'समानो मन्त्रः समितिः समानी'

UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 2nd Semester Examination, 2023

CC4-CHEMISTRY

PHYSICAL CHEMISTRY

NEW AND OLD SYLLABUS

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.

GROUP-A

1. Answer any ***five*** questions: 1×5 = 5

(a) What are limitations of thermodynamics?

(b) Define Joule-Thomson coefficient.

(c) Give an example of cyclic process in thermodynamics.

(d) What is the unit of the quantity $T\Delta S$?

(e) Why are colligative properties called so?

(f) Which concentration of a solution is used to calculate the osmotic pressure of a dilute solution?

(g) What is the equivalent equation for open system for $dG = Vdp - SdT$?

(h) Write down Clausius inequality.

GROUP-B

2. Answer any ***three*** questions: 5×3 = 15

(a) (i) Show that the Hess's law is a direct consequence of the first law of thermodynamics. 2

(ii) Under which conditions *q* and *w* become state functions? 3

(b) (i) Prove that $\left(\frac{\partial P}{\partial T}\right)_V = \alpha/\beta$, where α and β are the coefficient of thermal expansion and compressibility factor, respectively. 3

(ii) Discuss differences between adiabatic cooling and Joule-Thomson cooling. 2

(c) (i) Write notes on Gibbs-Helmholtz equation. $2\frac{1}{2}$

(ii) Does equilibrium constant have any unit? $2\frac{1}{2}$

(d) (i) Prove that $\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$ starting from the appropriate Maxwell relationship. 3

(ii) State and explain the first law of thermodynamics. 2

(e) (i) At NTP 4 L of gas A was mixed with 20 L of gas B. Calculate the entropy change. $2\frac{1}{2}$

(ii) Calculate the enthalpy change for the transition- $2\frac{1}{2}$

C (graphite) $\longrightarrow$ C (diamond)

where enthalpy of combustion of C (graphite) and C (diamond) are -393.51 kJmol^{-1} and -395.41 kJmol^{-1}, respectively.

GROUP-C

3. Answer any ***two*** questions: $10\times2 = 20$

(a) (i) Derive Gibbs-Duhem equation. 3

(ii) Why chemical potential is a measure of escaping tendency? 2

(iii) Justify or criticize: a system must be isolated if neither heat nor matter can enter or leave the system. 2

(iv) Starting from the same initial state if final volume be the same then show that for an ideal gas final pressure in the isothermal reversible expansion is greater than adiabatic reversible expansion. 3

(b) (i) Deduce thermodynamically $\pi = cRT$, where the symbols have their usual meaning. 4

(ii) The average osmotic pressure of human blood is 7.38 atm at 27°C. What should be the total concentration of various solutes in the blood? 3

(iii) Why colligative properties are intensive properties? 2

(iv) Mention one thermodynamic criterion for a dilute solution to the ideal. 1

(c) (i) Prove that between two reservoirs, a reversible engine is more efficient than an irreversible one. 3

(ii) Heat of neutralization of all strong acids with strong alkalis in aqueous solution is almost constant. Explain. 2

(iii) Adiabatic curves are steeper than the isothermal curves. Explain critically. 2

(iv) Explain the elevation of boiling point with the help of vapour pressure-temperature curve. 2

(v) Show that in an isothermal expansion of an ideal gas $\Delta H = 0$. 1

(d) (i) Derive an expression for equilibrium constant from thermodynamic consideration. 3

(ii) Show that $T_i = 2a/Rb$ for a Van der Waals gas using the relation 3

$$\mu_{JT} = \frac{1}{C_{P.M}}\left[\frac{2a}{RT} - \frac{3ab}{R^2T^2}\cdot P - b\right]$$

(iii) If the equilibrium constant is doubled when the temperature rises from 290 K to 310 K, find the standard enthalpy of the reaction. 3

(iv) Write down the combined form of first and second laws of thermodynamics. 1

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