

Kinetics Worksheet #4



The following data about the reaction shown above were obtained from three experiments:

Trial	[A]	[B]	Rate of Formation of C ($M \text{ min}^{-1}$)
1	0.60	0.15	6.3×10^{-3}
2	0.20	0.60	2.8×10^{-3}
3	0.20	0.15	7.0×10^{-4}

- (a) What is the rate law for this reaction?
- (b) What is the numerical value of the rate constant k ? What are the units for k ?



For the reaction above, carried out in a solution at 30°C , the following kinetic data were obtained:

Trial	[A]	[B]	Rate of Reaction (M/hr)
1	0.240	0.480	8.00
2	0.240	0.120	2.00
3	0.360	0.240	9.00
4	0.120	0.120	0.500
5	0.240	0.0600	1.00
6	0.0140	1.35	?

- (a) Write the rate law expression for this reaction.
- (b) Calculate the value of the specific rate constant k at 30°C and specify its units.
- (c) Calculate the initial rate of this reaction at 30°C for Trial #6.

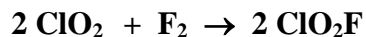
1987 B



Trial	Initial [A]	Initial [B]	Initial Rate of Formation of C (M min^{-1})
1	0.0836	0.202	5.2×10^{-5}
2	0.0836	0.404	2.08×10^{-4}
3	0.0418	0.404	1.04×10^{-4}
4	0.0316	?	1.27×10^{-4}

- (a) According to the data shown, what is the rate law for the reaction above?
- (b) On the basis of the rate law from part (a), calculate the specific rate constant. Specify the units.
- (c) What is the numerical value for the initial rate of disappearance of B for Trial #1 ?
- (d) Calculate the initial concentration of **B** for Trial #4.

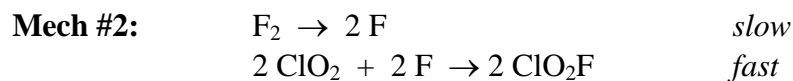
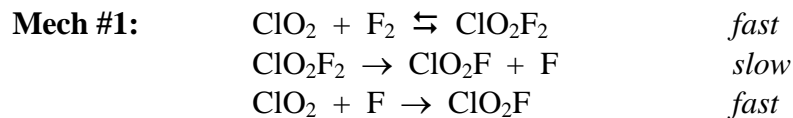
1991 B



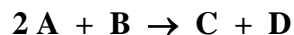
The following results were obtained when the reaction represented above was studied at 25°C.

Trial	Initial [ClO ₂]	Initial [F ₂]	Initial Rate of Increase of ClO ₂ F (M min ⁻¹)
1	0.010	0.10	2.4 x 10 ⁻³
2	0.010	0.40	9.6 x 10 ⁻³
3	0.020	0.20	9.6 x 10 ⁻³

- (a) Write the rate law expression for the reaction above.
- (b) Calculate the numerical value for the rate constant and specify the units.
- (c) In trial #2, what is the initial rate of decrease of [F₂] ?
- (d) Which of the two proposed reaction mechanisms shown below is consistent with the rate law developed in part (a) ? Justify your choice.



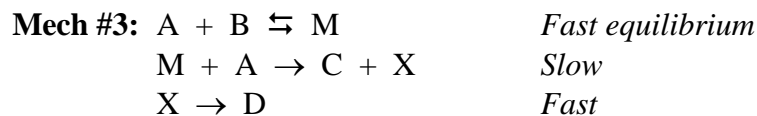
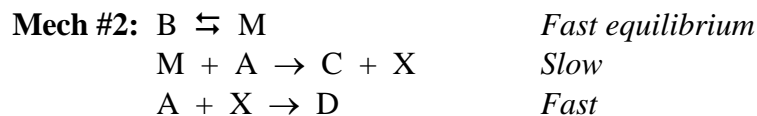
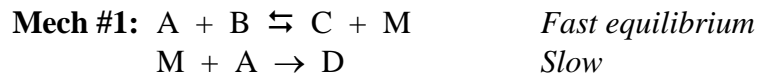
1997 B



The following results were obtained when the reaction represented above was studied at 25°C.

Experiment	Initial [A]	Initial [B]	Initial Rate of Formation of C (M min ⁻¹)
1	0.25	0.75	4.3×10^{-4}
2	0.75	0.75	1.3×10^{-3}
3	1.50	1.50	5.3×10^{-3}
4	1.75	?	8.0×10^{-3}

- (a) Determine the order of the reaction with respect to A and to B.
- (b) Write the rate law for the reaction. Calculate the value of the rate constant, specifying units.
- (c) Determine the initial rate of change of [A] in Experiment #3.
- (d) Determine the initial concentration of **B** in Experiment #4.
- (e) Identify which of the reaction mechanisms represented below is consistent with the rate law developed in part (b). Justify your choice.



Kinetics Worksheet #4
Bracken Answers

1972

- (a) Rate = $k[A]^2[B]$
- (b) $k = 0.12 \text{ M}^{-2}\text{min}^{-1}$

1981 B

- (a) Rate = $k[A]^2[B]$
- (b) $k = 289 \text{ M}^{-2}\text{hr}^{-1}$
- (c) Rate = 0.0765 M hr^{-1}

1987 B

- (a) Rate = $k[A][B]^2$
- (b) $k = 0.0152 \text{ M}^{-2}\text{min}^{-1}$
- (c) $2.6 \times 10^{-5} \text{ M min}^{-1}$ (from balanced equation, C forms twice as fast as B disappears)
- (d) $[B] = 0.514 \text{ M}$

1991 B

- (a) Rate = $k[\text{ClO}_2][\text{F}_2]$
- (b) $k = 2.4 \text{ M}^{-1}\text{min}^{-1}$
- (c) $4.8 \times 10^{-3} \text{ M min}^{-1}$ (from balanced equation, $[\text{F}_2]$ decreases at half the rate ClO_2F appears)
- (d) Mech #1: Rate = $k[\text{ClO}_2][\text{F}_2]$
Mech #2: Rate = $k[\text{F}_2]$

Mechanism #1, when all intermediates are removed, matches the rate law observed in the experimental data. Therefore, mechanism #1 is consistent.

1997 B

- (a) Rate is first order with respect to A (compare trials 1 & 2)
Rate is first order with respect to B (compare trials 2 & 3)
- (b) $k = 0.0023 \text{ M}^{-1}\text{min}^{-1}$
- (c) $1.06 \times 10^{-2} \text{ M min}^{-1}$
- (d) $[B] = 1.99 \text{ M}$
- (e) Mech #1 Rate = $k[A]^2[B][C]^{-1}$
Mech #2 Rate = $k[A][B]$
Mech #3 Rate = $k[A]^2[B]$

Mechanism #2 is consistent with the experimental data because it matches the observation that the rate is first order with respect to A and first order with respect to B.