USN

18BT41

Fourth Semester B.E. Degree Examination, July/August 2022 **Stoichiometry**

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Define the following:
 - (i) Normality
 - (ii) Molarity
 - (iii) Equivalent weight
 - (iv) Volume percent
 - (v) Dalton's law

(10 Marks)

b. A chemist is interested in preparing 500 ml of 1 normal, 1 molar and 1 molal solution of H₂SO₄. Assuming the density of H₂SO₄ solution to be 1.075 g/cm³, calculate the quantities of H₂SO₄ to be taken to prepare these solutions. (10 Marks)

OR

- a. A natural gas has the following composition by volume, $CH_4 = 82\%$, $C_2H_6 = 12\%$ and $N_2 = 6\%$. Calculate:
 - (i) Composition by weight
 - (ii) Average molecular weight
 - (iii) Density of the gas at 288 K and 101.325 kPa
 - (iv) Specific gravity (average molecular weight of air is 28.84) (10 Marks)
 - b. A compound whose molecular weight is 103, analysis: C 81.5%, $H_2 4.9\%$ and $N_2 13.6\%$. What is the molecular formula? (06 Marks)
 - c. Ethanol and water forms a azeotrope containing 96% ethanol by weight. Find the composition of azeotrope by mole%. (04 Marks)

Module-2

- 3 a. A feed to a continuous fractionating column analysis by weight 28% benzene and 72% toluene. The analysis of distillate shows 52 weight % benzene and 5% benzene was found in bottom product. Calculate:
 - (i) Amount of distillate and bottom product per 1000 kg of feed/hour
 - (ii) Percentage recovery of benzene

(Note: All percentage are given by weight)

(10 Marks)

- b. 2500 kg of wet solids containing 70% solids by weight are fed to tray dryer where it is dried by hot air. The product finally obtain is found to contain 1% moisture by weight. Calculate:
 - (i) Amount (in kg) of water removed from wet solids
 - (ii) Amount (in kg) of product obtained.

(10 Marks)

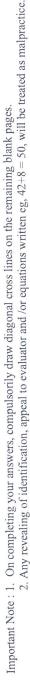
OR

- a. Define fuel. Classify fuels and write a note on characteristics of fuel.
- (10 Marks)
- b. The gross heating value of gaseous propane (C₃H₈) at 298 K is 2219.5 kJ/mol. Calculate its net heating value considering latent heat of water vapour at 298 K is 2442.5 kJ/mol.

(06 Marks)

c. Write a note on ultimate and proximate analyses of fuels.

(04 Marks)



Module-3

- With block diagrams, define: 5
 - (ii) Bypass operation
- (iii) Purge operation

(06 Marks)

b. Fresh juice contains 15% solids and rest 85% water. It is concentrated to contain 40% solids by weight. It is found in an evaporator system that juice escapes water leaving concentrated juice 55% with flat taste. To overcome this problem, part of the fresh juice bypasses the evaporator. Calculate:

Fraction of juice that bypasses evaporator

Concentrated juice produced (containing 40% solids) per 100 kg of fresh juice fed to

Define the following: 6

(i) Yield

(ii) Selectivity

(iii) Limiting Reactant

(10 Marks)

(v) % excess

b. A combustion chamber is fed with butane and excess air. Combustion of butane is complete. The composition of gases on volume basis is given by $CO_2 = 9.39\%$, $H_2O = 11.73\%$, $O_2 = 4.70\%$ and $N_2 = 74.18\%$. Find % excess air used and mole ratio of air to butane used. (10 Marks)

Module-4

Define the following:

(i) Heat of reaction

(ii) Heat of formation

(iii) Heat of combustion

(iv) Hess's law of constant heat summation

b. Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction: $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$

Data : $\Delta H_R^{\circ} = -90.41 \text{ kJ/mol}$ $C_p^{\circ} = a + bT + cT^2 + dT^3, \text{ kJ/(kmol.K)} \text{ or J/(mol.K)}$

C _p a · o			- 6	1 109
Component	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
	29.0277	-2.8165	11.6437	-4.7063
CO (g)		1.0194	-0.1476	0.769
$H_2(g)$	28.6105			-28.497
CH ₃ OH (g)	21.137	70.843	25.86	-28.497

(12 Marks)

OR

Calculate the standard heat of formation of n-propanol liquid using the following data:

Standard heat of formation of $CO_2(g) = -393.51 \text{ kJ/mol}$

Standard heat of formation of H₂O = 285.83 kJ/mol

Standard heat of combustion of n-propanol $(C_3H_7OH)(l) = -2028.19 \text{ kJ/mol}$

(10 Marks)

b. Pure ethylene is heated from 303 K to 523 K at atmospheric pressure. Calculate the heat added per kmol ethylene using heat capacity data given below:

 $C_p^o = 4.1261 + 155.0213 \times 10^{-3} \text{ T} - 81.5455 \times 10^{-6} \text{ T}^2 + 16.9755 \times 10^{-9} \text{ T}^3$

(10 Marks)

Module-5

- Explain the different downstream process involved in production of ethanol with a flow (10 Marks)
 - Explain briefly about historical development of bioprocess technology.

- Explain with an example, the process flow sheet and unit operations involved in bioprocess 10
 - Explain the different downstream process involved in production of pencillin with a flow chart.