This question paper contains 8 printed pages]

Your Roll No.....

562

B.Sc./B.Sc. (Hons.)/I **A**

CH-103-CHEMISTRY

(Admissions 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. (*a*) Why is 'S' orbital spherically symmetrical ? 2

(*b*) What is the difference between an orbit and orbital ? 2

(*c*) What is the concept of multiplicity ? 2

(*d*) Why is NaCl a better conductor of electricity in fused state or in solution than in the solid state, even though it is made up of ions in the solid state itself ? 2

P.T.O.

(*e*) What is Madelung constant ? Give its significance. 2

(*f*) Which of the two NH_3 or NF_3 has higher dipole moment ? Give reasons. 2½

2. (*a*) Explain the physical significance of Ψ and ψ^2. 2

(*b*) What do you understand by shielding effect ? 2

(*c*) Draw the shapes of 4*d* orbitals indicating sign of wave function. 2

(*d*) What are the limitations of Aufbau principle ? Give examples. 2

(*e*) Sketch the appropriate radial wave functions for 1*s*, 2*s* and 2*p* orbitals and give apparent features of these functions. 4½

3. (*a*) Define Hess's law. Calculate the lattice enthalpy of hypothetical $NaCl_2$ from the following data using Born-Haber cycle :

Heat of atomization of Na(s) = + 109 kJ mol^{-1}

Heat of atomization of Cl_2(g) = + 247 kJ mol^{-1}

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

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

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

(*b*) Using VSEPR theory, predict the shapes of the following :

SF_4, H_2O 2

(*c*) Write short note on resonance and resonance energy. 2

(*d*) Draw molecular orbital energy level diagrams for B_2 and O_2 and predict :

(*i*) Bond order and

(*ii*) Magnetic properties of these molecules. 3½

(*e*) Explain "The decomposition temperatures of $CdCO_3$ is 350°C while that of $CaCO_3$ is 900°C despite the fact that Cd^{2+} and Ca^{2+} have the same size." 2

Section B

(Organic Chemistry)

Attempt any *two* questions.

1. (*a*) Allylic and benzylic anions are more stable than their non-allylic and non-benzylic counterparts. Explain.

(*b*) Rank the following compounds in order of ascending basicity giving reason :

p-(Trifluoromethyl) aniline, *p*-methylaniline, *p*-(fluoromethyl) aniline.

(*c*) (*i*) Give the structures of :

(E)-3-methyl–2–pentene, (Z)-3-isobutyl-2-heptene

(*ii*) Which of the following alkenes can exist as *cis-trans* isomer ? Write their structures :

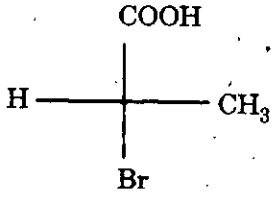
$CH_2=CHCH_2CH_3$, $CH_3CH=CHCH_3$,

$CH_3CH_2CH=CHCl$

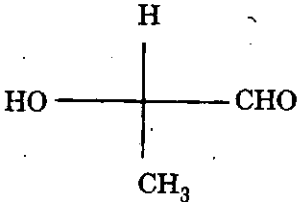
(*d*) Indicate the hybridization of each carbon in $CH_3C \equiv CH$, and predict a value for each bond angle. 2½,3,4,3

2. (*a*) Assign R or S configuration to the chiral centers in the following molecules :

(*i*)



(*ii*)



(*b*) (*i*) What is the difference between enantiomers and diastereomers ? Explain with the help of a suitable example.

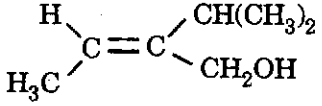
(*ii*) An aqueous solution of pure stereoisomer X of concentration 0.10 g/mL had observed rotation -30° in a 1.0 dm tube at 589.6 nm (the sodium D line) and 25°C. Calculate its $[\alpha]_D$ at this temperature.

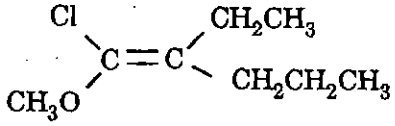
(c) Draw Newman projection formulae for the eclipsed and staggered forms of ethane. Plot a graph of potential energy versus bond rotation in ethane.

(d) Arrange the following carbocations in order of increasing stability and give reasons :

$Me\overset{+}{C}HMe$ $CH_2 = CHCH_2^+$ $MeCH_2CH_2^+$ 3,4,3,2½

3. (a) Assign E or Z configuration to the following alkenes giving the priorities to the attached groups :

(i) 

(ii) 

(b) Draw two different chair conformations of methylcyclohexane and label all positions as axial or equatorial explaining which is more stable.

(c) How could you separate a mixture of 4-chlorophenol and 4-chlorocyclohexanol.

(*d*) Write short notes on any *two* of the following :

(*i*) Baeyers strain theory and its limitations

(*ii*) Hyperconjugation

(*iii*) Hydrogen bonding. 3,3,2½,4

Section C

Attempt *two* questions in all.

Log tables and calculator may be allowed.

R = 8.314 J/K/mol.

1. (*a*) Calculate the pH of 0.1 M CH_3COOH. The dissociation constant of acetic acid is 1.8×10^{-5}. 4

(*b*) A buffer solution contains 0.25 M NH_4OH and 0.4 M NH_4Cl. If the pH of buffer is 9.05, calculate the dissociation constant K_b for NH_4OH. 4

(*c*) Calculate the work done when pressure on 2 moles of hydrogen gas is reduced from 20 to 1 atm at a constant temperature of 273 K. The gas behaves ideally. Also calculate ΔE and q. 4½

2. (*a*) What is Hess's law of constant heat summation ? Give examples of burning of carbon to CO_2 and formation of sodium hydroxide from Na to explain the law. 6

(*b*) Derive the following relationship for the salt of a weak acid and strong base : 6½

$$pH = - \log \sqrt{\frac{K_w \, K_a}{C}}$$

3. (*a*) Explain why an aqueous solution of $CuSO_4$ is acidic and that of NaCl is neutral. 4½

(*b*) Define the following : 8

(*i*) State functions

(*ii*) Exact differentials

(*iii*) Lattice energy

(*iv*) Solubility product.