Reg. No.										

प्रज्ञानं ब्रह्म

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION - JUNE 2016

SUBJECT: INTRODUCTION TO CHEMICAL ENGINEERING (CHM 121)

(BRANCH: CHEMICAL)

MONDAY, 13TH JUNE, 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE FULL Questions.**
- ✓ **Missing data, if any, may be suitably assumed.**
- ✓ **At. Wt. Cu: 63.5, O:16, S: 32, Na: 23, H:1, C:12, Ca:40, Mg:24, N:14, Cl:35.5**

1A A commercial grade of sulfuric acid has a density of 1.84 g/ml and a concentration of 96% H_2SO_4 (by wt.) and 4% water. Calculate:

1. The molarity
2. The molality
3. The mole fraction of H_2SO_4

1B Convert:

i. 1000 inch to km

ii. 20 ft of hydrostatic head of water to kPa.

iii 10,000 BTU/hr $ft^{2o}F$ to $W/cm^2\ ^oC$ **(10+10)**

2A How many of each of the following are contained in 100.0 g of CO_2 *(M* = 44)?
(1) mol CO_2 ; (2) lb-moles CO_2; (3) mol of Carbon (C); (4) mol of O; (5) mol of O_2; (6) gram of O; (7) molecules of CO_2 .

2B A waste acid from a nitration process contains 21 % HNO_3, 55 % H_2SO_4, and 24 % water. The acid is to be concentrated to contain 28 % HNO_3, 62 % H_2SO_4 by wt. by the addition of conc. H_2SO_4 and HNO_3 having concentrations 93 % and 90 % by wt. respectively. Calculate the weight of the waste acid and conc. acid required to obtain a product of 1000 kg.

(10+10)

3A A mixture of Benzene and Nitrogen at a temperature of 24°C and a pressure of 1 bar has a relative humidity of 60%. It is desired to recover 80% of Benzene present by cooling to 10°C and compressing to a suitable pressure. What should that pressure be?
Vapor pressure of Benzene at 24°C=12.2 kN/m^2
Vapor pressure of Benzene at 10°C =6 kN/m^2

3B Acetone nitrile is produced by the reaction of propylene, ammonia and O_2.
$C_3H_6 + NH_3 + 3/2\ O_2 \rightarrow C_3H_3N + 3\ H_2O$
The feed contains 10 % propylene, 12 % ammonia and 78 % air (in mole %)

i. Determine the limiting reactant

ii. % by which the other reactants are in excess.

iii. Molar flow rates of all components of product gas for 100 moles of feed mixture if a conversion of 30% is achieved.

(08+12)

4A Determine the flue gas analysis and air-fuel ratio by wt. when a fuel oil with 84.5% C, 11.8% H_2, 3.2 % S, 0.4% O, 0.1% ash is burned with 25% excess air.

4B 1000 kg/hr of a mixture of 40 mole % Ethylene Di-Chloride (A) and rest Phenol (B) is to be separated in a distillation column. The concentration of A in the distillate product is 95 mole % A and bottom stream contains 10% B. Determine the flow rate of the distillate and residue product streams.

(14+06)

5A A saturated solution of $MgSO_4$ at 80^{o}C is cooled to 30^{o}C in a crystallizer. During cooling 4% of the water is lost by evaporation. Calculate the quantity of feed solution required to be fed to the crystallizer to obtain 1000 kg of crystals of $MgSO_4.7H_2O$

Temperature ^{o}C	Solubility (g $MgSO_4$/100 g water)
80	64.2
30	40.8

5B Fresh orange juice contains 12% solids and balance water, the concentrated juice contains 42% solids. In the present process the evaporator is bypassed with a fraction of fruit juice. The juice that exits out of the evaporator is concentrated to 58% solids and the product is mixed with fresh juice to achieve the final concentration. Calculate

i) Amount of concentrated fruit juice produce per 750 kg of fresh juice.
ii) Fraction of feed that bypasses the evaporator.

(10+10)

6 Coal containing C=80%, H_2=10%, S=0.5%, O_2=5%, N_2=4.5% is burned with air. 15% excess air is employed and combustion is complete. If 100 kg/hr of coal is burned, calculate:

i. Volume of air supplied at NTP
ii. Kg of air required/ kg of coal burned
iii. Volume of combustion product at 500^{o}C.
iv. Volumetric composition of the product.

(20 MARKS)

7 The equation for methanol synthesis is given by the equation

$CO_2 + H_2 \rightarrow CH_3OH + H_2O$

The H_2 and CO_2 entering in stoichiometric quantities contain 0.5% inert by volume. The process is under steady state. The concentration of the inerts going into the reactor must be held at 2% by volume. The conversion is 60 % per pass. Calculate:

i. Moles recycled/ moles fed
ii. Moles purged/ moles fed

(20 MARKS)

8A The flue gases are leaving the chimney of a boiler at 300^{o}C the molar composition of which are as follows. CO_2=11.3%, CO=0.26%, H_2O=13.04%, O_2=2%, N_2=73.4%.

Calculate Q in 1 kg mole of gas mixture above 25^{o}C using the following C_p data (Kcal / Kg mole ^{o}K)

$CO_2 = 6.396 + 10.1 \times 10^{-3} T - 3.354 \times 10^{-7} T^2$

$CO = 6.48 + 1.566 \times 10^{-3} T - 2.359 \times 10^{-7} T^2$

$H_2O = 6.732 + 1.505 \times 10^{-3} T - 1.791 \times 10^{-7} T^2$

$O_2 = 6.97 + 3.464 \times 10^{-3} T - 4.83 \times 10^{-7} T^2$

$N_2 = 6.529 + 1.448 \times 10^{-3} T - 3.271 \times 10^{-7} T^2$

8B Calculate the heat of reaction for the following. Is the reaction exothermic or endothermic?

$CH_4 + 2\ H_2O \rightarrow CO_2 + 4H_2$

ΔH^{o}_F Data (KJ / Kg mole)

CH_4 = -74.9

H_2O = -2412

CO_2 = -393.7

H_2=0

(15+05)