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 $3d^5 4s^1$ has higher exchange energy than $3d^4 4s^2$. **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 axis. 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^- **4**

(c) Explain

(i) I_3^- and XeF_2 molecules have linear geometry. **1½**

(ii) Consider the hypothetical reaction

$$Na(s) + Cl_2(g) \rightarrow NaCl_2(s)$$

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 Na(s) = + 109 $kJmol^{-1}$

Heat of atomization of $Cl_2(g)$ = + 247 $kJmol^{-1}$

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

Lattice enthalpy of $NaCl_2(s)$ = –2155 $kJmol^{-1}$

The first and second ionization enthalpies of Na(g) are +494 and + 4561 kJ mol^{-1} respectively. **3**

SECTION – B

(Organic Chemistry)

Attempt any **two** questions

4. Explain why ?

   (i) α-Bromopropionic acid is a stronger acid than β-Bromopropionic acid

   (ii) Aniline is a weaker base than methyl-amine

   (iii) $CH_3\overset{\ominus}{C}H_2$ is more stable than $CH_3\overset{\ominus}{C}H(CH_3)$

   (iv) Isobutyl group is of higher priority than n-butyl group

   (v) Glycerol has higher boiling point than n-propanol $2\frac{1}{2} \times 5$

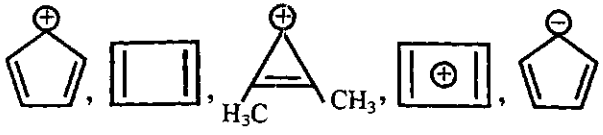
5. (a) Giving reasons arrange the following .

   CH_3CH_2COOH(I), $HOCH_2CH_2COOH$(II),

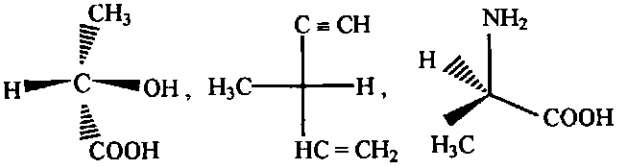
   $ClCH_2CH_2COOH$(III), $CH_3CH(Cl)COOH$(IV)

   and $BrCH_2CH_2COOH$(V) in increasing order of acid strength. 4

   (b) Which of the following possesses aromaticity ? 2



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



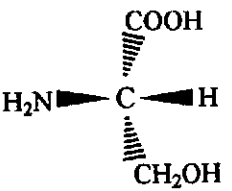
(d) How many stereoisomers are possible for 2, 3 dichlorobutane ? Write their configurations **2½**

6 (a) Distinguish between the following terms :

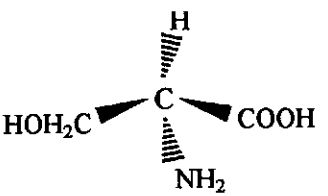
(i) Homolytic and Heterolytic cleavage

(ii) Enantiomers and diastereomers **3**

(b) (i)



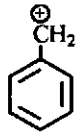
(ii)



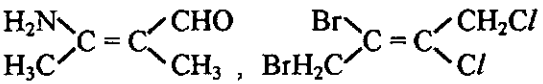
What is the relationship between (i) and (ii) Enantiomers or two orientations of the same molecule ? **2**

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

$CH_3^{\oplus}$, $CH_3-CH_2^{\oplus}$, $CH_3-{}^{\oplus}CH-CH_3$

and  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 1atm ? 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 $\Delta H°_{298}$ values in kcal/mol.

$Fe_2O_3(s) + 3C(s) \rightarrow 2Fe(s) + 3CO(g) \quad \Delta H = 117$

$FeO(s) + C(s) \rightarrow Fe(s) + CO(g) \quad \Delta H = 37$

$2CO(g) + O_2(g) \rightarrow 2CO_2(g) \quad \Delta H = -135$

$C(s) + O_2(g) \rightarrow CO_2(g) \quad \Delta H = -94$

Find the heats of formation of $FeO_{(s)}$ and $Fe_2O_3(s)$ 4 ½

9 (a) Show that the pH of a solution of a salt of strong acid and weak base is given by

$$pH = -0.5 [\log K_w - \log K_b + \log C]$$ 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 $PbI_2 = 7.9 \times 10^{-9}$. Ignore the amount of iodide coming from PbI_2 in the sodium iodide solution. 4½