## Name:

## Worksheet #6

**Period:** 

Seat#:

## **Mathematical Questions**

- Show your work when applicable! Show units! •
- •
- •
- Get an actual answer, including units! Box your answer! Some answers are provided. They are underlined at the end. For rate order type problems be sure to include the following information. Your work does not need to be in chart format. •

Trials	Which [ ] is	Which [ ] is being changed and	What factor is the	Order based
being used	held constant	by what factor is it changed by	rate changed by	on rate data
1&3	[H <sub>2</sub> ]	[O <sub>2</sub> ] x 2	x 2	1

1)	) What happens to the rate if you increase the surface area?			2) What does temperature measure?			3)	What is activation energy? What is the energy being used for?	
4)	) What is a transition state (sometimes called an activated complex)?			5) What is a catalyst?			6)	Why can average rates be negative, but the rates when using a rate law are always positive?	
7)	Given the	following e	experime	ntal data	, find the rat	e law and tl	he ra	ate constant for the reaction: $k = 2.1 M^{-1}s^{-1}$	
	NO (g) + r	$1O_2 (g) + O_2$	$(g) \rightarrow N_2$	<b>J</b> <sub>5 (g)</sub>	10 J M	Initial Rate	,		
	Kun		, M [r	О <sub>2</sub> ] <sub>0</sub> , м	[0 <sub>2</sub> ] <sub>0</sub> , M	Ms <sup>-1</sup>			
	2	0.10	M	0.10 M 0.10 M	0.10 M	4.2 x 10 <sup>-2</sup>	_		
	3	0.20	М	0.30 M	0.20 M	$1.26 \times 10^{-1}$			
	4	0.10	M	0.10 M	0.20 M	2.1 × 10 <sup>-2</sup>			
8)	The react BrO <sub>3</sub> (aq) Using the the overa	tion betwee + 5Br <sup>-</sup> (aq) + e data from 4 Il reaction c 0.10 0.20 0.20 0.10	n broma 6H <sup>+</sup> (aq) - 4 experir order, and [Br-] (M 0.10 0.10 0.20 0.10	te ions ar → 3Br <sub>2(1)</sub> - nents shi d the valu 0.10 0.10 0.20 24 + 28	nd bromide i + 3H₂O(I) own below c ue of the rate M) rate (M/ 8.0 × 10- 1.6 × 10- 3.2 × 10- 3.2 × 10- 3.2 × 10-	ons in acidi letermine th e constant l s) -4 -3 -3 -3 -3	ic ac ne oi <. <u>k =</u>	queous solution is rders of the rate of reaction for all three reactants, = $8.0 L^3/mol^3$ .s	
9)	I ne initial rate of the reaction $2A + 2B \rightarrow C + D$ is determined for different initial conditions, with the results listed in the following table: $k = 0.103 M^2 s^{-1}$								
	Run #	[A] <sub>0</sub> , M	[B] <sub>0</sub> . M	Initial r	ate, M/s				
	1	0.185	0.133	3.35	x 10 <sup>-4</sup>				
	2	0.185	0.266	1.35	x 10 <sup>-3</sup>				
	3	0.370	0.133	6.75	x 10 <sup>-4</sup>				
	4	0.370	0.266	2.70	x 10 <sup>-3</sup>				

1       0.10       0.10       0.10       8.0 x 10 <sup>4</sup> 2       0.20       0.10       0.10       1.6 x 10 <sup>3</sup> 3       0.10       0.20       0.10       1.6 x 10 <sup>3</sup> 4       0.10       0.40       0.20       3.2 x 10 <sup>3</sup> he reaction of iodide ion with hypochlorite ion, OCI <sup>-</sup> (which is foun DCI <sup>-</sup> + I <sup>-</sup> → OI <sup>-</sup> + CI <sup>-</sup> It is a rapid reaction that gives the following rat Determine the value of the rate constant.         Initial Concentrations       Rate of Formation (mol L <sup>-1</sup> s <sup>-1</sup> )         [OCI <sup>-</sup> ]       [I <sup>-</sup> ]       (mol/L) of CI <sup>-</sup> 1.7 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 1.75 × 10 <sup>4</sup> 3.4 × 10 <sup>-3</sup> 1.75 × 10 <sup>4</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 3	d in liquid bleach), follows the equation e data. What is the rate law for the reaction . Overall order . Rate constant
2       0.20       0.10       0.10       1.6 x 10 <sup>-3</sup> 3       0.10       0.20       0.10       1.6 x 10 <sup>-3</sup> 4       0.10       0.40       0.20       3.2 x 10 <sup>-3</sup> he reaction of iodide ion with hypochlorite ion, OCI <sup>-</sup> (which is foun 0.40       0.20       3.2 x 10 <sup>-3</sup> betermine the value of the rate constant.       Initial Concentrations       Rate of Formation (mol L <sup>-1</sup> s <sup>-1</sup> )         [OCI <sup>-</sup> ]       [I <sup>-</sup> ]       (mol L <sup>-1</sup> s <sup>-1</sup> )       (mol/L) of Cl <sup>-</sup> 1.7 × 10 <sup>-3</sup> 1.75 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 3.4 × 10 <sup>-3</sup> 1.77 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup>	d in liquid bleach), follows the equation e data. What is the rate law for the reaction.
3       0.10       0.20       0.10       1.6 x 10 <sup>-3</sup> 4       0.10       0.40       0.20       3.2 x 10 <sup>-3</sup> Che reaction of iodide ion with hypochlorite ion, OCI <sup>-</sup> (which is foun DCI <sup>-</sup> + CI <sup>-</sup> It is a rapid reaction that gives the following rat Determine the value of the rate constant.         Initial Concentrations       Rate of Formation (mol L <sup>-1</sup> s <sup>-1</sup> ) (mol/L) of CI <sup>-</sup> [OCI <sup>-</sup> ]       [I <sup>-</sup> ]       (mol L <sup>-1</sup> s <sup>-1</sup> ) (mol/L) of CI <sup>-</sup> 1.7 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 1.75 × 10 <sup>4</sup> 3.4 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 0.010 M       0.020 M       0.020 M/s       0.020 M/s         2       0.015 M       0.020 M       0.030 M/s         3       0.010 M       0.020 M       ?	d in liquid bleach), follows the equation e data. What is the rate law for the reaction.
The reaction of iodide ion with hypochlorite ion, OCI <sup>-</sup> (which is foun DCI <sup>-</sup> + I <sup>-</sup> → OI <sup>-</sup> + CI <sup>-</sup> It is a rapid reaction that gives the following rate Determine the value of the rate constant. $\begin{array}{c c c c c c c c c c c c c c c c c c c $	d in liquid bleach), follows the equation e data. What is the rate law for the reaction.
The reaction of iodide ion with hypochlorite ion, OCI <sup>-</sup> (which is foun DCI <sup>-</sup> + I <sup>-</sup> $\rightarrow$ OI <sup>-</sup> + CI <sup>-</sup> It is a rapid reaction that gives the following rate Determine the value of the rate constant. Initial Concentrations       Rate of Formation         [OCI <sup>-</sup> ]       [I <sup>-</sup> ]         (mol L <sup>-1</sup> s <sup>-1</sup> )         [OCI <sup>-</sup> ]       [I <sup>-</sup> ]         (mol L <sup>-1</sup> s <sup>-1</sup> )         (mol L <sup>-1</sup> s <sup>-1</sup> )         1.7 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 0.4 × 10 <sup>-3</sup> 0.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 0.8 × 10 <sup>-1</sup> RATE         0.8 × 10 <sup>-1</sup> RATE         0.8 × 10 <sup>-1</sup> RATE         0.17 × 10 <sup>-3</sup> 0.4 × 10 <sup>-1</sup> 0.8 × 10 <sup>-1</sup> RATE         0.10 M       0.020 M         0.010 M       0.020 M/s         2       0.015 M       0.020 M         3       0.010 M       0.020 M         3       0.010 M       0.020 M	d in liquid bleach), follows the equation e data. What is the rate law for the reaction.
Initial Concentrations       Rate of Formation         [OCI <sup>-</sup> ]       [I <sup>-</sup> ]       (mol L <sup>-1</sup> s <sup>-1</sup> ) $(mol L^{-1} s^{-1})$ $(mol L^{-1} s^{-1})$ $(mol/L)$ of Cl <sup>-</sup> $1.7 \times 10^{-3}$ $1.7 \times 10^{-3}$ $1.7 \times 10^{-3}$ $3.50 \times 10^4$ $3.4 \times 10^{-3}$ $1.7 \times 10^{-3}$ $3.50 \times 10^4$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^4$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^4$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^4$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^4$ $0.17 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^4$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^4$ $NH_4^+(aq) + \_NO_2^-(aq) \rightarrow \_N_2(q) + \_H_2O(q)$ C.        NH4^+(aq) +NO_2^-(aq) \rightarrowN2(q) +H2O(q)       C.         Init Integration Model	Overall order
Initial Concentrations         Rate of Formation (mol L <sup>-1</sup> s <sup>-1</sup> ) (mol/L) of Cl <sup>-</sup> [OCI <sup>-</sup> ]         [I <sup>-</sup> ]         (mol/L) of Cl <sup>-</sup> 1.7 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 1.75 × 10 <sup>4</sup> 3.4 × 10 <sup>-3</sup> 1.7 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> 1.7 × 10 <sup>-3</sup> 3.4 × 10 <sup>-3</sup> 3.50 × 10 <sup>4</sup> NH <sub>4</sub> <sup>+</sup> (aq) +NO <sub>2</sub> <sup>-</sup> (aq) →N2(g) +H2O(l)         C.           Initial         [NH <sub>4</sub> <sup>+</sup> ]         [NO <sub>2</sub> -]         RATE         d.           1         0.010 M         0.020 M         0.030 M/s         3         0.010 M         0.010 M         0.005 M/s           2         0.015 M         0.020 M         ?         ?         d.	<ul> <li>Overall order</li> <li>Rate constant</li> </ul>
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	<ul> <li>Overall order</li> <li>Rate constant</li> </ul>
$1.7 \times 10^{-3}$ $1.7 \times 10^{-3}$ $1.75 \times 10^{4}$ $3.4 \times 10^{-3}$ $1.7 \times 10^{-3}$ $3.50 \times 10^{4}$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ $0.017 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ $0.017 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ $0.011 \times 10^{-3}$ $0.010 \times 10^{-3}$ $0.020 \times 10^{4}$ $0.010 \times 10^{-3}$ $0.020 \times 10^{-3}$ $0.020 \times 10^{-3}$ $0.010 \times 10^{-3}$ $0.020 \times 10^{-3}$ $0.010 \times 10^{-3}$ $1 = 0.010 \times 10^{-3} \times 10^{-3}$ $0.020 \times 10^{-3}$ $0.010 \times 10^{-3}$ $2 = 0.015 \times 10^{-3} \times 10^{-3}$ $0.020 \times 10^{-3}$ $0.000 \times 10^{-3}$ $3 = 0.010 \times 10^{-3} \times 10^{-3} \times 10^{-3}$ $0.020 \times 10^{-3} \times 10^{-3}$ $0.020 \times 10^{-3} \times 10^{-3}$ $4 = 0.015 \times 10^{-3} \times 10$	Overall order
$3.4 \times 10^{-3}$ $1.7 \times 10^{-3}$ $3.50 \times 10^{4}$ $1.7 \times 10^{-3}$ $3.4 \times 10^{-3}$ $3.50 \times 10^{4}$ Determine the items below given the following data for nis reaction:       C. $NH_4^+(aq) + \_NO_2^-(aq) \rightarrow \_N_2(g) + \_H_2O(l)$ C.         Image: Contrast of the following data for non-section:       C. $1 = 0.010 \text{ M}$ $0.020 \text{ M}$ $0.020 \text{ M/s}$ $2 = 0.015 \text{ M}$ $0.020 \text{ M}$ $0.030 \text{ M/s}$ d. $3 = 0.010 \text{ M}$ $0.020 \text{ M}$ $0.030 \text{ M/s}$ d. $4 = 0.015 \text{ M}$ $0.020 \text{ M}$ ?       ?	Overall order
1.7 × 10       3.4 × 10       3.30 × 10         Determine the items below given the following data for his reaction:       C.        NH4 <sup>+</sup> (aq) +NO2 <sup>-</sup> (aq) →N2(g) +H2O(I)       C.         [rial [NH4 <sup>+</sup> ] [NO2 <sup>-</sup> ] RATE 1 0.010 M 0.020 M 0.020 M/s 2 0.015 M 0.020 M 0.030 M/s 3 0.010 M 0.010 M 0.005 M/s 4 0.015 M 0.020 M ?       d.	<ul> <li>Overall order</li> <li>Rate constant</li> </ul>
Determine the items below given the following data for         nis reaction:       C.        NH4 <sup>+</sup> (aq) +NO2 <sup>-</sup> (aq) →N2(g) +H2O(I)         Trial [NH4 <sup>+</sup> ] [NO2 <sup>-</sup> ] RATE d.         1 0.010 M 0.020 M 0.020 M/s         2 0.015 M 0.020 M 0.030 M/s         3 0.010 M 0.010 M 0.005 M/s         4 0.015 M 0.020 M ?	Overall order Rate constant
his reaction:       C.        NH4 <sup>+</sup> (aq) +NO2 <sup>-</sup> (aq) →N2(g) +H2O(l)         Irial       [NH <sub>4</sub> <sup>+</sup> ]       [NO <sub>2</sub> -]       RATE       d.         1       0.010 M       0.020 M       0.030 M/s       d.         2       0.015 M       0.020 M       0.005 M/s       d.         3       0.010 M       0.020 M       ?       r	Overall order
$ \begin{array}{c c} NH_{4^{+}(aq)} + \_NO_{2^{-}(aq)} \rightarrow \_N_{2(g)} + \_H_{2}O_{(l)} \\ \hline \\ \hline \\ \hline \\ 1 & 0.010 \text{ M} & 0.020 \text{ M} & 0.020 \text{ M/s} \\ 2 & 0.015 \text{ M} & 0.020 \text{ M} & 0.030 \text{ M/s} \\ 3 & 0.010 \text{ M} & 0.010 \text{ M} & 0.005 \text{ M/s} \\ 4 & 0.015 \text{ M} & 0.020 \text{ M} & ? \\ \end{array} $	. Rate constant
Image: Note of the second se	. Rate constant
2         0.015 M         0.020 M         0.030 M/s           3         0.010 M         0.010 M         0.005 M/s           4         0.015 M         0.020 M         ?	
a. General/skeleton/generic rate law	
e.	. Rate for trial #4
b. Rate orders	
Vrite expressions for the rate of formation of the	
roduct(s) in each of the following. Indicate the units of C. he rate constant. (Assume each are single step reactions)	$3 0 \rightarrow 0_3$
a. $H_2 + Cl_2 \rightarrow 2 HCl$ d.	2 HI + Cl <sub>2</sub> → 2 HCl + $I_2$

14) Determ this rea	nine the items be action: 2A + 2	B → C + D	bllowing data for	C.	Overall order	
Run #	[A] <sub>0</sub> , M	[B] <sub>0</sub> , M	Initial rate, M/s			
1	0.185	0.133	3.35 x 10 <sup>-4</sup>			
2	0.185	0.266	1.35 X 10 <sup>-3</sup>	d.	Rate constant	
3	0.370	0.133	6.75 X 10 <sup>-4</sup>			
4	0.370	0.266	2.70 X 10 <sup>-3</sup>			
5	0.432	0.543	?			
a.	General/skelet	on/generic rate	law			
b.	Rate orders			e.	Rate for trial #5	
<b>15)</b> For the double for this doublin a. b. c. d.	e following react e, while doubling s reaction? Justif ng/quadrupling Rate = k [A] <sup>2</sup> [B Rate = k [A][B] Rate = k [A][B] Rate = k[A] <sup>16</sup> [E	ion: A + B → 2C the amount of y your answer b pattern describe ] 2 3]	, it is found that B causes the rea by making up pre ed above.	doubling the ction rate to tend data to	amount of A causes the quadruple. What is the show that rate law resu	e reaction rate to best rate low equation ults in the
<b>16)</b> What work of -1?	would it mean fo	r a reactant to l	have an order	<b>17)</b> What v of -2?	vould it mean for a reac	tant to have an order
<ul> <li>18) The fol temper reactio like me graph p items:</li> <li>De</li> <li>Lai</li> <li>Co</li> <li>Sn</li> <li>Ta</li> <li>Sh in f</li> <li>Sta</li> </ul>	lowing data were rature. Make a g n at t = 200 seco to show you ho paper here: <u>https</u> escriptive title beled axis – nan insistent scale the nooth line of bes ngent line in a se ow your actual of this box aple your graph to 5 #6 packet	collected for the raph of concentre onds and t = 600 w to do it, come s://tinyurl.com/y2 he and units! hat is labeled t fit in one color econd color color color color color the back of the back o	ne reaction SO <sub>2</sub> C ration versus time ) seconds. (I sug see me! If you c <u>2wyjuja</u> Make su	il₂ → SO₂ + C e and determ gest using E annot use E re your graph	Cl₂ at a certain ine the rate of the XCEL. If you would cel then you can print has the following	[SO <sub>2</sub> Cl <sub>2</sub> ]         Time(s)           0.100         0           0.082         100           0.055         300           0.045         400           0.037         500           0.030         600           0.025         700           0.020         800