

S. No. of Question Paper: 1201

Unique Paper Code : 32171201

Name of the Course : B.Sc. (H) Chemistry

Name of the Paper : Organic Chemistry -I

Semester : II

Time: 3 Hours

Maximum Marks: 75

Instructions for Candidates

Write your Roll no. on the top immediately on receipt of this question paper.

Attempt any six questions.

All questions carry equal marks



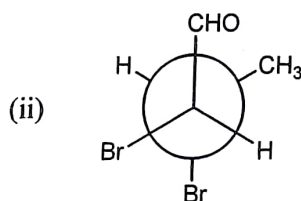
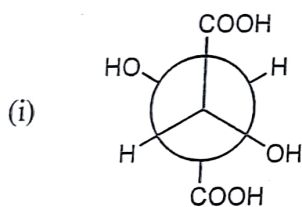
Ques 1 (a) What happens when $\text{CH}_3\text{CH}=\text{CH}_2$ reacts with HBr in presence of peroxides? Explain with mechanism.

(b) Calculate the % of various isomers formed during the photo monochlorination of 2,3-dimethylbutane. (The relative reactivities 1° : 2° : 3° H's are 1:4:5)

(c) Discuss the reaction of toluene with $\text{CH}_3\text{CH}_2\text{Cl}$ in presence of anhydrous AlCl_3

(4.5, 4x2)

Ques 2 (a) Convert the following into Fischer projection

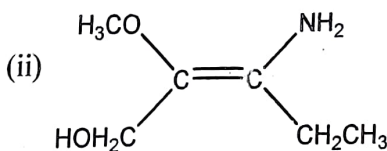
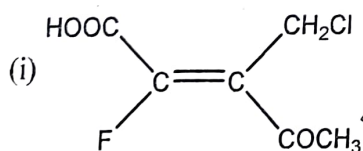


(b) Explain the stability of allyl radical in terms of (i) resonance (ii) π orbital overlap.

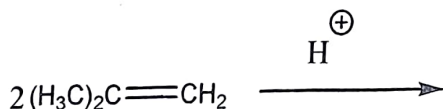
(c) Draw the various conformations of cyclohexane. Explain their relative stability

(4.5, 4x2)

Ques 3 (a) Assign E/Z to the following:



(b) Complete the reaction giving mechanism



(c) In chlorobenzene, chlorine deactivates the benzene ring but ortho- & para-directing. Why?

(4.5, 4x2)

Ques 4 (a) Do the following conversions:

- (i) Benzene to benzoic acid
- (ii) Propene to 3-chloropropene

(b) Draw all possible stereoisomers 3-bromobutan-2-ol. Give stereochemical relationship between them

(c) Suggest any two experimental evidences to support the E1 mechanism

(4.5, 4x2)

Ques 5 (a) Buta-1,3-diene reacts with HCl at 40°C to yield 1,4-addition product as major product whereas 1,2-addition product predominates at -80°C. Explain.

(b) 2,2-Dimethylpropan-1-ol and 3-methylbutan-2-ol undergo dehydration to yield the same product. Explain.

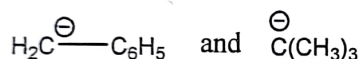
(c) Give reason:

(i) Terminal alkynes are acidic in nature.

(ii) CH_2Cl_2 has greater dipole moment than CHCl_3

(4.5, 4x2)

Ques 6. (a) Compare the stability of



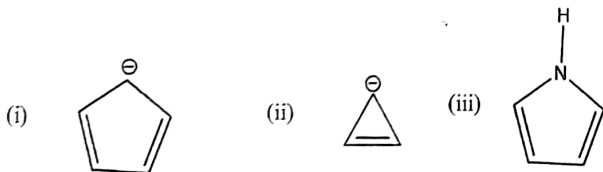
(b) Chlorine is more reactive whereas bromine is more selective in halogenation of alkanes. Explain

(c) Why alkynes are less reactive than alkenes towards electrophilic addition reaction?

(4.5, 4x2)

Ques 7 (a) How will you convert But-2-yne to cis- But-2-ene and trans- But-2-ene?

(b) Define Huckel's rule of aromaticity. Which of the given molecules is/are aromatic?

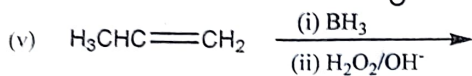
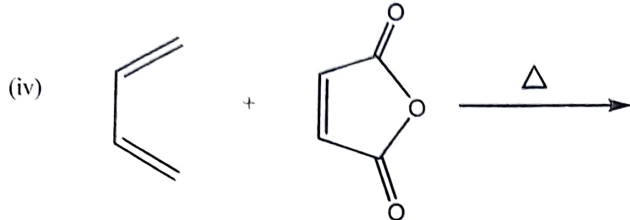
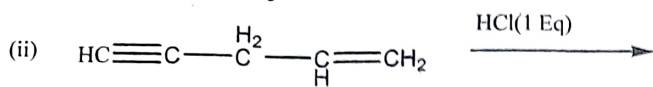
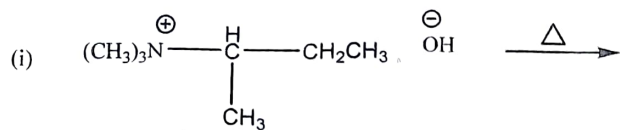


(c) Suggest a suitable method of resolution of a racemic mixture of ($\pm$) carboxylic acid.

(4.5, 4x2)

Ques 8 (a) Differentiate between enantiomers and diastereomers with suitable example

(b) Complete the following reactions (any four)



(4.5, 4x2)

1202



ROLL NO. 21/5/25

Sr. No. of Question Paper:

Unique Paper code: 32171202

Name of the paper: CHEMICAL THERMODYNAMICS AND ITS APPLICATIONS

Name of the Course: B.Sc. (H) Chemistry

Semester: II

Duration: 3 hours

Maximum marks: 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper
2. Attempt Six question in all.
3. Q.1 is compulsory
4. Use of Scientific calculator is allowed.

Q.1 Attempt any five.

- (a) Adiabatic expansion of an ideal gas results in fall in temperature. Why?
- (b) What are extensive and intensive properties? Classify the following into extensive and intensive properties: Enthalpy, heat capacity, molar heat capacity, molar volume.
- (c) Reversible adiabatic processes are often called *isentropic processes*. Explain
- (d) Explain residual entropy
- (e) Exothermic processes with negative value of ΔS are spontaneous at lower temperatures. True or False? Explain.
- (f) Why ΔG is used more compared to ΔA to express the condition of spontaneity of the reaction.

5 X 3

- Q.2 (a) Enthalpy of neutralization of HCl by NaOH is $-57.32 \text{ kJ mol}^{-1}$, by NH_4OH is $-51.34 \text{ kJ mol}^{-1}$. Enthalpy of neutralization of CH_3COOH by NaOH is $-49.86 \text{ kJ mol}^{-1}$. Find the enthalpy of neutralization of CH_3COOH by NH_4OH .
- (b) Calculate the change in ΔU when 1 mole of ethylene is burnt at 25°C with an excess of oxygen in a bomb calorimeter. Given

$$\Delta H_f^\circ(\text{C}_2\text{H}_4) = + 52.3 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ(\text{CO}_2) = - 393.5 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ(\text{H}_2\text{O}) = - 285.8 \text{ kJ mol}^{-1}$$

- (c) Describe Joule-Thomson experiment. Show that the expansion in this experiment is an isenthalpic process.

(4,4,4)

Q.3 (a) Derive the following:

$$(i) \left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$$

$$(ii) T_2 = T_1 \left(\frac{C_V + R \frac{P_2}{P_1}}{C_P} \right)$$

- (b) What is chemical potential? Derive Gibbs-Duhem equation.
- (c) Calculate the bond energy of C-H bond, given the heat of combustion of methane (CH_4), graphite and hydrogen are 891 kJ mol^{-1} , 394 kJ mol^{-1} and 286 kJ mol^{-1} respectively while the heat of sublimation of graphite is 717 kJ mol^{-1} and heat of dissociation of hydrogen molecule is 436 kJ mol^{-1} .

(4,4,4)

Q.4 (a) (a) Calculate the maximum efficiency of a steam engine operating between 110°C and 25°C. What would be the efficiency of the engine if the boiler temperature is raised to 140 °C, the temperature of the sink remaining the same.

(b) (b) Calculate the work involved when 15.3 g nitrobenzene is electrolytically reduced to aniline under a potential difference of 8.0 volts.

(c) Show that entropy change for an ideal gas is :

$$\Delta S = C_V \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1}$$

(4,4,4)

Q.5 (a) One mole of an ideal gas is expanded isothermally from P_1, V_1 to P_2, V_2 in two stages. First stage uses constant opposing pressure P' , and 2nd stage uses constant opposing pressure P_2 .

Show that maximum value of work produced is given by $2RT[1 - (\frac{P_1}{P_2})^{\frac{1}{2}}]$ and $P' = \sqrt{P_1 P_2}$

(b) Evaluate the Joule- Thomson coefficient :

$\mu_{JT} = \frac{1}{C_p} [T(\frac{\partial V}{\partial T})_P - V] = (\frac{\partial T}{\partial P})_H$ in terms of a, R, T , and C_p for a gas that has the equation of state $V = \frac{nRT}{P} - \frac{na}{R^2 T^2}$. Would the gas have an inversion temperature? Explain.

(c) Derive the expression for the chemical potential of an ideal gas in a mixture of gases and mention each term in the expression.

(4,4,4)

Q.6 (a) Differentiate between the following (*any two*):

(i) Reversible and Irreversible process

(ii) Bond dissociation enthalpy and Bond enthalpy

(iii) Enthalpy and Internal energy

(b) ClBrO_3 molecule can have four possible arrangements with nearly the same energy. Calculate the residual entropy of ClBrO_3 molecule.

(c) Ascertain whether $dz = xy dx + \frac{1}{2}x^2 dy$ is an exact differential is or not.

(4,4,4)

Q.7 (a) Prove that the 'V' in an ideal gas equation is a state function.

(b) One mole of Zn(s) is heated from 300K to 1500 K. Calculate the entropy changes from the following data: m.pt. of $\text{Zn} = 692 \text{ K}$, b.pt. of $\text{Zn} = 1180 \text{ K}$, enthalpy of fusion = 7.53 kJ mol^{-1} , enthalpy of vaporization = 1159 kJ mol^{-1} , specific heat capacity of Zn in solid, liquid and gaseous phases are 0.384, 0.512 and $0.312 \text{ J g}^{-1} \text{ K}^{-1}$ respectively, molar mass of $\text{Zn} = 65.38 \text{ g mol}^{-1}$.

(c) Vant Hoff factor, i , for aqueous solution of CH_3COOH depends on the concentration of the solution. Explain.

(3,6,3)

Q.8 Write short notes on any three of the following.

(a) Adiabatic Flame Temperature.

(b) Gibbs Helmholtz equation

(c) Hess's Law of constant heat of summation

(d) Osmosis

(4,4,4)

This question paper contains 3 printed pages]

29/5/25

Roll No.

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S. No. of Question Paper : 2676

Unique Paper Code : 42351211

Name of the Paper : Calculus and Matrices

Name of the Course : DSC : Analytical/Industrial Chemistry
(CBCS-LOCF)

Semester : II

Duration : 3 Hours

Maximum Marks : 75

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

Attempt all questions by selecting two parts from each question.

Parts of the question to be attempted together.

Use of calculator is not allowed.

1. (a) Sketch the graph of $y = -(x + 2)^2 + 3$.
(b) Find the critical points of $f(x) = x^3 - 12x - 5$ and identify the open intervals on which f is increasing and on which f is decreasing.
(c) Use $\epsilon - \delta$ definition to prove that $\lim_{x \rightarrow -1} (7x + 5) = -2$. 6½, 6½, 6½
2. (a) Verify that $w(x, t) = e^{-c^2 \pi^2 t} \sin \pi x$ is a solution of the heat equation.
(b) Find the slope of the sphere $x^2 + y^2 + z^2 = 1$ in the y -direction at the point $\left(\frac{2}{3}, \frac{1}{3}, \frac{2}{3}\right)$.
(c) Draw the level curves of $f(x, y) = y^2 - x^2$ of height $k = 0, 1, 2$. 6, 6, 6

P.T.O.

3. (a) Discuss the validity of Rolle's theorem for $f(x) = (x - a)^m (x - b)^n$ in $[a, b]$, m, n are positive integers.

(b) Prove that : $\frac{x}{1+x} < \log(1+x) < x$, $x > 0$.

(c) If $y = \frac{\sin^{-1} x}{\sqrt{1-x^2}}$, prove that $(1-x^2) y_{n+2} - (2n+1)xy_n - x^2y_{n-1} = 0$.

$6\frac{1}{2}, 6\frac{1}{2}, 6\frac{1}{2}$

4. (a) Reduce the following matrix to Echelon Form :

$$\begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 5 & 6 & 8 \\ 3 & 4 & 10 & 12 \end{bmatrix}.$$

(b) Let $v_1 = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, $v_2 = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$, $v_3 = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$.

(i) Determine if the set $\{v_1, v_2, v_3\}$ is linearly independent.

(ii) If possible, find a linear dependence relation between them.

(c) Find rank of the following matrix : $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 1 & 4 \\ 3 & 0 & 5 \end{bmatrix}$. $6, 6, 6$

5. (a) Let $A = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$ and define a linear transformation $T : \mathbf{R}^2 \rightarrow \mathbf{R}^2$ by

$$T(x) = Ax. \text{ Find the images under } T \text{ of } u = \begin{bmatrix} 1 \\ -3 \end{bmatrix}, v = \begin{bmatrix} a \\ b \end{bmatrix}.$$

- (b) Find eigen values of $A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & -3 & 0 \\ 4 & -13 & 1 \end{bmatrix}$.

- (c) Diagonalise the following matrix, if possible :

$$A = \begin{bmatrix} 4 & 2 & 2 \\ 2 & 4 & 2 \\ 2 & 2 & 4 \end{bmatrix}.$$

6½, 6½, 6½

6. (a) If $\cos \theta + \cos \phi + \cos \psi = \sin \theta + \sin \phi + \sin \psi = 0$. Prove that :

$$\cos 3\theta + \cos 3\phi + \cos 3\psi = 3 \cos (\theta + \phi + \psi) \text{ and } \sin 3\theta + \sin 3\phi + \sin 3\psi = 3 \sin(\theta + \phi + \psi).$$

- (b) Express $\sin^6 \theta$ in terms of cosines of multiples of θ .

- (c) Find the centre and radius of the circle whose equation is $\left| \frac{z-i}{z+i} \right| = 3$.

6, 6, 6

June 9025 H

This question paper contains 4 printed pages]

Roll No.

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S. No. of Question Paper : 5774

Unique Paper Code : 2172011201

Name of the Paper : DSC : Chemistry of s- and p-Block Elements

Name of the Course : B.Sc. (H) Chemistry

Semester : II (UGCF-NEP)

Duration : 3 Hours



Maximum Marks : 90

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

Attempt any six questions out of eight questions.

All questions carry equal marks.

1. Explain any five of the following :

- Ionization energies of group 13 elements (B to Tl) show irregular trends.
- IF_7 is always stored in pyrex glass bottles.
- Oxygen exists as diatomic molecule while sulphur exists as S_8 .
- Behaviour of alkali metals in liquid ammonia.
- Carbon shows maximum Catenation tendency than other elements of group 14 elements.
- The increasing order of reducing character of Group 15 hydrides down the group.

5×3

P.T.O.

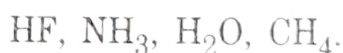
2. (a) What are interhalogen compounds ? Draw the structure of ClF_3 and ICl_3 in solid state.
- (b) Discuss Van Arkel-De Boer process for the purification of metals Ti, Zr, V and Th. Write the chemical equations involved.
- (c) Explain briefly :
- (i) Helium and Neon do not form Clathrate compounds.
- (ii) Why does Li form oxides whereas Na form peroxides and other elements of the 1st Group form superoxides on heating in air ? 3×5
3. (a) Describe the Hydrometallurgical process or cyanide process for the extraction of silver and gold. Write the chemical equations involved during extraction.
- (b) Discuss the structure and bonding behaviour in B_2H_6 molecule. Write the reactions of diborane with H_2O and NH_3 :
- (i) $\text{B}_2\text{H}_6 + \text{H}_2\text{O} \longrightarrow$
- (ii) $\text{B}_2\text{H}_6 + \text{NH}_3 \xrightarrow{\Delta}$
- (c) Nitrogen is chemically inert while phosphorus is quite reactive, explain. Discuss about the allotropes of phosphorus. 3×5
4. Attempt any *five* of the following :
- (a) Why F_2 is strongest oxidizing agent though electron affinity of Cl_2 is more ?
- (b) Describe the order of stability of hydrides of group 14 elements (CH_4 , SiH_4 , GeH_4 and SnH_4) towards water.

- (c) Arrange in the order of increasing oxidising power and acidic strength of HClO , HClO_2 , HClO_3 and HClO_4 ? Give reasons.
- (d) Explain the characteristic properties of alkali and alkaline earth metals towards flame colouration.
- (e) Explain the structure and bonding behaviour in basic beryllium acetate.
- (f) What are allotropes ? What is the basic difference between diamond and graphite ?

5×3

5. Attempt any *five* of the following :

- (a) H_2O is a liquid while H_2S is gas. Explain.
- (b) Give the structure and the name of the product formed when two molecules of H_3PO_4 (ortho phosphoric acid) condensed to each other.
- (c) Explain the structure of XeF_2 on the basis of MOT.
- (d) Beryllium shows anomalous behaviour and dissimilarities with other alkaline earth metals. Explain with *three* suitable examples.
- (e) Arrange the following in increasing order of their boiling points and justify :



- (f) BaO is more soluble than MgO but BaSO_4 is insoluble, however MgSO_4 is quite soluble in water. Explain.

5×3

6. (a) Explain the diagonal relationship between Boron and Silicon. Explain with the help of electronegativity concept and polarising power concept.

- (b) What are Clathrates compounds ? What are the conditions for the formation of Clathrates compounds ? Discuss the type and preparation of Gas hydrate and quinol based Clathrates compounds.
- (c) What are crown ethers ? Write the structure of crown-4 with lithium ion and crown-6 with potassium ion. 3×5

7. Attempt any *five* of the following :

- (a) Draw the structure of Mg-EDTA complex.
- (b) What is inert pair effect ? Sb^{3+} is reducing in nature and Bi^{3+} is stable. Explain.
- (c) Arrange the following in increasing order of boiling points :
 NH_3 , PH_3 , AsH_3 and SbH_3 .
- (d) Give the structure of peroxydisulphuric acid and also the products obtained on its hydrolysis.
- (e) Alkali metals are strong reducing agents. Explain.
- (f) Why is SbCl_6 not known but SF_6 is a known compound ? 5×3

8. Write short notes on any *three* :

- (a) Allotropes of Sulphur
- (b) Pseudo halogens
- (c) Ellingham diagrams for the reduction of metal oxides
- (d) 2, 2, 2-cryptand for potassium ion. 3×5

This question paper contains 5 printed pages

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Roll No.

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S. No. of Question Paper : 5795

Unique Paper Code : 2172011202

Name of the Paper : DSC : Haloalkanes, Arenes, Haloarenes,
Alcohols, Phenols, Ethers and Epoxides

Name of the Course : B.Sc. (Hons.) Chemistry

Semester : II

Duration : 2 Hours

Maximum Marks : 60

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

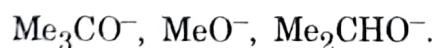
Attempt four questions in all.

Question No. 1 is compulsory.

Each question carries 15 marks.

1. Answer the following (any five) :

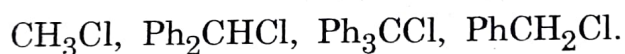
- (a) Arrange the following alkoxide nucleophiles in decreasing order of S_N2 reactivity giving reasons :



- (b) Why is nitrobenzene a suitable solvent for the Friedel-Crafts alkylation of PhBr while benzene is not ?
- (c) Which is a stronger base, RO^- or RS^- ? Which will be a better nucleophile in aqueous solution and DMSO ?

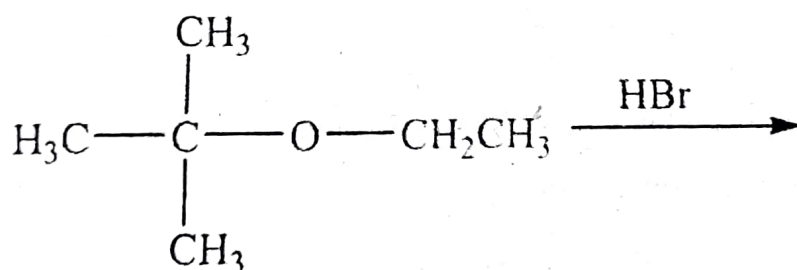
P.T.O.

- (d) How many mononitration products would be formed from each isomeric dibromobenzene ?
- (e) Comment on acidic properties of isomeric nitrophenols.
- (f) Why do aryl halides and vinyl halides show low reactivity towards nucleophilic substitution reactions compared to alkyl halides ?
- (g) How many molecules of HIO_4 would be consumed for oxidation of propane-1, 2, 3-triol and what are the products formed ?
- (h) Giving reasons, arrange the following in increasing order of reactivity towards alkaline hydrolysis by $\text{S}_{\text{N}}1$ reaction :



3×5=15

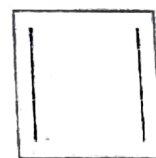
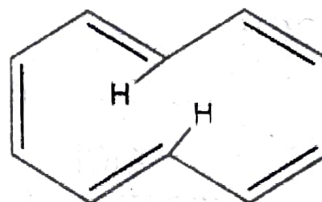
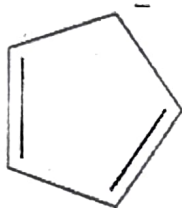
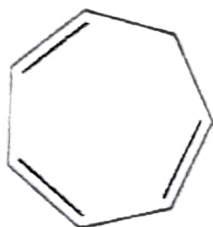
2. (a) Write the product of the following reaction with mechanism :



- (b) Why 2, 4, 6-trinitrochlorobenzene is easily hydrolysed in the presence of aq. NaOH solution but not chlorobenzene ?
- (c) The reaction of $(\text{CH}_3)_3\text{C}-\text{Cl}$ with CH_3O^- does not give of $(\text{CH}_3)_3\text{C}-\text{OCH}_3$.

5,5,5

3. (a) What happens when tertiary butyl bromide is treated with water ?
Give its mechanism with stereochemical aspect.
- (b) How would you distinguish between the following by a chemical reaction :
- (i) 1-butanol and diethyl ether
- (ii) tert-butyl alcohol and methanol.
- (c) Classify the following compounds as aromatic, antiaromatic and non-aromatic ?



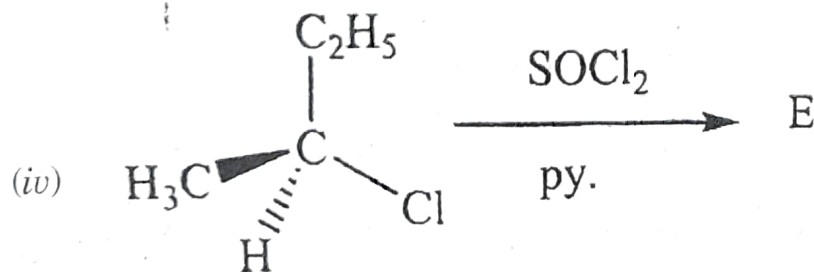
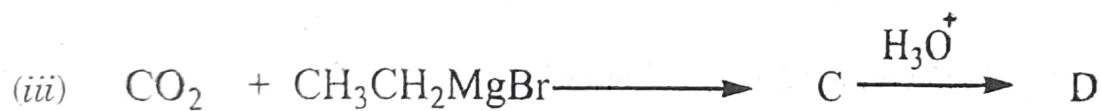
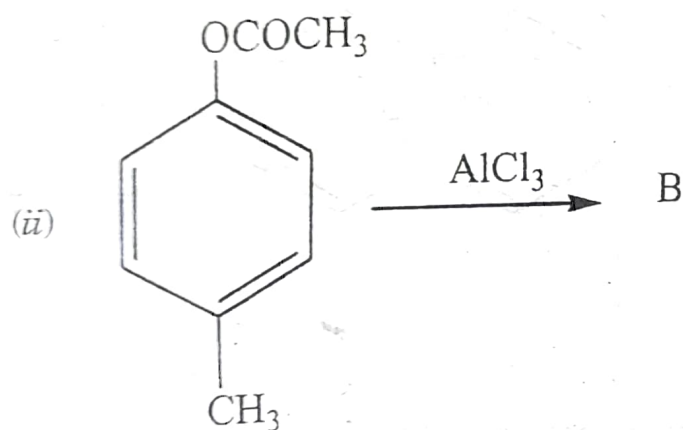
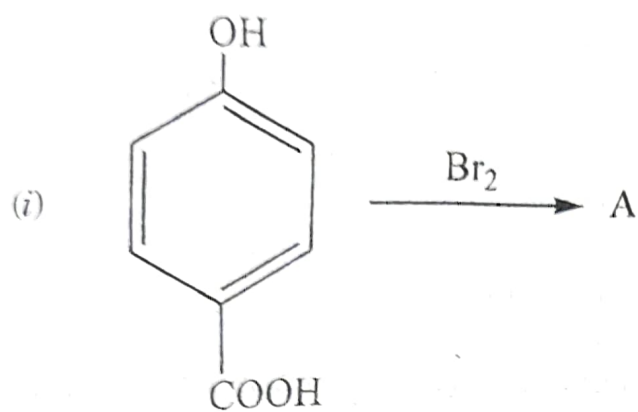
5,5,5

4. (a) Outline the following conversions (any *three*) :
- (i) Benzyl alcohol from methanal
- (ii) Salicylic acid from phenol
- (iii) Acetone from methyl bromide
- (iv) Benzene to *m*-bromobenzoic acid.
- (b) Both o-bromoanisole and m-bromoanisole give the same product on reaction with NaNH_2 in the presence of liquid ammonia. 9,6

P.T.O.

5. Complete the following reactions ;

15



This question paper contains 7 printed pages]

June 2025 ✓

Roll No.

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S. No. of Question Paper : 5815

Unique Paper Code : 2172011203

Name of the Paper : Chemical Thermodynamics and its Applications

Name of the Course : B.Sc. (H) Chemistry

Semester : II

Duration : 3 Hours

Maximum Marks : 90



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

Attempt six questions in all.

Question No. 1 is compulsory.

Use of scientific calculators and log tables is allowed.

1. Answer the following questions (any five) :

5×3=15

(a) The entropy of crystalline ice is not zero at 0 K. Explain.

(b) Giving suitable examples, explain the meaning of endergonic and exergonic reactions.

P.T.O.

- (c) The enthalpy of neutralization of a strong monoprotic acid with a strong monoprotic base is always constant. Explain.
- (d) With the help of mathematical expressions, explain why ΔA is called "work function".
- (e) Classify the following as extensive/intensive— Kinetic energy, Pressure, entropy, molar heat capacity, chemical potential, Temperature.
- (f) To predict the spontaneity of a process both ΔS_{sys} and ΔS_{surr} are considered but ΔG alone is sufficient for the same. Explain.
- (g) Define integral enthalpy of solution and dilution.

2. (a) Derive cyclic rule

$$\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T + 1 = 0.$$

Prove it for $PV_m = RT$.

- (b) With the help of suitable mathematical expression, discuss under what conditions heating and cooling effects are produced in the Joule Thomson experiment involving real gases. Define Inversion temperature and write down its expression for a real gas.

- (c) Six moles of an ideal gas expands isothermally and reversibly from a pressure of 10 atm to 2 atm at 27°C. Calculate the values of q , w , ΔU and ΔH involved in the process. Will the values of heat and work be the same or different had the process been carried out irreversibly ? Why ? 5,5,5
3. (a) Write down the statement of Hess's law of constant heat summation and explain it with the help of an example. Is Hess's law valid for heat exchanged ' q ' in a process ? Is it valid for entropy change ' ΔS ' ? Give reason for your answer.
- (b) Using the given data, calculate the enthalpy of formation of acetic acid :
- (i) Enthalpy of sublimation of graphite = 718.39 kJ mol⁻¹
- (ii) Enthalpy of dissociation of hydrogen gas = 435.97 kJ mol⁻¹
- (iii) Enthalpy of dissociation of oxygen gas = 495.04 kJ mol⁻¹

Bond	Bond enthalpy (kJ mol ⁻¹)
C—C	347.69
C—H	413.38
C = O	728.02
C—O	351.46
O—H	462.75

- (c) Derive an expression for determination of variation of enthalpy of reaction with temperature. 5,5,5
4. (a) Describe Carnot cycle. A Carnot engine operates between 500 K and 250 K. If it absorbs 1000 J of heat from the hot reservoir, calculate the work done and efficiency.
- (b) Define enthalpy of combustion. Calculate the enthalpy of formation of ethyl alcohol given the enthalpy of combustion of ethyl alcohol is $-1381 \text{ kJ mol}^{-1}$, and enthalpy of formation of $\text{H}_2\text{O} (l)$ and $\text{CO}_2 (g)$ are -287 kJ mol^{-1} and -395 kJ mol^{-1} respectively.
- (c) Show mathematically that the magnitude of the work involved in a reversible expansion of an ideal gas from volume V_1 and V_2 is larger than the corresponding work involved in an irreversible expansion against a constant pressure of P_2 . 5,5,5
5. (a) Derive :

$$(i) \quad \left(\frac{\partial S}{\partial P} \right)_T = - \frac{1}{\left(\frac{\partial T}{\partial V} \right)_P}$$

$$(ii) \quad \left(\frac{\partial U}{\partial V} \right)_T = T \left(\frac{\partial P}{\partial T} \right)_V - P.$$

- (b) State third law of thermodynamics. Absolute entropy of liquid water at 298 K has to be calculated. Write all the steps involved. Also write the final expression for calculation of entropy.
- (c) Calculate the $\Delta_{\text{mix}}G$, $\Delta_{\text{mix}}S$ and $\Delta_{\text{mix}}H$ when 20 mol of an ideal gas A is mixed in 20 mol of ideal gas B, at 298 K and 1 atm pressure. 5,5,5
6. (a) Calculate $\Delta_r G$ for the following process : $\text{H}_2\text{O} (l, 2 \text{ atm}, 373 \text{ K}) \rightarrow \text{H}_2\text{O} (g, 2 \text{ atm}, 373 \text{ K})$ where atm stands for atmospheric pressure.
- (b) Derive the expression for the entropy of mixing for two ideal gases and show how it contributes to the spontaneity of the mixing process.
- (c) Predict if ΔS_{sys} is positive, negative or zero in each of the following giving reason :
- (i) $\text{NH}_4\text{NO}_3 (s) + 3\text{H}_2 (g) \rightarrow 3\text{H}_2\text{O} (g) + \text{N}_2\text{H}_4 (g)$
- (ii) Crystallization of NaCl
- (iii) Reversible adiabatic expansion of an ideal gas
- (iv) $2 \text{SO}_2 (g) + \text{O}_2 (g) \rightarrow 2 \text{SO}_3 (g)$
- (v) $\text{C} (\text{graphite}) + \frac{1}{2}\text{O}_2 (g) \rightarrow \text{CO} (g).$ 5,5,5

7. (a) Show that $\Delta_r H = \Delta_r U + \Delta \nu_g RT$ for a chemical reaction involving gases.

What will be the relation for condensed phases ?

- (b) Partial molar volume of a component in a solution depends on the nature as well as the amount of the other components. Explain qualitatively.

- (c) Derive the relations :

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

$$(ii) \quad \left(\frac{\partial \mu_i}{\partial P} \right)_{T, n_j's} = V_{i, pm}$$

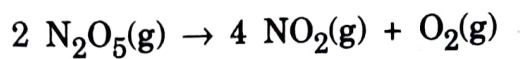
5,5,5

8. (a) Starting from $H = U + PV$ and first law of thermodynamics, derive the following expression for an ideal gas :

$$\Delta S = n C_{p,m} \ln \frac{T_2}{T_1} - n R \ln \frac{P_2}{P_1}.$$

- (b) Explain the term escaping tendency. Prove that a substance will flow spontaneously from a region of higher chemical potential to a region of lower chemical potential.

- (c) Calculate $\Delta_r G^\circ$ for the following reaction at 300 K from the data provided :



	N_2O_5	NO_2	O_2
$\Delta_f H^\circ / \text{kJ mol}^{-1}$	11.3	33.18	0
$S^\circ / \text{J K}^{-1} \text{mol}^{-1}$	355.7	240.06	205.14

Is the reaction spontaneous ?

5,5,5