Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION APRIL / MAY 2017

SUBJECT: INTRODUCTION TO CHEMICAL ENGINEERING (CHM 121)

(BRANCH: CHEMICAL)

Wednesday, 26 April 2017

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

- ✓ **Answer ANY FIVE full Questions.**
- ✓ **Missing data, if any, may be suitably assumed.**
- ✓ **Atomic Mass-Mg: 24.3, O:16, N:14, S: 32, Na: 23, H:1, C:12, Ca:40, Cl: 35.5, Cu:63.5, Br:80, K:39, P:31**

1A i. The viscosity of water at 60°F is given as 7.8×10^{-4} lb ft^{-1} s^{-1}. Calculate this viscosity in N s m^{-2}. **(3+4+3)**

ii. The thermal conductivity of aluminium is given as 120 BTU ft^{-1} h^{-1} °F^{-1}. Calculate this thermal conductivity in W m^{-1} °C^{-1}.

iii) Convert 2 lb/(ft^3 °F) to kg/(m^3 K)

1B Dimethyl formamide (DMF, C_3H_7NO, s.g.=0.944) and Phosphorus oxy-chloride ($POCl_3$, s.g.= 1.64) are to be placed in a flask to conduct a reaction. Find:

i. The molar mass of DMF and $POCL_3$ **10**

ii. If 40 mL of DMF is taken in the flask to which $POCL_3$ is to be added in a molar ratio of 2.5:1 (DMF: $POCL_3$), calculate the volume of $POCl_3$ to be taken in mL.

(At. Mass: P:31; Cl:35.5, N:14, C:12)

2A A solution containing sodium sulfate in water is crystallized out by cooling the solution to 5°C. The original solution is saturated to 40°C and deca-hydrate crystals are obtained. Estimate the wt. of crystal obtained by cooling a batch of 2000 kg of this solution. **10**

Solubility at 40°C= 32.6 %

Solubility at 5°C= 5.75 %

Both solubilities have units of kg Na_2SO4/ kg solution

(Molecular Wts: Na_2SO_4=142 , $Na_2SO_4.10H_2O$= 322)

2B Answer the following: **10**

1. How many moles are there in 50.0g of nitrobenzene ($C_6H_5O_2N$)?
2. If the specific gravity of same is 1.203, what is the density in g/cm^3?
3. What is the volume occupied by 50.0g of nitrobenzene in cm^3 and ft^3
4. How many molecules are contained in 50.0g of nitrobenzene?

3A On a particular day at Manipal, the weather conditions are reported as 35°C dry bulb temperature and 80% relative humidity at a barometric pressure of 752 mm Hg. Calculate:

i. Absolute humidity
ii. Saturation humidity
iii. % humidity
iv. Humid Heat **10**

v. Humid Volume

Given: Cp of air = 1.001 kJ/kg ^oC

Cp of water vapour = 1.001 kJ/kg ^oC

Vapor pressure at 35^oC=31 mm Hg

10

3B An oil well drilling mud is made up of 45% treated clay and 55% water by weight. After trial it is found that a mud containing 48% clay would be more suitable. To reconstitute the mud, in what proportion the dry clay and the original mud is to be mixed?

4A Gas having the following composition is burned with 25% excess air. CH_4 =15%, CS_2= 30%, CO_2=11%, H_2=8%, O_2=1%, N_2=35%. Calculate the flue gas analysis on SO_2 free basis in volume % and wt %. **12**

4B 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 **8**

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

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

5A Calcium hypochlorite is produced by absorbing chlorine in milk of lime. A gas bearing chlorine enters the absorption apparatus at a pressure of 740mm Hg and a temperature of 23.89^oC.The partial pressure of chlorine is 59mm Hg the remainder being inert gas. The gas leaves the absorption apparatus at a temperature of 26.67^oC and a pressure of 743 mm Hg with a partial pressure of chlorine of 0.5 mm Hg.

Calculate: **10**

i. Volume of gas leaving the apparatus per 2.8m^3 entering

ii. Wt. of chlorine absorbed per 2.8m^3 of gas entering

5B It is desired to make a 24% by wt. of caustic soda solution. It is done in 2 steps. The caustic soda is dissolved in a dissolution tank in a correct quantity of water to produce 50% solution. After complete dissolution, the solution is taken to a dilution tank, where some water is added to produce 24% by wt. of solution. **10**

Calculate the wt. ratios of water added to both the tanks.

6A The flue gases are leaving the chimney of a boiler at 300^oC 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^oC using the following C_p data (kcal / kg mole ^oK)

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

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

$H_2O = 6.732 + 1.505 \times 10^{-3}\ T - 1.791 \times 10^{-7}\ T^2$ **15**

6B The standard heats of the following combustion have been determined experimentally

$C_2H_6 + 7/2\ O_2 \rightarrow 2CO_2 + 3H_2O \quad \Delta H = -1559$ kJ/mole

$C + O_2 \rightarrow CO_2 \quad \Delta H = -393.5$ kJ/mole

$H_2 + 1/2 O_2 \rightarrow H_2O \quad \Delta H = -285.8$ kJ/mole

Using Hess's law, determine the standard heat of reaction for

$2C + 3H_2 \rightarrow C_2H_6$ **5**

7 N_2 and H_2 mixed in a mole ratio of 1:3 is used for manufacturing NH_3. The conversion per pass is 18%. Ammonia is separated and the unconverted gases are recycled. The feed contains 0.2 moles of Argon per 100 moles of N_2 and H_2 mix by volume. The tolerance limit of Argon entering the reactor is 6 parts per 100 parts of N_2 and H_2 mix by volume. Calculate **20**

i. The fraction of the recycle that must be continuously purged.

ii. Recycle ratio

8A Urea is produced as per the following reaction **10**

$2\ NH_3+CO_2 \rightarrow NH_2COONH_4$

$NH_2COONH_4 \rightarrow NH_2CONH_2+H_2O$

If only 60% of NH_3 takes part in the reaction and 1000 kg of urea is to be produced, Find :

i. Volume of NH_3 to be fed at STP

ii. The amount of H_2O produced

8B Solid material with 15% water is to be dried to 7% water under the following conditions: **10**

Fresh air is mixed with recycled air and is blown over the solid. The humidity of fresh air =0.01 kg water/ kg of dry air and the recycled air has a humidity=0.1 kg of water/ kg of dry air. They are mixed in such a way that the entering mix to the drier has a humidity of 0.03 kg water/ kg dry air. Calculate

i. Kg of dry air/ 100 kg of wet material

ii. Kg of water removed/ kg of feed

iii. Ratio of recycled air to fresh air

iv. If fresh air enters at 60oC and 10 atm, find the volume of the air entering.