

GENSET EDUCATION ACADEMY

CHEMISTRY 1000

**TUTORIAL SHEET 5 SOLUTIONS
(Chemical Kinetics)**

COMPILED BY TUTOR POUL

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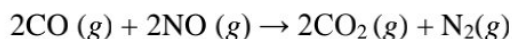
**THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY
ACADEMIC YEAR 2022
TERM 1
CHE 1000: INTRODUCTORY CHEMISTRY**

ASSIGNMENT SHEET 5

24th August 2023

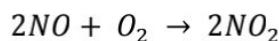
Answer all the problems in a HARD COVER book and submit in ROOM 124 before 10:00 hrs on Thursday, 1st September 2023

1. Give two (2) quantities that must be measured to establish the rate of a chemical reaction and state five (5) factors that affect the rate of a chemical reaction.
2. What are the units for each of the following if the concentrations are expressed molar (M) and the time in seconds (s)?
 - a) rate constant for a zero-order rate law
 - b) rate constant for a first-order rate law
 - c) rate constant for a second-order rate law
3. Given a reaction below:



Give a reason why the rate of disappearance of NO and the rate of formation of N₂ are not the same in the reaction.

4. State the Arrhenius equation and define the parameters in the equation
5. Nitrogen monoxide can be oxidized by atmospheric oxygen to form nitrogen dioxide as shown in the equation:



If at a particular moment during the reaction nitrogen monoxide (NO) is reacting at the rate of 0.066 M/s.

- a) At what rate is NO₂ being formed?
 - b) At what rate is molecular oxygen reacting?
6. The reaction $2\text{A} + \text{B} \rightarrow \text{Products}$ was found to yield the following data.

Initial concentration (mol/L)		Initial rate of reaction of A (mol/L s)
A	B	
0.10	0.10	0.0015
0.20	0.10	0.0030
0.10	0.0500	0.00075

- a) Determine the order of the reaction
- b) What is the rate law for the reaction?
- c) What is the rate constant for the reaction with its correct units?
7. The oxidation of NO produces the brownish-red gas NO₂, which is a component of urban air pollution. $2\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$. The rate law for reaction is $\text{rate} = k[\text{NO}]^2[\text{O}_3]$. At 25 °C, $k = 7.1 \times 10^9 \text{M}^{-2}\text{s}^{-1}$.
- a) What would be the rate of the reaction if $[\text{NO}] = 0.0010 \text{ M}$ and $[\text{O}_3] = 0.034 \text{ M}$?
- b) What is the reaction order with respect to each reactant?
- c) What is the overall order of the reaction
8. The decomposition of sulfuryl chloride, SO₂Cl₂, a chemical used in variety of organic syntheses is $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$. Given the rate constant for this reaction is $k = 2.2 \times 10^{-5} \text{s}^{-1}$ at 320 °C. If the initial SO₂Cl₂, concentration in a container is 0.0040 M, what will be its concentration
- a) After 1.00 hours
- b) After 1.00 days
9. Variation of the rate constant with temperature for the first-order reaction. is given in the following table.

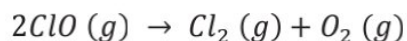
T(°C)	K (s ⁻¹)
25	1.74×10^{-5}
35	6.61×10^{-5}
45	2.51×10^{-4}
55	7.59×10^{-4}
65	2.40×10^{-3}



Determine graphically the activation energy for the reaction.

10. The rate constant of a first order reaction is $4.60 \times 10^{-4} \text{s}^{-1}$ at 350°C . If the activation energy is 104 kJ/mol , calculate the temperature at which its rate constant is $8.80 \times 10^{-4} \text{s}^{-1}$.

11. Chlorine oxide (ClO), which plays an important role in the depletion of ozone, decays rapidly at room temperature according to the equation



From the following data, determine the reaction order and calculate the rate constant of the reaction.

Time (s)	[ClO] M
0.12×10^{-3}	8.49×10^{-6}
0.96×10^{-3}	7.10×10^{-6}
2.24×10^{-3}	5.79×10^{-6}
3.20×10^{-3}	5.20×10^{-6}
4.00×10^{-3}	4.77×10^{-6}

12. The thermal decomposition of N_2O_5 obeys first-order kinetics. At 45°C , a plot of $\ln [\text{N}_2\text{O}_5]$ versus t gives a slope of $-6.18 \times 10^{-4} \text{min}^{-1}$. What is the half-life of the reaction?

TUTORIAL SHEET 5 SOLUTIONS

QUESTION 1

=> molarity of reactant or product

=> Time

• Factors affecting the rate include;

- Temperature

- Concentration of reactants

- Surface area if solids are involved

- The presence of catalysts

- The absence of a catalyst

- The presence of light

QUESTION 2

(a) The units of a rate constant can be found by the formula;

$$\text{Units of } k \Rightarrow M^{1-n} t^{-1}$$

where M = molarity

t = Time

n = order of reaction.

(a) For a Zero Order

$$k \Rightarrow M^{-n} t^{-1} \quad n=0$$

$$\Rightarrow M^{1-0} t^{-1}$$

$$\Rightarrow M t^{-1}$$

$$\Rightarrow \frac{M}{t} = \text{ms}^{-1}$$

$$\frac{M}{t} = \text{ms}^{-1}$$

(b) for a first order

$$\begin{aligned}
 k &\Rightarrow M^{1-n} t^{-1} & n=1 \\
 &\Rightarrow M^{1-1} t^{-1} \\
 &\Rightarrow M^0 t^{-1} \\
 &\Rightarrow 1 s^{-1} \\
 &\Rightarrow s^{-1} \\
 &\underline{\underline{\#}}
 \end{aligned}$$

(c) for a second order

$$\begin{aligned}
 k &\Rightarrow M^{1-n} t^{-1} & n=2 \\
 &\Rightarrow M^{1-2} t^{-1} \\
 &\Rightarrow M^{-1} t^{-1} \\
 &\Rightarrow \frac{1}{M} \times \frac{1}{t} \\
 &\Rightarrow M^{-1} s^{-1} \\
 &\underline{\underline{\#}}
 \end{aligned}$$

QUESTION 3

This is because of the 2:1 stoichiometric ratio between NO and N₂, the NO must use 2 moles of each mole of N₂ produced. This means that the rate of consumption of NO is twice as fast as the rate of production of N₂.

QUESTION 12

- obeys first order

$$T = 45^{\circ}\text{C} \quad \text{slope} = -6.18 \times 10^{-4} \text{ min}^{-1}$$

$$t_{1/2} = ?$$

$$\text{Half life} = \frac{0.693}{k}$$

$$|\text{slope}| = k = 6.18 \times 10^{-4} \text{ min}^{-1}$$

$$\text{Half life} = \frac{0.693}{6.18 \times 10^{-4}}$$

$$= 1,121.359223$$

$$= 1,121.359223$$

$$= 1.121 \times 10^3 \text{ minutes}$$

~~///~~

Kagone mange Jobie iwah!

TUTOR FOUR SOLUTIONS.

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