St. Paul's C.M. College
Semester-3, Mid-Term Test, March 2026
Chemistry (Honours), Paper: DSCC-3
(Physical Chemistry - I)
Full Marks: 25, Time: 1 hr

Answer all the question nos. 1, 2, 3, 4 and 5.

1. (a) Draw T-S diagram of a Carnot cycle with proper labelling. [2]

(b) $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

In an experiment, 2·0 moles of NOCl was placed in a one-litre flask and the concentration of NO after equilibrium established, was found to be 0·4 mol/L. The equilibrium constant at 30°C is ——— $\times 10^{-4}$. [2]

(c) State and explain the law of independent migration of ions'. [2]

2. (a) Using Maxwell's relation, show that

$$Tds = C_V dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$$

$$= C_p dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$$ [3]

(b) Calculate the entropy change when,
(i) one mole of He and one mole of H_2 are mixed at constant temperature (298K).
(ii) One mole of He is mixed with one mole of He at constant temperature (298K). [2]

3. (a) For the reaction $A(g) \rightleftharpoons B(g)$ at 495 K, $\Delta_r G^\circ = -9.478\ kJ\ mol^{-1}$. If we start the reaction in a closed container at 495 K with 22 milimoles of A, the amount of B in the equilibrium mixture is ——— milimoles (Round off to the nearest integer). [3]

(b) Justify that absolute zero temperature cannot be attained since efficiency of a reversible carnot engine must be less than 1. [1]

4. (a) Graphically show that equivalent conductance at infinite dilution values can be obtained by plotting equivalent conductance vs. $\sqrt{c}$ for strong electrolytes but not for weak electrolytes. [2]

(b) Equal volumes of two solutions, one having pH = 6 and other having pH = 4 are mixed. What would be the pH of the resulting solution. [3]

5. (a) Derive from Ostwald's dilution law, a suitable equation which may be used to determine Λ_o and dissociation constant (Ka) of a weak electrolyte like acetic acid. [2]

(b) 50 mL of 0.1 M CH_3COOH is being titrated against 0.1 M NaOH. When 25 mL of NaOH has been added, the pH of the solution will be ____ $\times 10^{-2}$ (Nearest integer).

[Given: pKa (CH_3COOH) = 4.76, $\log 2 = 0.30$]. [3]