

CHE-4

BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

June, 2005

CHEMISTRY

CHE-4 : PHYSICAL CHEMISTRY

Time : 2 hours

Maximum Marks : 50

Note :

- (i) Attempt all the parts. Answer **five** questions from each of the three parts, A, B and C. From Part D, answer **four** questions.
- (ii) Logarithmic tables may be obtained from the Hall Superintendent for use.

PART A

Answer any **five** questions.

1. Write down the following with proper SI unit symbols and prefixes :
 - (a) 10^{-9} metre
 - (b) 10^{-12} second

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1

P.T.O.

2. State the value of \bar{C}_p / \bar{C}_v for helium gas. 1
3. What happens when hydrogen gas is allowed to undergo Joule-Thomson expansion at room temperature? 1
4. Identify the type of system in each of the following cases :
 - (a) A tree in a garden
 - (b) Tea in thermos flask 1
5. What is a gel? 1
6. Based on energy released during adsorption, how can you distinguish between physisorption and chemisorption? 1
7. How are K_p and K_c related to each other for a reaction between ideal gases? 1
8. State the name given to the equilibrium point among ice, water and vapour. 1

PART B

Attempt any **five** questions.

9. Starting from $\theta = \frac{K_p}{1 + K_p}$, derive the relation,

$$p = \frac{\theta}{K(1 - \theta)} \quad 2$$

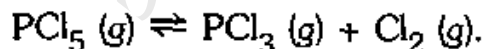
10. What is Tyndall effect ? Suggest an application for this effect. 2

11. State Henry's law. Why cannot fish live in warm water ? 2

12. State distribution law. State any one application of distribution law. 2

13. Calculate the osmotic pressure of an aqueous solution containing 50.0 kg of sucrose in 1.00 m³ of a solution at 300 K. (Molar mass of sucrose = 0.342 kg mol⁻¹; R = 8.314 J mol⁻¹ K⁻¹) 2

14. Consider the following reaction,



How would the equilibrium be affected by

- (i) the addition of Cl₂ (g), and
- (ii) the decrease in the volume of the container ? 2

PART C

Answer any **five** questions.

17. The standard enthalpy of formation of $\text{H}_2\text{O} (l)$ at 298 K is $-285.8 \text{ kJ mol}^{-1}$. Calculate the standard internal energy change $[\Delta_r U^0 (\text{H}_2\text{O})]$ for the formation of water at 298 K. ($R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$). 3
18. Prove that for a reversible adiabatic process,
 $T V^{\gamma-1} = \text{constant}$. 3
19. (a) State Trouton's rule.
(b) The molar enthalpy of vaporization and boiling point of ammonia are 23.3 kJ mol^{-1} and 240 K respectively. Does it obey Trouton's rule? 3
20. Derive the SI units for van der Waals constants 'a' and 'b'. 3
21. Calculate the ratio $u_{\text{mp}} : \bar{u} : u_{\text{rms}}$ for a gas of molar mass M_m . Does the value of this ratio depend on temperature? 3
22. (a) Define quantum efficiency of a photochemical reaction.
(b) The quantum yield for the photochemical formation of hydrogen chloride is high in the absence of oxygen but low when oxygen is present. Explain. 3

23. (a) Define molarity.

(b) Concentrated sulphuric acid contains 98% acid by weight. Its density is $1.85 \times 10^3 \text{ kg m}^{-3}$. Calculate its molarity.

(Molar mass of sulphuric acid = $0.098 \text{ kg mol}^{-1}$)

3

24. An aqueous solution prepared by dissolving 0.5 kg of potassium chloride in 100 kg of water was found to freeze at 272.76 K. Calculate the van't Hoff factor and degree of dissociation of solute at this concentration. K_f for H_2O is $1.85 \text{ K kg mol}^{-1}$ and freezing point of water is 273 K.

(Molar mass of KCl is $7.45 \times 10^{-2} \text{ kg mol}^{-1}$)

3

PART D

Answer any **four** questions.

- 25.** (a) Derive the integrated rate law for zeroth order reaction. 2
- (b) The decomposition of hydrogen iodide on gold at 323 K is zeroth order reaction and the rate constant is $1.20 \times 10^{-4} \text{ M s}^{-1}$.
- (i) If the initial concentration of hydrogen iodide is 0.50 M, calculate its concentration after $3.00 \times 10^3 \text{ s}$.
- (ii) How long will it take for all the hydrogen iodide to decompose ? 3
- 26.** (a) Define solubility product. Explain its use in qualitative mixture analysis. 3
- (b) Calculate the molarity of HCN solution that is 0.01% ionised at equilibrium. (K_a for HCN = 6.0×10^{-10}) 2
- 27.** (a) State the Faraday's laws of electrolysis. 3
- (b) 1 dm^3 of 2.0 M CuSO_4 solution is electrolysed using platinum electrodes by passing 4.50 A current for 9000 s. Calculate the mass of copper deposited. (Atomic mass of Cu = 63.54) 2

28. (a) State second law of thermodynamics. 2

(b) Derive an expression useful in calculating entropy of mixing of two ideal gases. 3

29. (a) Distinguish between spontaneous and non-spontaneous processes. 2

(b) Starting from $G = H - TS$, derive the following relation :

$$\left[\frac{\partial(G/T)}{\partial T} \right]_p = - \frac{H}{T^2} \quad 3$$

30. (a) How do we define anode and cathode in terms of oxidation and reduction reactions ? What sign, positive or negative, would you assign to anode and cathode in (i) a galvanic cell, (ii) an electrolytic cell ? 3

(b) Write the reactions that take place at the cathode and the anode during the discharge of a lead storage battery. 2