

Name: \_\_\_\_\_

Period: \_\_\_\_\_

Seat#: \_\_\_\_\_

**Directions:** Any worksheet that is labeled with an \* means it is suggested extra practice. We do not always have time to assign every possible worksheet that would be good practice for you to do. You can do this worksheet when you have extra time, when you finish something early, or to help you study for a quiz or a test. If and when you choose to do this Extra Practice worksheet, please do the work on binder paper. If we end up with extra class time then portions of this may turn into required work. If that happens you will be told which problems are turned into required. Remember there is tons of other extra practice on the class website...and the entire internet! See me if you need help finding practice on a topic you are struggling with.

- **Show work for ANY math problem and include ALL units.**
- **Some answers provided at the end of the question. The answers are underlined.**

- 1) Nitrosyl chloride is produced from the reaction of nitrogen(II) oxide and chlorine.  $2\text{NO}(g) + \text{Cl}_2(g) \rightarrow 2\text{NOCl}(g)$   
The following initial rates at a given temperature were obtained for the concentrations listed below. What is the **rate law**?

Experiment	Rate	NO	Cl <sub>2</sub>
1	2.21	0.25	0.25
2	8.83	0.50	0.25
3	17.5	0.50	0.50

- 2) The table presents data for the reaction:  $2\text{H}_2(g) + 2\text{NO}(g) \rightarrow 2\text{H}_2\text{O}(g) + \text{N}_2(g)$  The temperature of the reaction is constant. The initial rate is in arbitrary units. What is the **rate law** for this reaction?

Exp.	[NO]	[H <sub>2</sub> ]	Rate
I	$6.0 \times 10^{-3}$	$1.0 \times 10^{-3}$	18
II	$6.0 \times 10^{-3}$	$2.0 \times 10^{-3}$	36
III	$1.0 \times 10^{-3}$	$6.0 \times 10^{-3}$	3
IV	$2.0 \times 10^{-3}$	$6.0 \times 10^{-3}$	12

- 3) The following data are for Questions a through e and refer to the reaction:  $\text{A} + 2\text{B} + 3\text{C} \rightarrow 2\text{Y} + \text{Z}$ .

trial	initial [A]	initial [B]	initial [C]	rate
#1	0.10	0.02	0.04	10 M/hr
#2	0.10	0.03	0.04	15 M/hr
#3	0.20	0.02	0.08	80 M/hr
#4	0.20	0.02	0.16	160 M/hr
#5	0.05	0.01	0.08	?

- a) What is the reaction rate equation for the reactants and products above?
- b) What is the order for the reactant above?
- c) What is the overall order of the reaction above?
- d) What is the rate law for the reaction above?
- e) What is the rate for trial #5 above?

- 4) The times listed in the following table are those required for the concentration of  $\text{S}_2\text{O}_8^{2-}$  to decrease by 0.00050 M as measured in an "iodine clock" reaction at 23°C. **What is the rate law?** The net Rxn is:  $\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{SO}_4^{2-}$

trial	initial [S <sub>2</sub> O <sub>8</sub> <sup>2-</sup> ]	initial [I <sup>-</sup> ]	Time (sec)
#1	0.0400	0.0800	39
#2	0.0400	0.0400	78
#3	0.0100	0.0800	156
#4	0.0200	0.0200	?

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5) Determine the **rate law** and calculate the **rate constant** for the following data.

trial	initial [A]	initial [B]	rate
#1	$1.00 \times 10^{-3}$	$0.25 \times 10^{-3}$	$0.26 \times 10^{-9}$
#2	$1.00 \times 10^{-3}$	$0.50 \times 10^{-3}$	$0.52 \times 10^{-9}$
#3	$1.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$1.04 \times 10^{-9}$
#4	$2.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$4.16 \times 10^{-9}$
#5	$3.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$9.36 \times 10^{-9}$
#6	$4.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$16.64 \times 10^{-9}$

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6) Determine the **rate law** and calculate the **rate constant** for the following data.

trial	initial [X]	initial [Y]	rate
#1	$1.00 \times 10^{-2}$	$4.00 \times 10^{-4}$	$6.00 \times 10^{-3}$
#2	$2.00 \times 10^{-2}$	$4.00 \times 10^{-4}$	$1.20 \times 10^{-2}$
#3	$4.00 \times 10^{-2}$	$4.00 \times 10^{-4}$	$2.40 \times 10^{-2}$
#4	$1.00 \times 10^{-2}$	$8.00 \times 10^{-4}$	$6.00 \times 10^{-3}$

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7) For the reaction:  $2A + B + 2C \rightarrow D + E$  The following initial rate data was collected at constant temperature. Determine the **correct rate law** for this reaction. All units are arbitrary.

Trial	[A]	[B]	[C]	Rate
1	0.225	0.150	0.350	0.0217
2	0.450	0.150	0.350	0.0439
3	0.225	0.250	0.350	0.0362
4	0.225	0.150	0.600	0.01270

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8) Rate data were obtained for following reaction  $A + 2B \rightarrow C + 2D$  What is the rate law expression for this reaction?

Exp.	Initial A (mol/L)	Initial B (mol/L)	Init. Rate of Formation of C ( $M \text{ min}^{-1}$ )
1	0.10	0.10	$3.0 \times 10^{-4}$
2	0.30	0.30	$9.0 \times 10^{-4}$
3	0.10	0.30	$3.0 \times 10^{-4}$
4	0.20	0.40	$6.0 \times 10^{-4}$

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9) For the reaction  $A + B \rightarrow \text{products}$ , the following initial rates were found. What is the rate law for this reaction?

Trial 1: [A] = 0.50 M; [B] = 1.50 M; Initial rate =  $4.2 \times 10^{-3} M/\text{min}$

Trial 2: [A] = 1.50 M; [B] = 1.50 M; Initial rate =  $1.3 \times 10^{-2} M/\text{min}$

Trial 3: [A] = 3.00 M; [B] = 3.00 M; Initial rate =  $5.2 \times 10^{-2} M/\text{min}$

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10) The following data were obtained for this chemical reaction:  $A + B \rightarrow \text{products}$

Exp.	Initial A (mmol/L)	Initial B (mmol/L)	Init. Rate of Formation of products ( $mM \text{ min}^{-1}$ )
1	4.0	6.0	1.60
2	2.0	6.0	0.80
3	4.0	3.0	0.40

a) Determine the rate law for this reaction.

b) Find the rate constant.

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11) The following data were obtained for the chemical reaction:  $A + B \rightarrow \text{products}$

Exp.	Initial A (mol/L)	Initial B (mol/L)	Init. Rate of Formation of products ( $M s^{-1}$ )
1	0.040	0.040	$9.6 \times 10^{-6}$
2	0.080	0.040	$1.92 \times 10^{-5}$
3	0.080	0.020	$9.6 \times 10^{-6}$

- Determine the rate law for this reaction.
- Find the rate constant.
- What is the initial rate of reaction when  $[A]_0 = 0.12 M$  and  $[B]_0 = 0.015$

12)  $2A + B \rightarrow C + D$  The following data about the reaction above were obtained from three experiments. Calculate the rate expression in terms of  $[A]$  for experiment 1.

Exp.	$[A]$	$[B]$	Initial rate of formation of C
1	0.6	0.15	$6.3 \times 10^{-3}$
2	0.2	0.6	$2.8 \times 10^{-3}$
3	0.2	0.15	$7.0 \times 10^{-4}$

13) Determine the proper form of the rate law for:  $CH_3CHO(g) \rightarrow CH_4(g) + CO(g)$

Exp.	$[CH_3CHO]$	$[CO]$	Rate ( $M s^{-1}$ )
1	0.30	0.20	0.60
2	0.10	0.30	0.067
3	0.10	0.20	0.067

14) Determine the rate law, including the values of the orders and rate law constant, for the following reaction using the experimental data provided.  $Q + X \rightarrow \text{products}$

Trial	$[Q]$	$[X]$	Rate
1	0.12 M	0.10 M	$1.5 \times 10^{-3} M/\text{min}$
2	0.24 M	0.10 M	$3.0 \times 10^{-3} M/\text{min}$
3	0.12 M	0.20 M	$1.2 \times 10^{-2} M/\text{min}$

15) With the following data, use the method of initial rates to find the reaction orders with respect to  $NO$  and  $O_2$ :

Trial	$[NO]_0$	$[O_2]_0$	Initial reaction rate, $M/s$
1	0.020	0.010	0.028
2	0.020	0.020	0.057
3	0.040	0.020	0.227

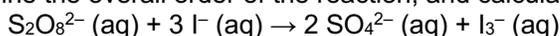
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- 16) A rate law is 1/2 order with respect to a reactant. What is the effect on the rate when the concentration of this reactant is doubled?
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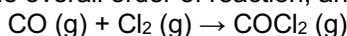
- 17) Using the experimental data provided, determine the order of reaction with respect to each reactant, write the rate law, determine the overall order of the reaction, and calculate the rate law constant, k.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L•s)
	$\text{S}_2\text{O}_8^{2-}$	$\text{I}^-$	
1	0.15	0.21	1.14
2	0.22	0.21	1.70
3	0.22	0.12	0.98

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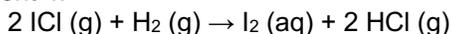
- 18) Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, the overall order of reaction, and calculate the rate law constant, k.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L•s)
	CO	Cl	
1	0.12	0.20	0.121
2	0.24	0.20	0.241
3	0.12	0.40	0.483

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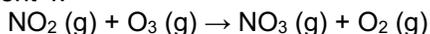
- 19) Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, the overall order of reaction, and calculate the rate law constant, k. Use the data to predict the reaction rate for Experiment 4.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L•s)
	ICl	$\text{H}_2$	
1	1.5	1.5	$3.7 \times 10^{-7}$
2	3.0	1.5	$7.4 \times 10^{-7}$
3	3.0	4.5	$2.2 \times 10^{-6}$
4	4.7	2.7	?

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- 20) Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, the overall order of reaction, and calculate the rate law constant, k. Use the data to predict the reaction rate for Experiment 4.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L•s)
	$\text{NO}_2$	$\text{O}_3$	
1	0.21	0.70	6.3
2	0.21	1.39	12.5
3	0.38	0.70	11.4
4	0.66	0.18	?

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- 21) The reduction of bromate ions,  $\text{BrO}_3^-$ , by bromide ions in acidic solution has a rate law

$$R = k [\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2.$$

- What are the orders with respect to the reactants?
  - What is the overall order?
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- 22) The reaction between bromomethane and hydroxide ion in aqueous solution is first order with respect to bromomethane, and second order overall. Write the rate law.