17315

21718

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions : *(1)* ***All*** *questions are* ***compulsory****.*
(2) Answer ***each*** *next main question on a* ***new*** *page.*
(3) Illustrate your answers with ***neat*** *sketches* ***wherever*** *necessary.*
(4) Figures to the ***right*** *indicate* ***full*** *marks.*
(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 : **(2×4=8)**

a) State Dalton's law and write its mathematical statement.

b) Give mathematical statement of ideal gas law and state the value of universal gas constant with its unit in SI system.

c) Define standard heat of formation and standard heat of combustion.

d) Draw a labelled diagram of distillation operation and an overall material balance equation for distillation.

e) Calculate the volume occupied by 20 kg of chlorine gas at a pressure of 100 KPa and 298 K.

f) Convert 105.6 KPa.g in absolute pressure.

B) Attempt **any two** of the following : **(2×6=12)**

a) A cylinder contains 15 kg of liquid propane. What volume in m^3 will propane occupy if it is released and brought to NTP conditions ?

b) Calculate the density of air containing 21% O_2, 79% N_2 by volume at 503 K and 1519.875 KPa.

c) Prove : Mole% of A = Mole fraction of A × 100.

2. Attempt **any four** of the following : **(4×4=16)**

a) Write the outline of a procedure for material balance calculations involving no chemical reactions.

b) The ground nut 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 percentage recovery of oil.

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Marks

c) In production of SO_3, 100 Kmol of SO_2 and 200 Kmol of O_2 are fed to a reactor. The product stream found to contain 80 Kmol SO_3. Find the percent conversion of SO_2.

d) Define the following terms with examples :

i) Stoichiometric equation.

ii) Stoichiometric ratio.

e) In the manufacture of sulphur trioxide, feed to a reactor consist of 50 Kmol SO_2 and 150 Kmol air. Calculate the % excess air is used.

f) Calculate the heat that must be added to 3 Kmol air to heat it from 298 K to 473 K using the mean molal heat capacity data for air given below :

C^o_{pm} (between 473 K and 298 K) = 29.3955 kJ/(Kmol K).

3. Attempt **any two** of the following : **(2×8=16)**

a) A feed containing 60 mole% A, 30 mole% B and 10 mole% C inerts enters a reactor. 80 percent of original A reacts according to following reaction.

$2A + B \rightarrow C$

Find the composition of product stream on mole basis.

b) The dilute acid containing 25% H_2SO_4 is concentrated by commercial grade sulphuric acid containing 98% H_2SO_4 to obtain desired acid containing 65% H_2SO_4. Find the quantities of the acids required to make 1000 kg of desired acid.

c) A feed to a continuous fractionating column analyses by weight 28% benzene and 72% toluene. The analysis of the distillate shows 52 weight% benzene and 5 weight % benzene was found in the bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Also calculate the percent recovery of benzene.

4. Attempt **any two** of the following : **(2×8=16)**

a) Calculate the standard heat of formation of n-propanol liquid using the following data.

Std. heat of formation of $CO_2(g) = -393.51$ kJ/mol

Std. heat of formation of $H_2O(l) = -285.83$ kJ/mol

Std. heat of combustion of n-propanol liquid = – 2028.19 kJ/mol

b) Soyabean seeds are extracted with hexane in batch extractors. The flaked seeds are found to contain 18.6% oil, 69% solids and 12.4% moisture (by weight). At the end of the extraction process, cake is separated from hexane-oil mixture. The cake is analysed to contain 0.8% oil, 87.7% solids and 11.5% moisture (by wt.). Find the percentage recovery of oil.

c) Prove : Pressure% = Mole% = Volume%.

Marks

5. Attempt **any two** of the following : **(2×8=16)**

a) A tray dryer is fed with 1000 kg of wet orthonitroaniline containing 10% water. The dried product contains 99.5% orthonitroaniline and the rest water. Find the percentage of original water that is removed in the dryer.

b) A stream of CO_2 flowing at a rate of 100 Kmol/min is heated from 298 K to 383 K. Calculate the heat that must be transferred using Cp^o.

Data : $Cp^o = a + bT + CT^2 + dT^3$, kJ/(Kmol.K)

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CO_2	21.3655	64.2841	– 41.0506	9.7999

c) Calculate the standard heat of reaction of the following reaction :

$C_2H_5OH(g) \rightarrow CH_3CHO(g) + H_2(g)$

Data :

Component	ΔH^o_C, kJ/mol
$C_2H_5OH(g)$	– 1410.09
$CH_3CHO(g)$	– 11.92.65
$H_2(g)$	– 285.83

6. Attempt **any four** of the following : **(4×4=16)**

a) Write mathematical equation of Van-der Waals equation of state. Write the values for a and b constants.

b) Write overall material balance for evaporation and draw block diagram of evaporation indicating inflow and outflow materials.

c) Define the following terms :

1) Heat capacity
2) Heat of combustion.

d) Explain Hesse's law of constant heat summation with example.

e) Differentiate between conversion and yield.

f) Define Recycling and state any four reasons for performing recycling operation in industry.