RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, DECEMBER 2018

FIRST YEAR (BATCH 2018-21)

Date : 14/12/2018 **CHEMISTRY (Honours)**

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

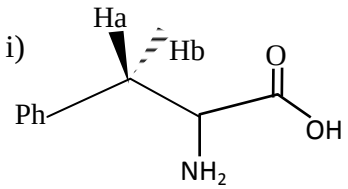
[Use one Answer Book for Unit I and another Answer Book for Unit II & III]

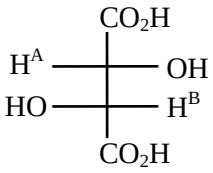
(Attempt one question from each Unit)

Unit I

[15 marks]

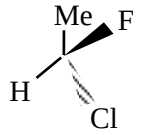
1. a) Justify or Criticise:
   (i) C_2 of (E)-2-butene is a stereogenic centre.
   (ii) If a molecule has (R)-configuration, is must be dextrorotatory. [3]
   b) How many stereoisomers are possible of the following compound CH_3-CH(OH)CH(OH) CH(OH)CH_3. Represent each diastereomer in Fischer projection formula indicating meso-and optically active forms and designate the absolute configuration of the chiral centres of any one diastereomer. [4]
   c) An optically pure sample of R -(-)-2-butanol shows specific rotation of -13.6^0. What relative molar proportion of S -(+)-2-butanol and R -(-)-2- butanol would give a specific rotation of $+6.8^0$? [3]
   d) Identity Ha and Hb in each of the following structures as homotopic, enantiotopic or diasterotopic ligands. [2]

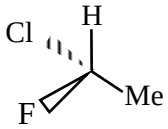
i) 

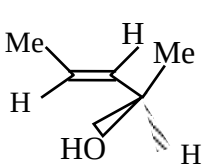
ii) 

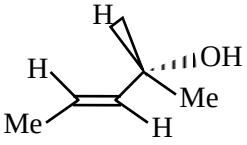
   e) Give an outline of the chemical method of resolution of a racemic alcohol. [3]

2. a) Label the following molecules as homomers, enantiomers or diastereomers: [2]

i) 

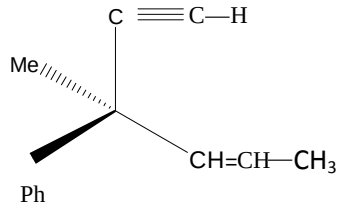
and 

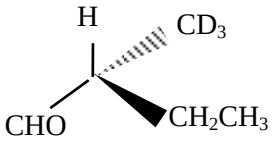
ii) 

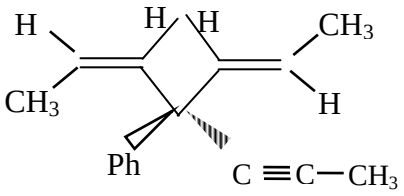
and 

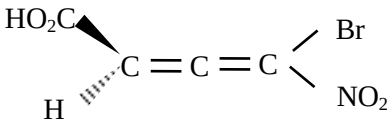
   b) Draw Fischer projection formula of (2R ,3S) -3-phenyl-2-butanol and convert it into flying wedge notation. [2]
   c) Cite examples through their structures according to the instructions given.
   i) A molecule having S_2 axis showing the axis.
   ii) A molecule having two σ planes showing the planes. [2]

d) Assign R/S descriptors to the chiral centres and to the allene in the following compounds. [4]

i) 

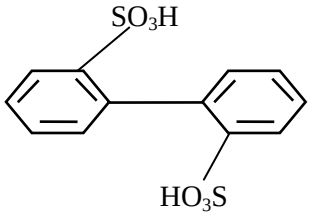
ii) 

iii) 

iv) 

e) Draw the conformational free energy diagram of ethyleneglycol with respect to rotation around C_1-C_2 bond and indicate the conformers in the diagram. [4]

f) Predict whether the following compound will be resolvable or not with proper reason. [1]



Unit II [13 marks]

3. a) Show from the Maxwell's velocity distribution, that the most probable velocity of the gas is a function of temperature of the gas. [3]

b) The virial equation of state in terms of pressure P is given by

$$Z = 1 + \frac{1}{RT}(b - \frac{a}{RT})P + \frac{a}{(RT)^3}(2b - \frac{a}{RT})P^2$$

Set up an expression for the initial slope of Z versus P curve of a real gas and obtain the expression for Boyle temperature. [3]

c) The critial temp, and pressure for NO gas are 177K and 64 atm, respectively, and for CCl_4 they are 550 K and 45 atm, respectively. Which gas has (i) the smaller value of the van der Waals constant 'b' (ii) the smaller value of 'a' (iii) larger critical volume (iv) behaves more ideally at 300K and 10 atm? [1+2+1+1]

d) Show that ratio of rate of collisions on wall for CO_2 gas molecules to that of NH_3 molecules is

$$\frac{\left(\frac{dN_w}{dt}\right)_{CO_2}}{\left(\frac{dN_w}{dt}\right)_{NH_3}} = \frac{P_1}{P_2} \times \sqrt{\frac{T_2}{T_1}}$$ [2]

4. a) Show that the ratio of heat capacities, γ, for water vapour is 7/6, assuming it to behave ideally. [3]

b) Use the Maxwell's distribution of molecular speeds to estimate the fraction of N_2 molecules at 500 K that have speeds in the range 290-300 m sec^{-1}. [3]

c) Out of the three types of intermolecular forces –dipole-dipole force, dipole-induced dipole force, the first one depends on temperature. Explain. [2]

d) For three gases A, B, C $m_A = 2m_B = \frac{1}{2}m_c$ and $T_A = 2T_B = T_C$. Which of the gases have (i) same speed distribution and (ii) same energy distribution? [2]

e) Suppose that a gas contains 10 molecules having instantaneous speed of 2×10^2 ms^{-1}, 30 molecules with a speed of 4×10^2 ms^{-1} and 15 molecules with a speed of 6×10^2 ms^{-1}. Calculate $\langle v^2 \rangle^{1/2}$ mentioning the assumption, if any. [3]

Unit III [12 marks]

5. a) 1 mole of an ideal monatomic gas undergoes a reversible change from 25°C and 1 atm pressure to twice the original volume in such a way that $\Delta U = 0$. Calculate Q and ΔH. [3]

b) Under what conditions ΔH and ΔU (assuming all species to behave as ideal gases and reaction occurring at constant temperature) of a reaction will be equal? Derive the integrated form of the Kirchoff's equation to show the variation of ΔH^0 of a reaction with temperature. [4]

c) The internal energy remains constant in every isothermal process in a closed system. Justify or criticize the statement. [2]

d) Consider the reaction $A + BC \rightleftharpoons AB + C$. Show that the enthalpy change of this reaction is independent of the enthalpy of formation of the elements A, B or C. [3]

6. a) An ideal gas undergoes an expansion process at constant pressure. Does the internal energy increase or decrease? Justify. [3]

b) A differential quantity is given as f = 2ydx + 3xdy. If x, y are independent coordinates explain whether f is state function. [2]

c) Given: heat of formation of H_2O_2: 1070.6 kJ/mole. Bond energy of a single O-H bond in water: 463.34 kJ. Calculate the O-O bond strength in H_2O_2. [2]

d) One mole of an ideal, monatomic gas initially at STP (273K, 1 atm) experiences a reversible process in which the pressure is doubled. The nature of the process is unspecified, but ΔU = 900 cal and q is 400 cal .Calculate the final T, V, ΔH and W for the process. [3]

e) Prove that for an ideal gas $\left(\frac{\partial C_v}{\partial V}\right)_T = 0.$ [2]

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