

2 SEM TDC CHMH (CBCS) C 4

2024

(May)

CHEMISTRY

(Core)

Paper : C-4

(Physical Chemistry)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

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

1. Choose the correct option from the following :

1×6=6

(a) Which of the following is an intensive property?

(i) Internal energy, U

(ii) Gibbs' free energy, G

(iii) Enthalpy, H

(iv) Specific heat capacity, C_s

(b) Heat of neutralization of acetic acid and sodium hydroxide is

(i) 57.1 kJ

(ii) <57.1 kJ

(iii) >57.1 kJ

(iv) 2.09 kJ

(c) The Boltzmann entropy equation is

(i) $S = nRT \ln W$

(ii) $S = k \ln W$

(iii) $S = 2k \ln W$

(iv) $S = nk \ln \frac{V_2}{V_1}$

(d) The correct relationship between K_c and K_p for the equilibrium in case of the hypothetical gaseous reaction



is

(i) $K_p = K_c(RT)^2$

(ii) $K_p = K_c$

(iii) $K_p = K_c RT$

(iv) $K_c = \frac{1}{K_p}$

(e) Isotonic solutions have the same osmotic pressure at the same temperature and have the same

- (i) molal concentration
- (ii) molar concentration
- (iii) strength
- (iv) percentage of solute by weight

(f) van't Hoff factor is defined as

- (i) $i = \frac{\text{Observed molar mass}}{\text{Normal molar mass}}$
- (ii) $i = \frac{\text{Normal molar mass}}{\text{Observed molar mass}}$
- (iii) $i = \frac{\text{Normal colligative property}}{\text{Observed colligative property}}$
- (iv) $i = \frac{\text{Normal osmotic pressure}}{\text{Observed osmotic pressure}}$

2. Answer the following questions : 2×7=14

- (a) State and explain the first law of thermodynamics.
- (b) What is bond energy? How are the bond energies of the products and the reactants related to the enthalpy of the reaction?

- (c) What is meant by the entropy of a system? Write its unit.
- (d) Define efficiency of a heat engine. Can the efficiency of a heat engine be unity?
- (e) What do you mean by partial molar properties of an open system?
- (f) What are colligative properties? Give examples.
- (g) Define molal elevation constant. Write its unit.

UNIT—I

3. Answer the following questions (any four) :

3×4=12

- (a) What is an adiabatic process? Derive a relationship between temperature and volume for an adiabatic reversible expansion of an ideal gas. 1+2=3
- (b) Derive an expression for the amount of work done during the expansion of an ideal gas from volume V_1 to V_2 .

- (c) For a gaseous reaction, deduce the relationship between heat of reaction at constant pressure and at constant volume.
- (d) Derive Kirchhoff's equation for the effect of temperature on heat of reaction.
- (e) Write the criteria of spontaneity of a reaction. A reaction has $\Delta H = 40.4 \text{ kJ/mol}$ and $\Delta S = 101 \text{ J/mol K}$. At what temperature will the equilibrium be established and what should be the temperature for the reaction to be spontaneous? 1+2=3
- (f) What is meant by enthalpy of neutralization? Why are the enthalpies of neutralization of all strong acids with strong bases almost identical? 1+2=3
- (g) What is residual entropy? How is it calculated? 1+2=3

UNIT—II

4. Answer any one of the following questions : 4

- (a) What is chemical potential? Deduce the Gibbs-Duhem equation. 1+3=4

- (b) Derive an expression of Gibbs' free energy of mixing two ideal gases. Calculate the Gibbs' free energy of mixing ΔG_{mix} , when 1 mole of helium, 2 moles of argon and 3 moles of neon are mixed at 298 K and 0.1 atm pressure. 3+1=4

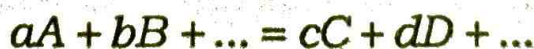
UNIT—III

5. Answer the following questions (any *three*) :

3×3=9

- (a) Write the Le Chatelier principle. Explain how this principle is used in the commercial production of ammonia by Haber process. 1+2=3

- (b) Derive an expression for the change in Gibbs' free energy for the following gas phase reaction :



- (c) What are exoergic and endoergic reactions? Give examples. 1+2=3
- (d) Define equilibrium constant in the light of law of mass action. Write any two characteristics of the equilibrium state. 2+1=3

UNIT—IV

6. Answer the following questions (any two) :

4×2=8

(a) What is relative lowering of vapour pressure? Explain how this law can be used for determining molar mass of a dissolved substance.

1+3=4

(b) (i) What is the physical significance of chemical potential? Explain.

2

(ii) What are isotonic solutions? Discuss.

2

(c) Explain under which conditions abnormal molar masses of solutes are obtained from the measurement of colligative properties of their solutions. Write the expression of degree of association, α of a solute in a solution in terms of van't Hoff factor.

3+1=4

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