This question paper contains **4** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **97**

Unique Paper Code : **217586** **G**

Name of the Paper : **CHCT-501 : Chemistry—I**

Name of the Course : **B.Sc. (Prog.) Physical Sciences, Part III (Concurrent Course)**

Semester : **V**

Duration : **3 Hours** Maximum Marks : **75**

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

Question No. **1** is compulsory.

Both Section A and Section B are compulsory.

Attempt *three* questions from Section A and *three* questions from Section B.

1. Attempt any *five* parts from the following :

   (*a*) Write down the Schrodinger wave equation of Hydrogen atom. Describe the various terms involved. 3

   (*b*) What do you understand by Aufbau's principle. State the $(n+1)$ rule. 3

   (*c*) Explain why melting point of NaCl is higher than that of $AlCl_3$. 3

   (*d*) State the second law of thermodynamics and justify the statement qualitatively. 3

   (*e*) Explain why C_P is always greater than C_V. 3

   (*f*) What is Common Ion Effect ? Explain with the help of an example. 3

Section A

Attempt any *three* questions.

2. (*a*) Show the Born-Haber Cycle for the formulation of ionic KF. Give the meaning of each and every term used in the cycle. 5

(*b*) Calculate the lattice energy of NaCl crystal from the following data by the use of Born-Haber Cycle. Sublimation energy = 108.7 kJ/mol, Dissociation Energy for Cl_2 = 225.9 kJ/mol, Ionization Energy for Na(g) = 489.5 kJ/mol, Electron affinity for Cl(g) = –351.4 kJ/mol, Heat of formation of NaCl = –414.2 kJ/mol. 3

(*c*) What is the physical significance of the Madelung's constant in the Born-Lande equation ? 2

3. Give reasons for any *four* of the following : 4×2.5=10

(*a*) $BaSO_4$ is insoluble in water

(*b*) Noble gases do not form ionic halides

(*c*) LiCl has a higher boiling point than HCl

(*d*) AgF, AgCl and AgBr have similar structures but the order of hardness differs.

(*e*) Silver halides have lattice energies similar to alkali halides but still insoluble in water.

4. (*a*) Give the quantum mechanical expression and the physical significance of normalization principle. 3

(*b*) Explain the importance of the radial probability distribution curves and plot the same for 1*s*, 2*s* and 2*p* orbitals of H atom. 5

(*c*) Why are 2*d* and 3*f* orbitals not possible ? 2

5. (*a*) Predict the shape and the type of hybridization in each of the following molecules : 5

BeF_2, H_2O, SF_6, ClF_3, XeF_4.

(*b*) Draw the MO diagram for CO molecule and calculate its bond order. 3

(*c*) State the limitations of the Valence Bond Theory. 2

Section B

Attempt any *three* questions.

6. (*a*) Calculate q, w, ΔU and ΔH for an isothermal reversible and isothermal irreversible expansion of an ideal gas. 6

(*b*) Calculate the heat of formation of KCl from the following data : 4

(*i*) $KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$ $\Delta H = -57.3$ kJ/mol

(*ii*) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286.2$ kJ/mol

(*iii*) $\frac{1}{2} H_2(g) + \frac{1}{2} Cl_2 \rightarrow HCl(aq)$ $\Delta H = -164.4$ kJ/mol

(*iv*) $K(s) + \frac{1}{2} O_2(g) + \frac{1}{2} H_2(g) + aq \rightarrow KOH(aq)$ $\Delta H = -487.4$ kJ/mol

(*v*) $KCl(s) + aq \rightarrow KCl(aq)$ $\Delta H = +18.4$ kJ/mol

7. (*a*) Derive the following relation for a salt of strong acid and weak base : 6

$$pH = \frac{1}{2} [pKa + pKw - pK_b]$$

(*b*) Calculate the solubility in grams per litre of $Al(OH)_3$ in water at 25°C if the value of $K_{sp} = 8.5 \times 10^{-32}$. 4

8. (*a*) Derive the following Thermodynamic expression :

$$\Delta G = \Delta H + T\left[\frac{\partial \Delta G}{\partial T}\right]P$$

and give the name of this equation. 5

(*b*) Calculate the entropy change for the fusion of 1 mole of a solid which melts at 300K. The latent heat of fusion is 2.51 kJ/mol. 2

(*c*) Show that : 3

$$\left(\frac{\partial P}{\partial S}\right)_V = \left(\frac{\partial T}{\partial V}\right)_S.$$

9. Write short notes on any *four* : 4×2.5=10

(*i*) Carnot cycle for an ideal gas

(*ii*) Ostwald's dilution law

(*iii*) Arrhenius Theory of Electrolytic Dissociation

(*iv*) Buffer Action of Acidic Buffer (qualitative explanation)

(*v*) Henderson-Hasselbalch equation for Basic Buffer.