Use separate answer script for each group

B.Sc.(Honours) Examination, 2018

Semester-I (CBCS)
Chemistry (Honours)
Core Course: CC-2
(Organic Chemistry and Physical Chemistry)

Time: Three Hours **Full Marks: 60**

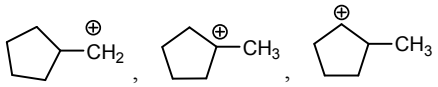
Questions are of value as indicated in the margin.

Group-A (Marks: 30)
(Organic Chemistry)

Answer ***any three*** questions.

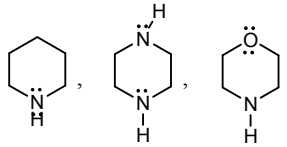
1. a) C = O bond energy is higher than double of C – O single bond energy. Explain why? 2
   b) How the X(F, Cl) group influences on the acidity of the following carboxylic acid? 1

   c) Draw the resonance structures of diazo-methane (CH_2N_2). Arrange their stability in increasing order. 1+1
   d) Give an example of steric inhibition to resonance. 1
   e) $\overset{(-)}{C}(CN)_3$ is planar but $\overset{(-)}{C}(CH_3)_3$ is pyramidal in shape. Why? 2
   f) Arrange the following carbocations in order of their decreasing stability. Give reason. 1+1



(I) (II) (III)

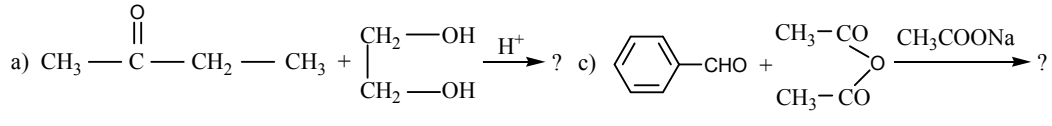
2. a) Methyl alcohol is more acidic than methylthiol. Why? 2
   b) Compare the acidity of chloroacetic acid and fluoroacetic acid in gaseous phase. 2
   c) Arrange the following compounds in order of their decreasing basicity. Give explanation. 3

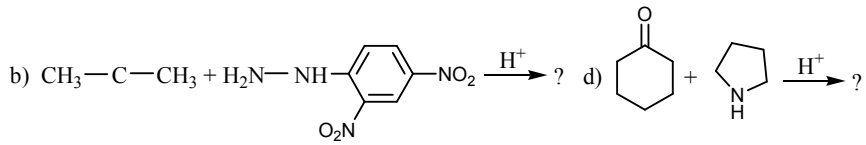


(I) (II) (III)

   d) Methyl chloride shows greater dipole moment than chloroform. Why? 2
   e) Double stranded DNA structure has been possible due to hydrogen bond formation. True or false? 1

3. Predict the major product and suggest a plausible mechanism for each of the following reactions. 2.5x4

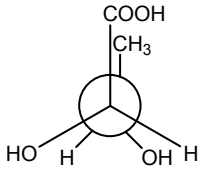




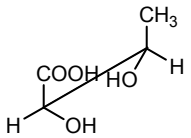
4. a) Write down the Fischer projection by (2*S*, 3*r*, 4*R*)-2,3,4-trihydroxypentan-1,5-dioic acid. 2

P.T.O.

b) What is the stereochemical relationship between I and II? 2



(I)



(II)

c) What is atropisomerism? Explain the phenomenon in case of 3′-bromobiphenyl-2-trimethylarsonium iodide. 2

d) 2,3-Pentadiene does not possess any chiral carbon but shows optical activity. How would you explain this situation? 3

e) Offer an example of a *meso*-isomer which is not an acid. 1

5. a) Define 'centre of symmetry' with a suitable example. 2

b) *Meso*-tartaric acid is optically inactive due to the presence of a plane of symmetry within the molecule. How far this statement is correct? 2

c) Sketch the possible rotamers for n-butane. 3

d) Draw all the possible stereoisomers of 3-bromo-2,4-pentanediol, and comment on their chiroptic nature. 3

Group-B (Marks: 30)
(Physical Chemistry)

Unit-I

Answer***any two***questions.

1. a) Indicate the wrong assumptions about ideal gas which were considered for correction in van der Waals equation. 1

b) What is the London dispersion force? Arrange, I_2, Br_2 and Cl_2 in the increasing order of the London dispersion force. 2

c) Critical temperature of real gases arises due to inter molecular attractive force – explain. 1.5

d) What is the Boyle temperature? Derive its expression from van der Waals equation. 1.5

e) Show two plots of compressibility vs. pressure for different gases keeping temperature constant in one case and in other case taking one gas at different temperature. 1.5

2. a) Derive the expressions of P_c, V_c and T_c from Dieterici equation of state. Then find the critical coefficient. 3

b) Express van der Waals and Dieterici equations of state in the form of Virial equation. 2

c) Suppose for a van der Waals gas inter molecular attraction is neglected. The volume of one mole of such a gas at 0^oC and 50atm. is 2.1036×10^{-2} times the volume of the gas at NTP. Calculate the diameter of the gas molecule. 2.5

3. a) Show the plot of Maxwell's speed distribution for H_2, He and Cl_2 keeping fixed temperature and number of molecules. 1

b) Calculate mean kinetic energy of gas molecules using Maxwell's speed distribution function. 2

c) Find the ratio of most probable, average and root mean square speed of gas molecules. 1

d) Calculate the relative average speed between a molecule of gas A and a molecules of gas B in a mixture. Assume that the average angle of collision is90^o. 1

e) At any given temperature the density of a gas is 0.08g/lt. and the r.m.s. speed is 18.4×10^4 cmS^{-1}. Calculate the pressure of the gas in atm. unit. 2.5

4. a) Define mean free path of a gas molecule. Derive an expression for mean free path both in case of single gas and mixture of two gases. 1+1+2
   b) Discuss the effect of temperature and pressure on mean free path. 2
   c) Calculate the mean free path of N_2 gas at 25°C and 1 atm. pressure (given, $\sigma_{N_2} = 3.7^{\circ}\text{A}$). 1.5

Unit-II

Answer ***any two*** questions.

5. a) Give at least two examples of thermodynamic systems. Are these macroscopic or microscopic or both? Based on your examples state the criterias for a system to be thermodynamic one from the microscopic point of view. 0.5+0.5+1
   b) Define enthalpy using 1st law of thermodynamics. Could you justify whether it is an extensive or intensive state property? 2+1.5
   c) In an adiabatic expansion of one mole of an ideal gas from initial temperature of 25°C, the work produced is 1200J. If $C_V = 1.5R$, calculate the final temperature, Q, W, ΔU and ΔH. 2

6. a) Derive the relation,
   $$df = \left(\frac{\partial f}{\partial x}\right)_y dx + \left(\frac{\partial f}{\partial y}\right)_x dy.$$
   Where f is a function of x and y. Under what condition this equation is valid? Justify the relation for this condition with a suitable example. 1.5+1.5
   b) A given close system is at stationary state. How can you identify whether the given system is at equilibrium or steady state? 3
   c) What is equilibrium thermodynamics? 1.5

7. a) $C_V = \frac{dQ_V}{dT}$ and $C_P = \frac{dQ_P}{dT}$ may have value between $-\infty$ to $+\infty$. Comment on the statement with proper arguments. 1.5+1.5
   b) Plot P vs. V in the same diagram for isothermal and adiabatic reversible processes, respectively. Explain the key features of the curves. 1+2
   c) What is the definition of pressure in thermodynamics? 1.5

8. One mole of an ideal gas is expanded from T, P_1, V_1 to T, P_2, V_2 in two stages;

	Opposing pressure	Volume change
First stage	P' (constant)	V_1 to V'
Second stage	P_2 (constant)	V' to V_2

   We specify that the point P', V' lies on the isotherm at the temperature T.
   a) Formulate the expression for the work produced in this experiment in terms of T, P_1, P_2 and P'. 3
   b) For what value of P' does the work in this two-stage expansion have a maximum value? 3
   c) What is the maximum value of the work produced? 1.5

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