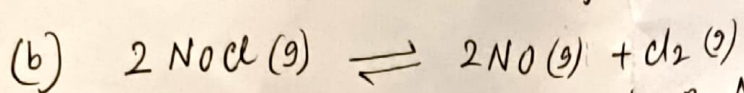


Full Marks: 25, Time: 1 hr

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]



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

$$T ds = C_v dT + T \left(\frac{\partial p}{\partial T} \right)_v dV$$

$$= C_p dT - T \left(\frac{\partial v}{\partial T} \right)_p dp$$

[3]

(b) Calculate the entropy change when,

(i) one mole of He and one mole of H₂ 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 $A(\text{g}) \rightleftharpoons B(\text{g})$ at 495 K, $\Delta_r G^\circ = -9.478 \text{ kJ mol}^{-1}$. If we start the reaction in a closed container at 495 K with 22 millimoles of A, the amount of B in the equilibrium mixture is _____ millimoles (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_0 and dissociation constant (K_a) 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 $\text{---} \times 10^{-2}$ (Nearest integer).
[Given: $\text{p}K_a(\text{CH}_3\text{COOH}) = 4.76$, $\log 2 = 0.30$]. [3]