



**KENYATTA UNIVERSITY**  
**UNIVERSITY EXAMINATIONS 2010/2011**  
**INSTITUTE OF OPEN LEARNING**  
**EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND**  
**BACHELOR OF EDUCATION (SCIENCE)**  
**SCH 305: CHEMICAL KINETICS**

**DATE:** FRIDAY 4<sup>TH</sup> FEBRUARY 2011

**TIME:** 8.00 A.M – 10.00 A.M

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**INSTRUCTIONS**

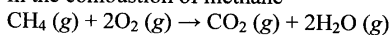
Answer ALL questions

$R = 8.314 \text{ JK}^{-1}\text{mol}^{-1} = 0.0821 \text{ l-atm K}^{-1}\text{mol}^{-1}$  (Total Marks – 70)

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**Question 1**

In the combustion of methane

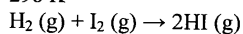


The rate of consumption of oxygen was found to be  $-\Delta[\text{O}_2] / \Delta t = 0.2 \text{ mol s}^{-1}$

- What is the average reaction rate with respect to combustion of methane?
- What is the rate of production of gaseous  $\text{CO}_2$ ?
- If initially there were 10.00 mol of  $\text{CH}_4$ , how many moles of  $\text{CH}_4$  would be present after 40 s?

**Question 2**

The formation of gaseous hydrogen iodide,  $\text{HI}(\text{g})$ , was monitored at a temperature of 298 K



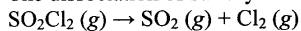
The following data on the rate of reaction were collected,

| Initial conc $[\text{H}_2] / \text{mol dm}^{-3}$ | Initial conc $[\text{I}_2] / \text{mol dm}^{-3}$ | Initial rate of reaction<br>$/ \text{mol dm}^{-3} \text{ s}^{-1}$ |
|--|--|---|
| 0.100  | 0.200  | $8.0 \times 10^{-3}$  |
| 0.200  | 0.200  | $16.0 \times 10^{-3}$   |
| 0.100  | 0.050  | $2.0 \times 10^{-3}$  |

- Derive an expression for the rate law
- Calculate  $k$ , the rate constant for this reaction at 298 K stating clearly its units
- Predict the initial rate of reaction at 298 K if  
 Initial conc  $[H_2] = 0.050 \text{ mol dm}^{-3}$   
 Initial conc  $[I_2] = 0.050 \text{ mol dm}^{-3}$

### Question 3

The dissociation of suluryl chloride,  $SO_2Cl_2$ , is first order with respect to  $SO_2Cl_2$



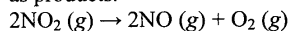
The reaction was performed at 298 K and the following data were obtained:

| Time / s | Conc. $[SO_2Cl_2] / \text{mol dm}^{-3}$ |
|----------|---|
| 0        | 1.000                                   |
| 2500     | 0.947                                   |
| 5000     | 0.895                                   |
| 7500     | 0.848                                   |
| 10000    | 0.803                                   |

- State the rate equation for the dissociation
- Using a graphical method, calculate the value of the rate constant,  $k$ , giving its units
- Calculate the half-life for the reaction

### Question 4

In the decomposition of nitrogen dioxide,  $NO_2$ , nitrous oxide and oxygen are formed as products.



The reaction was performed at various temperatures and the rate constants were found to be as follows:

| T/°C | $k / \text{dm}^3 \text{mol}^{-1} \text{s}^{-1}$ |
|------|---|
| 100  | $1.1 \times 10^{-9}$                            |
| 200  | $1.8 \times 10^{-8}$                            |
| 300  | $1.2 \times 10^{-7}$                            |
| 400  | $4.4 \times 10^{-7}$                            |

- Rearrange the Arrhenius equation, and, by plotting a graph, find the activation energy and Arrhenius factor for the decomposition of  $NO_2$  (Check carefully your units for the temperature)
- Hence predict the value of  $k$  at a temperature of 500°C

### Question 5

- Define the term *elementary step*, and describe the difference between a *unimolecular-* and *bimolecular- elementary step*.