

Five Year Integrated M.Sc. Examination 2022

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

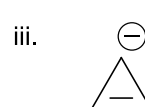
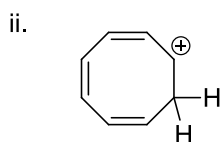
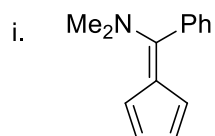
Answer *any four* questions

1. (a) Find out the ground state term symbol of an f^{12} electronic state. 2
(b) State Pauli's exclusion principle. Hence establish that a d -orbital cannot accommodate more than 10 electrons. 1+2
2. (a) State Slater's rule for estimating shielding contributions by various electrons. Find out the effective nuclear charge on a d electron having $Z = 28$. 1.5+1.5
(b) Write down one mechanism each for radioactive change of a nucleus with N/P ratio (i) above and (ii) below the region of stability. 2
3. (a) What do you understand by kinetic isotope effect? Give appropriate example. 2
(b) What is transient and secular equilibrium in connection to radioactivity? Draw the nature of the decay curves in these two types of equilibrium. 2+1
4. (a) What are the conditions for a wave function to be acceptable? 2
(b) Distinguish between an orbit and an orbital. 1
(c) In the light of Aufbau's Principle, explain how many elements appear in periods 1 to 7 of the periodic table. 2
5. (a) Using de Broglie hypothesis arrive at Bohr's condition for stable orbits of electron. 2
(b) What is the difference between absorption spectra and emission spectra? Write the names of the different series of lines in the spectrum of hydrogen atom and explain the formula that gives the wave numbers of the lines in each series. 1+2

Group-B

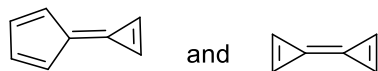
Answer *any four* questions

6. (a) State Hückel's rule of aromaticity, hence label the following compound as aromatic, non-aromatic, antiaromatic or homoaromatic. Explain: 1.0+1.5

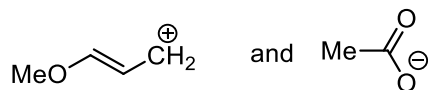


(b) Explain the observed dipole moment of chloroform ($\mu = 1.10$ D), dichloromethane ($\mu = 1.60$ D), and chloromethane (methyl chloride, $\mu = 1.85$ D). 2.5

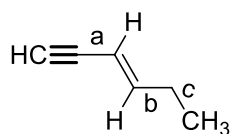
7. (a) Which of the following fulvalenes are significantly polar (higher dipole moment) and why? 1.5



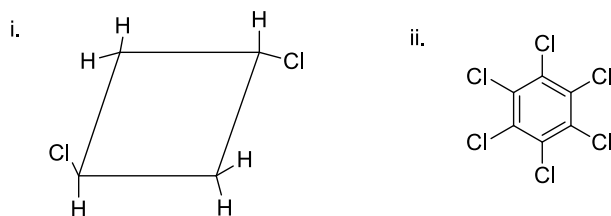
(b) Draw the resonating structures for the following compounds: 1.0+0.5



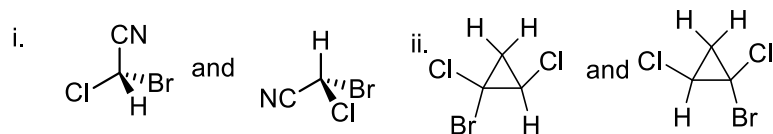
(c) Arrange with reasons the following C-C single bonds marked with a, b and c in order of increasing bond length: 2.0



8. (a) Indicate the element(s) of symmetry, if any, present in the following molecules. 2.0



(b) Label the following pairs of molecules as homomers, enantiomers or diastereomers with justification. 2.0

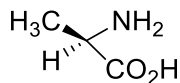


(c) Draw (R)-2-Bromobutane (Gauche form in Newman Projection). 1.0

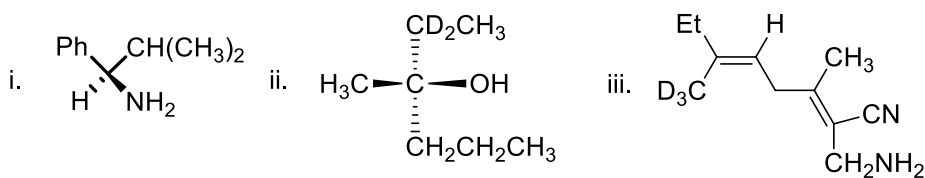
9. (a) Pure (-) enantiomer of an optically active compound A has a specific rotation $[\alpha]_D^{20} = -51.3^\circ$, what is the optical purity of a sample of A which shows a rotation -33.95° ? How much of each enantiomer is present in the enantiomeric mixture? 1.5

(b) Draw the energy profile diagram of n-butane as a function of rotation about C2-C3 bond and label the maxima and minima with proper conformations. Comment on their relative stabilities. 2.5

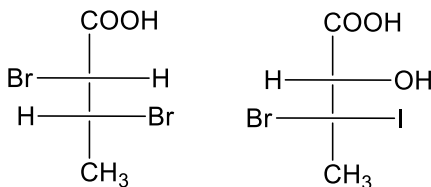
(c) Convert the following Flying-Wedge to Fischer projections formulae: 1.0



10. (a) Define enantiomer and diastereomer. How will they behave under chiral environment? 1.0
 (b) Assign R/S or E/Z descriptor to the following compounds showing priority sequence of ligands (*any two*). 2.0



- (c) Convert the given Fischer projection into Newman, corresponding sawhorse projection formulae (only staggered conformations). 2.0



Group-C

Answer *any four* questions

11. What is the “collision frequency” of a gas molecule? Derive the expression of the collision frequency (Z_{AA}) in an ideal gas, when there are ‘N’ numbers of molecules present in volume (V). The radius of each molecule (A) is ‘r’. 1+4
12. Write down the equation (Don’t derive) of the Maxwell’s distribution of molecular speed of an ideal gas and hence derive the expression for the most probable speed (C_m) of the gas. What do you mean by most probable speed? 1+3+1
13. (a) Define “bond moment and dipole moment”. The dipole moment of CCl_4 is zero, though bond moment of $\text{C} \rightarrow \text{Cl}$ is non-zero. Explain. 1+2
 (b) Define “London Forces”. 2
14. (a) What are the specific heats at constant pressure (C_p) and constant volume (C_v) of an ideal gas? 2
 (b) Write down the different degrees of freedom a water molecule possesses and hence calculate the heat capacity of the water molecule at T K. 1+2
15. (a) Write the basic assumptions of the kinetic model of gases. 2
 (b) Why the ideal gas equation needs to be corrected? Derive the equation of state of a van der Waals gas. 1+2