

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  $\text{NH}_3$  and  $\text{H}_2\text{O}$  are  $\text{sp}^3$  hybridized, the HNH bond angle is  $107^\circ$  whereas HOH bond angle  $104.5^\circ$  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  $\text{NH}_3$  molecule is higher than that of  $\text{NF}_3$ , though the N - H bond is less polar than the N - F bond  $2\frac{1}{2}$
- (iv)  $\text{BaO}$  is 2000 times more soluble than  $\text{MgO}$ , but  $\text{BaSO}_4$  is insoluble, however  $\text{MgSO}_4$  is quite soluble in water  $2\frac{1}{2}$
- (v) s-orbitals are spherically symmetrical  $2\frac{1}{2}$
2. (a) Write the time-independent Schrodinger wave equation for hydrogen atom and explain the physical significance of  $\Psi^2$ .  $2\frac{1}{2}$
- (b) Sketch the radial probability curve for 3s, 3p and 3d orbitals on the same set of axes.  $2\frac{1}{2}$
- (c) What is the concept of multiplicity rule ? How do you justify the Hund's rule of maximum multiplicity ?  $2\frac{1}{2}$
- (d) Justify which of the following orbitals are not feasible :
- 1p, 5f, 3g, 2d  $2\frac{1}{2}$
- (e) Draw the shapes 3d orbitals, indicating the sign of wave function  $2\frac{1}{2}$
3. (a) Draw the molecular orbital energy level diagrams for  $\text{C}_2$  and  $\text{O}_2$  molecules and explain the following
- (i) Oxygen is paramagnetic
- (ii)  $\text{C}_2$  molecule is diamagnetic
- (iii) The bond order in  $\text{C}_2$  is 2
- (iv) The bond order in  $\text{O}_2^+$  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)  $\text{Na}^+$  or  $\text{Mg}^{2+}$

(II)  $\text{Cu}^{2+}$  or  $\text{Ca}^{2+}$

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

(I)  $\text{Cl}^-$  or  $\text{I}^-$

(II)  $\text{O}^{2-}$  or  $\text{F}^-$

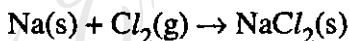
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(c) Explain

(i)  $\text{I}_3^-$  and  $\text{XeF}_2$  molecules have linear geometry.

1½

(ii) Consider the hypothetical reaction,



Where the products contain  $\text{Na}^{2+}$  ions and  $\text{Cl}^-$  ions. Estimate the heat of formation of  $\text{NaCl}_2$  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  $\text{Na(g)}$  are  $+494$  and  $+4561 \text{ kJ mol}^{-1}$  respectively.

3

## SECTION - B

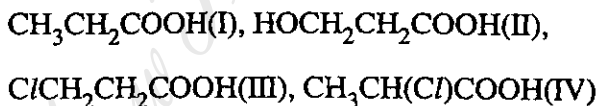
### (Organic Chemistry)

Attempt any two questions

4. Explain why ?

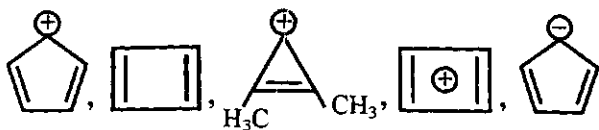
- (i)  $\alpha$ -Bromopropionic acid is a stronger acid than  $\beta$ -Bromopropionic acid
- (ii) Aniline is a weaker base than methyl-amine
- (iii)  $\text{CH}_3\overset{\ominus}{\text{C}}\text{H}_2$  is more stable than  $\text{CH}_3\overset{\ominus}{\underset{\text{CH}_3}{\text{C}}}\text{H}$
- (iv) Isobutyl group is of higher priority than n-butyl group
- (v) Glycerol has higher boiling point than n-propanol 2½ × 5

5. (a) Giving reasons arrange the following .

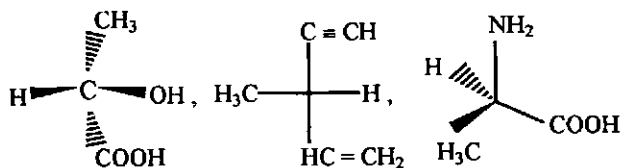


and  $\text{BrCH}_2\text{CH}_2\text{COOH}$ (V) in increasing order of acid strength. 4

(b) Which of the following possesses aromaticity ? 2



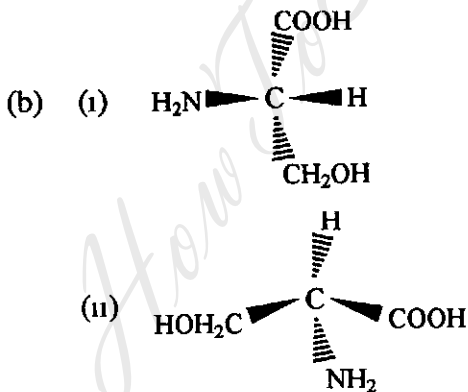
- (c) Assign R or S configuration to any **two** of the following . 4



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

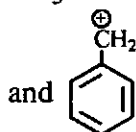
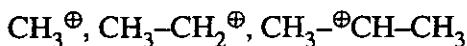
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- 6 (a) Distinguish between the following terms : 3
- (i) Homolytic and Heterolytic cleavage
  - (ii) Enantiomers and diastereomers



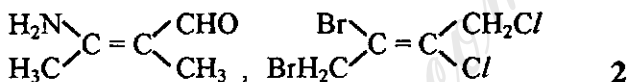
What is the relationship between (i) and (ii) Enantiomers or two orientations of the same molecule ? 2

- (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  $\text{NH}_4\text{Cl}$  in addition to  $\text{NH}_4\text{OH}$  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  $25^\circ\text{C}$ . 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  $\Delta H^\circ_{298}$  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  $1.8 \times 10^{-5}$  4
- (c) Calculate the molar solubility of  $\text{PbI}_2$  (i) in water and (ii) in  $0.200 \text{ M}$  sodium iodide solution.  $K_{\text{sp}}$  of  $\text{PbI}_2 = 7.9 \times 10^{-9}$ . Ignore the amount of iodide coming from  $\text{PbI}_2$  in the sodium iodide solution. 4½
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