

UNIVERSITY OF GHANA

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**BSC ENGINEERING SECOND SEMESTER EXAMINATIONS: 2014/2015**

**FPEN 306: CHEMICAL REACTION ENGINEERING (2 CREDITS)**

**INSTRUCTION:**

**ANSWER ALL QUESTIONS IN SECTION A, AND 3 OTHERS FROM SECTION B (i.e. making a Total of 5 questions)**

**TIME ALLOWED: 2 HOURS.**

**SECTION A**

**1**

- a) Define and give examples of:
- i. Reversible reaction
  - ii. Irreversible reaction
  - iii. Equilibrium reaction
  - iv. Molecularity of a reaction and give examples for uni, bi, and trimolecular reaction
  - v. Elementary and non-elementary reaction
  - vi. Order of a reaction
  - vii. Rate of a reaction
  - viii. A zero order reaction
  - ix. Chemical potential
  - x. Stoichiometry

(20 Marks)

**2**

A rocket engine burns a stoichiometric mixture of fuel (liquid hydrogen) in oxidant (liquid oxygen). The combustion chamber is cylindrical, 75 cm long and 60 cm in diameter and the combustion process 108 kg/s of exhaust gases. If combustion is complete, find the rate of reaction of hydrogen and of oxygen.

(20 Marks)

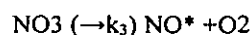
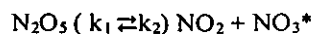
## SECTION B

3

- a) A reaction has the stoichiometric equation  $A + B = 2R$ . What is the order of the reaction? (4 Marks)
- b) Given the reaction  $2NO_2 + \frac{1}{2}O_2 = N_2O_5$ , what is the relation between the rates of formation and disappearance of the three reaction components? (6 Marks)
- c) For the complex reaction with stoichiometry  $A + 3B \Rightarrow 2R + S$  and second order rate equation  $-r_A = k_1[A][B]$ , are the reaction rates related as follows? If the rates are not so related, then how are they related? Please account for the signs, + or – (10 Marks)

4

From the following schemes



- a) Show the number of elementary reactions in the schemes shown. (5 Marks)
- b) Show that the reactions identified in Q3a follow a first order decomposition of  $N_2O_5$ . (15 Marks)

5

- a) For a gas reaction at 400K the rate is reported as:

$$dP_A/dt = 3.66P_A^2, \text{ atm/hr}$$

- i. What is the unit of the rate constant? (8 Marks)
- ii. What is the value of the rate constant for this reaction if the rate equation is expressed as

$$-r_A = -\frac{1}{V} \frac{dN_A}{dt} = kC^2, \text{ mol/m}^3.s$$

(12 Marks)

6

- b) A liquid decomposes by first order kinetics, and in a batch reactor 50% of A is converted in 5 minutes run. How much longer would it take to reach 75% conversion?  
(12 Marks)
- c) A 10 minutes experimental run shows that 75% of liquid reactant is converted to product by a half-order rate. What would be the fraction converted in a half-hour run?  
(8 Marks)