



TECHNICAL UNIVERSITY OF MOMBASA
FACULTY OF APPLIED AND HEALTH SCIENCES
DEPARTMENT OF PURE & APPLIED SCIENCES
UNIVERSITY EXAMINATION FOR THE BACHELOR OF
TECHNOLOGY IN APPLIED CHEMISTRY
(BTAC 14S & BTAC 15S2)
ACH 4206 : CHEMICAL PROCESSES
END OF SEMESTER EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

DATE: Pick Date Apr 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt question ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

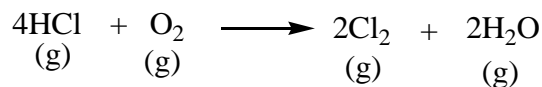
QUESTION ONE

- a) Briefly define each of the following:
- i. Block flow diagram (2 marks)
 - ii. Flow sheet (2 marks)
- b) In the manufacture of cement, limestone is first crushed before being heated at 1000°C to give CO_2 and CaO . Based on this description draw a block flow diagram (4 marks)

- c) Highlight four reasons for undertaking mass balance calculations (4 marks)
- d) Three raw materials are mixed in a tank to make a final product in the ration 1:0.4:1.5 respectively. The first raw material contain A and B with 50% C. The second raw material contain C while the third raw material contain A and B with 75% A. assuming a continuous process at steady, find the flow and composition of the product. (6 marks)
- e) Skim milk is prepared by the removal of some fat from the whole milk. The skim milk is found to contain 90.5% water, 3.5% protein, 5.1% carbohydrates, 0.1% fat and 0.8% ash. If the original milk 4.5% fat, calculate its composition assuming fat only was removed to make the skim milk and that there were no losses in processing. (6 marks)
- f) When 16g of CuSO_4 were dissolved in 384g of water, the temperature rose by 3.95°C . Determine the enthalpy of formation of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ from the anhydrous salt and water, if the enthalpy of solution of the crystal hydrate is 11.7kJ/mol , and the specific heat of the solution is $4.18\text{kJ/kg}\cdot\text{K}$. ($\text{CuSO}_4 = 159.6\text{g/mol}$) (6 marks)

QUESTION TWO

- a) In the production of chlorine gas by oxidation of hydrochloric acid gas, air is used 30% in excess of that theoretically required. The reaction is:



Based on 4 kmol HCl:

- Calculate the weight ratio of air to hydrochloric acid gas in feed (Molar masses $\text{H}=1$, $\text{Cl}=35.5$, $\text{O}=16$, $\text{N}=14$) (8 marks)
 - If the oxidation is 80% complete, find the composition of the product stream on mole basis (5 marks)
- b) A solution of potassium dichromate in water contains 15% $\text{K}_2\text{Cr}_2\text{O}_7$ by weight. 1000kg of this solution is evaporated to remove some amount of water. The remaining solution is cooled to 20°C . If the yield of $\text{K}_2\text{Cr}_2\text{O}_7$ crystals is 80%, calculate the amount of water evaporated. (Given solubility of $\text{K}_2\text{Cr}_2\text{O}_7$ at 20°C is 114.7kg per 1000kg of water). (7 marks)

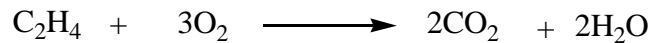
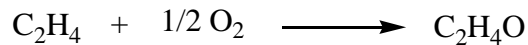
QUESTION THREE

- a) If 36,000kg of whole milk containing 4% fat is to be separated in a 6 hour period into skim milk with 0.45% fat and cream with 45% fat. Determine the hourly flow rates of the output streams from a continuous centrifuge which accomplishes this separation? (10 marks)

- b) A textile dryer is found to consume $4\text{m}^3/\text{hr}$ of natural gas with a calorific value of 800kJ/mol . If the throughput of the dryer is 60kg of wet cloth per hour, drying it from 55% moisture to 10% moisture, estimate the overall efficiency of the dryer taking into account the latent heat of vaporization only. (Latent heat of vaporization of water is 2257kJ/K , 1 mole gas at STP = 22.4L). (10 marks)

QUESTION FOUR

- a) Ethylene oxide is produced by oxidation of ethylene. 100kmol of ethylene are fed to a reactor and the product is found to 80kmol ethylene oxide and 10kmol CO_2 . The reactions are:

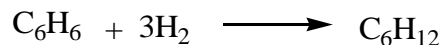


Calculate:

- i. The % conversion of ethylene (8 marks)
 - ii. The % yield to ethylene oxide (3 marks)
- b) Potatoes are dried from 14% total solids to 93% total solids. What is the product yield from each 1000kg of raw potatoes assuming that 8% by weight of the original potatoes is lost in peeling? (9 marks)

QUESTION FIVE

- a) Gaseous benzene (C_6H_6) reacts with hydrogen gas in the presence of Ni catalyst as per the reaction below



The hydrogen gas fed is 30% excess above that required by the above reaction. If the conversion is 50% and yield is 90% . Calculate the requirement of benzene and hydrogen gas for production of 100 moles cyclohexane

(10 marks)

- b) Find an expression for the drag force R on a smooth sphere of diameter D , moving with uniform velocity u , in a fluid of density ρ , and dynamic viscosity, μ .

(10 marks)