

Name: _____

Period: _____

Seat#: _____

Directions: Show all work in a way that would earn you credit on the AP Test!

1) Consider the reaction: $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$

The following data were obtained from three experiments using the method of initial rates:

| | Initial [NO] mol L ⁻¹ | Initial [O ₂] mol L ⁻¹ | Initial Rate [NO] mol L ⁻¹ s ⁻¹ |
|--------|----------------------------------|---|---|
| Exp. 1 | 0.010 | 0.010 | 2.5×10^{-5} |
| Exp. 2 | 0.020 | 0.010 | 1.0×10^{-4} |
| Exp. 3 | 0.010 | 0.020 | 5.0×10^{-5} |

| | |
|---|--|
| <p>a) Determine the order of the rxn for each reactant.</p> | <p>b) Write the rate equation for the reaction</p> |
| <p>c) Calculate the rate constant.</p> <p style="text-align: right;"><u>$25 \text{ L}^2 \cdot \text{mol}^2 \cdot \text{s}^{-1}$</u></p> | <p>d) Calculate the rate (in mol L⁻¹s⁻¹) at the instant when [NO] = 0.015 mol L⁻¹ and [O₂] = 0.0050 mol L⁻¹</p> <p style="text-align: right;"><u>$2.8 \times 10^{-5} \text{ M} \cdot \text{s}^{-1}$</u></p> |
| <p>e. At the instant when NO is reacting at the rate $1.0 \times 10^{-4} \text{ mol L}^{-1}\text{s}^{-1}$, what is the rate at which O₂ is reactant and NO₂ is forming? (Hint: Use coefficients)</p> <p style="text-align: right;"><u>$5.0 \times 10^{-5}, 1.0 \times 10^{-4}$</u></p> | |

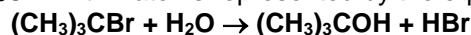
2) The reaction $2 \text{NO}(\text{g}) + 2 \text{H}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$ was studied at 904 °C, and the data in the table were collected.

| | Initial [NO] mol L ⁻¹ | Initial [H ₂] mol L ⁻¹ | Initial Rate [N ₂] mol L ⁻¹ s ⁻¹ |
|--------|----------------------------------|---|--|
| Exp. 1 | 0.420 | 0.122 | 0.136 |
| Exp. 2 | 0.210 | 0.122 | 0.0339 |
| Exp. 3 | 0.210 | 0.244 | 0.0678 |
| Exp. 4 | 0.105 | 0.488 | 0.0339 |

| | |
|---|--|
| <p>a) Determine the order of the reaction for each reactant.</p> | <p>b) Write the rate equation for the reaction</p> |
| <p>c) Calculate the rate constant at 904 °C.</p> <p style="text-align: right;"><u>$6.32 \text{ L}^2 \cdot \text{mol}^2 \cdot \text{s}^{-1}$</u></p> | <p>d) Find the rate of appearance of N₂ at the instant when [NO] = 0.350 M and [H₂] = 0.205 M</p> <p style="text-align: right;"><u>$0.159 \text{ M} \cdot \text{s}^{-1}$</u></p> |

Dougherty Valley HS Chemistry - AP
Kinetics – Method of Initial Rates

3) The reaction of tbutyl-bromide $(\text{CH}_3)_3\text{CBr}$ with water is represented by the equation:

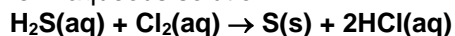


The following data were obtained from three experiments using the method of initial rates:

| | Initial $[(\text{CH}_3)_3\text{CBr}] \text{ mol L}^{-1}$ | Initial $[\text{H}_2\text{O}] \text{ mol L}^{-1}$ | Initial Rate $[\text{NO}] \text{ mol L}^{-1} \text{ s}^{-1}$ |
|--------|--|---|--|
| Exp. 1 | 5.0×10^{-2} | 2.0×10^{-2} | 2.0×10^{-6} |
| Exp. 2 | 5.0×10^{-2} | 4.0×10^{-2} | 2.0×10^{-6} |
| Exp. 3 | 1.0×10^{-1} | 4.0×10^{-2} | 4.0×10^{-6} |

| | |
|--|---|
| a) What is the order with respect to $(\text{CH}_3)_3\text{CBr}$? | b) What is the order with respect to H_2O ? |
| c) What is the overall order of the reaction? | d) Write the rate equation |
| e) e. Calculate the rate constant, k, for the reaction. | |
| <i>4.0 E-5 sec⁻¹</i> | |

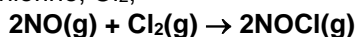
4) Hydrogen Sulfide is oxidized by chlorine in aqueous solution.



The experimental rate law is: $\text{Rate} = k[\text{H}_2\text{S}][\text{Cl}_2]$

| | | |
|--|---|-------------------------------|
| a) What is the reaction order with respect to H_2S ? | b) What is the reaction order with respect to Cl_2 ? | c) What is the overall order? |
|--|---|-------------------------------|

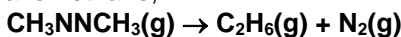
5) For the reaction of nitric oxide, NO, with chlorine, Cl_2 ,



The observed rate law is: $\text{Rate} = k[\text{NO}]^2[\text{Cl}_2]$;

| | | |
|---|---|-------------------------------|
| a) What is the reaction order with respect to NO? | b) What is the reaction order with respect to Cl_2 ? | c) What is the overall order? |
|---|---|-------------------------------|

6) In experiments on the decomposition of azomethane,



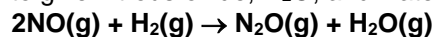
The following data were obtained:

| | Initial $[\text{CH}_3\text{NNCH}_3] \text{ mol L}^{-1}$ | Initial Rate $\text{mol L}^{-1} \text{ s}^{-1}$ |
|--------|---|---|
| Exp. 1 | 1.13×10^{-2} | 2.8×10^{-6} |
| Exp. 2 | 2.26×10^{-2} | 5.6×10^{-6} |

| | |
|-----------------------------------|--|
| a) What is the rate law? | b) What is the value of the rate constant? |
| <i>k = 2.5 E-4 s⁻¹</i> | |

Dougherty Valley HS Chemistry - AP
Kinetics – Method of Initial Rates

7) Nitric Oxide, NO, reacts with hydrogen to give nitrous oxide, N₂O, and water:



In a series of experiments, the following initial rates of disappearance of NO were obtained:

| | Initial [NO(g)] mol L ⁻¹ | Initial [H ₂ (g)] mol L ⁻¹ | Initial Rate [NO] mol L ⁻¹ s ⁻¹ |
|--------|-------------------------------------|--|---|
| Exp. 1 | 6.4 x 10 ⁻³ | 2.2 x 10 ⁻³ | 2.6 x 10 ⁻⁵ |
| Exp. 2 | 12.8 x 10 ⁻³ | 2.2 x 10 ⁻³ | 1.0 x 10 ⁻⁴ |
| Exp. 3 | 6.4 x 10 ⁻³ | 4.5 x 10 ⁻³ | 5.1 x 10 ⁻⁵ |

| | |
|--|--|
| <p>a) What is the rate law?</p> | <p>b) What is the value of the rate constant?</p> |
|--|--|

k = 2.9 E2 s⁻¹

8) Chlorine dioxide, ClO₂, is a reddish-yellow gas that is soluble in water. In basic solution it gives ClO₃⁻ and ClO₂⁻ ions.



To obtain the rate law for this reaction, the following experiments were run and, for each, the initial rate of reaction of ClO₂ was determined. Obtain the rate law and the value of the rate constant.

| | Initial [ClO ₂] mol L ⁻¹ | Initial [OH ⁻] mol L ⁻¹ | Initial Rate mol L ⁻¹ s ⁻¹ |
|--------|---|--|--|
| Exp. 1 | 0.060 | 0.030 | 0.0248 |
| Exp. 2 | 0.020 | 0.030 | 0.00276 |
| Exp. 3 | 0.020 | 0.090 | 0.00828 |

| | |
|--|--|
| <p>a) What is the rate law?</p> | <p>b) What is the value of the rate constant?</p> |
|--|--|

k = 2.3 E2 M⁻²s⁻¹