RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, DECEMBER 2017

FIRST YEAR (BATCH 2017-20)

Date : 12/12/2017 **CHEMISTRY (Honours)**

Time : 11.00 am – 1.00 pm Paper : I [Gr-A] Full Marks : 40

[Use one Answer Book for Unit I and another Answer Book for Unit II & III]

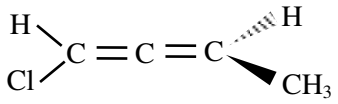
(Attempt one question from each Unit)

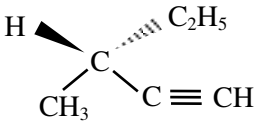
Unit I

[15 marks]

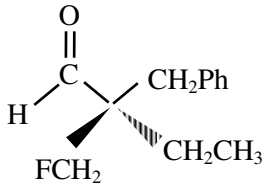
1. a) Draw the energy profile diagram of 1, 2 – dichloroethane for rotation about C – C bond and label the maxima and minima with appropriate conformations. Compare the relative stabilities of the conformations, with explanation. [3]

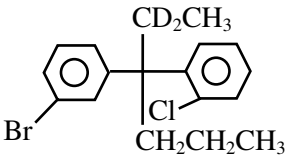
   b) Assign the following compound with R/S discriptor. [2]

   i) 

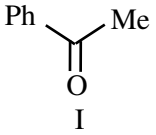
   ii) 

   c) Assign R/S configurational descriptor of the chiral centres of the following molecules; show the priority order. [3]

   i) 

   ii) 

   d) Write the 3D structre of the product alcohol when $H^{(-)}$ attacks from the Re-face of the following molecule (I). Assign R/S designation at the chiral centre of the product. [2]

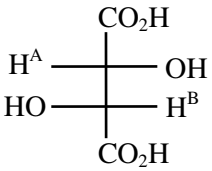
   

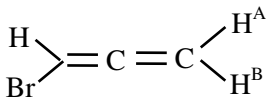
   I

   e) Draw the structure of *meso*–2,3,4–tribrmopentane in Fischer Projection Formula and explain that C-3 is a pseudoasymmetric centre. [2]

   f) What is "Umbrella (invertomeric) effect"; explain in terms of $R_1R_2R_3N:$. [1]

   g) Identify H^A and H^B in each of the following structures as homotopic, enantiotopic or diastereotopic. [2]

   i) 

   ii) 

2. a) What do you mean by conformation and configuration? Explain with the help of examples. [3]

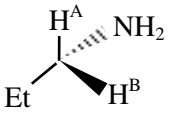
   b) Justify or criticise : [3]

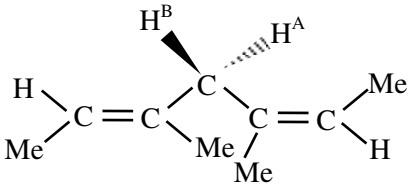
   i) C–2 of propanoic acid is a prochiral centre.

   ii) Methane molecule has an S_4-axis.

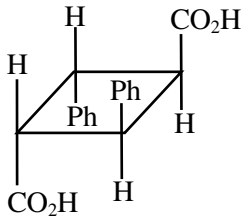
   iii) ethylene glycol has higher dipole moment than 1, 2-dichloroethane.

   c) Identify the *pro*-R and *pro*-S hydrogen atoms (marked 'A' and 'B') in case of the following molecules. [2]

   i) 

   ii) 

d) Indicate the symmetry element(s) present in the following molecules. [1]

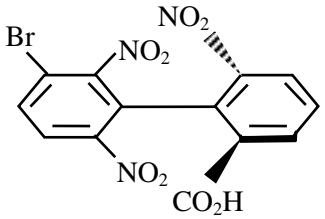


e) Write the structure of the following compounds.
i) (2E, 4Z)-Hexadienoic acid ii) Acetophenone-(E)-Oxime [2]

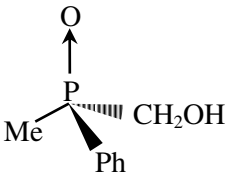
f) How would you resolve a racemic alcohol? [2]

g) Explain whether the following compounds are resolvable or not : [2]

i)

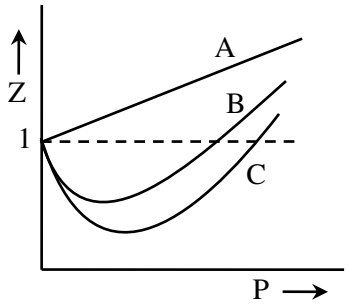


ii)



Unit II [13 marks]

3. a) Given below the Z – P plots of three gases A, B, C at 0°C, Answer the followings with explanation (briefly)



i) Which gas has greater value of van der Waals constant, a?
ii) Which gas can be best described by the equation of state $P(V_m - b) = RT$ at 0°C?
iii) Which gas has lowest T_B? [4]

b) If the speed distribution in one-dimension is given as : $\frac{1}{N}\frac{dn_{C_x}}{dc_x} = \left(\frac{m}{2\pi K_B T}\right)^{1/2} e^{-mc_x^2/2K_B T}$ (terms having their usual meaning), then derive the form for the average energy in one-dimension. Given $\int_{-\infty}^{\infty} e^{-\beta x^2 dx} = \left(\frac{\pi}{\beta}\right)^{1/2}$ and $\int_{-\infty}^{\infty} x^2 e^{-\beta x^2} dx = \frac{1}{2\beta}\left(\frac{\pi}{\beta}\right)^{3/2}$. [3]

c) Apply principle of equipartition of energy to find out the expression of $\bar{C}_V$ for N_2O. [3]

d) Explain the idea of continuity of states using a suitable graphical plot. [3]

4. a) For gases N_2, CO (i) compare the speed distribution curves at temperature $T_{N_2} = T_{CO}$ and (ii) compare energy distribution curves at $T_{N_2} = 2T_{CO}$. [4]

b) Calculate the mean free path for H_2 (collision cross section $\sigma_{H_2} = 2 \cdot 3 \times 10^{-17} m^2$) at 298 K at a pressure of 1 atm. [2]

c) Starting from the mathematical form of the speed distribution in three dimension, derive the corresponding energy distribution. [3]

d) Consider a mixture of gas— CO_2, H_2O and O_2, all being of real nature. The second virial coefficient being a function of intermolecular interactions, is dependent on the physical properties of molecules. Name the type of interactions possibly found in the mixture. Also explain them. [2]

e) Using a suitable equation explain how the mean free path depends on the pressure of the system. [2]

Unit III [12 marks]

5. a) One mole of an ideal gas with molar $C_V = \left(\frac{3}{2}\right)R$, initially at 293K and 1·0 MPa pressure undergoes a two stage transformation—

i) Stage I : Isothermal, reversible expansion to double the initial volume.

ii) Stage II : Beginning at the final state of stage I, keeping the volume constant, the temperature is raised to 353 K.

For each stage I, II and for the overall change, calculate Q, W, ΔU and ΔH. [4]

b) Calculate ΔU and ΔH (per mole, at 25°C) for the reaction : $C_6H_5COOH(S) + \frac{15}{2}O_2(g) \rightarrow 7CO_2(g) + 3H_2O(\ell)$ if the heat evolved while burning 1 gm of C_6H_5COOH in excess O_2 and constant volume was 26·36 KJ, at 25°C (neglect volume of solids and liquids compared to gases). [4]

c) Derive the expression for the reversible isothermal work of expansion for a van der Waals gas. [2]

d) 1 mole of an ideal gas at 1 bar and 298 K is compressed at constant temperature and constant external pressure of 5 bar; caused due to a 100kg mass falling in the surrounding. Determine the distance the mass moved in the surrounding under earth's gravitational field (take g = 9·8 ms^{-2}). [2]

6. a) One mole of an ideal gas of $C_V = 6\,calK^{-1}mole^{-1}$ expands adiabatically from STP to 0·1 atm. (i) Calculate q, w change in U and H if the expansion is reversible (ii) Calculate the final state if the adiabatic expansion is irreversible and such that the work does is 10% of the value in (i). The final pressure is still 0·1 atm. [3+3]

b) State if the following thermodynamic properties are extensive or intensive : (i) density, (ii) specific heat capacity (iii) entropy (iv) enthalpy. [2]

c) Justify that the work done by a system for an isothermal expansion has the maximum magnitude for a reversible transformation. [4]

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