GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Third Semester Regular) Examinations, December – 2023

22BCHPC23003 – Chemical Process Calculation

(Chemical)

Time: 3 hrs Maximum: 70 Marks

Answer all questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions	CO #	Blooms Level
a. The specific gravity of hydrocarbon oil is 0.88 at 288 K. Calculate its value in Baume scale and API scale.	CO2	K4
b. What is the density of CO_2 at NTP?	CO2	K2
c. State Roult's law and Henry's law.	CO1	K2
d. The GCV of gaseous n-butane is 2880kj/mol at 298 K. Calculate NCV in kJ/mol and kJ/kg units using latent heat of water vapour at 298 K and 2442.5 kJ/kg.	CO2	K3
e. Differentiate adiabatic reaction temperature and theoretical flame temperature.	CO1	K3

PART – B **(15 x 4 = 60 Marks)**

Answer ***ALL*** questions	Marks	CO #	Blooms Level
2. a. A body weighs 1 kg in air, 0.9 kg in water and 0.85 kg in a liquid. What is the specific gravity of the liquid?	7	CO2	K3
b. 500 cubic meters of 30 ^{0}API gas oil is blended with 2000 cubic meters of 15^0 API fuel oil. What is the density of the resultant mixture in kg/m^3? The density of water at 288.5 K = 0.999 g/ml.	8	CO2	K4
(OR)			
c. An aqueous solution of NaCl contains 20% NaCl. The density of the solution is 1.16 g/ml. 500 ml of water of density 1 g/ml is added to 1 litre of solution. What will be the molarity, normality and molality of the resulting solution?	7	CO2	K3
d. A liquid mixture contains three components A (MW=72), B (MW= 58) and C (MW=56) in which A and B are present in the mole ratio of 1.5:1 and the weight % of B is 25%. A sample of mixture is found to contain 10 kg of C. Calculate the total number of moles of the mixture.	8	CO2	K4
3.a. The Antoine constants for n-heptane are A=13.8587, b=2911.32 and C= 56.56. P^s s in kPa and t is in K. Calculate (i) The vapour pressure of n-heptane at 325 K (ii) The normal boiling point of n-heptane	7	CO2	K4

b.	An aqueous solution of acetaldehyde contains 2% acetaldehyde by weight. The partial pressure of acetaldehyde over the solution is found to be 41.4 kPa at 367 K. What will be the partial pressure over a 0.1 molal solution at the same temperature?	8	CO2	K2
	(OR)			
c.	Bottled liquid gas containing n-Butane (50 mol %), Propane (45 mol %) and Ethane (5 mol %) with vapour pressures at 30^0C in bar as 3.4, 10.8, 46.6 respectively sold for household use. Determine the pressure of the system and the equilibrium vapour composition at 30^0C.	7	CO2	K4
d.	Define the terms (i) Heat capacity (ii) Specific heat capacity (iii) mean heat capacity of single gas (iv) heat capacity of gas mixtures (v) mean heat capacity of gas mixture.	8	CO2	K2
4.a.	Propane is burned with excess air to ensure complete combustion. If 55 kg of CO_2 and 15 kg of CO are obtained when propane is completely burned with 500 kg air, determine: the mass of propane burnt in kg and the percent excess air.	8	CO2	K4
b.	An aqueous solution of Na_2CO_3 contains 15% carbonate by weight. 80% of the carbonate is recovered as $Na_2CO_3.10H_2O$ by evaporation of water and subsequent cooling to 278 K. The solubility of Na_2CO_3 at 278 K is 9% (weight). On the basis of 100 kg of solution treated, determine the following: (i) the quantity of crystal formed (ii) the amount of water evaporated	7	CO2	K3
	(OR)			
c.	Soap as produced contains 50% moisture on a wet basis. Before it can be pressed into cake for sale, the moisture would be reduced to 20%. How many 100g cakes can be pressed from 1000 kg of wet soap?	8	CO2	K4
d.	Sulphur trioxide gas is obtained by the combustion of iron pyrites (FeS_2) according tothe following reaction: $4FeS_2 + 15O_2 \longrightarrow 2Fe_2O_3 + 8SO_3$ i) How many kilograms of pyrites are burned to obtain 100 kg of SO_3? ii) How many kilograms of oxygen are consumed in the production of 50 kg of SO_3?	8	CO2	K3
5.a.	Obtain the empirical equation for calculating the heat of reaction at any temperature T (K) for the following reaction: $CH_4(g) + C_2H_6(g) \longrightarrow C_3H_8(g)$ Data: Standard heat of reaction at 298 k = -82.66 kJ/mol, Sp. Heat = $a + bT + cT^2$, kJ/(mol.K)	15	CO3	K4

Component	a	bx10^3	C x10^6
CH_4	19.2494	52.1135	11.973
C_2H_6	4.1261	155.0213	81.5455
C_3H_8	4.2227	306.264	158.6316

Using the same expression, calculate the heat of reaction at 600 ^{0}C.

(OR)

b. Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction: 15 CO3 K4

$$CO_{(g)} + 2\,H_{2(g)} \rightarrow CH_3OH_{(g)}$$

Data: $\Delta H_R^0 = -90.41\ kJ/mol$

Component	a	b × 10^3	c × 10^6
$CO_{(g)}$	29.0277	-2.8165	11.6437
$H_{2(g)}$	28.6105	1.0194	-0.1476
$CH_3OH_{(g)}$	21.137	70.843	25.86

Also calculate the standard heat of reaction at 700 K.

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