B.Sc. RNLK-/CC-1(T)/22

2022

Chemistry

[First Semester]

Paper - CC-1(T)

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Group - A

1. Answer any five questions : 5×2=10

(a) A gas expands (i) isothermally from volume v_1 to v_2 (ii) Adiabatically from volume v_3 to v_4 in a leak proof container. Identify the type of system in each case (close / open/ isolated).

(b) For a reversible cyclic process Δ System is less than Δ S surroudings justify or criticise.

(c) For an ideal gas obeying the Maxwellian distribution of molecular speed in three-dimension. Find the maximum value of $\left(\frac{1}{n}\right)\frac{dN}{dc}$ for a gas of molar mass 4.0 gm mol^{-1} kept at 127°C.

(d) Calculate $^{a}/_{b}$ for a gas for which T_B=500 K.

(e) Half-life a reaction is doubled when the initial concentration of a reactant. What is the order of the reaction with respect to the reactant?

(f) Calculate the percentage increase of rate comtant for a 5% increase in temperature. given E=20KJ Mol^{-1} and T=300K.

(g) Define turn over number.

(h) Catalyst is like a tunnel in chemical reaction –Explain.

Group - B

Answer any four from the following : 5×4=20

2. (a) (i) Derive an expression of average time required to travel unit distance for gas molecule. 3

(ii) A gas obeying the $P(V-b)=RT$ has the compressiblity factor $Z=1.0018$ at 27ºC and 1 atm pressure. Assuming the gas molecule to be spherical in shape. Calculate its molecular weight. 2

(b) (i) Find the unit of $\frac{d\ln k}{dT}$ for a n^{th} order reaction. 2

(ii) Explain energy of activation and entropy of activation and comment on. 3

(c) (i) For a reaction is logarithm of concentration vs. time plot is a straight line with (–ve) slope. What is the order of the reaction. 2

(ii) The slope and intercept of the plot $\frac{1}{R^0}$ vs $\frac{1}{[s]_0}$ are 3.5×10^2_5 and $5\times10^4 mol^{-1}$ L respectively where Rº and $[s]_0$ are the initial rate and initial rate ain initial substract concentration ofentynce catalysed reaction obeying Michelis – Menten kinetics. Estimate k_M and turn-over number when the initial concentraton of cnzyme. $[E]_0=2.5\times10^{-9}$ mol L^{-1}. 3

(d) (i) A carnot engine working between 0ºC and 100ºC taken up 840J from the HTR. Calculate the *w* and heat rejected. 2

(ii) Show that $\left(\frac{\partial s}{\partial T}\right)_V = \frac{Cv}{T}$ for a gas. 3

(e) (i) For the reaction $H_2O(g) \rightarrow H_2(g) + O_2(g)$: ΔH^o =242 KJ mol^{-1} at 290K. Find ΔH^o at 310K. Assume that over the temperature range c_p values are effectively constant are given by $Cp(H_2O, g)$ =35.5, $Cp(H_2,g)$=28.8 and $Cp(O_2,g)$=29.1 all are in units of $JK^{-1}mol^{-1}$. 3

(ii) Isothermal free expansion of an ideal gas must be adiabatic – justify or criticize. 4

(f) Two moles of an ideal gas at 27ºC are enclosed in a leak proof cylinder filled with a movable friction len piston and thermally insulated system or not. The pressure on the piston is release very slowly to effect a quasi-static expansion to double its volume. Calculate

(i) the final temperature.

(ii) the change in enthalpy of the gas and

(iii) the work done by the gas. Given [Cv=1.5R] 5

Group -C

Answer one of the following : 1×10=10

3. (a) (i) Derive the expression for most probable velocity from Maxwell-Boltzman distribution law. 3

(ii) Dra a carnot cycle with an ideal gas the working substance in U-S plane. 3

(iii) Derive the expression for adiabatic revessible work of an ideal gas. What will be its magnitude when $\gamma \rightarrow 0$? 4

(b) (i) Discuss the important kinetic features of the Lindemann theory of unimolecular reaction. 4

(ii) Hydrolysis of ethelacetate by a solution of strong acid in an example of specific acid (H^+) catalysed reaction.– Explain. 3

(iii) The effective rate constant of a first order reaction following Lindemann mechanism has the following values :

$k=2.5\times10^{-3}$ Sec^{-1} when $[A] = 5\times10^{2}(M)$

and $k = 4.2\times10^{-3}$ Sec^{-1} when $[A]=9.8\times10^{-2}(M)$

Find the rate comtant for the activation step (K_2) and the rates of K_{-2}/K_1 3