

17315

21314

3 Hours / 100 Marks

Seat No.

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- Instructions* – (1) All Questions are *Compulsory*.
(2) Answer each next main Question on a new page.
(3) Assume suitable data, if necessary.
(4) Use of Non-programmable Electronic Pocket Calculator is permissible.
(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. a) Attempt any **FOUR** of the following: **8**
- i) Write down the condition for NTP and STP.
 - ii) $\text{CO} + 2\text{H}_2 \longrightarrow \text{CH}_3\text{OH}$ In the above reaction given, what is Stoichiometric coefficient of CO and H_2 ? Also write weight ratio of CO and H_2 .
 - iii) State Dalton's law and give its mathematical statement.
 - iv) State Raoult's law and Henry's law.
 - v) Write application of Hess's law.
 - vi) Define conversion and yield.

P.T.O.

b) Attempt any TWO of the following:

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- i) A mixture of CH_4 and C_2H_4 has the average molecular weight of 22.4. Find mole % CH_4 and C_2H_6 in the mixture.
- ii) The Henry's law constant for oxygen in water at 298°K is $4.46 \times 10^6 \text{ KPa/mole fraction}$. Find the solubility of oxygen in water at 298°K for a partial pressure of 25.33 KPa.
- iii) A gas contained in a closed vessel at a pressure of 121.59 KPa gauge and 299°K is heated to a temperature of 1273°K . Find the pressure to which a closed vessel should be designed.

2. Attempt any FOUR of the following:

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- a) A single effect evaporator is fed with 10000 kg/hr of weak liquor containing 15 % caustic by weight and is concentrated to get thick liquor containing 40 % by weight caustic (NaOH). Calculate
 - i) kg/hr of water evaporated
 - ii) kg/hr of thick liquor obtained.
- b) Define recycling and state any four reasons for performing recycling operation in industry.
- c) Define excess component and limiting component with suitable example.

- d) Formaldehyde is produced from methanol according to following reaction $\text{CH}_3\text{OH} \longrightarrow \text{HCHO} + \text{H}_2$ in a catalytic reactor. The production of formaldehyde is 33.33 Kmol/h. If conversion of methanol is 65 %. Calculate the required feed rate of methanol.
- e) A combustion reactor is fed with 50 Kmol/hr of butane and 2100 Kmol/hr of air calculate % excess air used.
- f) Define specific heat and latent heat also write unit of heat in SI unit.

3. Attempt any **TWO** of the following:

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- a) Ethylene oxide is produced by oxidation of ethylene. 100 Kmol of ethylene are fed to a reactor and the product is found to contain 80 Kmol ethylene oxide and 10 Kmol CO_2 . Calculate:
- percentage conversion of ethylene
 - % yield of ethylene oxide.
- b) In order to carry out nitration reaction, it is desire to have a mixed acid containing 39 % HNO_3 , 42 % H_2SO_4 and 19 % H_2O (by weight) Nitric acid of 68.3 % strength (by weight) is readily available. Calculate:
- Required strength of sulphuric acid to obtained the above mixed acid
 - The weight ratio of nitric acid to mixed acid.

- c) A feed containing 50 % benzene and 50 % toluene is fed to a distillation column at the rate of 5000 kg/hr. The top product contain 95 % benzene and the bottom product contains 92 % toluene.

Calculate:

- i) Mass flow rate of top and bottom product.
- ii) % recovery of benzene.

4. Attempt any TWO of the following:

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- a) Calculate the standard heat of formation of n-propanol liquid using the following data, standard heat of formulation of $\text{CO}_2(\text{g}) = -393.51 \text{ KJ/mol}$; standard heat of formation of $\text{H}_2\text{O}(\text{l}) = -285.83 \text{ KJ/mol}$; standard heat of combustion of n-propanol liquid = -2028.19 KJ/mol .
- b) A wet lumber containing 5 % water is fe to the dryer. The moist air leaving the dryer contains, 2 weight percent water. How much air is required to dry 2000 kg/hr of the wet lumber.
- c) In the manufacture of sulphur trioxide, feed to reactor consists of 50 Kmol SO_2 and 150 Kmol air calculate the % excess air used.

5. Attempt any TWO of the following:

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- a) A sample of dry flue gas has the following composition by volume $\text{CO}_2 = 13.4 \%$, $\text{N}_2 = 80.5 \%$, $\text{O}_2 = 6.1 \%$. Find the percentage excess air supplied, assuming that the fuel contain no nitrogen, the nitrogen and oxygen in flue gas must have come from air.

b) An evaporator system concentrating a weak liquor from 5 % to 50 % solids handles 100 kg of solids per hour. If the same system is to concentrate a weak liquor from 4 % to 35 %, Find the capacity of the system in terms of solids that can be handled per hour assuming water evaporating capacity to be same in both cases.

c) Calculate standard heat of reaction of the following reaction



Data:	Component	OH°C KJ/MOL
	$\text{C}_2\text{H}_5\text{OH}(\text{g})$	- 1410.09
	$\text{CH}_3\text{CHO}(\text{g})$	- 1192.65
	$\text{H}_2(\text{g})$	- 285.83

6. Attempt any **FOUR** of the following:

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- $\text{CH}_4 + 10\text{O}_2 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ which is excess component and why?
 - Draw a labelled diagram of distillation column operation and an overall material balance equation of the same.
 - The ground seeds containing 45 % oil and 45 % solids are fed to an expeller, the cake coming out of expeller is found to contain 80 % solids and 5 % oil. Find the % recovery of oil.
 - A sample of petrol contains 15 % H_2 and 85 % carbon by weight. Calculate the amount of air required for the complete combustion of 1 kg of petrol. Find the composition of the dry products on a volume basis if 15 % excess air is supplied.
 - In production of sulphur trioxide 100 Kmol of SO_2 and 200 Kmol of O_2 are fed to a reactor. The product stream is found to contain 80 Kmol SO_3 . Find % conversion of SO_2 .
 - What is sensible heat and a diabatic reaction?
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