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)

1. The reactant with the smallest maximum extent of reaction is the

   a) Excess reactant b) Limiting reactant

   c) Neither excess nor limiting reactant d) None of the mentioned

2. Which one is an incorrect conversion?

   a) 1 inch = 2.54 cm b) 1 mile = 5280 ft c) 1 ft. = 12 inch d) None of the mentioned

3. 10 moles of O_2 is added to 10 moles of H_2, how many moles of H_2O will it produce?

   a) 5 b) 10 c) 15 d) 20

4. What is the formula to calculate number of kg moles (n) of a gas?

   If m = mass of gas μ = molecular weight

   A. n = m . μ B. n = m / μ C. n = μ / m D. none of the above

5. 100 K.moles/hr of air is sent to a fermenter. What is the molar flow rate of O_2 to the fermenter?

6. Convert 499 g of $CuSO_4.5H_2O$ into moles.

7. Convert 50°F to Kelvin scale.

8. 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 $N_2$and 0.089kmol of O_2. Calculate a) Average Molecular Weight **(16)**

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 % HNO_3, 57% H_2SO_4; 20% water. This acid is to be concentrated to 27% HNO_3, 60% H_2SO_4 by addition of concentrated H_2SO_4containing 93% H_2SO_4 and concentrated nitric acid containing 90 % HNO_3. Calculate the amount in kg of waste and concentrated acids that must be combined to obtain 1000 kg of desired mixture. **(16)**

(OR)

(b) (i) The composition of the gas entering a converter is SO_2 – 72%, O_2 – 13.2% and N_2 – 79.6% and that of the gas leaving is SO_2 – 28%; o2 – 11.7% and 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% CO2, 7.1% O2 and the rest N2, 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)**

$CH_4(g)+2O_2(g) \rightarrow CO_2(g)+2H_2O(g)$

$\Delta H^{\circ}_f\ CH_4(g) = -75$ kJ/mol

$\Delta H^{\circ}_f\ CO_2(g) = -394$ kJ/mol

$\Delta H^{\circ}_f\ H_2O(g) = -284$ kJ/mol

(OR)

(b) (i) Calculate the heat of formation of glycerol ($C_3H_8O_3$)at 298.15 K from its elements using the following data: **(8)**

Data: $\Delta H^{\circ}_f\ CO_{2\,(g)} = -393.51$ KJ/mol

$\Delta H^{\circ}_f\ H_2O_{(l)} = -285.3$ KJ/mol

$\Delta H^{\circ}_C\ C_3H_8O_{3\,(l)} = -1659.10$ KJ/mol

(ii) A stream flowing at a rate of 15,000mol/h containing 25mol% N_2 and 75mol% 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	dx10^9
N_2	29.59	-5.41	13.18	-4.96
H_2	28.61	1.01	-0.14	0.76