LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **CHEMISTRY**

THIRD SEMESTER – **NOVEMBER 2022**

UCH 3503 – THERMODYNAMICS

Date: 03-12-2022 Dept. No. Max. : 100 Marks

Time: 09:00 AM - 12:00 NOON

SECTION A

Answer ALL the Questions in one or two sentences

1.	**Fill in the blanks**	**(5 x 1 = 5)**	
a)	The_____ of an ideal gas is proportional to its absolute temperature.	K1	CO1
b)	If the heat of formation of CO_2 is – 94 kcal mol^{-1}, then the enthalpy of CO_2 is_____.	K1	CO1
c)	For an isochoric process, ΔS_v = ___ ln (T_2/T_1).	K1	CO1
d)	The equilibrium constant is affected by change in _____.	K1	CO1
e)	The expression for rotational partition function (q_{rot}) is _____	K1	CO1
2.	**Choose the correct answer**	**(5 x 1 = 5)**	
a)	In the ideal gas equation PV = nRT (i) n is the number of molecules of a gas (ii) n is the number of moles of a gas (iii) P is the pressure of the one mole of a gas (iv) V is the volume of one mole of a gas	K1	CO1
b)	Heat of reaction is independent of _____. (i) temperature (ii) pressure (iii) physical state (iv) path adopted	K1	CO1
c)	If a process is both endothermic and spontaneous, then (i) $\Delta S > 0$ (ii) $\Delta S < 0$ (iii) $\Delta H < 0$ (iv) $\Delta G > 0$	K1	CO1
d)	A_2 (g) + B_2 (g) ⇌ 2AB (g) ; ΔH = +ve, the reaction _____ (i) increases by pressure (ii) occurs at 1000 atm pressure (iii) occurs at high temperature (iv) occurs at high pressure and temperature	K1	CO1
e)	_____ describes the quantum state of individual particle in the system. (i) microstate (ii) macrostate iii) thermodynamic (iv) equilibrium	K1	CO1
3.	**Choose the correct answer**	**(5 x 1 = 5)**	
a)	Which among the following is not an intensive property? (i) boiling point (ii) refractive index (iii) Molarity (iv) volume	K2	CO1
b)	For an ideal gas, Joule-Thomson coefficient is_____ (i) positive (ii) negative (iii) zero (iv) infinity	K2	CO1
c)	Unit of molar entropy is _____. (i) J K^{-1} mol^{-1} (ii) J mol^{-1} (iii) J K mol^{-1} (iv) J^{-1} K^{-1} mol^{-1}	K2	CO1
d)	Le Chatelier's principle is applicable to_____ (i) heterogeneous reaction (ii) homogenous reaction (iii) irreversible reaction (iv) system in equilibrium	K2	CO1
e)	The value of ln 10! is (i) 230 (ii) 13 (iii) 23 (iv) 130	K2	CO1

4.	**Match the following**				**(5 x 1 = 5)**	
a)	At constant volume	-	$K_f = K_r$		K2	CO1
b)	A reaction has a $+\Delta G$	-	Boyle's law		K2	CO1
c)	At equilibrium	-	q = 0		K2	CO1
d)	In adiabatic process	-	Isochoric		K2	CO1
e)	At constant temperature	-	Non-spontaneous process		K2	CO1

SECTION B

Answer any TWO of the following **(2 x 10 = 20)**

5.	(a)	Discuss the different types of molecular velocities.	(5)	K3	CO2
	(b)	Calculate the pressure exerted by one mole of carbon dioxide gas in a 1.32 dm^3 vessel at 48ºC using van der Waals gas. The van der constants are a = 3.59 dm^3 atm mol^{-2} and b = 0.0427 dm^3 mol^{-1}, R= 0.08206 dm^3 atm K^{-1} mol^{-1}.	(5)	K3	CO2
6.	(a)	Show that $C_p - C_v = R$.	(5)	K3	CO2
	(b)	Obtain the following expression for Joule-Thomson coefficient: $\mu_{JT} = \frac{dT}{dP} = -\frac{(\partial H/\partial P)_T}{C_P}$	(5)	K3	CO2
7.		Derive K_p and K_c for $2NH_3\,(g) \rightleftharpoons N_2\,(g) + 3H_2\,(g)$. Using Le Chatelier's principle, explain the effect of pressure on the above equilibrium.	(10)	K3	CO2
8	(a)	Derive any one Maxwell's relations between thermodynamic quantities.	(5)	K3	CO2
	(b)	State and explain Nernst heat theorem.	(5)	K3	CO2

SECTION C

Answer any TWO of the following **(2 x 10 = 20)**

9.	(a)	Explain the effect of temperature on Maxwell's distribution of molecular velocities.	(5)	K4	CO3
	(b)	Derive Kirchoff's equation.	(5)	K4	CO3
10.		With the help of Carnot cycle, Show that $w = q_2\,(T_2-T_1)/T_2$.	(10)	K4	CO3
11.	(a)	Write any two applications of bond energy.	(5)	K4	CO3
	(b)	Show the relationship between K_p and K_c. Calculate K_p for the given reaction having K_c value of 49 mol dm^3 at 27ºC. $2SO_3\,(g) \rightleftharpoons 2SO_2(g) + O_2\,(g)$	(5)	K4	CO3
12.		List the major assumptions of Maxwell-Boltzmann statistics. Explain the relation between energy and partition function.	(10)	K4	CO3

SECTION D

Answer any ONE of the following **(1 x 20 = 20)**

13.	(a)	Explain the principle of equipartition of energy.	(5)	K5	CO4
	(b)	State the Hess's law of constant heat summation. Explain its applications.	(10)	K5	CO4
	(c)	Derive Gibbs-Helmholtz equation.	(5)	K5	CO4
14.	(a)	Write notes on thermodynamic probability and macrostate.	(5)	K5	CO4
	(b)	State the Planck and Lewis-Randall formulations of third law of thermodynamics.	(5)	K5	CO4

	(c)	Explain Van't Hoff reaction isotherm. The standard free energy change ΔG^o of a reaction at 298 K is 28.5 kJ. Calculate the value of the equilibrium constant (K_{eq}).	(10)	K5	CO4
		SECTION E			
Answer any ONE of the following					**(1 x 20 = 20)**
15.	(a)	Summarize the postulates of kinetic theory of gases and derive the expression for kinetic gas equation.	(8)	K6	CO5
	(b)	Write short notes on the following: (i) Exact and inexact differentials (ii) Concept of enthalpy	(7)	K6	CO5
	(c)	Show that $P_1V_1^{\gamma} = P_2V_2^{\gamma}$.	(5)	K6	CO5
16.	(a)	Explain the thermodynamic working principle of a refrigerator.	(5)	K6	CO5
	(b)	Write in detail the effect of temperature and pressure on the following equilibrium using Le Chatelier's principle: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$; $\Delta H = +59.0$ kJ	(5)	K6	CO5
	(c)	Write the steps involved in the determination of absolute entropy of solids, liquids and gases?	(10)	K6	CO5

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