 molecule is diamagnetic
- (iii) The bond order in C_2 is 2
- (iv) The bond order in O_2^+ is 2.5 4

- (b) (i) State giving a reason in each case, which cation will exert a greater polarizing power in the following cases :

(I) Na^+ or Mg^{2+}

(II) Cu^{2+} or Ca^{2+}

- (ii) Of the following pairs of anions, which one will be more easily deformed ? Give reasons

(I) Cl^- or I^-

(II) O^{2-} or F^-

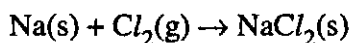
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- (c) Explain

- (i) I_3^- and XeF_2 molecules have linear geometry.

1½

- (ii) Consider the hypothetical reaction



Where the products contain Na^{2+} ions and Cl^- ions. Estimate the heat of formation of NaCl_2 from the following data by the use of Born-Haber cycle and comment upon its stability.

Heat of atomization of $\text{Na(s)} = +109 \text{ kJmol}^{-1}$

Heat of atomization of $\text{Cl}_2(\text{g}) = +247 \text{ kJmol}^{-1}$

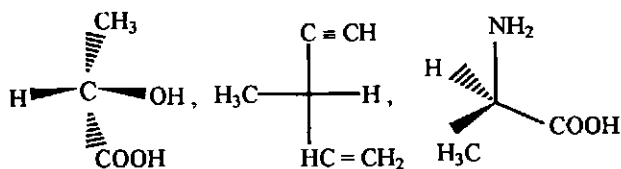
Electron gain enthalpy for $\text{Cl(g)} = -349 \text{ kJmol}^{-1}$

Lattice enthalpy of $\text{NaCl}_2(\text{s}) = -2155 \text{ kJmol}^{-1}$

The first and second ionization enthalpies of Na(g) are $+494$ and $+4561 \text{ kJ mol}^{-1}$ respectively.

3

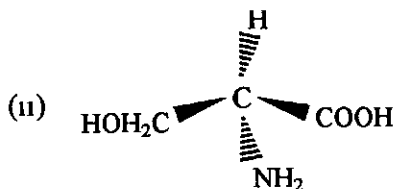
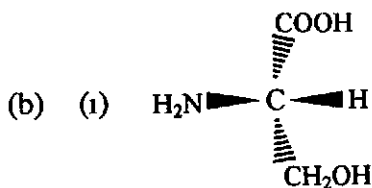
- (c) Assign R or S configuration to any **two** of the following . 4



- (d) How many stereoisomers are possible for 2, 3 dichlorobutane ? Write their configurations 2½

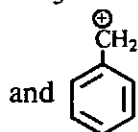
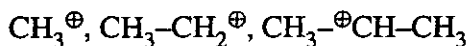
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- 6 (a) Distinguish between the following terms : 3
- (i) Homolytic and Heterolytic cleavage
- (ii) Enantiomers and diastereomers



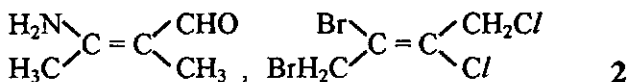
What is the relationship between (i) and (ii) Enantiomers or two orientations of the same molecule ? 2

- (c) Giving reasons, arrange the following carbocations in increasing order of stability :



5 ½

- (d) Assign E or Z configuration to the following



2

SECTION - C

Attempt any two questions

Use of Scientific Calculators is allowed

7. (a) In which of the following systems is the energy of the system conserved in every process (i) a closed system, (ii) an open system, (iii) an isolated system, (iv) a system enclosed in adiabatic walls ? Justify your choice 2 ½
- (b) Does the first law of thermodynamics impose any restrictions on the direction of a process ? Explain 2
- (c) Why is $\Delta U = 0$ for every cyclic process ? 2
- (d) Can the vapourisation of water at 100 °C and 1 atm pressure be treated as a reversible process ? Explain 2

- (e) How does the addition of excess NH_4Cl in addition to NH_4OH prevent the precipitation of Zinc hydroxide in a mixture of Al and Zn salt ? 2
- (f) The indicator range of Thymol blue is 1.2 to 2.8. Will it be a suitable indicator for a strong acid-strong base titration ? Explain 2
- 8 (a) Calculate the work done when 1 mole of a monatomic ideal gas undergoes a reversible adiabatic expansion from 2 L to 4 L at 25°C . Molar constant volume heat capacity of the gas is $1.5 R$. What would be the change in temperature if the expansion was against a constant external pressure of 1 atm ? 4
- (b) Derive the following equations :
- (i) $\Delta S = R \ln V_2/V_1$ for an ideal gas at constant temperature $\left(\frac{\partial T}{\partial V}\right)_S = - \left(\frac{\partial P}{\partial S}\right)_V$ 4
- (c) Given the following ΔH°_{298} values in kcal/mol.
- $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{C}(\text{s}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}(\text{g}) \quad \Delta H = 117$
- $\text{FeO}(\text{s}) + \text{C}(\text{s}) \rightarrow \text{Fe}(\text{s}) + \text{CO}(\text{g}) \quad \Delta H = 37$
- $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) \quad \Delta H = -135$
- $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \quad \Delta H = -94$
- Find the heats of formation of $\text{FeO}(\text{s})$ and $\text{Fe}_2\text{O}_3(\text{s})$ 4 1/2

- 9 (a) Show that the pH of a solution of a salt of strong acid and weak base is given by
- $$\text{pH} = -0.5 [\log K_w - \log K_b + \log C] \quad 4$$
- (b) Estimate the pH of a solution obtained by mixing 5 g of acetic acid and 7.5 g of sodium acetate in a 1 L standard flask and making it up to the mark. Dissociation constant of the acid is 1.8×10^{-5} 4
- (c) Calculate the molar solubility of PbI_2 (i) in water and (ii) in 0.200 M sodium iodide solution. K_{sp} of $\text{PbI}_2 = 7.9 \times 10^{-9}$. Ignore the amount of iodide coming from PbI_2 in the sodium iodide solution. 4½
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