

2022

Chemistry

B.Sc. First Semester End Examination - 2022

PAPER - CC-1T

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) Show that a gas characterised by the equation $P(v-b)=RT$ has no Boyle temperature.
- (b) The exponential term in the Maswell's distribution law of molecular speed has a negative sign. Does a positive sign in it make any sense?

(Turn Over)

(2)

- (c) Arrive at the condition of equilibrium in an isolated system from Clausius inequality.
- (d) The heat of combustion of liquid ethanol into CO_2 and liquid water is estimated to be -327 kcal at constant pressure. Calculate the heat change at constant volume at 27°C .
- (e) Heat cannot be converted to work in an isothermal cyclic process. Explain.
- (f) If out of N molecules of a gas at a given temperature, dn_u molecules have their x-component of velocity in the range u to $u+du$, then $(1/N) \cdot (dn_u/du)$ should be a function of u^2 and not of u . Comment.
- (g) A zero order reaction is always multistep-Explain.
- (h) How does temperature affect on chemical catalysts and enzyme catalysts? Explain

(3)

Group - B

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

2. (a) Assuming that CO_2 obeys Vander Waals equation, estimate the diameter of CO_2 molecules if the critical temperature and pressure of CO_2 are 31°C and 73 atms, respectively. 3
- (b) Show that Joule-Thomson experiment is an irreversible process. 2
3. (a) In a reversible adiabatic process the entropy of the surroundings is unaffected. Explain. 2
- (b) Arrive at the conditions under which the equality holds between the frequency factor and the rate constant in Arrhenius equation. 2
- (c) What is the time for completion for a second order reaction. 1

(4)

4. (a) Using the concept of Gamma function. Calculate the value of the integral : 2

$$\int_0^{\infty} e^{-bx^2} \cdot x^3 \cdot dx.$$

- (b) "Increasing the temperature of source is more efficient to increase engine's efficiency than decreasing the temperature of sink by same ΔT ." Is the statement either true or false? Explain. 3
5. (a) A reaction is depicted as $A + B \xrightleftharpoons[k_b]{k_a} I \xrightarrow{k_c} P$, $k = \frac{k_a}{k_b}$. Calculate the rate of formation of P. 3
- (b) The compressibility factor $z=1.00054$ at 0°C and 1 atm for a Vander Waal's gas. The Boyle temperature for that gas is 107K. Estimate the values of 'a' and 'b'. 2
6. (a) How does the time required for a first order reaction to go 99% completion relate to the half life of the reaction? 2

(5)

- (b) A perfect gas [$C_v, m \neq f(T)$ & $=3MR$] expands adiabatically into vacuum. Which of the following is correct? Explain
- (i) $T_2 = \frac{T_1}{2^{\frac{1}{\gamma}}}$ (ii) $T_2 = T_1$ 3
7. (a) Specific rate constant of a reaction has the unit $\text{litre}^2 \cdot \text{mol}^{-2} \cdot \text{sec}^{-1}$. What is its order? 1
- (b) Does the following relation correct? Justify 2
- $$\left(\frac{\partial x}{\partial y}\right)\left(\frac{\partial y}{\partial z}\right)\left(\frac{\partial z}{\partial x}\right) = 1$$
- (c) Why do the heat capacity value rise rapidly with temperature for a polyatomic gas and reach a limiting maximum. 2

(6)

Group - C

Answer any one question.

10×1=10

9. (a) A sample of milk kept at 25°C is found to sour 40 times as rapidly as when it is kept at 4°C. Estimate the activation energy for the souring process. 2
- (b) Suppose the two Carnot heat engines are connected in a series, such that the heat released by the first engine is used as the heat absorbed by the second. If the efficiencies of the two engines are n_1 and n_2 , show that the net efficiency of the combination is given by $n_{net} = n_1 + n_2 - n_1 n_2$. 4
- (c) Show that the fraction of molecules of an ideal gas moving with speeds between C_m and $1.001 C_m$ is constant for any gas at any temperature. 3
- (d) Among H, U, S, G and A which one does not belong with the others and why? 1
10. (a) Calculate average velocity and r.m.s. velocity from 1-D-Maxwell speed distribution law. 4

(7)

- (b) Show that the ratio of $t_{0.5}/t_{0.75}$ of any p^{th} order reaction ($p \neq 1$) with identical initial concentrations of the reactants, can be written as a function of p -alone. 3
- (c) The rate of hydrolysis of an ester, catalysed by strong acid, is almost doubled when the p^H is changed from 0.80 to 0.50. Justify whether this is an example of homogeneous catalysis. 2
- (d) The rate constant of a first order reaction, $K=0.20 \text{ min}^{-1}$. What does it mean? 1