

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:

12

- 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 4.46×10^6 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:

16

- 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:

16

- 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:

16

- 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 fed 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:

16

- 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:

16

- a) $\text{CH}_4 + 10\text{O}_2 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ which is excess component and why?
- b) Draw a labelled diagram of distillation column operation and an overall material balance equation of the same.
- c) 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.
- d) 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.
- e) 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 .
- f) What is sensible heat and a diabatic reaction?
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