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UG/1st Sem/CHEM(H)/T/19

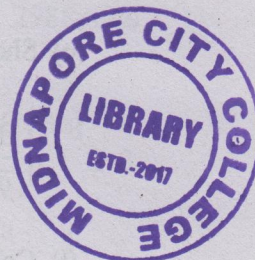
2019

B.Sc.

1st Semester Examination

CHEMISTRY (Honours)

Paper - C 2-T



Full Marks : 40

Time : 2 Hours

*The figures in the margin indicate full marks.  
Candidates are required to give their answers  
in their own words as far as practicable.*

**Group - A**

1. Answer any five questions : 5×2

(a) Prove that  $\mu_{JT} = \frac{1}{C_P} \left[ T \left( \frac{\partial V}{\partial T} \right)_P - V \right]$  2

(b) Write clausius inequality with proper explanation. 2

(c) What is pseudo first order reaction ? Give two examples. 2

[ Turn Over ]



( 2 )

(d) Write down the differences between order and molecularity of a chemical reaction. 2

(e) Show that for a van der Waals gas

$$\left(\frac{\partial H}{\partial P}\right)_T = b - \frac{2a}{RT} \quad 2$$

(f) Calculate the maximum efficiency of a steam engine operating between 30°C and 127°C. Also, calculate the amount of work done in a complete cycle if the quantity of heat taken is 1000 cal at 127°C. 2

(g) Derive the expression of most probable kinetic energy from Maxwell's kinetic energy distribution equation. 2

(h) Define Michaelis-Menten constant. What is turnover number? 1+1

### Group - B

Answer any *four* questions : 4×5

2. (a) Calculate the root mean square speed of ozone molecules at STP,

[Relative atomic mass of oxygen = 16]. 5

( 3 )

(b) Calculate the mean free path and binary collision frequency for oxygen molecules at 298K and pressure of 500 Torr.

[Given : molecules diameter =  $3.6 \times 10^{-10}$  m] 2+3

3. (a) Draw the rate versus time profile of a

(i) zero order reaction

(ii) first order reaction.

(b) For a second order reaction  $A \rightarrow \text{products}$ , show that the time required for 3/4th of the reactant to decay ( $t_{3/4}$ ) is equal to  $3t_{1/2}$ .  
 $2 \times \frac{1}{2} + 2 \times \frac{1}{2} = 5$

4. (a) Draw T-S diagram of a Carnot cycle. Label the states and various processes involved. What does the enclosed area signify?

(b) Show that  $\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$  using an appropriate Maxwell's equation. 3+2

5. (a) Show that  $C_V = -T\left(\frac{\partial^2 A}{\partial T^2}\right)_V$

[ Turn Over ]



( 4 )

- (b) Calculate  $\Delta H_f^\circ$  (298K) of sucrose (s) from the following data :

$$\Delta H_f^\circ(\text{H}_2\text{O}, l) = -285.8 \text{ kJ mol}^{-1}$$

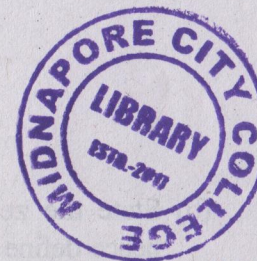
$$\Delta H_f^\circ(\text{CO}_2, g) = -393.5 \text{ kJ mol}^{-1}$$

$$\Delta H^\circ \text{ Combustion (sucrose, s)} = 5665 \text{ kJ mol}^{-1}$$

6. (a) Define Boyle temperature ( $T_B$ ). How is it related to the second virial coefficient ( $B_2$ ,  $v$ ) ?
- (b) The compression factor  $Z = 1.00054$  at  $0^\circ\text{C}$  and 1 atm for a van der Waals' gas. The Boyle temperature for that gas is 107K. Estimate the values of 'a' and 'b'.  $2\frac{1}{2}+2\frac{1}{2}$
7. (a) The standard heat of formation ( $\Delta H_f^\circ$ ) of  $\text{H}_2\text{O}$  and  $\text{H}_2\text{O}_2$  is  $x$  and  $y$  respectively. Evaluate the bond dissociation energy of the peroxide bond ( $-\text{O}-\text{O}-$ ) in terms of  $x$  and  $y$ .  $2\frac{1}{2}$
- (b) A certain first order reaction is 20% complete in 15 minutes at  $27^\circ\text{C}$ , but for the same extent of reaction at  $37^\circ\text{C}$ , only 5 minutes are required. Calculate activation energy of the reaction.  $2\frac{1}{2}$

( 5 )

Group - C



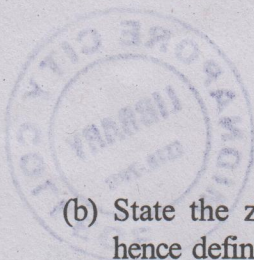
Answer any *one* question :

1×10

8. (a) The reduced equation of state for van der Waals' gas is  $\left(\pi + \frac{3}{\phi^2}\right)(3\phi - 1) = 8\theta$ , where the terms have their usual meaning. This equation is independent of 'a', 'b' and 'R' so it is applicable to all gases — Justify on criticize. 2
- (b) What is the principle of equipartition of energy? Explain with a suitable example. 3
- (c) State Maxwell's distribution formula for molecular speeds in three dimensions. Give schematic graphs for the distribution profile at  $T$  Kelvin, drawn for two gases helium and argon. Justify the differences in the two profiles. 3
- (d) The potential energy of attraction between polar molecules is given by  $U(r) = \frac{A}{r^n}$ . Comment on the sign of 'A' and its dependence on the properties of the molecule. 2
9. (a) Classify the following as intensive or extensive properties : (i) pressure (ii) free energy, (iii) surface tension (iv) molar enthalpy. 2

[ Turn Over ]





( 6 )

- (b) State the zeroth law of thermodynamics and hence define temperature. 2

(c) Show that  $\left(\frac{\partial S}{\partial P}\right)_T + \left(\frac{\partial V}{\partial T}\right)_P = 0$  2

- (d) Give a schematic plot of the energy profile diagrams for an exothermic reaction carried out in absence, and presence of a catalyst.

Hence, explain how a catalyst takes part in the reaction. 2

- (e) With a suitable example illustrate the pH dependence of enzyme catalyzed reactions. 2
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