

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

Subject : Chemistry

Paper : CC-II

Time: 2 Hours

Full Marks: 40

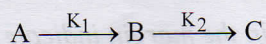
*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer *any five* questions from the following: 2×5=10
- (a) 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.
- (b) Find an expression for the number of molecules per cm^3 of an ideal gas.
- (c) Find the value of $[(9/2)/[(4)]]$.
- (d) Explain whether (i) latent heat of melting and (ii) specific gravity are extensive properties.
- (e) 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).
- (f) Why a carnot engine does not exhibit an efficiency of 100%?
- (g) Can an elementary reaction be of zero order? Explain.
- (h) Comment: Arrhenius factor is independent of temperature.
2. Answer *any two* questions from the following: 5×2=10
- (a) (i) 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.
- (ii) Find the percentage error in calculating the average kinetic energy of an ideal gas if one uses the average speed for such calculation.
- (iii) What is the dimension of frequency of binary collisions? 2+2+1=5
- (b) (i) Explain whether (PdV – VdP) is an exact differential.
- (ii) 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

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

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

(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 CH_4 at high temperature limit.

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

(iii) Assuming CO_2 to behave ideally, find the value of γ 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°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 ΔU for the photosynthesis process if $\Delta H = -1500 \text{ J mole}^{-1}$ of glucose at 27°C (ΔH and ΔU have their usual significance).
- (iv) Compute ΔS 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 cal gm^{-1} . 2+2+2+4=10