



# Technical University of Mombasa

Faculty of Applied and Health Sciences

**DEPARTMENT OF PURE AND APPLIED SCIENCES**  
UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF  
TECHNOLOGY IN APPLIED CHEMISTRY

## **ACH 4206 : CHEMISTRY PROCESS**

SPECIAL/SUPPLEMENTARY EXAMINATION

FEBRUARY 2013 SERIES

2

HOURS

Instructions to candidates:

This paper consist of **FIVE** questions

Answer question **ONE** (compulsory) and any other **TWO** questions

### Question ONE

a) Multiple choice

(10marks)

- (i) The objective of material and energy balance is to assess the;
- (A) Input-output
  - (B) Conversion efficiency
  - (C) Losses
  - (D) All of the above
  - (E) None of the above

- (ii) In the material balance of a process or unit operation process which component will not be considered on the input side?
- (A) Chemicals
  - (B) Air
  - (C) Recycle
  - (D) By product
- (iii) Sankey diagram shows in graphics
- (A) Energy input
  - (B) Energy output
  - (C) Energy balance
  - (D) All of the above
- (iv) In a furnace, the lower the exhaust temperature the \_\_\_\_\_ is the furnace efficiency.
- (A) Lower
  - (B) Moderate
  - (C) Higher
  - (D) None of the above
- (v) Energy supplied by combustion of fuel is equal to
- (A) Mass of fuel consumed X its calorific value
  - (B) Man of fuel consumed X its density
  - (C) Mass of duel consumed X its specific heat
  - (D) Mass of fuel consumed X heat capacity
- (vi) If feed of a hundred tones per hour at 5% con concentration is fed to a crystallizer, the product obtained at 25% concentration is equal to \_\_\_\_\_ tones per hour.
- (A) 20
  - (B) 25
  - (C) 35
  - (D) 40

(vii) Which of the following is the predominant loss in a furnace oil fired boiler.

(A) Dry flue gas losses

(B) Heat loss due to moisture in air

(C) Heat loss due to radiation and convection

(D) Heat loss due to moisture in the fuel

(viii) In a chemical reaction of two reactions A (200Kg) and B(200Kg), the conversion is 50% and A and B reacts in equal proportions. Calculate the weight of product formed.

(A) 150Kg

(B) 200Kg

(C) 250Kg

(D) 400Kg

(ix) In a utility steam boiler, heat loss due to radiation is normally is a range of

(A) 10%

(B) 14%

(C) 1%

(D) 8%

(x) Which one is a secondary form of energy

(A) Furnace oil

(B) Natural gas

(C) Electricity

(D) Coal

**b)** Outline TWO ways in which the study of material and energy balance is useful for a top manager. **(2marks)**

**c)** Consider the following pair of reactions

A → 2B(desired)

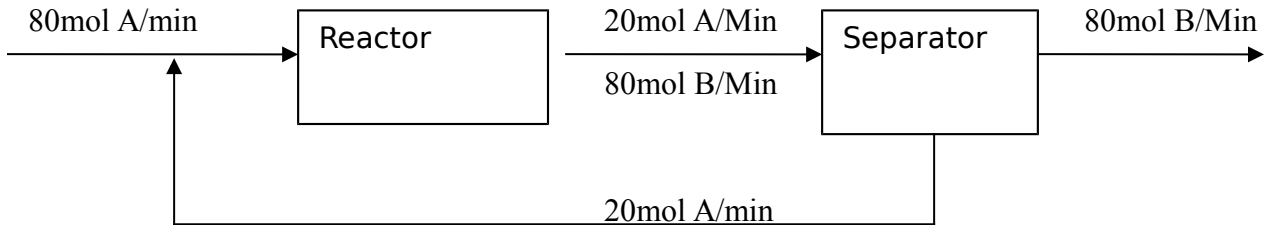
B → C (undesired)

100moles of A are fed to a batch reactor and the final product contained 10moles of A,

160 moles of B and 10 moles of C. Calculate the;

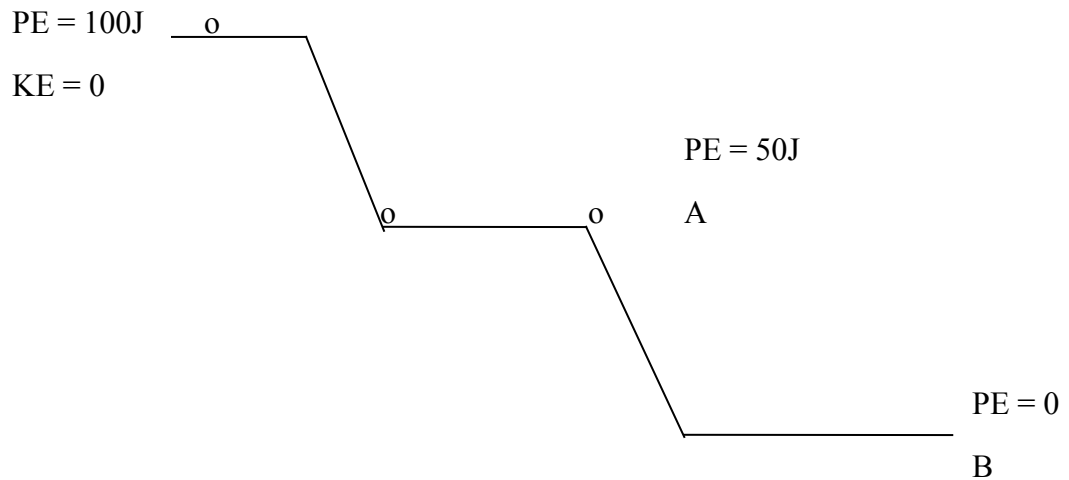
- i) Percentage yield of B (2 marks)
- ii) Selectivity of B relative to C. (3 marks)
- iii) Extent of the reactions.

d) Study the process given below and answer the questions that follow



Determine the

- (i) Overall conversion (2 marks)
- (ii) Single pass conversion (2 marks)
- e) (i) Differentiate between latent and sensible heat. (2 marks)
- (ii) A ball of 2Kg rolls from the top of a platform along the staircase to the floor as shown in the figure below.



Calculate the velocity at point A and B (4 marks)

### Question TWO

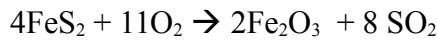
100% methane is fed into a burner with 130% excess air. Assume complete combustion occurs,

- (i) Draw a well labelled flow diagram for the process. (4 marks)

- (ii) Determine
- (a) The flow rates of the product gases. **(9marks)**
- (b) % mole of the product gas both as stock and or sat analysis. **(7marks)**

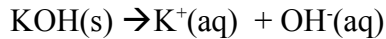
### Question THREE

- a) Calculate the composition of gases obtained by the burning of pure FeS<sub>2</sub> with 60% excess air. The oxidation proceeds to the reaction



Assume complete conversion and a basis of 4kmol of FeS<sub>2</sub>. **(5marks)**

- b) When 0.00Kg of KOH are added to 200g of water using a calorimeter (C<sub>p</sub> = 493.24J/K), the temperature rises from 23.4 to 35°C. Calculate the molar heat of solution.



Specific capacity of water = that of KOH(aq) solution = 4.18J/gK.

(K = 39, O = 16, H = 1) **(5marks)**

- c) An acetone/methanol solution containing 75mol% acetone is heated to a temperature where a liquid and vapour phase coexists. The vapour phase contains 85mol% acetone while the liquid phase contains 50mol% acetone.

The flow rate of the solution is 100mol/hr

- (i) Represent this information in a well labeled process flow diagram. **(3marks)**
- (ii) Determine the flow rates of the liquid and vapour streams exiting the separation chamber. **(7marks)**

### Question FOUR

- a) A textile dryer is found to consume 4m<sup>3</sup>/hr of natural gas with a calorific value of 800KJ/mol. The throughput of the dryer is 60Kg of wet cloth per hour, drying it from 55% moisture to 10% moisture, taking into account the latent heat of evaporation (2257KJ/Kg); (molar gas vol.at STP =22.4 litres)

Calculate

- (i) The heat needed in the process. **(5marks)**
- (ii) Heat used in the process **(3marks)**
- (iii) Thermal efficiency of the dryer. **(2marks)**
- b) A paint mixture containing 25% of a pigment and the balance water sells for Ksh 18/Kg

and a mixture containing 12% pigment for Ksh 10/Kg. A paint retailer produces a blend containing 17% pigment.

- i) Draw a well labeled diagram for the process **(3marks)**
- ii) How much should the product be sold (per Kg) to yield a 10% profit? **(7marks)**

### Question FIVE

a) For the reaction  $A \rightarrow 2B + C$  with inerts I present in the system, calculate

- (i)  $DH^{\circ}_{RX}$  **(3marks)**
- (ii)  $DC_p$  **(3marks)**
- (iii)  $DH_{RX}(400)$  **(4marks)**

Additional information

$H^{\circ}_A(298)$	=	-100Kcal/mol A	$C_{pA}$	=	80cal/mol°C
$H^{\circ}_B(298)$	=	-40Kcal/mol B	$C_{pB}$	=	20cal/mol°C
$H^{\circ}_C(298)$	=	-30kcal/mol°C	$C_{pc}$	=	30cal/mol°C
$H^{\circ}_I(298)$	=	-100kcal/mol I	$C_{pI}$	=	190cal/mol°C

b) An autoclave contains 1000 cans of pea soup. It is heated to an overall temperature of 100°C. The specific heats of the pea soup and the can metal are 4.1KJ/Kg°C and 0.50KJ/Kg°C respectively. The weight of each can is 60Kg and it contains 0.45Kg of pea soup. The cans are to be cooled to 40°C before leaving the autoclave. Assume that the heat content of the autoclave walls above 40°C is  $1.6 \times 10^4$  KJ and that there is no heat loss through the walls. Let  $w$  = the weight of cooling water required; and the datum temperature be 40°C the temperature of the cans leaving the autoclave. Cooling water enters at 15°C and leaves at 35°C.

- (i) Determine the heat entering the autoclave **(5marks)**
- (ii) Determine the heat leaving the autoclave. **(3marks)**
- (iii) Determine the amount of cooling water required. **(2marks)**