BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: III**
BRANCH: BIOTECHNOLOGY **SESSION : MO/2018**

SUBJECT : BT3029 CHEMICAL ENGINEERING I

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) What is the weight of 10 moles of a mixture with composition 15% O_2, 25% SO_2, 30% $COCl_2$, 25% SO_3 and 5% N_2? [2]

(b) A gaseous mixture is composed of 20% CO_2, 40% O_2 and 40% N_2. What is the mass fraction of N_2? [3]

Q2 (a) A compound contains 12% of carbon, 16% of oxygen, 28% of nitrogen, 4% of hydrogen and 40% calcium by weight, then what can be the possible molecular formula of the compound? [2]

(b) At 25°C, an aqueous solution containing 35% H_2SO_4 has a specific gravity of 1.2563. A quantity of 35% H_2SO_4 solution that contains 195.5 kg of H_2SO_4 is needed. [3]
i. Calculate the required volume of the solution in liters.
ii. Estimate the percentage error that would have resulted if pure component specific gravities (SG for H_2SO_4 = 1.8255) were used instead of the specific gravity of the aqueous solution.

Q3 A gaseous mixture (F) consists of 16 mol% CS_2 and 84 mol% air are fed to the absorption column at a rate of 1000 lbmole/hr. Most of the CS_2 input are absorbed by liquid benzene (L) which is fed to the top of the column. 1 % of benzene input are evaporated and out with the exit gas stream which consists of 96 mol% air, 2 mol% CS_2 and 2 mol% benzene. The product liquid stream (P) consists of benzene and CS_2. Calculate the mole flow rates of (G), (L) and (P) and the compositions. [5]

Q4 Mixing of battery (Sulfuric) Acid : [5]
You are asked to prepare a batch of 18.63% battery acid as follows. A tank of old weak battery acid (H_2SO_4) solution contains 12.43% H_2SO_4 (the remainder is pure water). If 200 kg of 77.7% H_2SO_4 is added to the tank, and the final solution is to be 18.63% H_2SO_4, how many kilograms of battery acid have been made?

Q5 Two reactions take place in a continuous reactor operating at steady state,
$C_2H_6 \rightarrow C_2H_4 + H_2$
$C_2H_6 + H_2 \rightarrow 2CH_4$
The feed stream contains 85.0 mole % ethane (C_2H_6) and 15 mole % inert (i.e. unreactive) components. The fractional conversion of ethane is 0.501, and the fractional yield of ethylene (C_2H_4) is 0.471. What is the molar composition of the product gas?

Q6 (a) If you feed 10 grams of N_2 gas and 10 grams of H_2 gas into a reactor: The chemical reaction takes place in the reactor is [2]
$N_2 + 3H_2 \rightarrow 2NH_3$
What is the maximum number of grams of NH_3 that can be produced?

(b) For the problem mentioned above What is the limiting reactant? What is the excess reactant? [3]

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