

## B.Sc. 1st Semester (Honours) Examination, 2019 (CBCS)

Subject : Chemistry

Paper : CC-II

Time: 2 Hours

Full Marks: 40

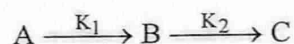
*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer *any five* questions from the following: 2×5=10
- Draw the PV—P isotherms for a real gas at temperatures  $T_1$ ,  $T_B$  and  $T_2$  with explanation where  $T_2 > T_B > T_1$  and  $T_B$  is the Boyle temperature.
  - Find an expression for the number of molecules per  $\text{cm}^3$  of an ideal gas.
  - Find the value of  $\left[\frac{(9/2)}{(4)}\right]$ .
  - Explain whether (i) latent heat of melting and (ii) specific gravity are extensive properties.
  - For a certain mechanical process with an ideal gas,  $\Delta u = \Delta H$ . Comment on the nature of the process (The terms have their usual significance).
  - Why a carnot engine does not exhibit an efficiency of 100%?
  - Can an elementary reaction be of zero order? Explain.
  - Comment: Arrhenius factor is independent of temperature.
2. Answer *any two* questions from the following: 5×2=10
- For one-dimensional motion of an ideal gas, Maxwell's speed distribution formula may be explained as  $P_u = \left(\frac{m}{2\pi KT}\right)^{1/2} e^{-\frac{mu^2}{2KT}} du$ . Arrive at Maxwell's kinetic energy distribution for the ideal gas as per above mentioned speed distribution.
    - Find the percentage error in calculating the average kinetic energy of an ideal gas if one uses the average speed for such calculation.
    - What is the dimension of frequency of binary collisions? 2+2+1=5
  - Explain whether (PdV – VdP) is an exact differential.
    - Is  $\left[\frac{\delta(A/T)}{\delta(1/T)}\right]_V$  a state function? Explain.

(iii) Why it is impossible to produce work by an isolated system during an isothermal process? 2+2+1=5

(c) (i) How can we determine the activation energy of a chemical reaction graphically?

(ii) Consider the following reaction:



Determine the expression of  $K_2$  for the above mentioned reaction. 2+3=5

(d) (i) Derive the thermodynamic equation of states

$$\left(\frac{\partial U}{\partial V}\right)_P = C_P \left(\frac{\partial T}{\partial V}\right)_P - P \text{ \&}$$

$$\left(\frac{\partial S}{\partial P}\right)_T = \frac{1}{T} \left[ \left(\frac{\partial H}{\partial P}\right)_T - V \right].$$

(ii) Define Turn Over Number. (2+2)+1=5

3. Answer any two questions from the following: 10×2=20

(a) (i) Calculate the  $C_V$  value of gaseous  $\text{CH}_4$  at high temperature limit.

(ii) Explain when and how does Dieterici's equation get converted to van der Waals equation.

(iii) Assuming  $\text{CO}_2$  to behave ideally, find the value of  $\gamma$  from the principle of equipartition of energy.

(iv) A certain gas has the equation of  $P = \frac{RT}{V-BT} - \frac{A}{V^3}$ , where "A" and "B" are the characteristic parameters of the gas. Determine the value of "A" and "B". 2+2+2+(2+2)=10

(b) (i) Show that two isothermal P-V plots of a system can never intersect.

(ii) Comment on the change in entropy of a system during an adiabatic irreversible process with reason.

(iii) Correlate "inversion temperature" with "Boyle temperature".

(iv) 5 moles of an ideal monatomic gas at  $27^\circ\text{C}$  and 10 atm pressure is expanded adiabatically against a constant pressure of 2 atm till the equilibrium is reached. Calculate the final temperature and the amount of work done. 2+2+2+(3+1)=10

- (c) (i) show that the observed rate constant for a reaction catalysed by both acids and bases with respective catalytic rate constant of  $K_{H^+}$  and  $K_{OH^-}$  will pass through a minimum when  $H^+$  Concentration is varied. Calculate the pH at which this minimum is observed at temperature 298K if  $K_{H^+}/K_{OH^-}=100$  .
- (ii) Show that any property proportional to the concentration of the reactant can be used to study a 1st order reaction without knowing the proportionality constant.
- (iii) If a 1st order reaction is 45% complete in 30 minutes, how long will it take for 90% completion?
- (iv) Show the graphical variation of the rate of a 2nd order reaction with concentration of the reactant with explanation. 4+2+2+2=10
- (d) (i) A reaction is catalysed by a metal ion in solution. Suggest a suitable kinetic method for determination of the concentration of the ion.
- (ii) Show that for a van der Waals gas  $\left(\frac{\partial C_V}{\partial V}\right)_T$  is estimated to be zero.
- (iii) Find the value of  $\Delta U$  for the photosynthesis process if  $\Delta H = -1500 \text{ J mole}^{-1}$  of glucose at  $27^\circ\text{C}$  ( $\Delta H$  and  $\Delta U$  have their usual significance).
- (iv) Compute  $\Delta S$  for the process  $H_2O(l, -10^\circ\text{C}) \rightarrow H_2O(s, -10^\circ\text{C})$ , if specific heat of liquid water be  $1 \text{ cal K}^{-1} \text{ gm}^{-1}$ , that of ice be  $0.5 \text{ cal K}^{-1} \text{ gm}^{-1}$  and latent heat of fusion of ice be  $80 \text{ cal gm}^{-1}$ . 2+2+2+4=10
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