

**FOURTH YEAR EXAMINATION FOR THE AWARD OF**  
**THE DEGREE OF BACHELOR OF SCIENCE IN PETROLEUM CHEMISTRY**  
**SECOND SEMESTER 2021/2022**  
**(FEBRUARY-JUNE, 2022)**

**CHEM 421: REACTOR DESIGN**

**STREAM: Y4 S2**

**TIME: 2 HOURS**

**DAY: MONDAY, 12. 00 PM – 2.00 PM**

**DATE: 16/05/2022**

**INSTRUCTIONS:**

- 1. Do not write anything on this question paper.***
- 2. Answer all questions in section A and any TWO (from section B.***

**SECTION A (COMPULSORY) – 40 MARKS**

**QUESTION ONE**

- Write down the Arrhenius equation and its significance in reactor design. [3marks]
- State the Baiss theory [2marks]
- Define the term Activation Energy as used in reactor design. [2marks]
- What determines the success or failure of any chemical plant? [2marks]
- Briefly explain the abbreviation CRE in reactor design [1 mark]

**QUESTION TWO**

Differentiate between the following terms as used in Reactor Design

- Conversion and Yield [2marks]
- Elementary and non-elementary reactions [2marks]
- Batch and semi-batch Reactors [2marks]
- Single and Multiple Reactors [2marks]
- Exothermic and Endothermic Reactions [2marks]

### QUESTION THREE

Using the general equation  $aA + bB \rightarrow cC + dD$ , answer the following questions;

- i. Define the term ,limiting reactant as used in Chemistry. [2marks]
- ii.
- iii. Give the stoichiometric coefficients of the above equation with respect to each reactant and product. [2marks]
- iv. Give the overall reaction order of the equation above [2marks]
- v. Assuming reactant B is the limiting reactant;
  - a) Give the corresponding stoichiometric coefficients of each reactant and product [4marks]
  - b) Write down the rate of reaction or disappearance of the limiting reactant. [2marks]
  - c) Derive the rates of formation equations of products C and D [4marks]

**Q.4** List the three main basic models used in estimation of most important process variables of different chemical reactors. [3marks]

**Q.5** Differentiate between reactors that work in steady state and transient state. Giving an example in each state. [2marks]

### SECTION B

Answer any TWO questions in this section

#### QUESTION SIX

- a) Name four types of reactors. [4marks]
- b) Give two important characteristics of a Tubular reactor. [2marks]
- c) Draw a batch reactor and label its important parts giving one advantage. [6marks]
- d) Give a clear difference between a packed bed reactor and a tubular reactor. [2marks]
- e) Write down one example of an homogeneous reaction. [1mark]

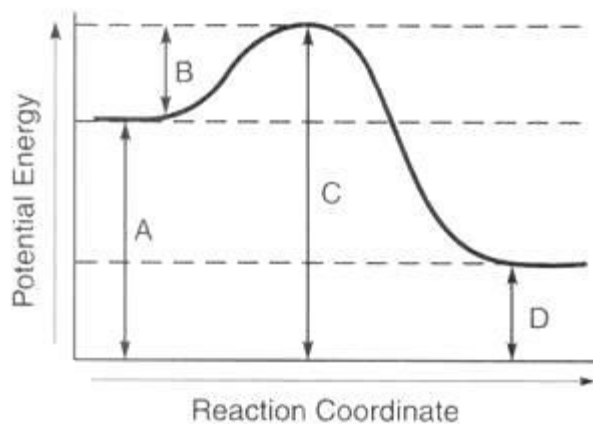
#### QUESTION SEVEN

- a) Briefly explain recycle reactors. [2marks]
- b) Which reactor minimizes unwanted side reaction? How? [2marks]
- c) Give two disadvantages of a continuous-stirred Tank Reactor, CSTR [2marks]
- d) There are a number of types of reactions in chemistry. Give two types of reactions based on the direction of reaction and give an example in each. [4marks]

- e) Reactor design knowledge and experience has been obtained from many areas. Which areas are they? [2marks]
- f) The performance and viability of any reactor in chemical industries relies upon three main factors. Briefly explain the factors. [3marks]

### QUESTION EIGHT

- a) Giving examples, state the five traditional types of reactions in Chemistry. [5marks]
- b) What does the term Molecularity mean in reaction design? [2marks]
- c) Write down an equation that can be used to estimate the activation energy of a reaction taking place at the same concentration but two different temperatures. [2marks]
- d) Using the graph below, answer the following questions;



- i. What kind of reaction depicts the graph above [1mark]
- ii. Briefly explain how this type of reaction takes place in a chemical reactor. Indicating the reactants, products and activated complex positions on the graph. [4marks]
- iii. What is **B**? [1mark]