Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – NOV. / DEC. 2016

SUBJECT: INTRODUCTION TO CHEMICAL ENGINEERING (CHM 121)

(BRANCH: CHEMICAL)

Monday, 12 December 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 limestone analyses as follows:
$CaCO_3$= 92.89 %, Insolubles = 1.7 %, $MgCO_3$= 5.41 %

i) How many kg of CaO can be made from 5 tonnes of this lime stone?
ii) How many kg of CO_2 can be recovered per kg of lime stone?
iii) How many kg of lime stone are needed to make 1 tonne of lime?

1B Two engineers are calculating the average molecular wt. of gas mixture containg O_2 and other gases. One uses the correct mol.wt. of 32 and finds the avg. mol. wt. as 37.6. The other uses an incorrect value of 16 and determines the avg. mol. wt. as 32.8. What is the % of O_2 in the mixture.

1C Convert:

i. 1500 km^3/ yr to m^3/day
ii. 10 BTU/lb^{o}F to kJ/kg^{o}C **(8+8+4)**

2A Answer the following:

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

2B A solution of NaCl in water is saturated at a temperature of 15^{o}C. Calculate the wt. of NaCl that can be dissolved by 45.36 kg of this solution if it is heated to a temperature of 65^{o}C.
Data:
Solution of NaCl at 15^{o}C = 2.776 kgmole NaCl /453.6 kg water
Solution of NaCl at 65^{o}C = 2.889 kgmoles NaCl/ 453.6 kg water **(10+10)**

3A An air water vapor system at temperature of 35^{o}C and a barometric pressure of 752 mm has a 80% relative humidity. Determine:

i. The absolute humidity
ii. Saturation humidity
iii. % humidity
iv. Humid heat

3B Pure CO_2 can be prepared by treating limestone with aq. H_2SO_4. The limestone used contains $CaCO_3$, $MgCO_3$ and inerts. The acid used contains 12% H_2SO_4. The residue from the process had the following combinations.
$CaSO_4$:8.56%, $MgSO_4$:5.23%, H_2SO_4:1.05%, Inerts:0.53%, CO_2: 0.12%, water: 84.51%
During the process, CO_2 and water vapors are distilled. Calculate:

i) The analysis of limestone.
ii) % excess of acid used. **(10+10)**

4A A fuel oil having the following composition is burnt in a furnace.
C=82%, H_2=12%, S=3%, impurities=3% Dry flue gas has the composition:
CO_2=11.2%, O_2=5.8%, N_2=83% Calculate:

i. % excess air
ii. Wt. of combustion air used/ kg of oil burnt

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
ii. % by which the other reactants are in excess. **(12+8)**

5A It is desired to make a 24% by wt. of caustic soda solution. It is done in 2 steps.

i. The caustic soda is dissolved in a dissolution tank in a correct quantity of water to produce 50% solution.
ii. After complete dissolution, the solution is taken to a dilution tank, where some more water is added to produce 24% by wt. of solution.

Calculate the wt. ratios of water added in step i) and step ii)

5B A liquid mixture of compounds A, B and C containing 20 Kg of A , 25% by wt. of B, and contains 2 mole of C per mole of B. The respective molecular wts. of A, B, C are 56, 58 and 72 and specific gravities are 0.58, 0.6 and0.67 respectively. Calculate

i. The analyses of the mixture in mole %,
ii. Molecular wt. of the mixture
iii. The volume % of A on B free basis **(10+10)**
iv. The total number of moles of mixture.

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6A Analysis of flue gas obtained from a gas containing no N_2 is given as follows
CO_2 =4.62%, CO= 3.08%, O_2=8.91%, N_2=83.39%

i) Calculate the moles of dry air per moles of dry flue gas
ii) % excess air
iii) Net H_2 burned per mole of dry flue gas
iv) Kg of fuel burnt per mole of dry flue gas
v) Analysis of fuel gas which is a mixture of CH_4 and C_2H_6

6B The mole percent (gas analysis) of a flue gas is given below:
N_2 = 79%
O_2 = 5%
CO_2 = 10%
CO = 6%
Calculate the average molecular weight of the mixture. **(15+5)**

7A Solid material with 15% water is to be dried to 7% water under the following conditions:
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 60^{o}C and 10 atm, find the volume of the air entering.

7B A solution of Calcium Chloride in water contains 62 parts of $CaCl_2$ per 100 parts water by weight after the crystallization process. Calculate the weight of solution necessary to dissolve 500 kg of $CaCl_2.6H_2O$ crystals at 25^{o}C (Solubilty at 25^{o}C is 7.38 kgmoles of $CaCl_2$ per 1000kg water.) **(12+8)**

8A Blast furnace gas has the following composition by volume is burned with air:
CO_2=13%, CO= 25%, H_2=3.5%, N_2=58.5%
Calculate:

i) % excess air used when the dry product of combustion contains 3.5% O_2
ii) % excess air when dry flue gas contains CO_2=19.5%, O_2= 5.8%, N_2=74.7%.

8B The standard heats of the following combustion have been determined experimentally
$C_2H_6 + 7/2\ O_2 \rightarrow 2CO_2 + 3H_2O$ ΔH= -1559 kJ/mole
$C + O_2 \rightarrow CO_2$ ΔH= - 393.5 kJ/mole
$H_2 + 1/2O_2 \rightarrow H_2O$ ΔH= -285.8 kJ/mole
Using Hess's law, determine the standard heat of reaction for
$2C + 3H_2 \rightarrow C_2H_6$ **(12+8)**