Reg. No. : | | | | | | | | | | | | |

Question Paper Code: R3C06

B.E./B.Tech. DEGREE EXAMINATION, NOV 2024

Third Semester

Biotechnology

R21UBT306 - STOICHIOMETRY

(Regulations R2021)

Duration: Three hours | Maximum: 100 Marks

Answer All Questions

PART A - (10 x 2 = 20 Marks)

1.	What are Fundamental units and derived units? Give examples	CO1-U
2.	How many grams of NH_4Cl are there in 5 mol?	CO2-App
3.	State ideal gas law.	CO1-U
4.	A gas mixture contains 0.28 kmol of HCl, 0.34 kmol of N_2 and 0.09 kgmol of O_2. Calculate average molecular weight of gas.	CO2-App
5.	Draw the block diagram of evaporator in material balance	CO1-U
6.	Define Degrees of Freedom	CO2-U
7.	State Raoult's law.	CO1-U
8.	Differentiate Open system and Closed system	CO1-U
9.	What is yield coefficient	CO1-U
10.	Define yield in chemical reaction	CO3-App

PART – B (5 x 16= 80 Marks)

11. (a) In the SI system, thermal conductivity has unit of W/(m K). The thermal conductivity of a solid material can be calculated as k = xQ/ AΔT, where Q is the rate of heat transfer, x is thickness of the solid, A is the area of heat transfer and ΔT is the temperature difference across the solid. The following values were obtained experimentally, Q = 20,000 kJ/h, A = 10 m^2, x = 10 cm and ΔT = 1000 K. CO4-Eva (16)

a) Calculate the thermal conductivity of the solid in W/(m K)

b) Express the thermal conductivity in kcal / (h m °C).

c) If the thermal conductivity of a second material is 0.15 Btu/(h ft °F), which one will make a better thermal conductor

Or

(b) An aqueous solution of K_2CO_3 contains 50% salt and the specific gravity of the solution is 1.53. Determine the following: CO4-Eva (16)

(a) The mole percent of the salt in the solution

(b) The volume percent of water assuming density of water is 1000 kg/m^3 and there is no volume change on mixing

(c) The molality of the solution

(d) The molarity of the solution

(e) The normality of the solution

12. (a) A mixture of acetone vapour and nitrogen gas at 101.3 kPa and 310 K contains acetone vapour to the extent that it exerts a partial pressure of 15 kPa. The vapour pressure of acetone is given by the Antoine equation CO3-Ana (16)

$$ln P^s = 14.5463 - \frac{2940.46}{T - 49.19}$$

where the pressure is in kPa and temperature is in K. Determine the following:

(a) The mole fraction of acetone in the mixture (2)

(b) The weight fraction of acetone in the mixture (2)

(c) The molal humidity (3)

(d) The absolute humidity (3)

(e) The molal saturation humidity (3)

(f) The absolute saturation humidity (3)

Or

(b) A natural gas has the following composition by volume: CO_2 = 0.8%, N_2 = 3.2 %, CH_4 =96%. Calculate
i) The Composition in weight percentage
ii) The average molecular weight
iii) The density at standard conditions in kg/m^3 — CO3-Ana — (16)

13. (a) In the azeotropic distillation of an ethanol–water solution, a feed mix-ture containing 95.6% alcohol is mixed with pure benzene and dis-tilled. The benzene forms a ternary azeotrope with alcohol–water with a composition of 74.1% benzene, 7.4% water and 18.5% alcohol, which is distilled over as the overhead product. Absolute alcohol is obtained as the residue product. Determine the quantity of benzene required for producing 100 kg of absolute alcohol. — CO2-App — (16)

Or

(b) A triple effect evaporator is used to concentrate 1000 kg of aqueous solution from a concentration of 20% solute to 80% solute. Assuming an equal amount of vaporization in each effect, calculate the composi-tion and weight of the solution entering the second and third effect evaporator. — CO2-App — (16)

14. (a) A spherical storage tank of 3 m in diameter is half filled with 12500 kg of an organic liquid at 7000 kPa. If the total internal energy in the tank is 5.3×10^6 kJ, what is the specific enthalpy of the fluid in the tank? — CO3-Ana — (16)

Or

(b) The heat capacity of Carbon di oxide is given by the following relation — CO3-Ana — (16)

$C_p = 26.54 + 42.454 \times 10^{-3} T - 14.298 \times 10^{-6} T^2$

Where Cp is in kJ/kmol K and T is in K

a) How much heat is required to heat 1 kg of CO_2 from 300 K to 1000K

b) obtain the relation expressing the heat capcity in kcal/kmol°C and temperature in °C

15. (a) Calculate the amount of heat given off when 1 m^3 of air at standard conditions cools from 500°C to -100°C at constant pressure. CO2-App (16)

Cp air = $6.386 + 1.763 \times 10^{-3}T - 0.2656 \times 10^{-6} T^2$ kcal/kmol K and T is in Kelvin.

Or

(b) Explain the concept of heat capacity and how it is being calculated for various substances CO2-App (16)