

[This question paper contains 4 printed pages.]

Your Roll No.....

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Sr. No. of Question Paper : 1773

G

Unique Paper Code : 2222511101

Name of the Paper : Mechanics

Name of the Course : B.Sc. (Prog.)

Semester : I

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **four** questions in all.
3. **All** questions carry equal marks.
4. Question No. 1 is compulsory.
5. Non-programmable calculator is allowed.



1. Attempt all : (5×3)

(a) If position vector is $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$, then find the value of $\vec{\nabla}(\ln r)$.

P.T.O.

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(b) What are conservative and non-conservative forces?

(c) Define moment of inertia. Why does the moment of inertia of a given body depend on the axis of rotation about which it rotates? Explain.

(d) State the Kepler's law of planetary motion.

(e) What are the basic postulates of special theory of relativity?

2. (a) Explain gradient, divergence and curl. What is the significance of divergence and curl of a vector? (7)

(b) Find the solution of the differential equation :

$$y'' - 5y' + 6y = 0; y(0) = 1 \text{ and } y'(0) = 2. \quad (5)$$

(c) What are central forces? Give two examples. (3)

3. (a) Determine the moment of inertia of a circular disc of mass M and radius R about an axis passing through its centre and perpendicular to its plane. (7)

- e (b) An empty freight car of mass $m_1 = 10,000$ kg rolls at $v_1 = 2$ m/sec on a level road and collides with a loaded car of mass $m_2 = 20,000$ kg standing at rest. If the cars couple together, find their speed v' after the collision, and also the loss in kinetic energy. (5)
- (c) Derive the expression of time dilation in relativistic motion. Why do we not observe the effect of time-dilation in everyday life? (3)
4. (a) Explain the failure of Galilean transformation equations and derive the length contraction expression by using Lorentz transformation equation. (7)
- (b) A body of mass 0.5 kg is moving in a circle of radius 0.3 m with constant speed of 0.2 m/s. Find out its angular momentum about (i) the centre of the circle, (ii) a point on the axis of the circle and at a distance of 0.4 m from its centre. (5)
- (c) We observe two galaxies A and B moving in opposite directions with speeds $0.5c$ and $0.4c$ respectively. What is the velocity of galaxy B as seen from galaxy A. (3)



5. (a) Deduce the differential equation of a damped harmonic oscillator. Obtain a solution and discuss in detail the case of under damping. (7)
- (b) Centre of mass is at A (2,2,2) when system consists of particles of masses 2,4 and 5 kg. If the centre of mass shift to B (4,4,4) on removing 5kg, what was its position? (5)
- (c) A particle is moving in one-dimensional with $x(t) = A \cos \omega t + B \sin \omega t$. Show that motion is simple harmonic. (3)



[Symbols:

C: speed of light.

ω : angular frequency]

[This question paper contains 8 printed pages.]

5 Your Roll No.....

Sr. No. of Question Paper : 1754

G

Unique Paper Code : 2172511101

Name of the Paper : DSC – Basic Concepts of Organic Chemistry

Name of the Course : B.Sc. (Prog.)

Semester : I

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

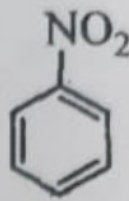
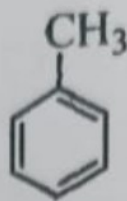
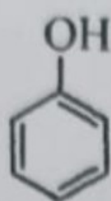
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions.
3. **All** questions carry equal marks.

1. Attempt any **five** :

(a) Giving reasons, arrange the following in increasing order of reactivity towards ring bromination :

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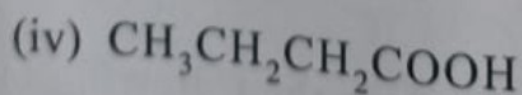
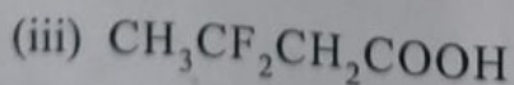
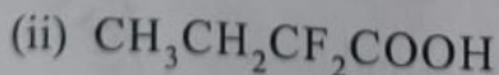
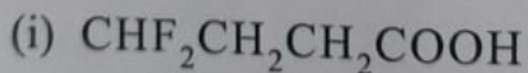




(b) What is Markownikoff's rule? Explain by taking the example of propene and HBr.

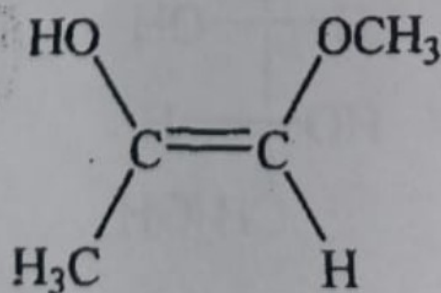
(c) Differentiate between D/L and d/l notations.

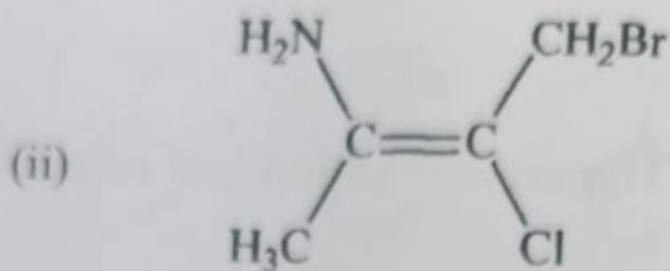
(d) Explain, which of the following compound would be strongest acid?



- (e) Amides are less basic than amines. Justify.
- (f) Explain Hyperconjugation and its applications.
- (g) What are free radicals? Explain decreasing order of stability of tertiary, Secondary, Primary alkyl free radical. (3,3,3,3,3)
- (a) Draw the structure and explain, why chair form is the most stable form of cyclohexane?
- (b) Assigning the priority order, explain how will you design at E/Z to the following :

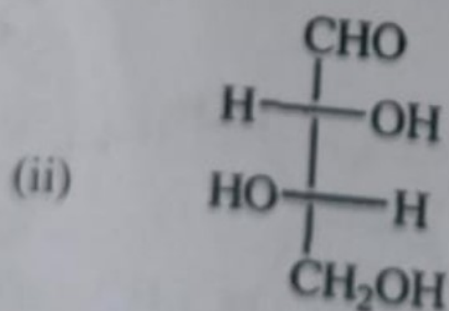
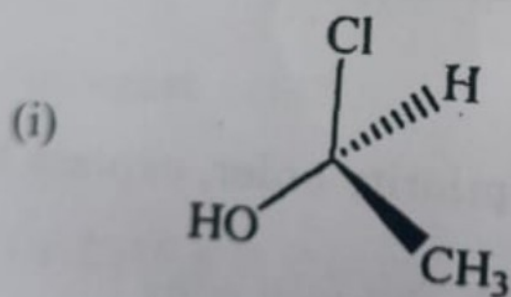
(i)





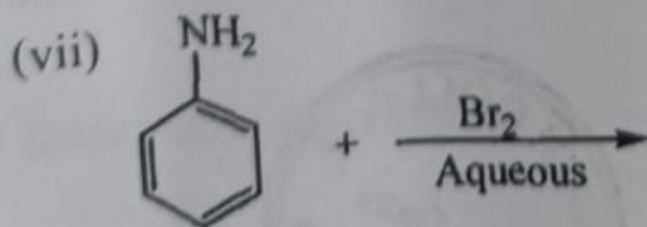
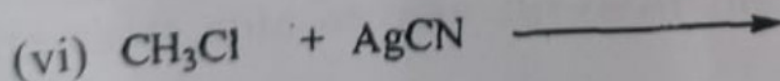
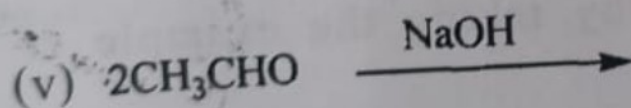
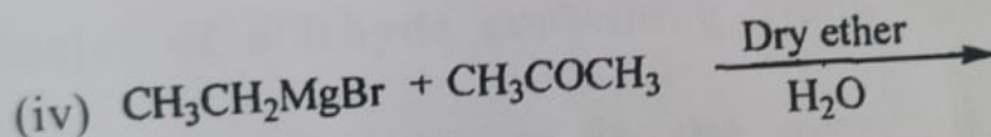
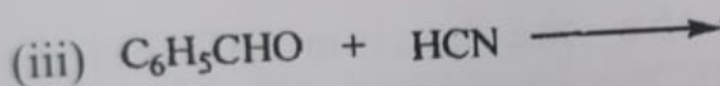
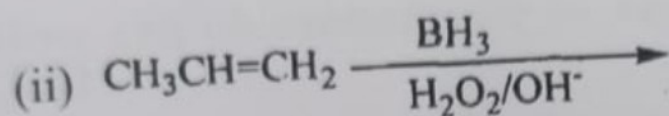
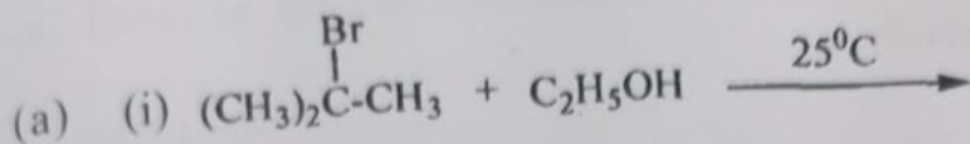
(c) What is the difference between meso stereoisomers and racemic mixture?

(d) Assigning the priority order and designate R/S to the following conformers :



(2,4,3,6)

Complete the following reactions (any Six) :



- (b) Arrange the following compounds in decreasing order of reactivity towards S_N1 reactions and justify.

1-Bromopentane, Allyl bromide, Vinyl bromide.

(2,2,2,2,2,3)

4. (a) Discuss the mechanism of Friedel-Crafts acylation.

- (b) Differentiate between Hoffman and Saytzeff elimination by taking the example of 2-Bromobutane.

- (c) Give the mechanism of nitration of benzene. Explain why nitration of toluene is easier than that of benzene?

(5,5,5)



Explain the following :

(a) Discuss the stereochemistry of the product of S_N2 reaction.

(b) How can chlorobenzene be converted into aniline via benzyne mechanism?

(c) Write the mechanism of the reaction when two moles of aldehyde containing α hydrogen undergo condensation in the presence of a base. (5,5,5)

6. Write short note on **any three** of the following :

(a) Reimer-Tiemann Reaction

(b) Beckmann rearrangement



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(c) Benzoin condensation

(d) Birch Reduction

(e) Pinacol-pinacolone rearrangement



[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1752

G

Unique Paper Code : 2172512302

Name of the Paper : DSC: Chemical Energetics
and Equilibria

Name of the Course : B.Sc. (Prog.)

Semester : III

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions in all.
3. Use of scientific calculator/log table is permitted.

NOTE :

$$R = 8.314 \text{ JK}^{-1}\text{mol}^{-1} = 0.0821 \text{ dm}^3\text{atm mol}^{-1}\text{K}^{-1}$$



P.T.O.

1. (a) Neatly draw the Born-Haber cycle for the formation of KCl(s) and calculate its lattice energy using the data given below :

$$\Delta_{\text{sub}}H(\text{K,s}) = 89 \text{ kJ mol}^{-1}$$

$$\frac{1}{2}\Delta_{\text{diss}}H(\text{Cl}_2,\text{g}) = 122 \text{ kJ mol}^{-1}$$

$$\Delta_{\text{IE}}H(\text{K,g}) = 418 \text{ kJ mol}^{-1}$$

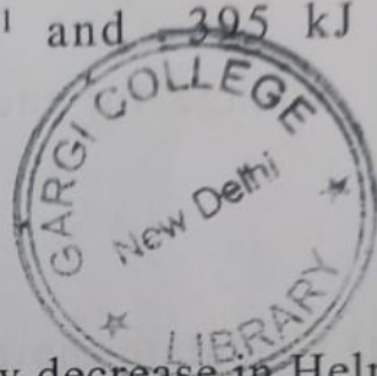
$$\Delta_{\text{EA}}H(\text{Cl,g}) = -349 \text{ kJ mol}^{-1}$$



$$\Delta_f H^0(\text{KCl,s}) = -437 \text{ kJ mol}^{-1} \quad (5)$$

- (b) State the third law of thermodynamics and explain its significance. What can you comment about the absolute entropy of laughing gas (N_2O) at 0 K?
- (5)

(c) Define enthalpy of formation. 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 $\text{CO}_2\text{(g)}$ are -287 kJ mol^{-1} and -395 kJ mol^{-1} respectively. (5)



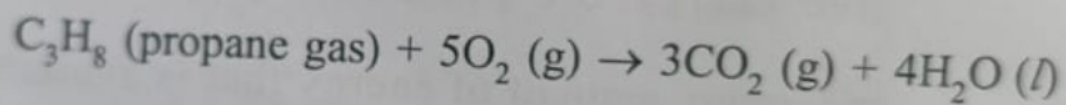
2. (a) Explain mathematically how decrease in Helmholtz free energy ΔA (work function) represents the maximum amount of energy that is available to be converted to work? (5)

(b) Explain why the enthalpy of neutralization of any strong acid with a strong base is always a constant i.e. $-57.3 \text{ kJ mol}^{-1}$. 100 mL of a weak acid (1 M) is mixed with 100 mL of a strong base (1 M). Comment on whether the enthalpy of neutralization will be less, more or same as compared to the value $-57.3 \text{ kJ mol}^{-1}$ and why? (5)

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- (c) One mole of an ideal gas expands reversibly from a volume of 10 dm^3 and temperature 25°C to a volume of 20 dm^3 and temperature -23°C . Assuming that $C_v = 1.5 R$, calculate the entropy change for the process. (5)

3. (a) Calculate the enthalpy change for the reaction



Given the average bond enthalpies (in kJ mol^{-1})

are



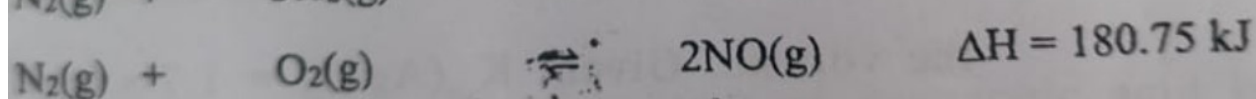
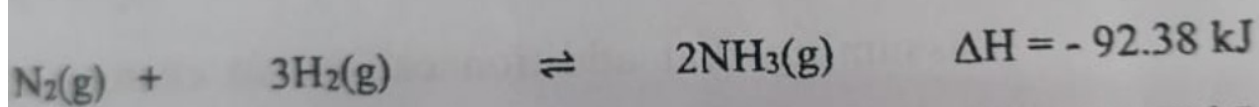
C-C	C-H	C=O	O=O	O-H
347	414	741	498	464

(5)

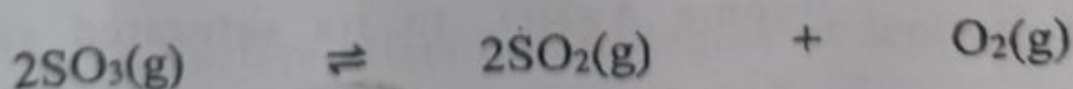
- (b) What is C_p and C_v . Show thermodynamically that for an ideal gas $C_p - C_v = nR$. (5)

(c) Calculate q , w , ΔU and ΔH for the reversible isothermal expansion of one mole of an ideal gas at 27°C from a volume of 10 dm^3 to a volume of 20 dm^3 . (5)

4. (a) State Le Chatelier's principle. With the help of this principle, work out the conditions which would favor the formation of ammonia and nitric oxide in the following reactions :



(b) Calculate K_c for the reaction



for which $K_p = 3.5 \times 10^{-23}\text{ atm}$ at 27°C . (5)



- (c) Calculate the degree of dissociation of Br_2 gas into Br atoms if at 1600 K and a total pressure of 0.1 atm, $K_p = 0.255$ atm. (5)
5. (a) Derive the Henderson Hasselbalch equation for the expression of pH of acidic buffer solutions. (5)
- (b) (i) Solid AgNO_3 is added to a of solution containing 0.1 M Cl^- and 0.001 M in CrO_4^{2-} . Which will precipitate first, AgCl or Ag_2CrO_4 , assuming that addition causes no change in the volume. Given: $K_{sp}(\text{AgCl}) = 1.7 \times 10^{-10} \text{ M}^2$, $K_{sp}(\text{Ag}_2\text{CrO}_4) = 1.9 \times 10^{-12} \text{ M}^3$. (2.5)
- (ii) Solubility of AgCl decreases on addition of some AgNO_3 to its saturated solution. Explain. (2.5)



(c) At 25°C , the degree of ionization of water was found to be 1.8×10^{-9} . Calculate the dissociation constant and the ionic product of water at this temperature. (5)

6. (a) For 0.01 M Propanoic acid at 25°C calculate the following :

- (i) Degree of ionization
- (ii) Hydrogen ion concentration
- (iii) pH and pOH



The dissociation constant of Propanoic acid is 1.34×10^{-5} M. (5)

(b) Explain the following : (5)

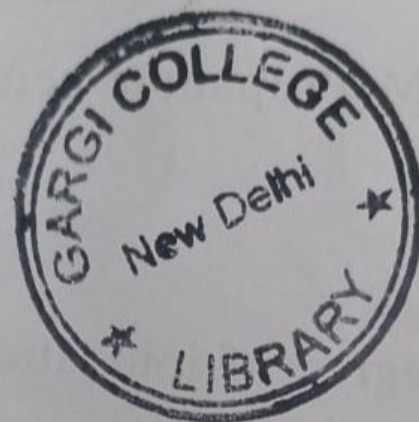
- (i) Factors affecting the degree of ionization of electrolyte
- (ii) Ionic product of water

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- (c) The solubility of CaF_2 in water at 20°C is 15.6 mg per dm^3 of the solution. Calculate the solubility product of CaF_2 . (At mean of $\text{Ca} = 40 \text{ u}$ and $\text{F} = 19 \text{ u}$) (5)



21 Your Roll No.....

Sr. No. of Question Paper : 4801

G

Unique Paper Code : 42354302

Name of the Paper : Algebra

Name of the Course : B.Sc. (Prog.)

Semester : III

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. This question paper has **six** questions in all.
3. Attempt any **two** parts from each question.
4. **All** questions are compulsory.

Unit I



1. (a) Find the inverse of $\begin{bmatrix} 2 & 1 \\ 4 & 3 \end{bmatrix}$ in $GL(2, Z_5)$, the group of 2×2 non-singular matrices over Z . Verify the answer by direct calculation. (6)

P.T.O.

(b) Describe the group of symmetries of a square and draw its Cayley's table. (6)

(c) Find the orders of each of the elements of $U(14)$. Show that it is cyclic and find all its generators. (6)

(a) Let G be a group and let $a \in G$. Prove that $\langle a^{-1} \rangle = \langle a \rangle$. (6)

(b) State and prove Lagrange's Theorem. (6)

(c) If G is a group such that $x^2 = e$ for all elements x of G where e is the identity element of G then prove that G is an abelian group. (6)

(a) Prove that in a finite group, the order of each element of the group divides the order of the group. (6)

(b) Define an alternating group. Find all the elements of A_4 . (6)

(c) Let $\sigma = (1,5,7)(2,5,3)(1,6)$. Then find σ^{17} . (6)



4. (a) (i) Let a belong to a ring R . Let $S = \{x \in R : ax = 0\}$. Show that S is a subring of R .

(ii) Prove or disprove $3\mathbb{Z} \cup 5\mathbb{Z}$ is a subring of the ring $\mathbb{Z}$ of integers. (6.5)

(b) State the Subring Test and Show that the set

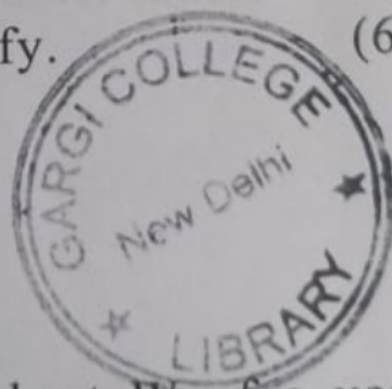
$$S = \left\{ \begin{bmatrix} x & x & x \\ x & x & x \\ x & x & x \end{bmatrix} : x \in \mathbb{R} \right\} \text{ is subring of the ring of all}$$

3×3 matrices over real numbers. Also find the unity of S . (6.5)

(c) Define an ideal of a ring R . Prove that the intersection of two ideals of a ring R is an ideal of a ring R . What can you say about the union of two ideals of a ring R ? Justify. (6.5)

Unit III

5. (a) Prove that a non - empty subset W of a vector space $V(F)$ is a subspace of V if and only if $\alpha x + \beta y \in W$ for all $\alpha, \beta \in F$ and $x, y \in W$. (6.5)



(b) Let $\{a, b, c\}$ be a basis for the Vector Space. Prove that the set $\{a+b, b+c, c+a\}$, $\{a, a+b, a+b+c\}$ are also bases of R^3 . (6.5)

(c) Define Linear Transformation. Check whether the mapping $T: R^2 \rightarrow R^2$ defined by $T(x, y) = (1+x, y)$ is a Linear Transformation. (6.5)

5. (a) Suppose that $T: R^2 \rightarrow R^2$ is a Linear Transformation. If $T(1,0) = (1,4)$ and $T(1,1) = (2,5)$. Find $T(2,3)$. Is T one-to-one? (6.5)

(b) Let $T: V \rightarrow U$ be a Linear Transformation. Then prove that T is one-to-one if and only if the null space $N(T) = \{0\}$. (6.5)

(c) Let $T: R^2 \rightarrow R^3$ be a Linear Transformation defined by $T(x,y) = (x, x+y, y)$. Find the Range, Rank, Kernal and Nullity of T . (6.5)



[This question paper contains 8 printed pages.]

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Your Roll No.....

Sr. No. of Question Paper : 4806

G

Unique Paper Code : 42174304

Name of the Paper : Solutions, Phase Equilibria,
Conductance, Electrochemistry
& Functional Group Organic
Chemistry-II

Name of the Course : B.Sc. (Prog.)

Semester : III

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. **Section A** and **Section B** carry equal marks.
3. Use separate answer sheets for **Section A** and **Section B**.
4. Use of simple calculator is allowed.

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SECTION A

(Attempt any three questions in all)

1. (a) Draw and discuss the phase diagram of water.

(b) Explain the impact of impurities on the CST of phenol-water system.

(c) Discuss the vapour pressure properties of two immiscible liquids. How are these facts utilized in determining molar mass of a liquid by steam distillation.

(4,4,4.5)

2. (a) Explain how we determine transport number using Hittorf's method.

(b) Plot well labelled conductometric titration curves obtained in the titration of

(i) strong acid and strong base

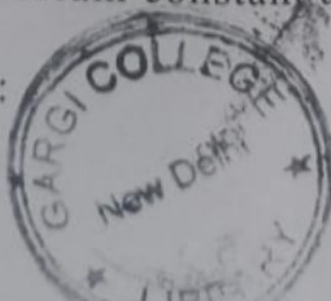
(ii) weak acid and strong base

State any two advantages of conductometric titration over volumetric titration using indicators.

- (c) Specific conductance of 0.01M acetic acid solution at 25°C is $1.63 \times 10^{-2} \text{ Sm}^{-1}$ and its molar conductance at infinite dilution is $390.7 \times 10^{-4} \text{ Sm}^2\text{mole}^{-1}$. Calculate the degree of dissociation and dissociation constant of the acid.

(4,4,4.5)

3. (a) Discuss the factors on which transport number depends.
- (b) Explain why $\text{KCl-NaCl-H}_2\text{O}$ is a 3-component system whereas $\text{KCl-NaBr-H}_2\text{O}$ is a 4-component system.
- (c) Calculate the equilibrium constant at 298K for the following reaction :



P.T.O.



(Given that $E^\circ(\text{Fe}^{+3}, \text{Fe}^{+2}) = +0.77\text{V}$ and $E^\circ(\text{Sn}^{+4}, \text{Sn}^{+2}) = +0.15\text{V}$)

(d) How does a salt bridge in galvanic cell prevent the liquid junction potential? (3,3,4,2.5)

4. Write short notes on the following (Any five) :

- (a) Concentration cells
- (b) Differentiate between Congruent and incongruent melting compound system.
- (c) Solvent extraction
- (d) Lever rule
- (e) Determination of Transport Number using Moving Boundary method.
- (f) Ag-AgCl electrode



(2.5×5=12.5)

SECTION B

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(Attempt any **three** questions in all)

5. (a) How will you distinguish between aniline N-methylaniline and N, N-dimethylaniline using nitrous acid? Give the reaction involved.
- (b) Describe Edman degradation method to determine the N-terminal amino acid in a peptide chain.
- (c) Explain the term isoelectric point and its application in the separation of amino acids.
- (d) How benzene diazonium chloride can be converted to (i) Benzene (ii) Phenol. (3.5, 3, 3, 2 × 1.5)
6. (a) Write the structure of products when D-glucose react with the following :



- (i) Excess of $C_6H_5NHNH_2$
- (ii) HI/Red Phosphorus
- (iii) Br_2 water



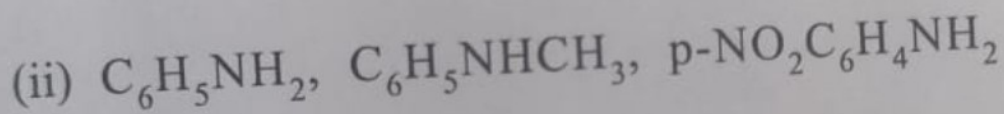
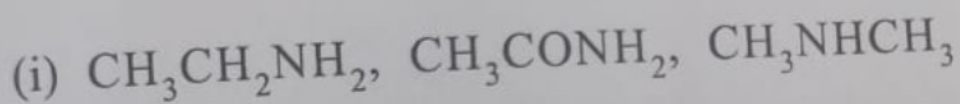
- (b) How will you convert an aldohexose to aldopentose sugar?
- (c) The alkaline hydrolysis of an ester is preferred than acidic hydrolysis. Justify.
- (d) Explain why direct nitration of aniline gives m-nitroaniline instead of o, p-products. How aniline can be converted into p-nitroaniline?

(3×1,3,3,3.5)

7. (a) What are essential amino acids? How will you synthesize glycylalanine starting from glycine and alanine using N-protection and C-activating group.

(b) What happens when aqueous solution of α -D-Glucose is kept for some time? Name the phenomenon and discuss the mechanism.

(c) Arrange the following in order of increasing basic strength and justify your answer :



(4.5, 4, 2 $\times$ 2)

(a) What are different methods used for estimation of amino acids in proteins?

(b) Write short notes on any **three** of the following :

(i) Claisen condensation

(ii) Schotten-Baumann Reaction



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(iii) Strecker synthesis

(iv) Diazo-coupling reaction



[This question paper contains 8 printed pages.]

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Your Roll No.....

Sr. No. of Question Paper : 1791

G

Unique Paper Code : 2173522002

Name of the Paper : DSE: Polynuclear
Hydrocarbons,
Pharmaceutical Compounds,
UV-Visible & IR
Spectroscopy

Name of the Course : B.Sc. (Prog.)

Semester : III

Duration : 2 Hours

Maximum Marks : 60

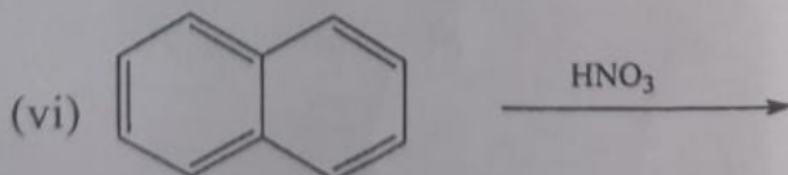
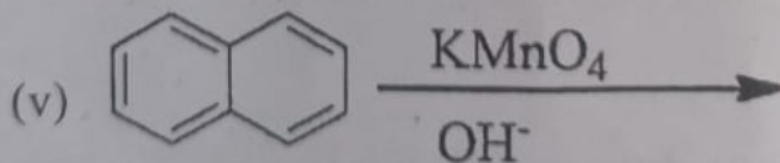
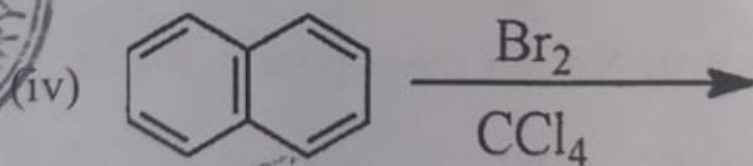
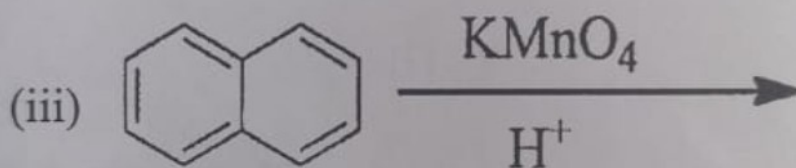
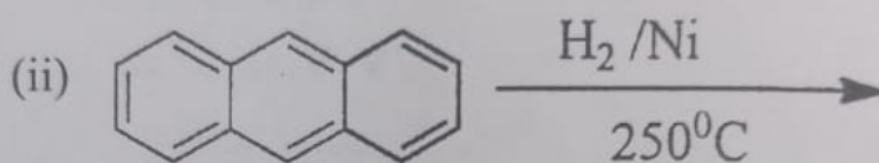
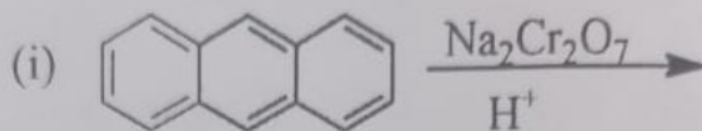
Instructions for Candidates

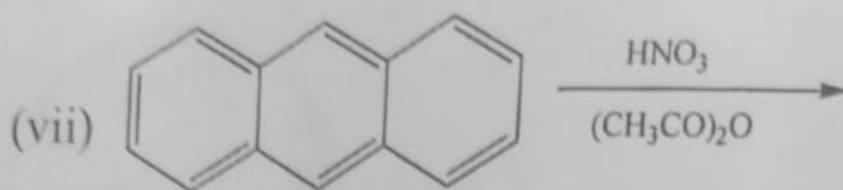
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All questions carry equal marks.
3. Answer **any four** questions in all.
4. Attempt all parts of a question together.



1. (a) Complete the following reactions:

(7×1)



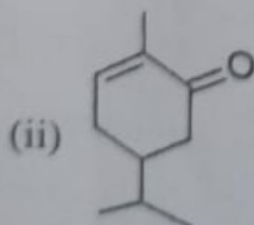
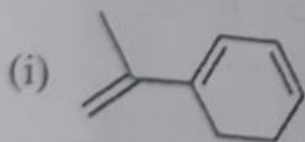


(b) Give reactions that show that naphthalene consists of two benzene rings fused together at ortho positions. (4)

(c) What is the medicinal importance of curcumin and neem? (2)

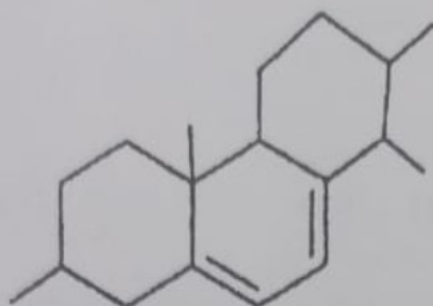
(d) How do antibiotics work in the body? (2)

2. (a) Calculate $\lambda_{\max}$ for the following: (3×3)



36

(iii)



Base value for α , β -unsaturated ketones = 215 nm

Increment for each substituent

Alkyl substituent or ring residue at the α -position = 10 nm, β -position = 12 nm, γ - or δ - or higher position = 18 nm, Exocyclic double bond = 5 nm, Double bond extended conjugation = 30 nm

Base value for acyclic /heteroannular diene = 214 nm, Homoannular diene = 253 nm

Increment for each substituent

Alkyl substituent or ring residue = 5 nm, Exocyclic double bond = 5 nm, Double bond extended conjugation = 30 nm

(b) How is IR spectroscopy useful to distinguish inter- and intramolecular hydrogen bonding? Explain using suitable example (4)

(c) What is an exocyclic bond? Draw a molecule with an exocyclic bond. (2)

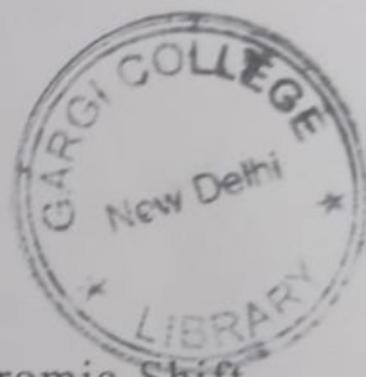
(a) Write a short note on the following: (2×4)

(i) Chromophore and Auxochrome

(ii) Bathochromic Shift and Hypsochromic Shift

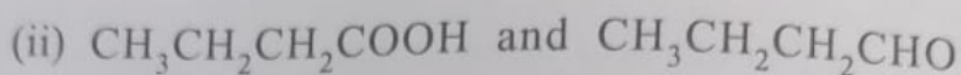
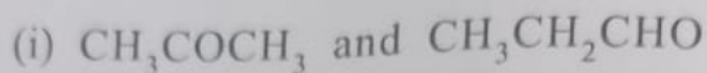
(b) Give the resonating structures of anthracene and comment on its aromatic behavior (4)

(c) Define analgesic drugs with examples. (3)



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4. (a) How will you distinguish between the following compounds using IR spectroscopy: (2×3)



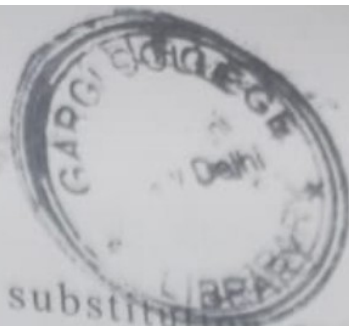
- (b) Explain the sulphonation of naphthalene at different temperatures. (4)

- (c) How will you convert naphthalene into decalin? (3)

- (d) What is the principle of IR spectroscopy? (2)

5. (a) Explain the importance of fingerprint and functional group region in IR Spectroscopy in structural determination. (4)





(b) Explain electrophilic substitution reaction in anthracene.

(4)

(c) Explain why naphthalene is more reactive than benzene towards electrophilic substitution reaction.

(4)

(d) Why are broad absorption bands observed in the UV spectrum instead of sharp peaks?

(3)

(a) What is the condition for a molecule to be IR active? Which of the following compounds are IR active and why, give reasons: O_2 , CO_2 , HCl , $CH_2=CH_2$, CH_3CHO .

(6)

(b) How is paracetamol synthesized? Give its mode of action.

(4)

1791

8

410

(c) Give the stepwise synthesis of anthracene using phthalic anhydride. (3)

(d) Give the structure of the chloroquine. (2)



[This question paper contains 4 printed pages.]

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Your Roll No.....

Sr. No. of Question Paper : 4862

G

Unique Paper Code : 42357501

Name of the Paper : Differential Equations

Name of the Course : B.Sc. (Prog.) – DSE

Semester : V

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 any **two** parts from each question.

1. (a) Find the value of A such that the following equation is exact and then solve it.

$$(Ax^2y + 2y^2)dx + (x^3 + 4xy)dy = 0.$$

- (b) Solve the initial-value problem

$$x^2 \frac{dy}{dx} + xy = \frac{y^3}{x}, \quad y(1) = 1.$$

(c) Solve the differential equation

$$(x + 2y - 1)dx - (x + 2y + 1)dy = 0. \quad (6+6)$$

2. (a) Find a family of oblique trajectories that intersect the family of curves

$$x + y = cx^2,$$

at angle α such that $\tan(\alpha) = 2$.

- (b) Show that x and x^2 are linearly independent solutions of the differential equation

$$x^2 \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} + 2y = 0 \text{ on the interval } 0 < x < \infty.$$

Find the solution of this differential equation which satisfies the conditions

$$y(1) = 3, y'(1) = 2.$$

- (c) Given that $y = x$ is a solution of

$$(x^2 - 1) \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} + 2y = 0.$$

Find a linearly independent solution by reducing the order. Also write the general solution.

(6+6)

3. (a) Solve the initial value problem

$$\frac{d^2 y}{dx^2} + 8 \frac{dy}{dx} + 16y = 8e^{-2x}, \quad y(0) = 2, \quad y'(0) = 0.$$



(b) Use the method of variation of parameters to solve

$$\frac{d^2y}{dx^2} + 6\frac{dy}{dx} + 9y = \frac{e^{-3x}}{x^3}.$$

(c) Find the general solution of

$$x^2 \frac{d^2y}{dx^2} - x(x+2) \frac{dy}{dx} + (x+2)y = x^3$$

given that $y = x$ and $y = xe^x$ are linearly independent solutions of the corresponding homogeneous equation. (6+6)

4. (a) Find the general solution of the equation

$$(3x+1)^2 \frac{d^2y}{dx^2} - (3x+1) \frac{dy}{dx} + 3y = 1.$$

(b) Find the general solution of the linear system

$$\frac{dx}{dt} + \frac{dy}{dt} - 2x - 4y = e^t,$$

$$\frac{dx}{dt} + \frac{dy}{dt} - y = e^{4t}.$$

(c) Find the general solution of the linear system

$$\frac{d^2x}{dt^2} + 4\frac{dy}{dt} + x - 4y = 0,$$

$$\frac{dx}{dt} + \frac{dy}{dt} - 3x + 9y = e^{2t}$$

(6+6)



5. (a) Find the partial differential equation satisfied by the following surface

$$z = f(x - y).$$

- (b) Find the general solution of the partial differential equation

$$(1 + x^2)u_x + u_y = 0.$$

- (c) Solve the following Cauchy problem

$$3u_x + 2u_y = 0, u(x, 0) = \sin(x). \quad (6.5+6.5)$$

6. (a) Apply the method of separation of variables $u(x, y) = f(x)g(y)$ to solve the following equation

$$u_x u_y = u^2.$$

- (b) Find general solution of the following second order partial differential equation with constant coefficients

$$4u_{xx} + u_{yy} = 0$$

- (c) Classify the following equation and obtain general solution by reducing it to canonical form

$$y^2 u_{xx} - x^2 u_{yy} = 0. \quad (7+7)$$

