

## 2. Chemistry (Chem.311), 2066

Time : 3 hrs.

Full Marks : 100

The Comprehensive Question of each group is compulsory.

Attempt EIGHT questions of Short Answer Questions of each group.

### Group "A" (Inorganic)

#### 1. Comprehensive Question

Give the derivation of Schrodinger's wave equation (time independent) and define the terms involved in it. What is the significance of  $\Psi$  and  $\Psi^2$  with reference to this equation? [7+2]

OR

What is meant by "Diagonal Relationship"?

Explain with reasons the diagonal relationship between the following pairs: (i) B and Si (ii) Be and Al (iii) Li and Mg. [3+6]

- (b) Alkanes are insoluble in water but alcohols are soluble. Explain.
- 4.11. What is Williamson ether synthesis? Give an example.

**Group "C" (Physical)**

**5. Comprehensive Question**

[10]

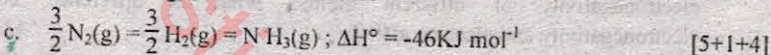
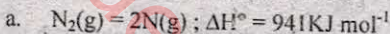
What is Maxwell's distribution of molecular speeds? Derive the average velocity of molecules from Maxwell's equation.

At what temperature will the molecules of oxygen have the same root mean square velocity as those of the molecules of nitrogen at 0°C? [2+4+4]

OR

Derive the equations for maximum work done in isothermal reversible and irreversible expansion of an ideal gas. Prove the statement that work done in an isothermal reversible expansion of an ideal gas.

Calculate the average bond energy of an N - H bond in ammonia at 25°C from the given thermochemical reactions:



**6. Short Answer Questions :**

[8×3=24]

- 6.1. What is meant by critical pressure? Why  $\text{CO}_2$  can be, but  $\text{O}_2$  cannot be liquified by applying pressure at room temperature?
- 6.2. Write short notes on any TWO :
- Bravais lattices
  - Classification of solids on the basis of nature of bonds
  - Crystal structure of NaCl.
- 6.3. What is meant by  $K_c$  and  $K_p$ ? Write down the expression for  $K_c$  of the reaction  $4\text{N H}_3(\text{g}) + 5 \text{O}_2(\text{g}) = 4\text{NO}(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$ .
- 6.4. What are  $K_{sp}$ ,  $K_w$  and  $K_a$  with reference to hydrolysis of salt and how they are related?
- 6.5. Explain why a mixture of  $\text{NH}_4\text{OH}$  and  $\text{NH}_4\text{Cl}$  can not provide a use full buffer solution of pH 4?
- 6.6. Calculate the pH of a buffer solution containing 0.5 M of  $\text{CH}_3\text{COONa}$  and 0.4M of  $\text{CH}_3\text{COOH}$ .  
(Given K for acetic acid is  $1.85 \times 10^{-5}$ )
- 6.7. Define the depression of freezing point of a solution. Why vapor pressure of a solution is less than that of pure solvent?
- 6.8. What is electro-dialysis? Explain the uses of dialysis.
- 6.9. What is most probable velocity of gas molecules?  
Calculate the most probable velocity of nitrogen gas at 25°C ( $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ).
- 6.10. Define enthalpy of neutralization. Why the enthalpy of neutralization for the reaction between strong acids and strong bases is almost constant?

- 6.11. Calculate the vapour pressure of a solution at 90°C containing 3.6 grams of cansugar (mol.wt. = 327 grams) in 70 grams of water. Vapour pressure of water at 90°C is 758mm of Hg.

## Chemistry (Chem. 311), 2067

Bachelor Level / Science & Tech. / I Year

Full Marks: 100

Time: 3 hrs.

The Comprehensive Question of each group is compulsory.

Attempt EIGHT questions of Short Answer Questions of each Group.

### GROUP "A" (INORGANIC)

#### 1. Comprehensive question

What are the main postulates of Bohr's atomic model? How does Bohr's model explain the atomic spectrum of hydrogen? [2+7]

OR

What is meant by electronegativity? Explain the Pauling's approach to obtain electronegativity of different atoms. What is difference between electronegativity and electron affinity? [2+6+1]

#### 2. Short Answer Questions

8x3=24

- 2.1. What is meant by Half-life period of a substance? Half-life of  $^{210}\text{Po}$  is 140 days. Calculate the number of days after which 1/4g of  $^{210}\text{Po}$  will be left undistintegrated from 1g of the isotope.
- 2.2. What the Lewis acid character of is in the order  $\text{BF}_3 < \text{Z BCl}_3 < \text{Z BBr}_3 < \text{Z BI}_3$ ? Explain.
- 2.3. Discuss briefly the crystal structure of NaCl.
- 2.4. Explain the terms: polarising power and polarizability.
- 2.5. What is meant by solubility product? Explain briefly its role in qualitative analysis.
- 2.6. What is meant by ionization potential? Why nitrogen has higher value of ionization energy than oxygen? Explain.
- 2.7. Predict the shape of the following molecules on the basis of hybridisation: (i)  $\text{PCl}_5$  (ii)  $\text{BrF}_3$  (iii)  $\text{XeF}_2$ .
- 2.8. What do you mean by Hund's rule of maximum multiplicity? Using this rule give the electronic configuration and number of electrons in the ground state of chromium (Atomic number 24).
- 2.9. What do you mean by stoichiometric and non-stoichiometric defects?
- 2.10. What is difference between bonding and antihonding molecular orbitals?
- 2.11. Explain the terms conductors insulators and semiconductors.

### GROUP "B" (ORGANIC)

#### 3. Comprehensive Question

What do you mean by conformation and configuration? Draw the different conformations for n-butane using Newman's projection formula and show their relative stability ( ) potential energy.

OR

What do you mean by term  $SN^1$  and  $SN^2$  reactions mid also five their mechanism? How do you account for the fact that the  $SN$  reaction proceeds with complete inversion of configuration whereas  $SN^1$  reaction proceeds with partial racemization plus net inversion?

4. **Short Answer Questions**

8x3=24

- 4.1. Define hyperconjugation. How hyperconjugation explain the stability of carbonium ions.
- 4.2. How do you account for the fact that the peroxide initiated addition of HBr to an unsymmetrical alkene molecule takes place against the Markovnikov's rule?
- 4.3. Give the mechanism for dehydrohalogenation of *t*-butyl bromide by alcoholic KOH.
- 4.4. Define racemic mixture and meso compounds with suitable examples and explain why they are optically inactive.
- 4.5. Write the preparation and uses of polyethylene.
- 4.6. Show your familiarity with green house effect.
- 4.7. Give the mechanism of chlorination of methane.
- 4.8. What is hydroboration reaction? Give an example.
- 4.9. Give an example of Williamson reaction. Write its mechanism.
- 4.10. (a) Which is more acidic and why, (i) ethane (ii) ethene (iii) ethyne?  
(b) Why boiling point of diethyl ether is lower than *n*-butanol?
- 4.11. Write the products when:  
(a) Propene reacts with alkaline  $KIO_4$ .  
(b) Propene reacts with  $O_3$  followed by  $Zn/H_2O$ .

**GROUP "C" (PHYSICAL)**

5. **Comprehensive Question**

What are the main, assumptions of kinetic theory of gases? Derive the kinetic gas equation.

Calculate the average kinetic energy of 28 grams of nitrogen gas at  $30^\circ C$  ( $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ).

[3+4+3]

OR

How does a buffer solution resist the change in pH even on addition of small amount of acid or base? How to calculate the pH of a buffer solution of a weak acid and its salt? Discuss about the buffer capacity and buffer range of acid or base.

Calculate the pH of 0.01 N HCl and 0.01 N NaOH solutions. [3+2+2+3]

6. **Short Answer Questions**

8x3=24

- 6.1. Define collision frequency. How does temperature influence the collision frequency?
- 6.2. Point out the differences between crystalline and amorphous structure.
- 6.3. State Lechatlier's principle. How does it explain the effect of temperature on chemical equilibrium?
- 6.4. What is meant by surface tension? Point out its importance and discuss

the drop weight method to determine the surface tension of a solution.

- 6.5. Explain how soap cleans a dirty cloth.
- 6.6. Calculate the osmotic pressure of an aqueous solution containing 90 grams of glucose per litre at 298°K assuming the solution to be, ideal. (Given: mol. wt. of glucose = 180 grams)
- 6.7. Define Hess's law of constant heat summation. Calculate the enthalpy of reaction  $H_2C = CH_2(g) + H_2(g) \rightarrow H_3C - CH_3(g)$ . (Given : bond energies of C = C, C - H, C - C and H - H are 6.15, 416.0, 347.2 and 435.0 KJ, respectively)
- 6.8. Define the thermodynamic term entropy and point out the difference between internal energy change and enthalpy change.
- 6.9. Calculate enthalpy change at 37°C for the reaction:  
 $\frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g) = HCl(g); \Delta H^\circ = -22.0 \text{ K Cals}$   
(Given :  $C_p = 6.8 \text{ cal/mole. deg}$  for  $H_2(g)$  at 25°C  
 $C_p = 7.7 \text{ cal/mole. deg}$  for  $Cl_2(g)$  at 25°C  
 $C_p = 6.8 \text{ cal/mole. deg}$  for  $HCl(g)$  at 25°C)
- 6.10. Show that the elevation of boiling point is directly proportional to the lowering of vapour pressure.  
60 ml of 0.1M acetic acid is mixed with 40 ml of 0.25 M sodium hydroxide solution. What will be the pH of the mixture? (Given  $K_a = 1.85 \times 10^{-5}$ )

## Chemistry (Chem.311), 2068

Bachelor Level / Science & Tech./ I Year

Full Marks: 100

Use separate answer-book for each group.

Time: 3 hrs.

The Comprehensive Question of each group is compulsory.

Attempt EIGHT questions of Short Answer Questions of each Group.

### GROUP "A" (INORGANIC)

#### 1. Comprehensive Question

What are assumptions on which Bohr's theory of atomic structure is based? What refinements are applied in Bohr's theory? Also point out the basic assumptions in wave mechanical model of atomic structure [3+3+3]

OR

What is Born - Haber cycle? Discuss its usefulness in explaining the stability of ionic compound. Can this concept be applied in the case of covalent compounds? [4+4+1]

#### 2. Short Answer Questions

8×3=24

- 2.1. What is meant by Group displacement law? Illustrate.
- 2.2. Point out any two differences between the I.V.P.A.O system of periodic table and long form periodic table.
- 2.3. What basic parameters are used in estimating the electro negativity of an element in Pauling's scale?
- 2.4. What are semiconductors? Use any concept of metallic bond to

explain the nature of semiconductors.

- 2.5. What are requirements that should be met in order that a gravimetric method be successful?
- 2.6. Point out an application of common ion effect in the wet test for basic radical.
- 2.7. Using VSEPR Theory, predict the shape of the following molecules:  
a.  $\text{CO}_2$       b.  $\text{H}_2\text{O}$       c.  $\text{SF}_6$
- 2.8. Using molecular orbital theory determine the bond order of oxygen molecule. How are the stability related to bond order and bond length?
- 2.9. Explain why electron affinity value of chlorine is higher than that of fluorine although the electro negativity of fluorine is higher than that of chlorine.
- 2.10. Draw the structure of  $\text{TiO}_2$  (Rutile structure).
- 2.11. What is HSAB principle? Explain why  $\text{Ag}(\text{CN})_2^-$  is very stable but  $\text{AgCl}_2^-$  is not stable.

### GROUP "B" (ORGANIC)

#### 3. Comprehensive Question

Describe  $\text{SN}^2$  reactions in terms of kinetics, mechanism and stereochemistry. Also write energy profile diagram for  $\text{SN}^2$  reaction. [7+2]

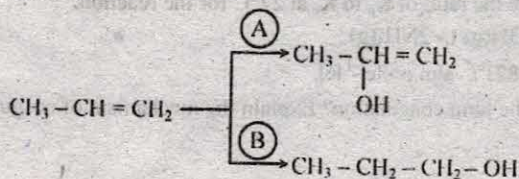
OR

Write down the kinetics and mechanism of  $\text{E1}$  and  $\text{E2}$  reactions. What factors determine the orientation of the double bond in elimination reactions? Describe. [6+3]

#### 4. Short Answer Questions

8x3=24

- 4.1. What is the difference between hyperconjugation and resonance effects? Describe giving examples.
- 4.2. Write the mechanism of the following reaction,  
$$\text{CH}_4 + \text{Cl}_2 \xrightarrow{h\nu} \text{CCl}_4$$
- 4.3. What is the function of the polarimeter? Define specific rotation.
- 4.4. What product is obtained when neopentyl halide is treated with ethoxide ion? Write complete reaction.
- 4.5. Show your acquaintance with Williamson synthesis giving one example with mechanism.
- 4.6. How is polyethylene prepared? What is its application?
- 4.7. Why is alkyne more acidic than alkene? Write a reaction to show the reduction of alkyne to alkene.
- 4.8. What are A and B?



- 4.9. What factors have contributed for ozone depletion? Describe.  
 4.10. What is meant by regioselective reaction? Give an example.  
 4.11. Write all possible stereoisomers, of tartaric acid. Label meso compound and two pairs of enantiomers and diastereomers.

### GROUP "C" (PHYSICAL)

#### 5. Comprehensive Question

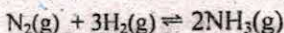
What are the main assumption of kinetic theory of gases and derive the kinetic gas equation.

Calculate the average kinetic energy of 28 gm of nitrogen gas at 30°C [R = 8.314 JK<sup>-1</sup> mole<sup>-1</sup>] [3+3+4]

OR

What are heat of reaction at constant volume and constant pressure? How are they related? Derive Kirchoffs equation.

The heat of reaction to



at 27°C is found to be -92 KJ. The C<sub>p</sub> value for N<sub>2</sub>, H<sub>2</sub> & NH<sub>3</sub> are 29.2, 28.8 and 35.1 J deg<sup>-1</sup>. mole<sup>-1</sup>, respectively. Calculate the heat of reaction at 57°C. [3+3+4]

#### 6. Short Answer Questions

8x3=24

- 6.1. What do you understand by the vapour pressure of liquid? How does it depend upon temperature?
- 6.2. 30 gm acetic acid is dissolved in water to make 5 litre of its solution. Calculate pH of the solution [K<sub>a</sub> of acetic acid = 1.8 x 10<sup>-5</sup>] molecular weight of acetic acid = 60.
- 6.3. State Raoult's law of vapour pressure of lowering. Why a solution of electrolyte does not obey this law?
- 6.4. What is dialysis? Explain the use of dialysis.
- 6.5. Explain the difference between crystalline and amorphous solids.
- 6.6. Give reasons why NH<sub>4</sub>Cl is acidic, KCN is alkaline and KCl is neutral to litmus?
- 6.7. What are isotonic, hypertonic and hypotonic solution?
- 6.8. What is meant by thermodynamic reversible process? Derive an expression for the work done in isothermal reversible expansion of an ideal gas.
- 6.9. Define the term viscosity. "Between dimethyl ether and ethyl alcohol. Which will have higher viscosity and why?"
- 6.10. Calculate the ratio of K<sub>p</sub> to K<sub>c</sub> at 27°C for the reaction.  

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
 [R = 0.0821 ℓ atm mole<sup>-1</sup> K].
- 6.11. Define the term coagulation? Explain the mechanism of coagulation.

# Chemistry (Chem.311), 2069

Bachelor Level/Science & Tech./I Year

Full Marks : 100

(For: Regular Examinee only)

Time : 3hrs.

Use separate answer-book for each group. The Comprehensive Question of each group is compulsory.

Attempt EIGHT the questions of Short answer questions of each group.

## GROUP 'A' (INORGANIC)

### 1. Comprehensive Questions :

- What do you understand by dual characters of electron ? Derive de-Broglie's equation.
- State Heisenberg's uncertainty principle and show how it give rise to the probability approach for the position of an electron in an atom. (4.5×2=9)

Or

Derive Born-Lande equation for lattice energy. Describe the role of lattice energy. (6+3=9)

### 2. Short answer questions

- Explain the following on the basis of molecular orbital theory.  $F_2$  molecule is diamagnetic while  $O_2$  molecule is paramagnetic.
- Half life period of  $^{125}_{53}I$  is 60 days, what percentage of the original radioactivity would be present after 180 days ?
- Complete the following nuclear reactions :
  - $^{14}_7N + ^4_2He \longrightarrow ^{17}_8O + \dots$
  - $^{10}_5B + ^2_1H \longrightarrow ^{11}_6C + \dots$
  - $^{35}_{17}Cl + ^1_0n \longrightarrow ^{35}_{16}S + \dots$
- What is Fajan's rule What are the factors that favours the polarisation ?
- What is electronegativity ? Give the Mulliken's approach to obtain electronegativity of different atoms.
- Calculate the heat of formation of  $CaCl_2$  from the following given values ( $Kj\ mol^{-1}$ )

$Ca_{(s)} \longrightarrow Ca_{(g)}$	$\Delta H = 17.6$
$Ca_{(g)} \longrightarrow Ca^+_{(g)}$	$\Delta H = 585.7$
$Ca^+_{(g)} \longrightarrow Ca^{++}_{(g)}$	$\Delta H = 1147$
$Cl_{2(g)} \longrightarrow 2Cl_{(g)}$	$\Delta H = 241.8$
$Cl_{(g)} + e^- \longrightarrow Cl^-_{(g)}$	$\Delta H = -379.5$
$Ca^{++} + 2Cl^- \longrightarrow Ca^{++}(Cl^-)_2$	$\Delta H = -2233$
- What is 'F-centres' ? What properties of the crystals are associated with 'F-centres' ?
- Why is the melting point of parahydroxybenzoic acid is much higher than that of orthohydroxybenzoic acid.
- Explain the refinements of Bohr theory of H-atom.
- Discuss the shape of  $SF_4$  on the basis of hybridization.
- What is meant by levelling effect and differentiating effect of solvent ?



- 2.12 What is redox titration? What do you understand by iodometry and iodimetry?

### GROUP 'B' (ORGANIC)

#### 3. Comprehensive Questions :

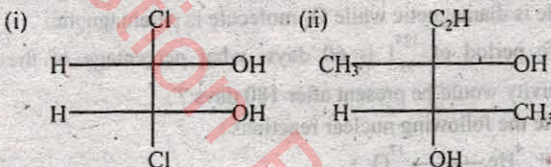
What are enantiomers and diastereomers? Write down the possible configurations of tartaric acid. Predict the pairs of enantiomer and diastereomer which of them are optically active and which of them are not. Why? Give meso tartaric acid and racemic tartaric acid. (2+3+1.5+1.5+1)

Or

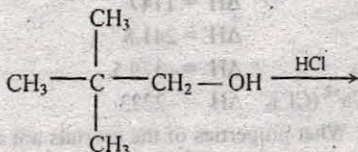
State and explain Markovnikov's orientation and Anti-Markovnikov's orientation with example of 2-pentene and give mechanism. Why, Anti-Markovnikov's orientation is only observed in the addition of HBr, but not in HCl?

#### 4. Short answer questions

- 4.1 Predict the product by coupling of lithium di-tert butyl cuprate with n-butylbromide. Give its IUPAC name.  
4.2 Assign R and S configuration to the following Fisher projection.



- 4.3 What is isotope effect? In what way isotope effect is useful in ascertaining the mechanism of  $E_2$ -reaction?  
4.4 Write the preparation and uses of polypropylene.  
4.5 Predict the proportion of isomeric product from chlorination of n-butane and iso-butane at room temperature.  
4.6 Account for the fact that ortho-nitrophenol is more volatile than para-nitrophenol.  
4.7 Hydration of propyne yields acetone rather than propionaldehyde. What does this suggest about the orientation of initial addition?  
4.8 Give the product and suggest a suitable mechanism for the following reaction.



- 4.9 Show that  $S_N1$  reaction proceeds with racemization plus some not inversion.  
4.10 Show your acquaintance with Hydroboration reaction.  
4.11 Why is acetylenic hydrogen acidic? Give reason.

### GROUP 'C' (PHYSICAL)

#### 5. Comprehensive Questions :

Define pH. Explain the pH change during the titration (a) strong acid with strong base (b) weak acid with strong base. Calculate pH of a solution obtained by mixing 20 ml 0.02M HCl with 200 ml of 0.01M NaOH Solution.

Or

(1+2+2+2+3)

Derive an expression for maximum work done when  $n$  mole of an ideal gas expand reversibly and isothermally ? Calculate the heat of formation of carbondisulphide. The heat of combustion of  $\text{CS}_2$  and S are  $-26.5 \text{ KCal mol}^{-1}$  and  $-94.3 \text{ KCal mol}^{-1}$  respectively. Heat of combustion of carbon is  $-94.1 \text{ Kcal mol}^{-1}$ .

#### 6. Short answer questions

8×3=24

- 6.1 What is difference between average velocity, rms velocity and most probable velocity ?
- 6.2 Write vander waal's equation. What are the significance of constant 'a' and 'b' ?
- 6.3 Define the term surface tension. How SI and CGS unit of surface tension are related ?
- 6.4 What are the typical properties of Ionic solids ?
- 6.5 Calculate the value of  $K_c$  for synthesis of ammonia when the equilibrium constant  $K_p$  at the temperature  $400^\circ \text{C}$  is  $1.6 \times 10^{-4}$ .
- 6.6 State Le-chatelier principle and explain the effect of temperature and pressure on the following equation.  
$$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 + 22.4 \text{ KCal}$$
$$\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO} - 43.2 \text{ KCal}$$
- 6.7 What are  $K_h$ ,  $K_w$  and  $K_a$  with reference to hydrolysis of salt and how they are related ?
- 6.8 Point out the reason for elevation of boiling point of a solvent with the addition of a non-volatile solute ?
- 6.9 Define common ion effect with example ?
- 6.10 What is protective colloids ?
- 6.11 In the light of calorific value of fuel explain the statement "Gasoline has high enthalpy density while hydrogen has high specific enthalpy" ?

### Chemistry (Chem. 101), 2070 (New course)

Bachelor Level / Science & Tech. / I Year

Full Marks: 100

Use separate answer-book for each group.

Time: 3 hrs.

The Comprehensive Question of each group is compulsory.

Attempt SIX questions of Short Answer Questions of each Group.

#### GROUP "A" (INORGANIC)

#### 1. Comprehensive Question

Write the basic postulates of Bohr's theory of atomic structure. Derive an expression for the energy of an electron in the hydrogen atom. [3+6]

OR

How does ionization potential differ from electron affinity? Discuss the factors that govern ionization energy of an element. [3+6]

2. Short Answer Questions

6x4=24

- 2.1 What is meant by aufbau principle? Give its limitations.
- 2.2 Explain the terms (1) Binding energy (2) Mass defect
- 2.3 Draw and briefly explain the structure of caesium chloride.
- 2.4 Suggest the geometry and type of hybridization of the following molecules:  
(1)  $SF_6$  (2)  $IF_7$   
(3)  $XeF_6$  (4)  $NH_3$
- 2.5 Predict the bond order in  $He_2$ ,  $CO$ ,  $F_2$  and  $N_2$  using molecular orbital theory.
- 2.6 State and explain the HSAB principle with suitable examples.
- 2.7 What is meant by gravimetric analysis? Explain the experimental techniques in gravimetric analysis.
- 2.8 What is VSEPR theory? Give its main points.
- 2.9 What are n-type and p-type semiconductors? Explain the nature of semiconductors using any concept of metallic bond.

GROUP "B" (ORGANIC)

3. Comprehensive Question

What are the conditions for an organic compound to show optical activity? Explain.

What is specific rotation? How can it be calculated? Describe. Taking tartaric acid as an example; show its enantiomers, diastereomers, meso compound and racemic mixture. [2+2+5]

OR

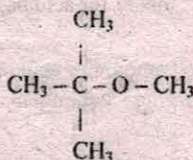
Give an account of E2 reaction (Elimination bimolecular) stressing on kinetics, mechanism, reactivity and orientation of the double bond. [9]

4. Short Answer Questions

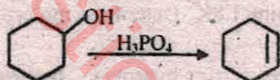
6x4=24

- 4.1. (a) Ethylene glycol,  $HOCH_2-CH_2-OH$ , has zero dipole moment even though carbon-oxygen bonds are strongly polarized. Explain why.  
(b) Water has  $pK_a = 15.74$  and acetylene has  $pK_a = 25$ . Which is stronger acid? Does hydroxide ion react with acetylene?
- 4.2. Distinguish the terms 'conformation' and 'configuration'. Write the conformations of n-butane. Which conformation is the most stable and why?
- 4.3. Account for the fact that an optically active sample of (S)-2-bromobutane,  $CH_3CHBrC_2H_5$ , racemizes in presence of bromide ion.
- 4.4. What are stereochemical outcomes of  $S_N1$  and  $S_N2$  reactions? Describe giving examples.
- 4.5. Identify the correct compound in each of the following case. Justify your choice.

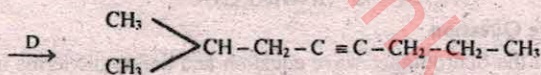
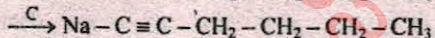
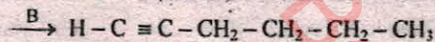
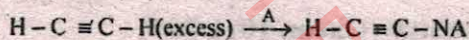
- (1) a compound believed to be either diethyl ether or propyl alcohol which is miscible in water.
- (2) a compound believed to be either allylmethyl ether or propyl alcohol which decolourizes a solution of  $\text{Br}_2$  in  $\text{CCl}_4$
- (3) a compound believed to be either cyclohexyl methyl ether or 2-methylcyclohexanol which evolves a gas when treated with  $\text{NaH}$ .
- 4.6 Outline a Williamson ether synthesis for tert - butyl methyl ether. Also write its mechanism.



- 4.7 What is hydroboration - oxidation? Illustrate giving one example with mechanism.
- 4.8 Write the mechanism of the following reaction



- 4.9 What are A, B, C and D?



### GROUP-C (PHYSICAL)

#### 5. Comprehensive Question

Explain the causes of deviation of gas from ideal behaviour. Derive the Vander Waals equation for real gas. What are the significance of Vander Waals constants? Calculate rms velocity of nitrogen molecules at  $27^\circ\text{C}$ . [2+4+2+2]

OR

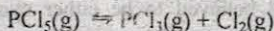
What do you mean by thermodynamically reversible process? Derive the expression for work done on reversible and irreversible isothermal expansion of an ideal gas. Calculate work done in Joules when 2 moles of an ideal gas are allowed to expand isothermally and rapidly from a volume of 10 L to 20 L against constant pressure of 1 atm at  $25^\circ\text{C}$ . [1+6+3]

#### 6. Short Answer Questions.

6×4=24

- 6.1 What do you mean by Boyle's temperature? How is it related to Van der Waal's constant?

- 6.2 Define surface tension. How do you measure surface tension of liquid by capillary rise method?
- 6.3 Write a concise note on Miller indices.
- 6.4 Discuss the equilibrium



and derive the expression for  $K_p$  and  $K_c$  in terms of degree of dissociation ( $\alpha$ ) and initial pressure or volume.

- 6.4 Discuss the Ostwald's theory for acid base indicators.
- 6.6 Explain why
- (1) addition of small amount of acid or base does not change the pH of solution containing equimolar mixture of  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$ .
  - (2) Aqueous solution of copper sulphate is acidic toward litmus.
- 6.7 What is elevation of boiling point? Derive a relation between elevation of boiling point and molecular mass of non volatile solute.
- 6.8 A solution containing 4.2g of organic compound in 50g acetone shows an elevation of boiling point 1.8K. Determine molecular mass. ( $K_b$  for acetone =  $1.71 \text{ K kg mol}^{-1}$ )
- 6.9 How would you prepare ferric hydroxide hydrosol? How-charge originated on this sol?

### Chemistry (Chem. 101), 2071

Bachelor Level (4 Yrs.)/I Year/Science & Tech.

Full Marks: 100

Time: 3 hrs.

#### GROUP "A" (INORGANIC)

##### 1. Comprehensive Question

- Write down the Schrodinger wave equation and define the terms involved in it. Draw the radial distribution function for 1S and 3P orbitals in a hydrogen atom.
- What are the main conditions in which the solutions to the wave equation are physically possible? [5+4]

OR

- Differentiate valence bond approach and molecular orbital theory. State L.C.A.O principle of molecular orbital theory, and use it to explain why  $\text{O}_2$  is paramagnetic. Also calculate its bond order. [2+6+1]

##### 2. Short Answer Questions

6×4=24

- 2.1 State Pauli exclusion principle, and show that in a given principal shell, there can be only two S and six P electrons.
- 2.2 The half life for  $^{27}\text{C}_0^{60}$  is 5.2 years. If 1g of this isotope is taken, how much will remain after 15.6 years?
- 2.3 What are the physical properties on which each of the following electronegativity scales is based?
  - (i) Pauling
  - (ii) Allred and Rochow.

- 2.4 How the atomic size vary in the periodic table? Give reasons.
- 2.5 What do you mean by point defects? Explain.
- 2.6 Explain the terms bond moment and dipole moment.
- 2.7 What is hydrogen bonding? How it affects the properties of HF and H<sub>2</sub>O.
- 2.8 Define HSAB principle with examples.
- 2.9 What is the fundamental principle of gravimetric analysis? Explain.

### GROUP "B" (ORGANIC)

#### 3. Comprehensive Question

Write an account of S<sub>N</sub>1 reaction stressing on kinetics, mechanism, reactivity and stereochemistry. [9]

OR

What products would you obtain from the reaction of 2,4-dimethylpent - 2 - ene with

- (i) BH<sub>3</sub> followed by H<sub>2</sub>O<sub>2</sub>, °OH
- (ii) Hg(oAc), H<sub>2</sub>O/THF followed by NaBH<sub>4</sub>

Write the mechanism of both of these reactions. [4.5+4.5]

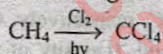
#### 4. Short Answer Questions

6×4=24

4.1 How do you account for the following:

- (a) The boiling point of ethanol is very much higher than that of its isomer, dimethyl ether.
- (b) Picric acid (2, 4, 6- trinitrophenol) liberates carbon dioxide from aqueous sodium bicarbonate, but phenol does not.

4.2 Write mechanism of the following reaction

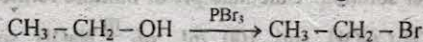


4.3 Define enantiomers and diastereomers giving examples. Draw a tetrahedral representation of (R) - 2 - chlorobutane.

4.4 What product would you expect from S<sub>N</sub><sup>2</sup> reaction of 1 - bromobutane with each of the following?

- (i) NaI (ii) KOH (iii) H - Cs ≡ C - Li (iv) NH<sub>3</sub>

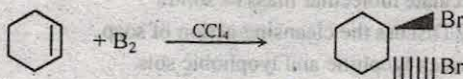
4.5 Write reactions to show that alcohols can act as both acids and bases. Write the mechanism of the following



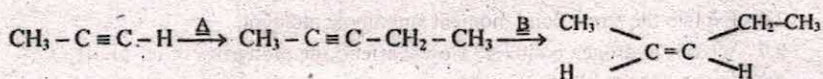
4.6 What is Williamson synthesis? Give one example. Also write its mechanism.

4.7 What factors determine the orientation of double bond in E-2 reactions? Describe giving examples.

4.8. Write the mechanism of the following reaction



4.9 Why is acetylenic hydrogen acidic? Explain. What are **A** and **B**?



### GROUP "C" (PHYSICAL)

#### 5. Comprehensive Question

What do you mean by molar heat capacity? Obtain the relation between molar heat capacity at constant pressure ( $C_p$ ) and molar heat capacity at constant volume ( $C_v$ ).

The standard heat of formation of ammonia is  $-46 - 10 \text{ KJ mol}^{-1}$  at 298K. Calculate heat of formation of ammonia at 800K. Given  $C_p$  values for  $\text{N}_2$ ,  $\text{H}_2$  and  $\text{NH}_3$  are 29.20, 28.82 and 35.06,  $\text{JK}^{-1} \text{mol}^{-1}$ , respectively. [2+4+4]

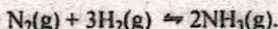
OR

Discuss the critical phenomenon on the basis of isotherm of carbon dioxide. Derive the expression for critical constant in terms of Van der Waal's constant. Calculate Van der Waal's constant for carbon dioxide if its critical temperature and critical pressure is  $31.1^\circ\text{C}$  and 72.8 atm, respectively.

#### 6. Short Answer Questions

6×4=24

- Define the term mean free path of gas molecules. How does mean free path changes on changing temperature and pressure of gas?
- Define the term coefficient of viscosity. The time taken to flow water and an unknown liquid through fixed marks of Ostwald viscometer is 105 and 200 secondary at  $25^\circ\text{C}$ , respectively. Calculate relative and absolute viscosity of unknown liquid. (Density of water =  $1.0 \text{ g ml}^{-1}$ , density of liquid  $0.8 \text{ g ml}^{-1}$ , and viscosity of water = 0.1 Poise)
- Discuss the various types of solid on the basis of dominant types of bond.
- State Le Chatelier principle. Explain the effect of addition of inert gas on following equilibrium such that (a) total volume kept constant (b) total pressure remains constant



- What is buffer solution? Calculate pH of mixture formed by mixing 200 mL of  $\frac{m}{2} \text{ CH}_3\text{COOH}$  and 100 mL of  $\frac{m}{2} \text{ NaOH}$  solution. ( $K_a$  for  $\text{CH}_3\text{COOH} = 1.8 \times 10^{-5}$ )
- Explain the term common ion effect. Mention its important applications.
- What do you mean by osmotic pressure? The osmotic pressure of solution containing 4.48 g of unknown solid in 100 mL of water at 298 K is 3.83 atm. Calculate molecular mass of solid.
- What are soaps? Discuss the cleansing action of soap.
- Distinguish between lyophilic and lyophobic sols.

# Chemistry (Chem 101), 2072

Bachelor Level (4 Yrs. Prog.) 1 Year/Science & Tech.

Full Marks: 100  
Time: 3 hrs.

Use separate answer-book for each group.

The Comprehensive Question of each group is compulsory.

Attempt SIX question of Short Answer Questions of each Group.

## Group "A" (INORGANIC)

### 1. Comprehensive Question

Derive the Schrodinger wave equation and define the terms involved in it. [9]

OR

What is meant by electron affinity? How does it differ from electro negativity?

Discuss the variation of electron affinity along a group and across a period. [1+2+3+3]

What are the factors that affect electron affinity? [6×4 = 24]

### 2. Short Answer Questions:

2.1. What are Hund's rule of maximum multiplicity and Heisenberg's uncertainty principle?

2.2. What is meant by natural radioactivity and artificial radioactivity? Explain.

2.3. What is lattice energy? Write Born-Landé equation and define the terms involved in it.

2.4. What is meant by dipole moment? How is it used to determine the percentage ionic character in a molecule? Illustrate it with an example.

2.5. Predict the geometry of  $\text{BF}_3$ ,  $\text{SF}_6$ ,  $\text{H}_2\text{S}$  and  $\text{IF}_7$  on the basis of VSEPR theory.

2.6. What is molecular orbital theory? Point out the difference between bonding and anti-bonding molecular orbital.

2.7. Draw molecular orbital energy level diagram for CO molecule. Give the bond order and magnetic properties of the molecule.

2.8. What are hard and soft acids and bases?

2.9. Give the general principles of gravimetric analysis.

## Group "B" (ORGANIC)

### 3. Comprehensive Question

Account for the fact that free radical addition of hydrogen bromide to propene occurs with orientation opposite to that of electrophilic addition. Suggest a possible reason why the peroxide effect is observed for HBr, but not for HCl.

OR

Define  $\text{S}_\text{N}1$  and  $\text{S}_\text{N}2$  reaction. Give the mechanism and stereo. chemistry of  $\text{S}_\text{N}1$  and  $\text{S}_\text{N}2$  reaction with appropriate justification. [4+4+1]

### 4. Short Answer Questions

4.1. What is meant by hyper conjugation? Why it is also termed no bond resonance? [6×4 = 24]

4.2. Define conformation. Draw the different conformation of n-butane and compare their stability.



- 4.3. How do you account for the fact that the presence of chiral carbon is not sufficient condition for optical activity?
- 4.4. How do you justify the stability order of alkyl carbocation is  $3^\circ > 2^\circ > 1^\circ$ ?
- 4.5. Give the mechanism of dehydrohalogenation of ethyl bromide by alcoholic KOH.
- 4.6. Write the preparation and uses of polypropylene.
- 4.7. How do you account for the fact that the boiling point of ether is less than corresponding alcohol? Write about Williamson's ether synthesis.
- 4.8. Describe with mechanism when primary alcohol is treated with alkaline  $\text{KMnO}_4$ .
- 4.9. How do you account for the fact that acetylene is weaker acid than water but stronger acid than ammonia?

#### Group "C" (PHYSICAL)

##### 5. Comprehensive Question

How does real gas deviate in their behavior from ideal gas? Give what of Vander Waal's constants. How does the Vander Waal's equation account for the PVT behavior of gases at (i) low pressure (ii) moderate pressure and (iii) high pressure? [2+2+6]

OR

Define Acid-base indicator. What is the mechanism of its action? Show with a rough graphical sketch how to choose an indicator for the titration of a weak acid with a strong base.

##### 6. Short Answer Questions

- 6.1. Define collision diameter and state the factors that affect collision frequency. [6×4 = 24]
- 6.2. Define surface tension and surface energy. Give an account of the experimental method for the determination of surface tension by drop weight method.
- 6.3. What are crystalline solids? Represent diagrammatically the Bravais Lattice of face-centred cubic lattice.
- 6.4. Discuss the procedure in determining Miller indices for a crystal plane.
- 6.5. Discuss briefly the various factors that affect the state of equilibrium of the following reaction.  

$$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g}), \Delta H = 180.75 \text{ KJ.}$$
- 6.6. What are the causes for association and dissociation in a solution? Determine the Van't Hoff factor for a 0.7% aqueous KCl solution that freezes at  $-0.24^\circ\text{C}$ . The  $K_f$  for water is  $1.86^\circ$ .
- 6.7. What is Tyndall effect? Give an example.
- 6.8. With an example show how Hess's law can be used to calculate the enthalpy of combustion of a reaction.
- 6.9. Derive the work done in reversible isothermal of an ideal gas. 5 moles of an ideal gas compresses isothermally and reversibly from a volume of  $2 \text{ dm}^3$  to a volume of  $8 \text{ dm}^3$  at  $27^\circ\text{C}$ . Find the maximum work done in Joules.