

(6)
(OR)

How many elements of symmetry are there in a simple cubic crystal? Calculate the limiting radius ratio of cation to anion in a tetrahedral crystal structure. 4

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Ex/SC/CHEM/UG/MAJOR/TH/11/101/2025

BACHELOR OF SCIENCE EXAMINATION, 2025

(1st Year, 1st Semester)

CHEMISTRY-I

PAPER : UG/MAJOR/TH/11/101

Time : Two Hours

Full Marks : 40

Use a separate Answer Script for each CO.

UNIT—101-I

Answer **all** questions :

[CO1]

1. (a) Name two limitations of Bohr's atomic model. How did Sommerfeld rectify the Bohr's model to explain the fine structure of the atom? 1+2
- (b) Determine the appropriate term symbol for the ground state of Cr^{3+} ion. 1
- (c) How will you interpret ψ (wave function) physically by taking into consideration both particle and wave characteristics? 2
- (d) Write down the time-independent Schrödinger wave equation. What do you mean by the terms eigenfunctions and eigenvalues? 2
- (e) Sketch the radial wave function of $2p$ orbital for the hydrogen atom. 1

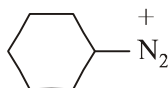
(2)

- (f) First Ionization Energies (IE_1) of B, Al, Ga and In are 801 kJ/mol, 582 kJ/mol, 578 kJ/mol and 558 kJ/mol, respectively. Explain the anomaly in IE_1 trend on going from Al to Ga. 1

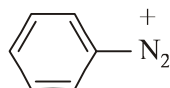
UNIT—101-O-a & O-b

[CO2]

2. (a) Oxidation of trimethylamine $[(CH_3)_3N]$, boiling point $5^\circ C$, dipole moment : 0.61D] produces trimethylamine oxide $[(CH_3)_3NO]$ as a colourless solid compound (melting point : $221^\circ C$, dipole moment : 5.4D). Write down the structure of trimethylamine oxide indicating the formal charges (if applicable) and qualitatively account for its aforesaid properties. 2
- (b) Comment on the relative stability of the following cations **A** and **B** with justification. 1

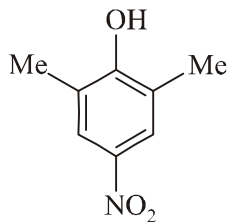


A

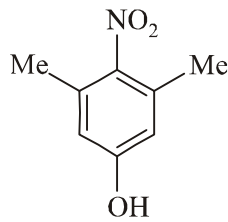


B

- (c) Which one of the following compounds (**C** and **D**) is more acidic and why? 2



C



D

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[Continued]

(5)

- (e) The reaction of 1,3-pentadiene and HCl generates 1,2 and 1,4 addition products and both are the same products. Determine the Kinetically Controlled Product (KCP, Arrhenius product) and Thermodynamically Controlled Product (TCP, van't Hoff product). Which one will be the major product? $2\frac{1}{2}$
- (f) What do you mean by primary kinetic isotopic effect? Explain the underline principle. $1\frac{1}{2}$

UNIT—101-P

Answer *any two* questions :

$3 \times 2 = 6$

[CO4]

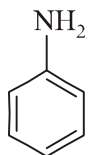
4. (a) Write down the Maxwell-Boltzmann velocity distribution equation. Draw and explain the distribution curves for same gas at different temperatures.
- (b) What is collision frequency (Z_{AA}) of gas molecules? Derive the expression for collision frequency (Z_{AA}).
- (c) What is virial equation of state? Express van der Waals equation in virial form and find Boyle temperature (T_B) from it.
5. Explain capillary action. How does viscosity of a liquid change with temperature? 4

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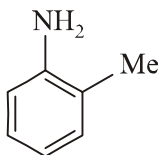
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(3)

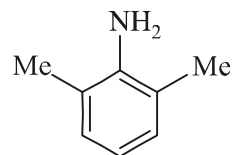
- (d) The pK_a values (in 50% aqueous ethanol) of the following bases (E, F and G) are 4.25, 3.98 and 3.42 respectively. Logically justify their basicity order. 2



E



F



G

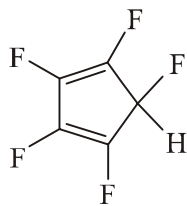
- (e) Briefly discuss with a suitable example what you mean by 'Frustrated Lewis Pair' (FLP). 2
- (f) Draw the π -molecular orbital pictures of HOMO and LUMO of 1,3-butadiene (in the ground state). 1

[CO3]

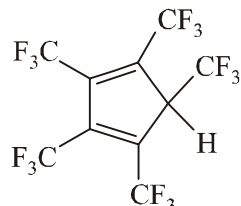
3. (a) Explain the following series of increasing acidity: 1½



pK_a 16



14



-2

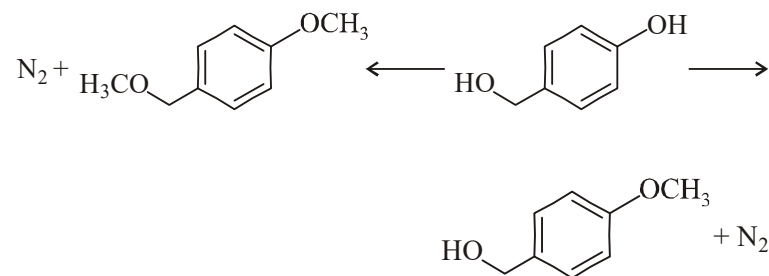
- (b) Tricyclopropylcyclopropene undergoes very rapid and facile hydride exchange with trityl cation. Explain the statement. 1

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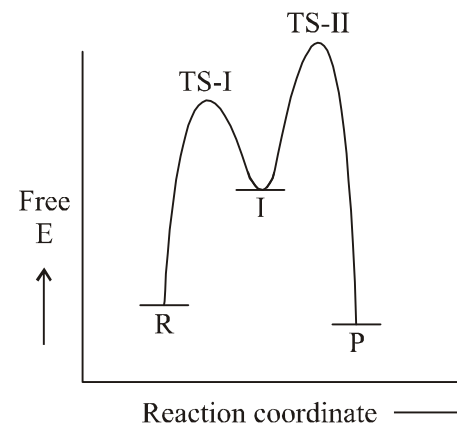
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(4)

- (c) Carry out the following transformations. Mention the reagents only: 1½



- (d) Determine the Rate Determining Step (RDS) of the reaction from the following energy profile diagram with suitable explanation. Calculate the free energy of activation of the overall reaction. 2



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[Continued]