

B.E./B.TECH. Degree Examination, December 2020

Third Semester

BT16301-STOICHIOMETRY AND PROCESS CALCULATIONS

(Regulation 2016)

Time: Three hours

Maximum : 80 Marks

Answer **ALL** questions**PART A - (8 X 2 = 16 marks)**

- The reactant with the smallest maximum extent of reaction is the
 - Excess reactant
 - Limiting reactant
 - Neither excess nor limiting reactant
 - None of the mentioned
- Which one is an incorrect conversion?
 - 1 inch = 2.54 cm
 - 1 mile = 5280 ft
 - 1 ft. = 12 inch
 - None of the mentioned
- 10 moles of O₂ is added to 10 moles of H₂, how many moles of H₂O will it produce?
 - 5
 - 10
 - 15
 - 20
- What is the formula to calculate number of kg moles (n) of a gas?
If m = mass of gas μ = molecular weight
 - $n = m \cdot \mu$
 - $n = m / \mu$
 - $n = \mu / m$
 - none of the above
- 100 K.moles/hr of air is sent to a fermenter. What is the molar flow rate of O₂ to the fermenter?
- Convert 499 g of CuSO₄.5H₂O into moles.
- Convert 50°F to Kelvin scale.
- What is the volume of 25 kg of chlorine gas at NTP?

PART B - (4 X16 = 64 marks)

09. (a) Explain in detail various types of unit system used in Process Engineering with suitable example (16)

(OR)

- (b) A gas mixture contains 0.274kmol of HCl, 0.337kmol of N₂ and 0.089kmol of O₂. (16)
Calculate a) Average Molecular Weight
b) Volume occupied by the mixture
c) partial pressure of each component at 405.3kPa and 303K
d) density of the gas mixture
10. (a) The waste acid from a nitrating process contains 23 % HNO₃, 57% H₂SO₄; 20% water. (16)
This acid is to be concentrated to 27% HNO₃, 60% H₂SO₄ by addition of concentrated H₂SO₄ containing 93% H₂SO₄ and concentrated nitric acid containing 90 % HNO₃.
Calculate the amount in kg of waste and concentrated acids that must be combined to obtain 1000 kg of desired mixture.

(OR)

- (b) (i) The composition of the gas entering a converter is $\text{SO}_2 - 72\%$, $\text{O}_2 - 13.2\%$ and $\text{N}_2 - 79.6\%$ and that of the gas leaving is $\text{SO}_2 - 28\%$, $\text{O}_2 - 11.7\%$ and $\text{N}_2 - 85.5\%$. Determine the % of SO_2 oxidised to SO_3 . (8)
- (ii) A high purity limestone is burnt in a lime-kiln which is fired externally with a coal containing 75.5% C, 5.5% H, 1.6% N, 1.1% S, 7.6% O and rest ash. The stack analysis is 20.2% CO_2 , 7.1% O_2 and the rest N_2 , Calculate: (8)
- (i) Kg of limestone burnt per kg of coal.
- (ii) Excess air used for combustion.

11. (a) (i) Discuss the various humidity concepts essential in the design of a process industry. (8)
- (ii) List the applications of Psychrometric charts in process industries. (8)

(OR)

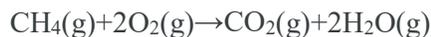
- (b) Explain the following (16)
- (i) Heat of formation (ii) Hess's law of constant heat summation

12. (a) (i) Heat capacity of acetic acid is given by: (8)

$$C_p = 155.48 - 10^{-3} T + 744.199 + 10^{-6} T^2.$$

Based on this equation, calculate the mean heat capacity for acetic acid for temperature range of 25°C and 50°C.

- (ii) Calculate the standard enthalpy of reaction for the combustion of methane: (8)



$$\Delta H_f^\circ \text{CH}_4(\text{g}) = -75 \text{ kJ/mol}$$

$$\Delta H_f^\circ \text{CO}_2(\text{g}) = -394 \text{ kJ/mol}$$

$$\Delta H_f^\circ \text{H}_2\text{O}(\text{g}) = -284 \text{ kJ/mol}$$

(OR)

- (b) (i) Calculate the heat of formation of glycerol ($\text{C}_3\text{H}_8\text{O}_3$) at 298.15 K from its elements using the following data: (8)

$$\text{Data: } \Delta H_f^\circ \text{CO}_2(\text{g}) = -393.51 \text{ KJ/mol}$$

$$\Delta H_f^\circ \text{H}_2\text{O}(\text{l}) = -285.3 \text{ KJ/mol}$$

$$\Delta H_c^\circ \text{C}_3\text{H}_8\text{O}_3(\text{l}) = -1659.10 \text{ KJ/mol}$$

- (ii) A stream flowing at a rate of 15,000 mol/h containing 25 mol% N_2 and 75 mol% H_2 is to be heated from 25°C to 200°C. Calculate the heat that must be transferred using C_p data given. (8)

Gas	a	b x 10 ³	c x 10 ⁶	d x 10 ⁹
N_2	29.59	-5.41	13.18	-4.96
H_2	28.61	1.01	-0.14	0.76