

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

FIRST YEAR [2017-20]

B.A./B.Sc. FIRST SEMESTER (July – December) 2017

Mid-Semester Examination, September 2017

Date : 12/09/2017

Time : 11 am – 1 pm

CHEMISTRY (Honours)

Paper : I

Full Marks : 50

[Use a separate Answer Book for each group]

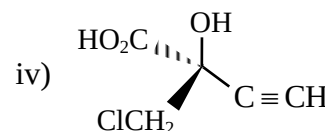
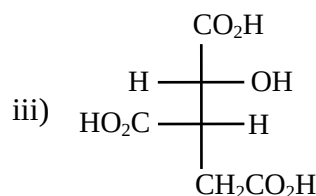
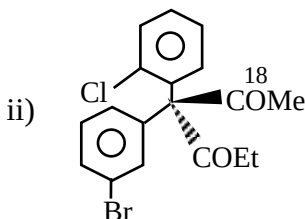
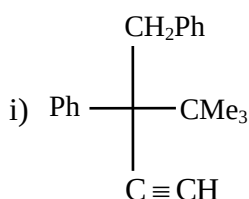
Group – A

[Attempt one question from each Unit]

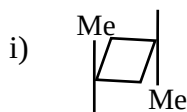
Unit - I

[8 marks]

1. a) Draw the structure of (2S, 3R)-3-bromo-2-butanol in Fisher projection formula. Designate it as Threo/Erythro nomenclature. Draw one staggered conformation of it in Newman projection. [3]
- b) Assign R/S configurational descriptor at the chiral centre of the following compounds. Indicate the priority sequence order. [5]



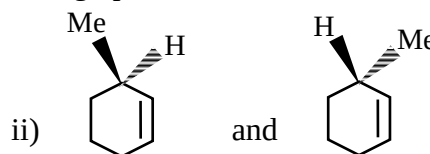
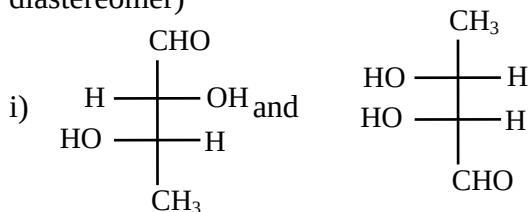
2. a) Indicate the symmetry elements present in the following compounds.



[2]

- b) Justify or criticise: If a molecule has a centre of symmetry, it must also possess S_2 axis. [2]

- c) Indicate the relationship between the following pair of molecules : (Enantiomer or diastereomer) [2]

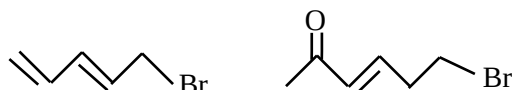


- d) Distinguish : Configuration and conformation. [2]

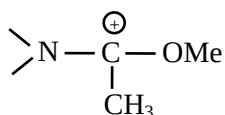
Unit - II

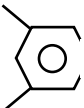
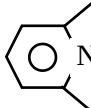
[8 marks]

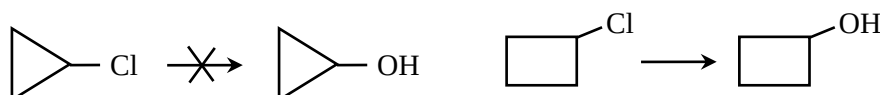
3. a) Indicate total number of possible molecular orbital for C_2H_4 . [1]
- b) Compare the dipole moment for the following compounds. [2]
 $\text{CH}_3\text{CH}_2\text{CHO}(\mu_1)$, $\text{CH}_3-\text{CH}=\text{CH}-\text{CHO}(\mu_2)$, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}_2(\mu_3)$.
- c) Dipole moment of acetone is more than formaldehyde — Explain. [1]
- d) Draw the Pi molecular orbital for allyl cation. [2]
- e) Compare the bond dissociation energy for C–Br bond for the following two compounds. [2]



4. a) Indicate total number of possible molecular orbital for C_2H_2 . [1]
 b) Compare dipole moment for p-Nitroaniline and aniline. [2]
 c) Write down the most stable canonical form for : [1]



- d)  can form stable complex with BMe_3 whereas  can't form any complex with BMe_3 —Explain. [2]
 e) Explain the following observation though both reactions are going through carbocation intermediate. [2]



Group – B

[Attempt one question from each Unit]

Unit – III

[8 marks]

5. a) N number of gas molecules, in a container of V vol. at T temp. gives pressure, P on striking on the walls of the container. If the molecules move in two directions only, then find out the expression for the pressure, P, exerted by the gas molecules. [4]
 b) Define the Maxwell's speed distribution equation for 3 dimensions, explaining the terms. [2]
 c) Find the probability that c for N_2 molecule in a system at 273·15K is in the range $650\text{ms}^{-1} \leq c \leq 651\text{ms}^{-1}$. [2]
 6. a) At which temperature, the average velocity of H_2 will match with the most probable speed of He gas at 400K? [2]
 b) The experimental data for C_v of O_2 does not match with the theoretically predicted value. Explain [3]
 c) Show that the fraction of molecules within speed range c and c+ dc are having energy within ϵ and $\epsilon + d\epsilon$. [3]

Unit – IV

[8 marks]

7. a) A gas is made to undergo the following isothermal changes in state—
 i) (P_i, V_i) to (P_f, V_f) in infinite number of steps
 ii) (P_f, V_f) to (P_i, V_i) in infinite number of steps
 What is the amount of net work done? Show graphically the amount of work done in both cases (i) and (ii). [3]
 b) Derive the equation for the work done in an isothermal, reversible expansion of one mole of a gas obeying the van der Waals' equation of state. [3]
 c) One mole of an ideal gas with $C_v = 2.5R$ is expanded adiabatically until the temperature drops from 293 K to 283 K. Calculate Q, W, ΔU , ΔH . [2]
 8. a) A cyclic process involving 1 mole of an ideal monatomic gas has $W = 100 \text{ J/cycle}$. Q (per cycle) is then (choose from the followings with proper argument) [2]
 i) zero (ii) 100J (iii) -100J (iv) can not tell since the process is not stated to be reversible.

- b) Prove that $C_p - C_v = nR$ for an ideal gas. Comment whether this value for a gas would be lower or higher than this for a gas that obeys the equation $P(V - b) = RT$. [3+1]
- c) 'Closed, adiabatic boundaries isolate a system from its surrounding.' Justify or criticize. [2]

Group – C

[Attempt one question from each Unit]

Unit – V

[9 marks]

9. a) What are the assumptions which Bohr model of hydrogen atom is based on? Cite two instances where the model turned out to be inadequate to provide proper explanation. [2+1]
- b) Calculate the shortest and longest wavelength lines in Paschen series in the hydrogen atomic spectra. (For Paschen series, $n_1 = 3$, $n_2 = n_1 + 1, n_1 + 2, n_1 + 3, \dots$; $R_H = 109677 \text{ cm}^{-1}$) [3]
- c) Radial probability distribution function, $P(r)$ for 1s orbital is expressed as $P(r) = 4\pi r^2 R(r)^2$ where, $R(r) = \frac{2}{a_0^{3/2}} e^{-\frac{r}{a_0}}$. Show that the most probable distance of electron from the nucleus is a_0 . [3]
10. a) What is the significance of a negative sign in the expression of energy of an electron in a hydrogen like atom or ion? [1]
- b) State what physical property is associated with each of the following quantum numbers and give the value of the property in terms of the quantum number. (i) n , (ii) ℓ (iii) m_ℓ , where the terms n , ℓ and m_ℓ have their usual significance. [3]
- c) What is the ratio of the radii of the first three Bohr orbits for hydrogen? [2]
- d) How many radial nodes are present in the following radial distribution functions. Specifying their locations would be unnecessary. [3]

$$\psi_1 = N_1 \frac{r^2}{a_0^2} e^{-\frac{r}{3a_0}}, \quad \psi_2 = N_2 \frac{r}{a_0} \left(2 - \frac{r}{3a_0} \right) e^{-\frac{r}{3a_0}}, \quad \psi_3 = N_3 \frac{r}{a_0} \left(3 - 2r - \frac{2r^2}{9a_0^2} \right) e^{-\frac{r}{3a_0}}.$$

N_1, N_2 and N_3 are constants.

Unit – VI

[9 marks]

11. a) Define Allred and Rochow's electronegativity scale. What are the advantages and disadvantages of Allred and Rochow method of electronegativity? [2+1.5+1.5]
- b) The univalent radius of Ca^{2+} is 117 pm; that for S^{2-} is 219 pm. Calculate the effective crystal radii of the ions, and comment on— 'the interionic distance in CaS is 284 pm'. [3]
- c) 'Electron affinity of noble gases are zero', comment. [1]
12. a) Arrange the following ions in increasing order of their ionic radii; Give reasons. $\text{Cl}^-, \text{Br}^-, \text{I}^-, \text{F}^-, \text{H}^-$. [2]
- b) It is very difficult task to separate Zr and Hf from their mixture. Explain. [2]
- c) Calculate the electronegativity of chlorine in both Pauling and Mulliken's scale. Given, EA (Cl) = 4.0 eV/atom; IE(Cl) = 13.0 eV/atom. [2]
- d) What is the relation between pauling electronegativity with the Allred-Rochow electronegativity co-efficient? [2]
- e) Mention the limitations of Slater's rule. [1]

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