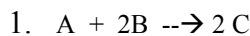


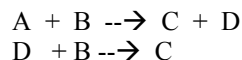
## Kinetics Free Response Practice Problems



The following results were obtained in experiments designed to study the rate of the reaction above:

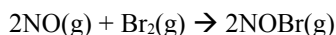
| Experiment | Initial Concentration (M)<br>[A] | Initial Concentration (M)<br>[B] | Initial Rate of Disappearance of A<br>(M/sec) |
|------------|----------------------------------|----------------------------------|---|
| 1          | 0.05                             | 0.05                             | $3.0 \times 10^{-3}$                          |
| 2          | 0.05                             | 0.10                             | $6.0 \times 10^{-3}$                          |
| 3          | 0.10                             | 0.10                             | $1.2 \times 10^{-2}$                          |
| 4          | 0.20                             | 0.10                             | $2.4 \times 10^{-2}$                          |

- (a) Determine the order of the reaction with respect to each of the reactants, and write the rate law for the reaction.  
 (b) Calculate the value of the rate constant,  $k$ , for the reaction. Include the units.  
 (c) If another experiment is attempted with [A] and [B], both 0.02M, what would be the initial rate of disappearance of A?  
 (d) The following reaction mechanism was proposed for the reaction above:



- (i) Show that the mechanism is consistent with the balanced reaction.  
 (ii) Show which step is the rate-determining step, and explain your choice.

2.



The following results were obtained in experiments designed to study the rate of the reaction above:

| Experiment | Initial Concentration (mol/L) |      | Initial Rate of Appearance of NOBr (M/sec) |
|------------|-------------------------------|------|--|
|            | [A]                           | [B]  |  |
| 1          | 0.02                          | 0.02 | $9.6 \times 10^{-2}$                       |
| 2          | 0.04                          | 0.02 | $3.8 \times 10^{-1}$                       |
| 3          | 0.02                          | 0.04 | $1.9 \times 10^{-1}$                       |

- (a) Write the rate law for the reaction.  
 (b) Calculate the value of the rate constant,  $k$ , for the reaction. Include the units.  
 (c) In experiment 2, what was the concentration of NO remaining when half of the original amount of  $Br_2$  was consumed?  
 (d) Which of the following reaction mechanisms is consistent with the rate law established in (a)? Explain your choice.
- I.  $NO + NO \leftrightarrow N_2O_2$  (fast)  
 $N_2O_2 + Br_2 \rightarrow 2NOBr$  (slow)
- II.  $Br_2 \rightarrow Br + Br$  (slow)  
 $2(NO + Br \rightarrow NOBr)$  (fast)

3.



Dinitrogen pentoxide gas decomposes according to the equation above. The first-order reaction was allowed to proceed at  $40^\circ C$  and the data below were collected.

| $[N_2O_5](M)$ | Time (min) |
|---------------|------------|
| 0.400         | 0.0        |
| 0.289         | 20.0       |
| 0.209         | 40.0       |
| 0.151         | 60.0       |
| 0.109         | 80.0       |

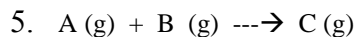
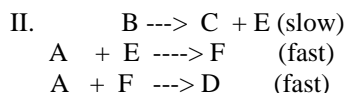
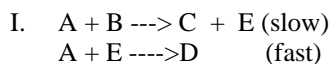
- (a) Calculate the rate constant for the reaction using the values for concentration and time given in the table. Include units with your answer.
- (b) After how many minutes will  $[N_2O_5]$  be equal to 0.350 M?
- (c) What will be the concentration of  $N_2O_5$  after 100 minutes have elapsed?
- (d) Calculate the initial rate of the reaction. Include units with your answer.
- (e) What is the half-life of the reaction?



The following results were obtained in experiments designed to study the rate of the reaction above:

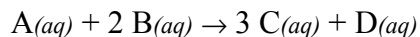
| Experiment | Initial Concentration (moles/L) |      | Initial Rate of Formation of D (M/min) |
|------------|---------------------------------|------|--|
|            | [A]                             | [B]  |  |
| 1          | 0.10                            | 0.10 | $1.5 \times 10^{-3}$                   |
| 2          | 0.20                            | 0.20 | $3.0 \times 10^{-3}$                   |
| 3          | 0.20                            | 0.40 | $6.0 \times 10^{-3}$                   |

- (a) Write the rate law for the reaction.
- (b) Calculate the value of the rate constant,  $k$ , for the reaction. Include the units.
- (c) If experiment 2 goes to completion, what will be the final concentration of D? Assume that the volume is unchanged over the course of the reaction and that no D was present at the start of the experiment.
- (d) Which of the following possible reaction mechanisms is consistent with the rate law found in (a)?



The reaction above is second order with respect to A and zero order with respect to B. Reactants A and B are present in a closed container. Predict how each of the following changes to the reaction system will affect the rate and rate constant and explain why.

- (a) More gas A is added to the container.
- (b) More gas B is added to the container.
- (c) The temperature is increased.
- (d) The inert gas D is added to the container.
- (e) The volume of the container is decreased.



6. For the reaction above, carried out in solution of 30°C, the following kinetic data were obtained:

| Experiment | Initial Conc. of Reactants (mole liter <sup>-1</sup> ) |                | Initial Rate of Reaction (mole liter <sup>-1</sup> hr <sup>-1</sup> ) |
|------------|--|----------------|---|
|            | A <sub>0</sub>   | B <sub>0</sub> |   |
| 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 value of the initial rate of this reaction at 30°C for the initial concentrations shown in experiment 6.
- (d) Assume that the reaction goes to completion. Under the conditions specified for experiment 2, what would be the final molar concentration of C?