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B.Sc./3rd Sem/CEM/25(NEP)

2025

3rd Semester Examination (CCFUP : NEP)

CHEMISTRY

Paper : MJ 3-T (Single Core Major)

(Physical Chemistry-I)

Full Marks : 40

Time : Two Hours

The figures in the margin indicate full marks.

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

Group - A

Answer any **five** questions : $2 \times 5 = 10$

1. Write the dimension and SI unit of pressure and enthalpy.
2. A substance decomposes according to second order rate law. If rate constant is $6.8 \times 10^{-4} \text{ lit mol}^{-1} \text{ s}^{-1}$, calculate half life when the initial concentration is $0.05 \text{ mol lit}^{-1}$.
3. Draw and explain $\log k$ vs. pH plot for a specific H^+ catalysed reaction.
4. Write the condition for a differential to be perfect.
5. State zeroth law of thermodynamics.

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(2)

6. Enthalpy of neutralisation of any strong acid and strong base is same. Explain.
7. $C_p - C_v$ value of H_2 and N_2 is same at very low pressure but different at high pressure. Explain.
8. Calculate the de Broglie wavelength of an electron travelling at 1% of the speed of light.

Group - B

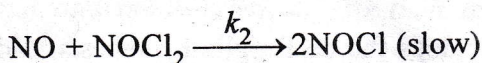
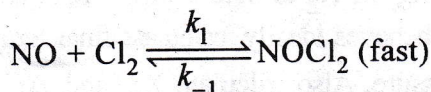
Answer any *four* questions : $5 \times 4 = 20$

9. (a) For a reaction rate = rate constant. What is the order of the reaction? Write few characteristics of such reaction.
- (b) Arrhenius factor is the high temperature limiting value of rate constant. Explain. $(1+2)+2$
10. (a) A reactant X gives two products Y and Z. The reaction is either parallel or consecutive. Explain graphically how will you confirm about the nature of the reaction.
- (b) During adiabatic expansion a gas cool down. Explain. $3+2$
11. (a) A first order gaseous reaction is 25% complete in 30 minutes at 227°C and in 10 minutes at 237°C . Calculate activation energy of the reaction.
- (b) The relation $dU = nC_v dT$ is valid for any gas. Justify or criticise the statement. $3+2$

12. (a) Show that Joule-Thomson expansion of gas is an isenthalpic process.

(b) What are the basic differences between photoelectric effect and Compton effect? 3+2

13. (a) The reaction $2\text{NO} + \text{Cl}_2 \xrightarrow{k} 2\text{NOCl}$ supports the following mechanism.



Considering steady state approximation of NOCl_2 , show that overall rate = $k[\text{NO}]^2[\text{Cl}_2]$.

(b) The speed of an electron is measured to be 100 ms^{-1} with an uncertainty of 0.1%. Calculate the minimum uncertainty in locating the position of the electron. 3+2

14. (a) What is meant by free expansion of gas? Find the value of work done for such expansion.

(b) Calculate the heat of formation of ammonia, given the heats of combustion of ammonia and hydrogen as -90.6 and $-68.3 \text{ kcal mol}^{-1}$ respectively. 2+3

P.T.O.

Group - C

Answer any *one* question : $10 \times 1 = 10$

15. (a) Derive the rate equation of a 2nd order reaction involving two reactants with different initial concentration.
- (b) N_2 gas expanded adiabatically and reversibly from a volume of 1 lit at $0^\circ C$ and 1 atm to a volume of 2 lit. C_v of N_2 is $20.8 \text{ J mol}^{-1} \text{ K}^{-1}$. Assuming the gas behaves ideally, calculate final temperature and pressure. Also calculate ΔU and ΔH for this process.
- (c) How does the de Broglie hypothesis lead to one important postulate of Bohr's theory? $4+4+2$
16. (a) Derive Kirchhoff's equation showing the variation of enthalpy change for a reaction with temperature.
- (b) Derive the relation between temperature and pressure for an adiabatic reversible process of an ideal gas.
- (c) When Li is irradiated with light, the kinetic energy of ejected electrons is $2.935 \times 10^{-19} \text{ J}$ for $\lambda = 300 \text{ nm}$ and $1.280 \times 10^{-19} \text{ J}$ for $\lambda = 400 \text{ nm}$. Calculate Planck constant.
- (d) Classify the following properties as extensive or intensive :
- (i) Density (ii) Heat capacity. $3+3+3+1$
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