

Five Year Integrated M.Sc. Examination 2023

Semester - I

Course: CH-1-1-1

(Chemistry)

Full Marks: 60

Time: Three Hours

Questions are of value as indicated in the margin

Group-A

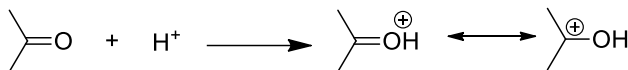
Answer **any four** questions

1. (a) Calculate the size of the He^+ ion from Bohr's Theory. 2
Given: $\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2\text{N}^{-1}\text{m}^{-2}$; $m = 9.109 \times 10^{-31} \text{ kg}$; $e = 1.602 \times 10^{-19} \text{ C}$
(b) Discuss on Sommerfeld's extension of Bohr's atomic model. 3
2. (a) Using tracer studies establish (i) non-equivalence of two sulfur atoms in $\text{S}_2\text{O}_3^{2-}$ ion and (ii) equivalence of iodine atoms in HgI_4^{2-} . 3
(b) Find out the wavelength (in nanometer) of the first line in the visible spectrum of hydrogen atom. 2
Given: Rydberg constant: $1.0974 \times 10^7 \text{ m}^{-1}$
3. (a) Write a short note on nuclear fission reaction. 2
(b) Define van der Waals' radii and covalent radii. Explain the variation of atomic radii along a period and down a group in the periodic table. 1+2
4. (a) Find out the ground state term symbol for a d^8 system. 2
(b) Define ionization potential. What are the factors controlling ionization potential? 1+2
5. (a) What are magic numbers? Give two examples to understand the stability of nucleus associated with magic numbers. 1+1
(b) State Pauli's exclusion principle. Hence establish that a p -orbital cannot accommodate more than 6 electrons. 1+2

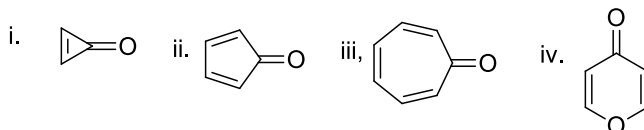
Group-B

Answer **any four** questions

6. (a) Protonation of a carbonyl group forms a cation with significant charge on the carbon atom. 2.0

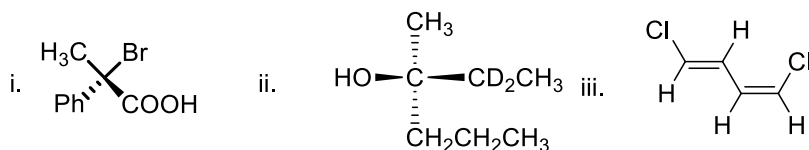


Identify the nature (aromatic or antiaromatic) of the formed cation on protonation of the following carbonyl compounds.



(b) Assign R/S or E/Z descriptor to the following compounds showing priority sequence of ligands.

3.0



7. (a) 1,2-Dibromoethane has zero dipole moment in gaseous phase but in solution the dipole moment increases with increase in polarity of the solvent. Explain.

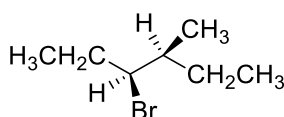
2.0

(b) An optically pure sample of (R)-(-)-2-butanol shows a specific rotation $+13.6^\circ$. What relative proportion of (S)-(+)-2-butanol and (R)-(-)-2-butanol would give a specific rotation of $+6.8^\circ$? What is the optical purity of the above mixture?

2.0

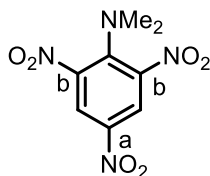
(c) Convert the following Flying-Wedge to Fischer projection formulae:

1.0



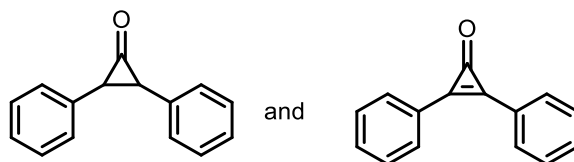
8. (a) Which C-N bond (a or b) has higher bond length. Explain.

2.0



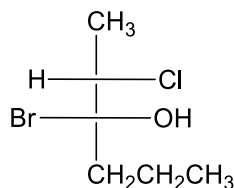
(b) Compare the dipole moments of the following compounds and explain.

2.0



(c) Convert the given Fischer projection into Newman and corresponding Sawhorse projection formulae (only staggered conformations).

1.0

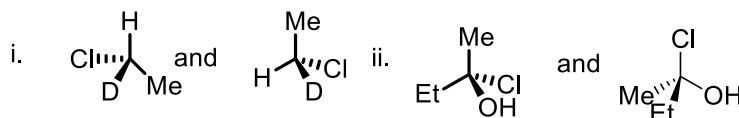


9. (a) Compare and explain the dipole moments of ethyl chloride and vinyl chloride (1-chloro ethene).

2.0

(b) Label the following pairs of molecules as homomers, enantiomers, or, diastereomers as the case may be with justification.

2.0



- (c) Dipole moments of MeF (1.56 D) and MeCl (1.51 D) are similar even though fluorine is more electronegative than chlorine. 1.0
10. (a) Compare the marked (a and b) bond length in the following compound. 1.5
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- (b) Indicate the element(s) of symmetry, if any, present in the following molecules. 1.0
- i. CHBr_3 ii.
- (c) Draw the energy profile diagram of propane and identify the conformers and compare their stability. 2.5

Group-C

Answer *any four* questions

11. (a) Using Maxwell's distribution of molecular speed, derive the expression for the root mean square speed (C_{rms}) of an ideal gas. 2
- (b) Calculate the pressure exerted by 22 g of CO_2 in 0.5 L container at 298.15 K using (i) ideal gas law and (ii) van der Waal's equation. 3
- Given, 'a' = 363.76 $\text{kPa}\cdot\text{L}^2\cdot\text{M}^{-2}$ and 'b' = 42.67 $\text{cm}^3\cdot\text{M}^{-1}$
12. Write notes on
- (a) Collision frequency 2
- (b) Mean free-path 2
- (c) Debye forces 1
13. (a) State the principal of equipartition of energy. Calculate the heat capacity (C_v) of N_2O (linear) molecule at room temperature. 1+2
- (b) What is critical temperature (T_c)? The critical temperature, T_c , and critical density of CO_2 gas are 31 °C and 0.341 $\text{g}\cdot\text{cm}^{-3}$, respectively. Calculate 'a' and 'b'. The molecular weight of CO_2 is 44. 2
14. (a) Define the term compression factor (Z). The compression factor for a gas at moderate pressure and temperature is less than one. Comment. 1+2
- (b) Calculate the temperature at which the average speed of hydrogen molecules is equal to that of oxygen molecules at 320 K 2
15. (a) Deduce the expression for the reduced equation of state of a van der Waal gas and hence define the laws of corresponding states. 2+1
- (b) Calculate the volume of 10 moles of methane at 100 atm pressure and 0 °C. At this temperature and pressure, the compression factor (z) is 0.75. 2