

22315

12425

3 Hours / 70 Marks

Seat No.

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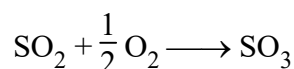
- Instructions :**
- (1) All Questions are *compulsory*.
 - (2) Illustrate your answers with neat sketches wherever necessary.
 - (3) Figures to the right indicate full marks.
 - (4) Assume suitable data, if necessary.
 - (5) Use of Non-programmable Electronic Pocket Calculator is permissible.

Marks

1. Attempt any FIVE of the following :

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- (a) Define pressure and write its SI unit.
- (b) State Charle's law with its mathematical expression.
- (c) List out different unit operations used in the chemical industry (any four).
- (d) Write the stoichiometric ratio of SO_2 to O_2 for the given reaction



- (e) Explain the term net calorific value.
- (f) State the law of conservation of energy.
- (g) Convert 50 lit/sec to m^3/hr .

2. Attempt any THREE of the following :

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- (a) Single effect evaporator concentrating a weak liquor containing 4% solids to 55% solids (by weight) is fed with 5000 kg/hr. of weak liquor. Calculate :
 - (i) Water evaporated per hour
 - (ii) Flow rate of thick liquor



- (b) Describe recycle and bypass operation with neat diagram.
- (c) Calculate the following for the reaction :
- $$\text{C}_2\text{H}_4 + 2\text{Cl}_2 \longrightarrow \text{C}_2\text{HCl}_3 + \text{H}_2 + \text{HCl}$$
- (i) The stoichiometric ratio of Cl_2 to C_2H_4 .
- (ii) If 4 Kmol Cl_2 are fed per Kmol C_2H_4 , find the percent excess Cl_2 .
- (iii) The amount of HCl produced from 50 kg of C_2H_4 assuming reaction goes to completion.
- (d) Calculate the heat needed to raise the temperature of 1 Kmol of ammonia from 311 K to 422 K using the mean molal heat capacity.

$$C_{p_m}^\circ \text{ for } \text{NH}_3 \text{ between } 311 \text{ K and } 298 \text{ K} = 35.86 \text{ kJ/Kmol} \cdot \text{K}$$

$$C_{p_m}^\circ \text{ for } \text{NH}_3 \text{ between } 422 \text{ K and } 298 \text{ K} = 37.70 \text{ kJ/Kmol} \cdot \text{K}$$

3. Attempt any THREE of the following :

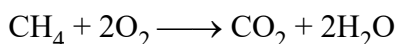
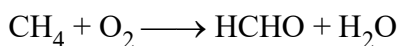
12

- (a) Equal masses of CO and N_2 are mixed together in a container at 300 K. The total pressure was found to be 405.3 KPa. Find the partial pressure of CO gas.
- (b) 2000 kg of wet solids containing 70% solids by weight are fed to a tray dryer where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight, calculate :

(i) The kg. of water removed from wet solid

(ii) The kg. of product obtained

- (c) Methane oxidation reactions are

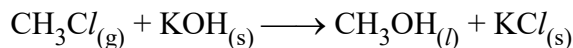


100 Kmol of methane are charged. If the product stream is found to contain 10 Kmol CO_2 and 40 Kmol formaldehyde calculate :

(i) The percent conversion of methane and

(ii) The yield of formaldehyde

- (d) Calculate the standard heat of reaction ΔH_R° of the following reaction :



Data :	Component	ΔH_F° kJ/mol at 25 °C
	$\text{CH}_3\text{Cl}_{(g)}$	-102.936
	$\text{KOH}_{(s)}$	-239.2
	$\text{CH}_3\text{OH}_{(l)}$	-424.764
	$\text{KCl}_{(s)}$	-436.747

4. Attempt any THREE of the following :

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- In a multiple effect evaporator system the second effect is maintained under vacuum of 475 mm Hg. Find the absolute pressure in KPa.
- A sample of gas having volume of 1 m³ is compressed to half of its original volume. The operation is carried for a fixed mass of gas at constant temperature. Calculate the percent increase in pressure.
- Describe the distillation operation with the help of block diagram and overall material balance equation.
- Formaldehyde (HCHO) is produced from methanol in a catalytic reactor. The production rate of formaldehyde is 1000 kg/hr. if the conversion of methanol (CH₃OH) is 65%, calculate the required feed rate of methanol.
- The gross calorific value of gaseous n-propanol (C₃H₇OH) at 298 K is 2067.44 kJ/mol. Find its net calorific value, using the latent heat of water vapour at 298 K = 2442.5 kJ/kg.

5. Attempt any TWO of the following :

12

- A mixture of CH₄ and C₂H₆ has density 1 kg/m³ at 273 K and 101.325 KPa pressure. Calculate the mole % of CH₄ and C₂H₆ in the mixture.

- (b) The waste acid from a nitrating process contains 30% H_2SO_4 , 35% HNO_3 and 35% H_2O by weight. The acid is to be concentrated to contain 39% H_2SO_4 , 42% HNO_3 by addition of concentrated sulphuric acid containing 98% H_2SO_4 and concentrated nitric acid containing 72% HNO_3 (by weight). Calculate the quantities of three acids to be mixed to get 1000 kg. of desired mixed acids.
- (c) The burning of limestone $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$ goes only 70% to completion in a certain kiln
- Determine the composition (wt.%) of the solid withdrawn from the kiln
 - Calculate the kilogram of CO_2 produced per kg. of limestone fed assuming that the limestone is pure.

6. Attempt any TWO of the following :

12

- (a) Sulphur dioxide is oxidized to sulfur trioxide. If the conversion is 70% and air is used in 80% excess over theoretical requirement, calculate :
- The Kmol air fed per Kmol Sulphur dioxide
 - The composition of gases leaving reactor.
- (b) A coke is known to contain 90% carbon and 10% non-combustible ash (by weight)
- How many mol of oxygen are theoretically required to burn 100 kg. of coke completely ?
 - If 50% (mole) excess air is supplied.
Calculate the analysis of gases at the end of combustion.
- (c) Calculate the heat of formation of n-phenol ($\text{C}_6\text{H}_5\text{OH}$) at 298.15 K from its elements using the following data :

Data :

Standard heat of formation of $\text{CO}_{2(g)} = -393.51 \text{ kJ/mol}$

Standard heat of formation of $\text{H}_2\text{O}_{(l)} = -285.83 \text{ kJ/mol}$

Heat of combustion of phenol crystals at 298.15 K = -3053.25 kJ/mol .
