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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 practiable.

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]

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

(e) Show that for a van der Waals gas

$$\left(\frac{\partial H}{\partial P}\right)_T = b - \frac{2a}{RT}$$ 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-Menlen constant. What is turn over 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

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

[Given : molecules diameter = 3.6×10^{-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 → products, show that the time required for 3/4th of the reactant to decay ($t_{3/4}$) is equal to $3t_{½}$. 2½+2½=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]

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

$\Delta H_f^{\circ}(H_2O, l) = -285.8$ kJ mol^{-1}

$\Delta H_f^{\circ}(CO_2, g) = -393.5\ kJ\ mol^{-1}$

ΔH° Combustion (sucrose, s) = 5665 kJ mol^{-1} 2+3

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°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'. 2½+2½

7. (a) The standard heat of formation $\left(\Delta H_f^{\circ}\right)$ of H_2O and H_2O_2 is x and y respectively. Evaluate the bond dissociation energy of the peroxide bond (—O—O—) in terms of x and y. 2½

(b) A certain first order reaction is 20% complete in 15 minutes at 27°C, but for the same extent of reaction at 37°C, only 5 minutes are required. Calculate activation energy of the reaction. 2½

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 $U(r) = A/r^n$. Comment on the sign of 'A' and its dependence on the properties of the molecule. 2

9. (a) Classify the following as intensive on extensive properties : (i) pressure (ii) free energy, (iii) surface tension (iv) molar enthalpy. 2

[Turn Over]

(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