

(4)

(OR)

Compton shift is independent of the wavelength of incident radiation but dependent on the angle of scattering of the photon: Justify/ Criticize. 3

10. Operators in quantum mechanics are hermitian in nature- Justify.

(OR)

Show that two nondegenerate eigenfunctions of a hermitian operator must be mutually orthogonal. 3

11. A free particle in one-dimensional box is in its ground state. What is the probability of finding the particle in the right one third length of the box?

(OR)

What are the degeneracies of the first four energy levels for particle in a three dimensional box with $l_x = l_y = l_z$? 3

12. For a cubic lattice show that the interplanar distance (d_{hkl})

is given by $d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$, where a = unit cell length. 2½

13. Silver crystallizes in the cubic lattice. The density is found to be 10.7 g cm^{-3} . If the unit cell length is 0.206 nm , suggest its unit cell type. 2½

★ ★ ★

BACHELOR OF SCIENCE EXAMINATION, 2025

(3rd Semester, CBCS)

CHEMISTRY (CORE)

PAPER : CORE / CHEM/TH/07

Time : Two Hours

Full Marks : 40

(20 marks for each Unit)

Use a separate answer script for each Unit.

UNIT—3071-P

Answer any **four** questions.

5×4=20

1. Mention whether following statements are **correct** or **incorrect**. 1×5=5

- (a) Volume decreases but entropy increases for the system during fusion of ice at 1.0 bar and 0°C .
- (b) Entropy change of the system for adiabatic irreversible expansion is zero.
- (c) Effect of temperature on the magnitude of dimerization constant is always negative.

(2)

- (d) Increase of temperature decreases the pH of pure water and it becomes acidic. As we know, the pH of pure water is 7.0 at 25 °C.
- (e) For a mixture system, partial molar Gibbs free energy is component specific property whereas Gibbs free energy is system specific one.
2. Derive the expression of Joule-Thomson co-efficient (μ_{JT}) for a gas obeying equation of State $P(V_m - b) = RT$. Comment on your finding. 5
3. (a) Mention factor/s influences and does not influence the Carnot efficiency.
- (b) Calculate ΔG when temperature of 2.0 mol of $N_2(g)$ increases from 298 K to 348 K at constant pressure of 2 bar. Given : $S_m(JK^{-1}mol^{-1}) = A + B \ln(T/K)$ for $N_2(g)$ where $A = 25.1$ and $B = 29.3$ in SI unit and both are independent of temperature. 2+3
4. What is 'Clausius Inequality'? Show that entropy of the Universe increases with each spontaneous change. 2+3
5. For vaporization of 2 mol liquid water into its vapor at 100 °C and 1 atm pressure, find W , ΔU , ΔG , ΔS and ΔA . Given : normal boiling point of liquid water is 100 °C. 5

(3)

6. (a) The molar work function (A_m) of a gas is expressed as: $A_m = -\left(\frac{a}{V_m}\right) - RT \ln(V_m - b) + f(T)$; where 'a' and 'b' are constants. Obtain the expression of pressure of this gas.
- (b) Derive $\left[\frac{\partial}{\partial T}\left(\frac{A}{T}\right)\right]_{V,n} = -\frac{U}{T^2}$; where each symbol bears usual meaning. 2+3

UNIT—3072-P

Answer *all* the questions.

7. Derive Wien's displacement law from Planck's equation of black-body radiation. What is Compton wavelength? 3+1
8. Examine whether the following are acceptable wave-functions :
- (i) $\cos^{-1} x [-1 \leq x \leq 1]$; (ii) $1/x [0 \leq x \leq \infty]$.

(OR)

Evaluate the commutator $\left[\frac{d^2}{dx^2}, x\right]$. 2

9. Show that 'zero point energy' of a freely moving particle in a one dimensional box is a consequence of Heisenberg's uncertainty principle.