

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech/(FT/BJ/NEW)/SEM-4/CH-401/2013

2013

INDUSTRIAL STOICHIOMETRY

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

i) Dimension of viscosity is

a) $M^2L^{-1}T$

b) $ML^{-1}T^{-1}$

c) MLT^{-1}

d) $ML^{-1}T^{-2}$.

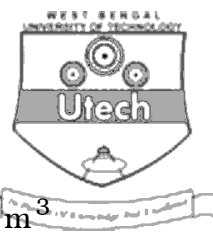
ii) The temperature at which the first drop of vapour
formed is

a) Bubble point

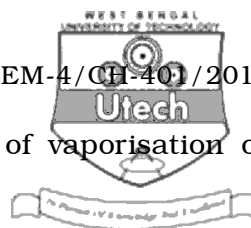
b) Boiling point

c) Dew point

d) Melting point.



- iii) The density of air at N.T.P. is
- a) 1.5 kg/m^3 b) 1.4 kg/m^3
c) 1.35 kg/m^3 d) 1.3 kg/m^3 .
- iv) Unit of humidity is
- a) %
b) kg moisture / kg dry air
c) kg moisture per m^3 of dry air
d) none of these.
- v) How many moles of K_2CO_3 will contain 117 kg potassium ?
- a) 1.5 k mol b) 2.0 k mol
c) 1.75 k mol d) 2.25 k mol.
- vi) Graphical Integration is more accurate when done by
- a) Rectangular rule b) Trapezoidal rule
c) Simpson's rule d) none of these.
- vii) If 50 kg of dry solid containing 6% water is obtained by drying 65 kg of wet material, what was the initial moisture content ?
- a) 27.7% b) 77%
c) 23% d) 21%.



viii) With increase in pressure the heat of vaporisation of liquids

- a) decreases
- b) increases
- c) remains unchanged
- d) may increase or decrease.

ix) Exponential equations are solved by plotting on

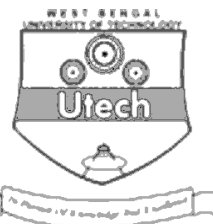
- a) rectangular graph b) semi-log graph
- c) log-log graph d) triangular graph.

x) Nusselt number is defined as

- a) $\frac{hk}{d}$ b) $\frac{kd}{h}$
- c) $\frac{hd}{k}$ d) none of these.

xi) Ideal solution obeys

- a) Boyle's law b) Fick's law
- c) Raoult's law d) none of these.



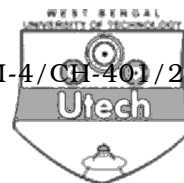
GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Stainless steel has a thermal conductivity k of 16.2 Btu/(hr) (ft) (°F). Convert this value into cal/(sec) (cm) (°R). Write an example of dimensionless group and show how it becomes unitless.
3. A natural gas has the following composition by volume % :
 CH_4 –83.5%, C_2H_6 –12.5 % and N_2 – 4%.
Find the following :
 - (i) Composition in weight percent
 - (ii) Average molecular weight.
4. Write a short note on any one of the following topics :
 - (i) Effect of temperature on heat of reaction
 - (ii) Buckingham *Pi*-theorem.
5. Write a short note on Trapezoid rule.
6. Briefly describe the steps of material balance.
7. An evaporator has a rated evaporation capacity of 500 kg water/hr. Calculate the rate of production of concentrated juice containing 45% total solid from raw juice containing 12% solid.



GROUP – C

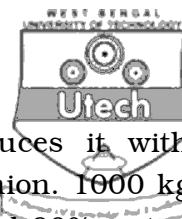
(Long Answer Type Questions)

Answer any *three* of the following.

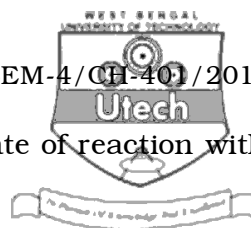
$3 \times 15 = 45$

8. a) Determine the quantity of sucrose crystals that will crystallize out of 100 kg of a 75% sucrose solution after cooling to 15°C. The mother liquor contains 66% sucrose.
- b) Pure $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ was crystallized from a solution containing 25% Na_2CO_3 by evaporating 15% of the water at a temperature of 25°C. Calculate the yield of crystals produced per 100 kg of original solution. Solubility of Na_2CO_3 at 25°C is 27.5 kg/100 kg of water.

$$7\frac{1}{2} + 7\frac{1}{2}$$
9. a) The spent acid from a Nitrating process contains 35% H_2SO_4 , 35% HNO_3 and 30% H_2O by weight. This acid is to be strengthened by the addition of conc. H_2SO_4 containing 95% H_2SO_4 and conc. HNO_3 containing 76% HNO_3 . The strengthened mixed acid is to contain 40% H_2SO_4 and 42% HNO_3 . Calculate the quantity of spent acid and the concentrated acids that should be mixed together to yield 1000 kg of the desired mixed acid.



- b) Alcohol manufacturing company produces it with a distillation column in a continuous fashion. 1000 kg of ethanol water mixture (10% ethanol and 90% water) is entering in the distillation column and after the completion of the process major product as distillate (60% ethanol and 40% water) and bottom product as waste are obtained. It was also given that the weight of the product is one tenth of feed and some distillate undergoes reflux operation. Now from these datas calculate the composition of the bottom and the mass of the alcohol lost in the bottom.
- $$7\frac{1}{2} + 7\frac{1}{2}$$
10. a) How much of water is required to raise the moisture content of a 100 kg material from 30% to 75% ?
- b) Determine the amount of apple juice concentrate containing 65% solid and single strength juice containing 15% solid that must be mixed to produce 100 kg of an apple juice concentrate containing 45% solids.
- $$5 + 10$$
11. A distillation column separates out 10000 kg/hr of a 50% benzene, 50% toluene mixture. The product (D) recovered from the condenser at the top of the column contains 95% benzene, and the bottom (W) from the column contains 96% toluene. The vapour stream (V) entering the condenser from the top of the column is 8000 kg/hr. A portion of the product from the condenser is returned to the column as reflux and the rest is withdrawn for use. Assume that the composition of the stream at the top of the column (V), the product withdrawn (D) and the reflux (R) are identical because the (V) stream is condensed completely. Find the ratio of the amount refluxed R to the product withdrawn (D).



12. a) The Arrhenius equation relates the rate of reaction with temperature as follows :

$$K = Ae^{-E_a/RT}$$

T (°C)	100	110	120	130
K	1.005×10^{-16}	1.07×10^{-15}	9.25×10^{-15}	6.96×10^{-14}

140	150
4.58×10^{-12}	3.19×10^{-12}

Using these data evaluate the values of E and K .

- b) For heat transfer to a fluid in turbulent flow through a pipe, the heat transfer coefficient h , is a function of the pipe diameter D , thermal conductivity of the fluid K , velocity of the fluid V , density of the fluid ρ , heat capacity C_p , and viscosity μ . Evaluate the dimensionless groups in this case.

8 + 7

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