

KATHMANDU UNIVERSITY
End Semester Examination [C]
April/May, 2023

Marks Scored:

Level : B.Tech.
Year : II

Course : ENVE 204
Semester : I

Exam Roll No. : Time: 30 mins.

F. M. : 10

Registration No.:

Date : 04 APR 2023

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate answer.

- The force required to accelerate a mass of 4 lbm at a rate of 9 ft/s^2 is
a. 1 lbf b. 1.12 lbf c. 1.16 lbf d. 1.22 lbf
- For the equation, $D \text{ (ft)} = 3 t \text{ (s)} + 4$, what is the dimension of the constant 4?
a. ft/s b. ft^2 c. ft/s^2 d. ft
- How many moles of O is present in 100 gm of CO_2 ?
a. 2.273 b. 3.124 c. 4.546 d. 4.779
- The _____ of a solution is the value of the molar concentration of the solute expressed in gram-moles solute/liter solution.
a. Molarity b. Mass concentration
c. Normality d. Molar concentration
- It is customary to use _____ basis for gases and _____ basis for solids and liquids in calculation concentration.
a. Mass, molar b. Molar, mass c. Mass, mass d. Molar, molar
- By their nature, batch and semi-batch processes are _____ state operations.
a. Steady b. Unsteady
c. Continuous d. Depends on the specific processes
- _____ is the theory of the proportions in which chemical species combine with one another.
a. Stoichiometric equation b. Stoichiometry
c. Stoichiometric ratio d. Balanced
- If 20 kmol/h of acetylene and 50 kmol/h of hydrogen are available for the reaction $\text{C}_2\text{H}_2 + 2\text{H}_2 \rightarrow \text{C}_2\text{H}_6$, fractional excess of hydrogen is
a. 0.25 b. 0.30 c. 0.40 d. 0.55
- 20 kmol/h of acetylene and 50 kmol/h of hydrogen are available for the reaction $\text{C}_2\text{H}_2 + 2\text{H}_2 \rightarrow \text{C}_2\text{H}_6$. It is found that only 20 kmol/h of hydrogen is left after the reaction. The amount of C_2H_6 formed is
a. 15 kmol b. 25 kmol c. 30 kmol d. 40 kmol

10. 20 kmol/h of acetylene and 50 kmol/h of hydrogen are available for the reaction $C_2H_2 + 2H_2 \rightarrow C_2H_6$. It is found that only 20 kmol/h of hydrogen is left after the reaction. The yield of the reaction is
 a. 0.25 b. 0.50 c. 0.75 d. 1.00
11. _____ is the ratio of the difference of reactant input and output from the process to the reactant input to the process.
 a. Yield b. Selectivity
 c. Single-pass conversion d. Overall conversion
12. A _____ stream is withdrawn from a process when a species enters in the process feed and is completely recycled.
 a. Purge b. Bypass c. Recycle d. Excess
13. The extent of reaction is a species _____ quantity.
 a. Independent b. Dependent
 c. Depends on the specific process d. Molecular
14. The volume occupied by 1 lb-mole of gas at standard temperature and pressure is _____
 a. 325 ft³ b. 343 ft³ c. 359 ft³ d. 373 ft³
15. The ideal critical specific volume is calculated using
 a. RT_c/p_c b. zRT_c/p_c c. nRT_r/p_r d. zRT_{ri}/p_{ri}
16. Air and liquid water are contained at equilibrium, in a closed chamber at 75 °C and 760 mm Hg. If the vapor pressure of water at 75 °C is 289 mm Hg, how much dry air is present in the gas phase?
 a. 0.42 b. 0.52 c. 0.62 d. 0.82
17. A relative humidity of 40% signifies that
 a. The partial pressure of water vapor is 4/10 of the vapor pressure of air at system temperature.
 b. The vapor pressure of air is 4/10 of the partial pressure of water vapor at system temperature.
 c. The partial pressure of water vapor is 4/10 of the vapor pressure of water at system temperature.
 d. The vapor pressure of air is 4/10 of the partial pressure of air at system temperature.
18. _____ Law is most often applied to non-condensable gases.
 a. Raoult's b. Henry's c. Dalton's d. Corresponding
19. A gas is confined in a cylinder by a piston. The initial pressure of the gas is 7 bar and the volume of 0.1 m³. The piston is held in place by latches. The whole apparatus is placed in a total vacuum and the restraining latched are removed so that the gas expands to double its initial volume. The work done in this process is
 a. 0 b. 0.1 c. 0.6 d. 0.7
20. The standard heat of reaction for the reaction $A + 2B \rightarrow 3C$ is -50 kJ/mol. Calculate the rate of enthalpy change if 2400 mol/s of C is produced in the reaction.
 a. -20000 kJ/s b. -30000 kJ/s c. -35000 kJ/s d. -40000 kJ/s

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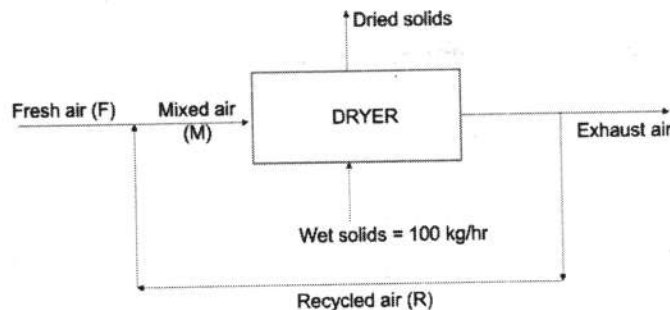
Level : B.Tech.
Year : II
Time : 2 hrs. 30 mins.

SECTION "B"
[40 marks]

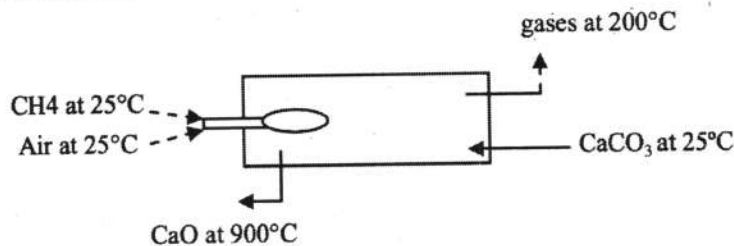
Attempt ALL questions.

1. In the carbonation of a soft drink, the total quantity of carbon dioxide required is the equivalent of 3 volumes of gas to one volume of water (3:1 ratio) at 25 °C and 1 atm. Ignoring all components other than carbon dioxide and water, calculate
 - a. Mass fraction of CO₂ in the drink. [3]
 - b. Mole fraction of CO₂ in the drink. [3]

2. A dryer is used to dry 100kg/h wet solids (wood) by hot air. It is known that the 19.19 kg of water is lost by the solids as it exits the dryer. Fresh air containing 0.02 kg water vapor per kg of dry air is available for drying. The air exiting the dryer contains 0.1 kg water vapor per kg of dry air. The ratio of dry air in recycle to dry air in fresh air is 3.
 - a. Calculate ratio of water vapor to dry air in the mixed air. [3]
 - b. Calculate the amount of fresh air. [4]



3. Lime is produced in a furnace by thermal conversion of limestone. The energy for conversion is provided by burning methane with 50% excess air as shown in the figure below. Assume the furnace is well insulated. Also, consider 24.5 kg of lime is produced per kg of methane burned.



- a. Write the equations for the combustion of methane and conversion of limestone to lime. [2]
- b. Calculate the total inlet enthalpy. [3]
- c. Calculate the total outlet enthalpy of the system. [5]

4. Air enters the cooling tower with a dry bulb temperature of 28 °C and a humidity ratio of 0.01 kg H₂O per kg of dry air. The exit air has a relative humidity of 80% and a humidity ratio of 0.03 kg H₂O per kg of dry air. If 84,000 kg/hr of water enters the cooling tower at 50 °C and exits at 30 °C, calculate the amount of air needed. [5]
5. An equimolar liquid mixture of benzene and toluene is in equilibrium with its vapor at 40 °C. Calculate the system pressure and the composition of vapor. [5]
6. Gas mixture consisting of 25% O₂, 35% N₂, 20% CO₂ and 20% CH₄ flows through a 1.2 in pipe at a speed of 3 m/s. The gas mixture is at 8000 kPa and 20 °C. Calculate the mass flow rate of the gas. [7]