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63 (FY)SEM-3/MAJ/CHMMAJ2024

2025

CHEMISTRY

Paper : CHMMAJ2024

(Physical Chemistry - I)

Full Marks : 50

Pass Marks : 20

Time : Two hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer : 1×5=5
- (a) What is the work done during a reversible isothermal free expansion of an ideal gas ?
- (i) Maximum
 - (ii) Minimum
 - (iii) Zero
 - (iv) Positive

- (b) Entropy decreases during
- (i) crystallization of sucrose from solution
 - (ii) rusting of iron
 - (iii) melting of ice
 - (iv) vaporization of camphore
- (c) For an endothermic reaction
- (i) q_p is negative
 - (ii) $\Delta_r H$ is positive
 - (iii) $\Delta_r H$ is negative
 - (iv) q_p is positive
- (d) An intensive property amongst the following is —
- (i) Mass
 - (ii) Volume
 - (iii) Number of moles
 - (iv) Temperature

(e) Which of the following pairs constitutes a buffer ?

(i) NaOH and HCl

(ii) NH_4NO_3 and HNO_2

(iii) HCl and KCl

(iv) HNO_2 and NaNO_2

2. Answer the following questions : **(any five)**
2×5=10

(a) Define internal energy. Write its important characteristics. 1+1=2

(b) What do you understand by

(i) State of system and

(ii) State variables ?

1+1=2

(c) State and explain Hess's Law.

(d) Derive the relation :

$$\Delta S = C_p \ln \frac{T_2}{T_1} + R \ln \frac{P_2}{P_1}$$

(e) Define Gibbs free energy. What is its significance ? 1+1=2

(f) Explain the term "Ionic Product of Water". Discuss the effect of temperature on the ionic product of water. 1+1=2

(g) Obtain the relationship between pH and pOH. What is the effect of temperature on pH? 1+1=2

3. Answer the following questions : **(any five)**
5×5=25

(a) (i) What are the limitations of first law of thermodynamics? 2

(ii) Write various statements of second law of thermodynamics. 2

(iii) What is entropy? 1

(b) Define with examples :

(i) Standard enthalpy of formation. 2½

(ii) Enthalpy of neutralization. 2½

(c) Obtain the following relations for an adiabatic process —

(i) $TV^{\gamma-1} = \text{Constant}$

(ii) $W = \frac{R}{\gamma - 1} [T_1 - T_2]$

2½×2=5

- (d) Prove that the entropy change for an ideal gas mixture is —

$$\Delta S = -nR \sum x_i \ln x_i$$

- (e) Define partial molar quantity and chemical potential. Derive Gibbs Duhem equation. 1+1+3=5

- (f) (i) What is Joule-Thomson experiment? Prove that Joule-Thomson's experiment in an isoenthalpic process. 1+1=2

- (ii) Explain *one* method of liquefaction of gases. 3

- (g) (i) Derive an expression for the entropy change in an isothermal reversible expansion of an ideal gas. 3

- (ii) Calculate the entropy change when one mole of an ideal gas expands from 1 litre to 10 litres at 300K ($R=2.0 \text{ cal}$). 2

- (h) Define the term "Buffer action". Write about the applications of buffer solution in Chemistry and Biology. Derive.

$$pH = pK_a + \log \frac{[\text{Salt}]}{[\text{Acid}]} \quad 1+2+2=5$$

4. Answer the following questions : **(any one)**
10×1=10

- (a) Prove the following relations :

$$(i) \quad \left(\frac{\partial S}{\partial V} \right)_T = \left(\frac{\partial P}{\partial T} \right)_V \quad 4$$

$$(ii) \quad \Delta G = \Delta H + T \left[\frac{\partial(\Delta G)}{\partial T} \right]_P \quad 4$$

$$(iii) \quad \left(\frac{\partial A}{\partial V} \right)_T = -P \quad 2$$

- (b) (i) Define degree of ionization and ionization constant. What is the relation between them ?

$$1+1+1=3$$

- (ii) Write about the factors affecting the degree of ionization. 2
- (iii) How temperature affect the degree of ionization ? 1
- (iv) What is the principle of acid-base titration ? 2
- (v) What is the main use of acid-base titration ? 2
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