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2 SEM TDC CHMH (CBCS) C 4

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(June/July)

CHEMISTRY

(Core)

Paper : C-4

(Physical Chemistry—II)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

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

1. Choose the correct answer : 1×6=6

(a) For a system to be at equilibrium,
the value of ΔG at constant temperature
and pressure must be

(i) $\Delta G_{T, P} > 0$

(ii) $\Delta G_{T, P} < 0$

(iii) $\Delta G_{T, P} = 0$

(iv) $\Delta G_{T, P} \geq 0$

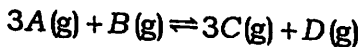
(b) The value of ΔS for an irreversible process is

- (i) positive
- (ii) negative
- (iii) zero
- (iv) None of the above

(c) The chemical potential is

- (i) partial molar enthalpy
- (ii) partial molar volume
- (iii) partial molar free energy
- (iv) partial molar internal energy

(d) For equilibrium in case of a hypothetical gaseous reaction



- (i) $K_p = K_c RT$
- (ii) $K_p = K_c (RT)^2$
- (iii) $K_p = K_c$
- (iv) $K_c = \frac{1}{K_p}$

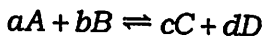
- (e) Regardless of the atmospheric pressure, the boiling point of a dilute solution as compared to that of pure solvent is
- (i) same
 - (ii) lower
 - (iii) higher
 - (iv) Any of the above
- (f) If z is a state function, then $\oint dz$ is equal to
- (i) zero
 - (ii) positive
 - (iii) negative
 - (iv) infinity

2. Answer any six of the following questions :

2×6=12

- (a) Write any two differences between reversible and irreversible processes.
- (b) Six moles of an ideal gas expand isothermally and reversibly from a volume of 1 dm^3 to a volume of 10 dm^3 at 27°C . What is the maximum work done?

- (c) Establish the relationship between enthalpy change and internal energy change for a gaseous reaction.
- (d) What are partial molar properties? Define chemical potential.
- (e) Derive the relation between K_p and K_c for the following reaction :



- (f) How are osmotic pressure measurements utilized for determining molar mass of a non-volatile solute?
- (g) What are extensive and intensive properties? Explain with examples.

UNIT—I

Answer any *two* questions from the following : $8 \times 2 = 16$

3. (a) Calculate the work done when a gas expands—
- (i) isothermally and reversibly from volume V_1 to V_2 ;
- (ii) isothermally and irreversibly from volume V_1 to V_2 .

From these, show that the work done in a reversible process is greater than that in an irreversible process. $2+2+2=6$

- (b) What is Joule-Thomson coefficient? Derive a relation between Joule-Thomson coefficient and thermodynamic quantities. 2
4. (a) Deduce a relation between temperature and volume for an adiabatic reversible expansion of an ideal gas. $2\frac{1}{2}$
- (b) One mole of an ideal gas ($\bar{C}_V = 12.55 \text{ J K}^{-1} \text{ mol}^{-1}$) at 300 K is compressed adiabatically and reversibly to one-fourth of its original volume. What is the final temperature of the gas? $2\frac{1}{2}$
- (c) Derive Kirchhoff's equation. 3
5. (a) Deduce an expression for the entropy changes associated with the changes in temperature and pressure of an ideal gas. 4
- (b) For a reaction $\Delta H = 10.5 \times 10^3 \text{ J mol}^{-1}$ and $\Delta S = 31 \text{ J K}^{-1} \text{ mol}^{-1}$ at 298 K, decide whether the reaction is spontaneous or not at this temperature. 2
- (c) State and explain the third law of thermodynamics. 2

UNIT—II

6. Answer either (a) or (b) :

3

(a) Discuss the variation of chemical potential with temperature and pressure.

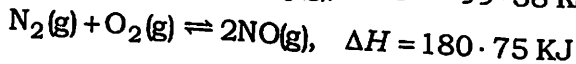
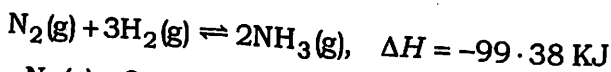
(b) Derive Gibbs-Duhem equation.

UNIT—III

7. Answer any two questions from the following :

4×2=8

(a) State and explain Le Chatelier's principle. With the help of this principle, work out the conditions which would favour the formation of ammonia and nitric oxide in the following reactions :



2+2=4

(b) (i) What are exergonic and endergonic reactions?

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(ii) Calculate K_c and K_x for the reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ for which $K_p = 0.157$ atm at 27°C and 1 atm pressure.

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- (c) Derive the relation between Gibbs' free energy change and reaction quotient. From this, establish the relation between standard Gibbs' free energy change and equilibrium constant of a reaction. 3+1=4

UNIT—IV

8. Answer any *two* questions from the following : 4×2=8

- (a) What is osmotic pressure? Derive a relation between osmotic pressure and relative lowering of vapour pressure.
- (b) What are isotonic solutions? A solution containing 8.77 g per dm^3 of urea (molar mass = 60 g mol^{-1}) was found to be isotonic with a 5-percent solution of an organic non-volatile solute. Calculate the molar mass of the latter. 1+3=4
- (c) Derive the relation between the elevation of boiling point of a dilute solution and the molality of that solution. Define molal elevation constant. 3+1=4

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