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2 SEM TDC CHMH (CBCS) C 4

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(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

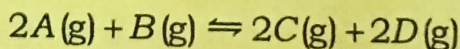
(i) $S = nRT \ln W$

(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

(6)

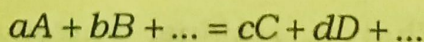
- (b) Derive an expression of Gibbs' free energy of mixing two ideal gases. Calculate the Gibbs' free energy of mixing ΔG_{mix} , when 1 mole of helium, 2 moles of argon and 3 moles of neon are mixed at 298 K and 0.1 atm pressure. 3+1=4

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
