

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

Third Semester

BT18302-Process Calculations

(Regulation 2018)

Time: Three hours

Maximum : 80 Marks

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

1. Convert 0.03 g/cm^3 to lb/ft^3
 (i) 1.88 lb/ft^3 (ii) 0.188 lb/ft^3 (iii) 18.8 lb/ft^3 (iv) 188 lb/ft^3
2. Which of the following statement is correct when mole fraction of component A= X_a , component B = X_b
 (i) $X_a/X_b = 1$ (ii) $X_a = X_b$ (iii) $X_a + X_b = 1$ (iv) $X_a X_b = 1$
3. $a \text{ NH}_3 + b \text{ O}_2 \rightarrow c \text{ NO}_2 + d \text{ H}_2\text{O}$, For a balanced reaction, the value of b is?
 (i) 1.5 (ii) 2.5 (iii) 3.5 (iv) 4.5
4. In the reaction $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$, if the heat liberated is 10 J, what is the heat of formation of CO?
 (i) -5 J (ii) 5 J (iii) -10 J (iv) 10 J
5. How many moles of NaOH are present in 200g of it?
6. Give a neat sketch of the flow diagram for the absorption process.
7. Differentiate dry bulb temperature and wet bulb temperature.
8. If the mole fraction of gaseous H_2O is 0.0287 and the total pressure is 0.977, calculate the partial pressure of H_2O .

PART B - (4 X16 = 64 marks)

09. (a) (i) Are process based calculations essential for a biotechnologist at bio-based industries? Justify your answer. **(8)**
 - (ii) Explain the basic principle of Recycle and Drying operations with a neat flow diagram. **(8)**
- (OR)**
- (b) (i) Express 380 mmHg pressure in atmospheres, kilopascal, torr, pounds per square inch, bar, and pascal. **(8)**
 - (ii) 200 mL of an aqueous sodium chloride solution contains 0.04 g NaCl. Calculate the concentration of NaCl in parts per million (ppm). **(8)**
10. (a) 1000 m^3 of a gas mixture containing H_2 , N_2 and CO_2 at 423 K was found to have the following ratio for the partial pressure of the gases $p_{\text{H}_2} : p_{\text{N}_2} : p_{\text{CO}_2} = 1:4:3$. If the total pressure is 2 atm, calculate (a) The mole fraction of each gas (b) Wt. % of these gases (c) The average mol. wt. (d). Weight of Carbon dioxide. **(16)**

(OR)

- (b) A 4.25L flask contains 3.46 mol CO₂ at 229 °C. Calculate the pressure of this sample of CO₂: (16)
- (a) From the ideal gas law (b) From the van der Waals equation
Data: $a = 3.61 \text{ L}^2 \text{ atm mol}^{-2}$; $b = 0.0428 \text{ L mol}^{-1}$
11. (a) (i) The standard heat of combustion of benzene is -3271 kJ/mol , the standard heat of formation of CO₂ is -394 kJ/mol , and for H₂O, -286 kJ/mol . Calculate the standard heat of formation of benzene. (8)
- (ii) The heat of combustion for the gases hydrogen, methane and ethane are -285.8 , -890.4 and -1559.9 kJ/mol respectively at 298K. Calculate the heat of reaction for the following reaction: (8)
- $$2\text{CH}_4(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g}) + \text{H}_2(\text{g})$$
- (OR)**
- (b) (i) How many grams of Al₂O₃ are formed from 15.0 L of O₂ at 97.3kPa & 21°C in the following reaction?: $\text{Al} + \text{O}_2 \rightarrow \text{Al}_2\text{O}_3$ (8)
- (ii) 80 g each of He, Ne, and Ar are in a container. The total pressure is 780 mm Hg. Find each gas's partial pressure. (8)
12. (a) (i) Soybean seeds oil is extracted with hexane in a batch extractor. The flaked seeds contain 18.2% oil, 69.5% solid and 12.3% moisture. At the end of the process, cake is separated from hexane oil mixture. The cake analysis yields 0.8% oil, 88.2% solids and 11.0% moisture. Find the percentage recovery of oil. All percentage are by weight. (8)
- (ii) A 2.00 g sample of ammonia is mixed with 4.00 g of oxygen. Which is the limiting reactant and how much excess reactant remains after the reaction has stopped? (8)
- (OR)**
- (b) (i) Calcium oxide is formed by decomposing limestone pure CaCO₃. In kiln, the reaction goes to 70% completion. (8)
- (i) What is the composition of the solid product withdrawn from the kiln?
- (ii) What is the yield in kg of CO₂ produced per kg of limestone charged?
- (ii) If 14.4 kg of CO₂ are formed in the reaction of 10 kg of C₇H₁₆: (8)
- $$\text{C}_7\text{H}_{16} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$$
- What is the percent of conversion of the C₇H₁₆ to convert to CO₂?