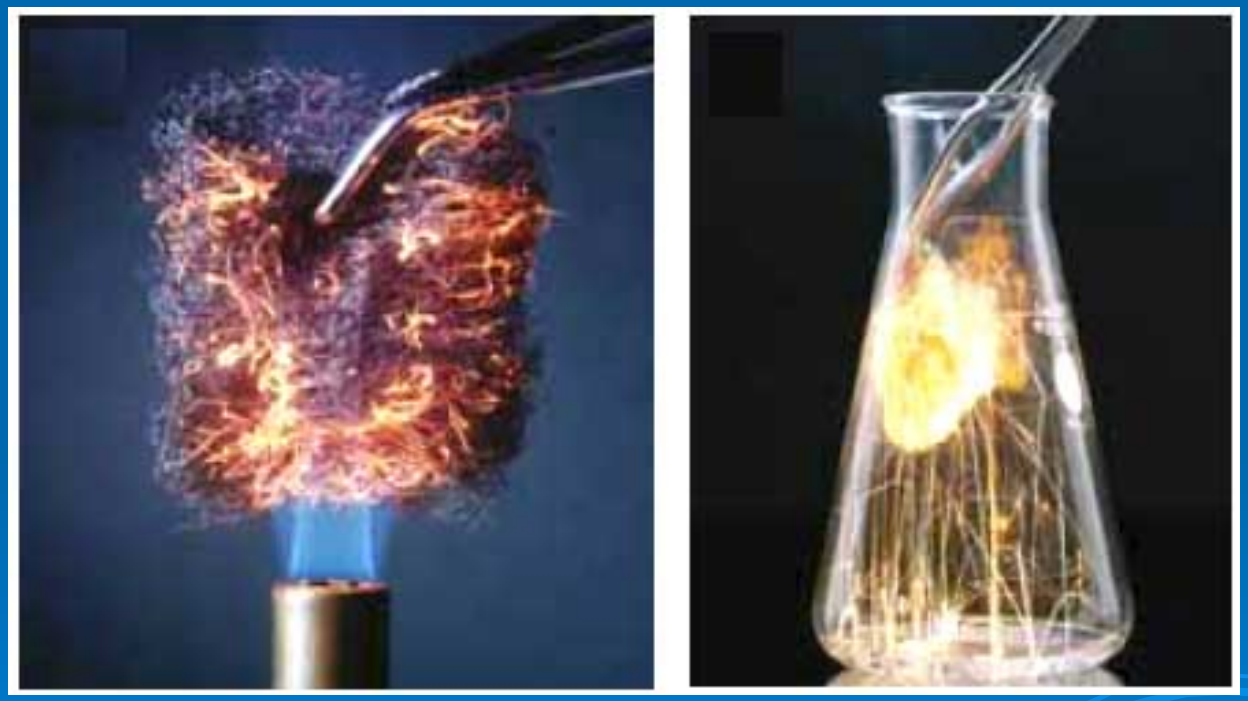
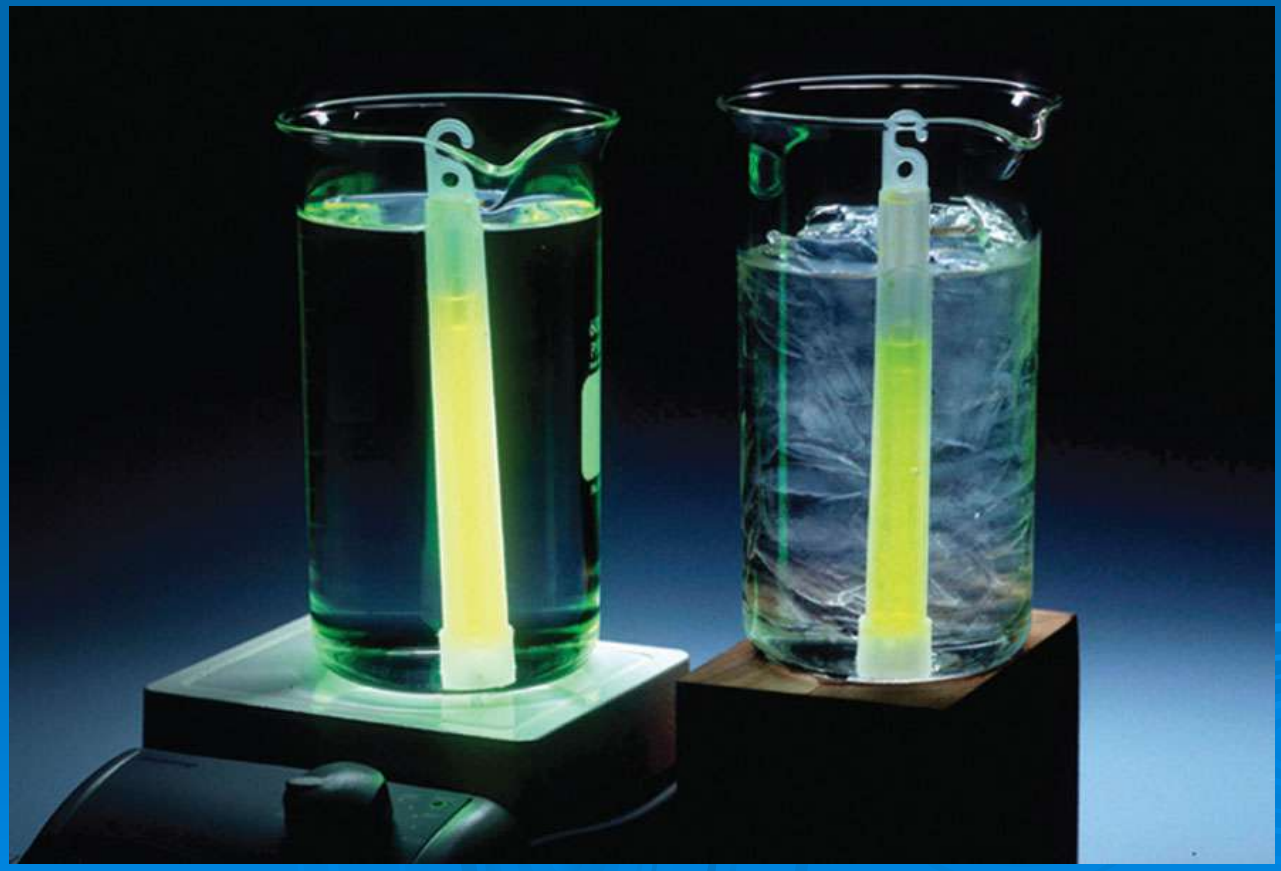
AP Chemistry
Chapter 14 Jeopardy



Jennie L. Borders

Round 1 – Chapter 14



Rate Laws	Half-Life	Graphing	Mechanisms	Activation Energy	Surprise
100	100	100	100	100	100
200	200	200	200	200	200
300	300	300	300	300	300
400	400	400	400	400	400
500	500	500	500	500	500

Rate Laws 100

The reaction $2ClO_2 + 2OH^- \leftrightarrow ClO_3^- + ClO_2^- + H_2O$ was studied with the following results:

Experiment	$[ClO_2]$ (M)	$[OH^-]$ (M)	Rate (M/s)
1	0.060	0.030	0.0248
2	0.020	0.030	0.00276
3	0.020	0.090	0.00828

Determine the rate law for the reaction.

$$Rate = k[ClO_2]^2[OH^-]$$

Rate Laws 200

The reaction $2ClO_2 + 2OH^- \leftrightarrow ClO_3^- + ClO_2^- + H_2O$ was studied with the following results:

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Calculate the rate constant.

$229.63\ M^{-2}s^{-1}$

Rate Laws 300

The reaction $2ClO_2 + 2OH^- \leftrightarrow ClO_3^- + ClO_2^- + H_2O$ was studied with the following results:

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1	0.060	0.030	0.0248
2	0.020	0.030	0.00276
3	0.020	0.090	0.00828

Calculate the rate when $[ClO_2]$ = 0.1M and $[OH^-]$ = 0.05M.

0.115 M/s

Rate Laws 400

The following data was measured for the reaction $BF_3 + NH_3 \leftrightarrows F_3BNH_3$

Experiment	$[BF_3]$ (M)	$[NH_3]$ (M)	Initial Rate (M/s)
1	0.250	0.250	0.2130
2	0.250	0.125	0.1065
3	0.200	0.100	0.0682
4	0.350	0.100	0.1193
5	0.175	0.100	0.0596

What is the rate law for the reaction?

$Rate = k[BF_3][NH_3]$

Rate Laws 500

The following data was measured for the reaction $BF_3 + NH_3 \leftrightarrow F_3BNH_3$

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2	0.250	0.125	0.1065
3	0.200	0.100	0.0682
4	0.350	0.100	0.1193
5	0.175	0.100	0.0596

What is the rate when $[BF_3] = 0.100M$ and $[NH_3] = 0.500M$?

0.1704 M/s

Half-Life 100

How do the half-lives of first-order and second-order reactions differ?

Since the half-lives of first-order reactions are not based on initial concentration, then all the half-lives are equal. Since the half-lives of second-order reactions are based on initial concentrations, then each half-life is longer than the previous one.

Half-Life 200

The isomerization of cyclopropane to propylene is a first-order process with a half-life of 19 minutes at 500^{o}C. The time it takes for the partial pressure of cyclopropane to decrease from 1.0 atmosphere to 0.125 atmosphere at 500^{o}C is closest to

a. 38 minutes
b. 57 minutes
c. 76 minutes
d. 152 minutes
e. 190 minutes

b

Half-Life 300

Molecular iodine, $I_{2(g)}$, dissociates into iodine atoms at 625K with a first-order rate constant of 0.271 s^{-1}. What is the half-life of the reaction?

2.56s

Half-Life 400

Molecular iodine, $I_{2(g)}$, dissociates into iodine atoms at 625K with a first-order rate constant of $0.271s^{-1}$. If you start with 0.050M I_2 at this temperature, how much will remain after 5.12s assuming that the iodine atoms do not recombine to form I_2?

0.012M

Half-Life 500

If the oxygen isotope ^{20}O has a half-life of 15 seconds, what fraction of a sample of pure ^{20}O remains after 1.0 minute?

a. ½
b. ¼
c. 7/30
d. 1/8
e. 1/16

e

Graphing 100

For a second-order reaction, what quantity, when graphed versus time, will yield a straight line?

1/[A]

Graphing 200

Consider the following data:

Time (s)	0	40	80	120	160
Moles of A	0.100	0.067	0.045	0.030	0.020

Determine whether the reaction is first order or second order.

First Order

Graphing 300

The gas-phase decomposition of NO_2, $2NO_2 \leftrightarrow 2NO + O_2$ is studied at 383°C, given the following data:

Time (s)	0.0	5.0	10.0	15.0	20.0
$[NO_2]$ (M)	0.100	0.017	0.009	0.0062	0.0047

Is the reaction first order or second order with respect to the concentration of NO_2?

Second Order

Graphing 400

At 23°C and in 0.5M HCl, the following data was obtained for the disappearance of sucrose:

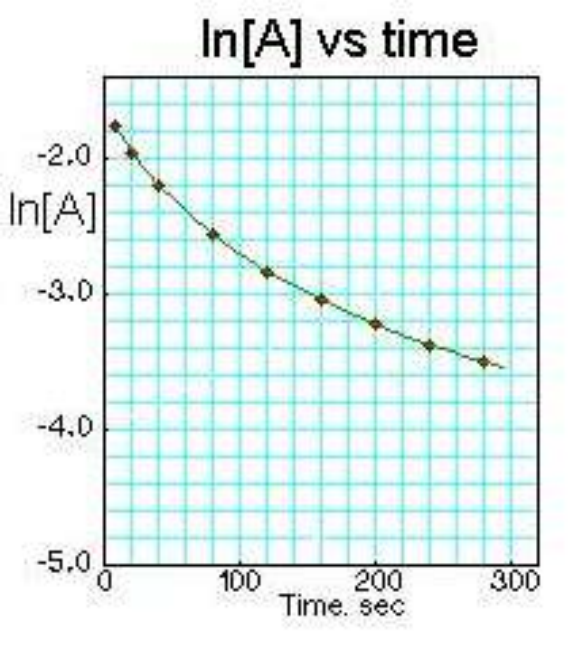
Time (min)	0	39	80	140	210
$[C_{12}H_{22}O_{11}]$ (M)	0.316	0.274	0.238	0.190	0.146

Is the reaction first order or second order with respect to $[C_{12}H_{22}O_{11}]$?

First Order

Graphing 500

Is the following reaction first or second order?



Second Order

Mechanisms 100

The decomposition of hydrogen peroxide is catalyzed by iodide ion. The catalyzed reaction is thought to proceed by a two-step mechanism:

$H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)

$IO^- + H_2O_2 \rightarrow H_2O + O_2 + I^-$ (fast)

Write the chemical equation for the overall process AND predict the rate law for the overall process.

$2H_2O_2 \rightarrow 2H_2O + O_2$ Rate = $k[H_2O_2]$

Mechanisms 200

Cyclopentane reacts with chlorine, $Cl_{2(g)}$, to produce $C_2H_9Cl_{(g)}$ and $HCl_{(g)}$. The following is a proposed mechanism for the reaction.

$Cl_2 \rightarrow 2\ Cl$(slow)

$Cl + C_5H_{10} \rightarrow HCl + C_5H_9$(fast)

$C_5H_9 + Cl \rightarrow C_5H_9Cl$(fast)

a. Write the rate law for the reaction.

b. A student claims that $Cl_{2(g)}$ is a catalyst in the reaction. Explain why the student's claim is false.

a. Rate = $k[Cl_2]$

b. A catalyst exists at the beginning and end of a reaction, but Cl_2 is consumed, so it is a reactant.

Mechanisms 300

You find the reaction $4HBr + O_2 \rightarrow 2H_2O + 2Br_2$ to be first order with respect to HBr and first order with respect to O_2. You propose the following mechanism:

$HBr + O_2 \rightarrow HOOBr$

$HOOBr + HBr \rightarrow 2HOBr$

$HOBr + HBr \rightarrow H_2O + Br_2$

Based of the rate law which step is rate determining?

$Rate = k[HBr][O_2]$

The first step is rate determining.

Mechanisms 400

The following mechanism has been proposed for the reaction of NO with H_2 to form N_2O and H_2O:

$$NO + NO \rightarrow N_2O_2$$

$$N_2O_2 + H_2 \rightarrow N_2O + H_2O$$

The observed rate law is rate = $k[NO]^2[H_2]$. What can we conclude about the relative speeds of the first and second reactions?

The second step is slow (rate determining) and the first step is fast.

Mechanisms 500

Ozone in the upper atmosphere can be destroyed by the following two-step mechanism:

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O \rightarrow Cl + O_2$

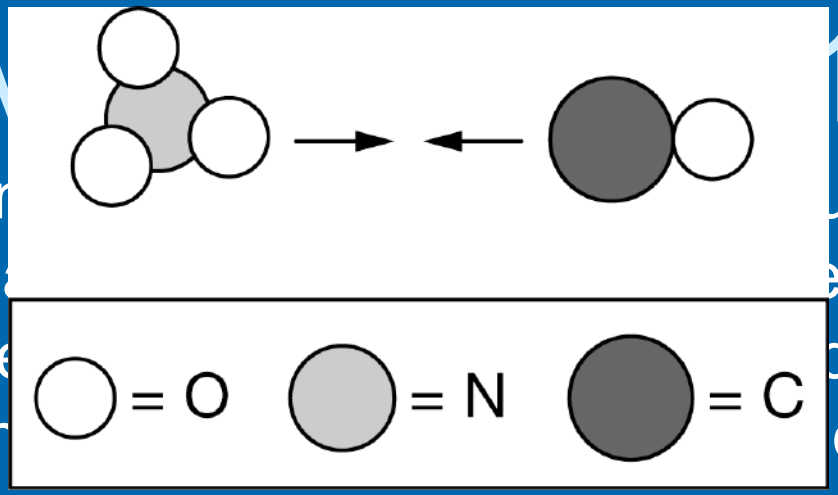
What is the overall reaction and list any catalysts or intermediates?

$O_3 + O \rightarrow 2O_2$

Catalyst – Cl

Intermediate - ClO

Activ 100 d



The slowest step in uires the collision represented e following most likely indicate d catalyst could in on?

a. The catalyst could change the reaction from second to third order.

b. The catalyst could increase the particles' speed, thereby increasing the value of the rate constant, k.

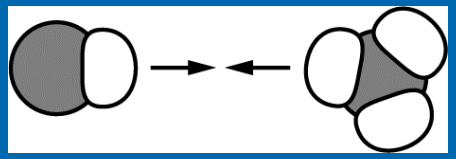
c. The catalyst could decrease the particles' speed, making it less likely that the particles will rebound without reacting when they collide.

d. The catalyst could adsorb one of the particles, making a successful (reaction-producing) collision with the other particle more likely.

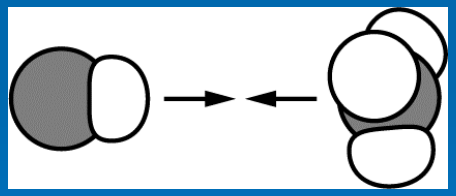
Activation Energy 200 d

The reaction between $NO_{(g)}$ and $NO_{3(g)}$ is represented by the equation below. Which of the following orientations of collisions between $NO_{(g)}$ and $NO_{3(g)}$ is most likely to be effective? $NO_{(g)} + NO_{3(g)} \rightarrow 2\ NO_{2(g)}$

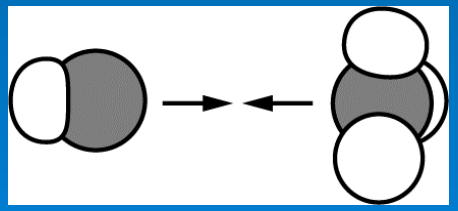
a.



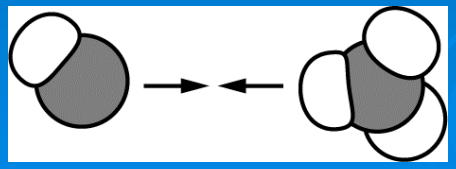
b.

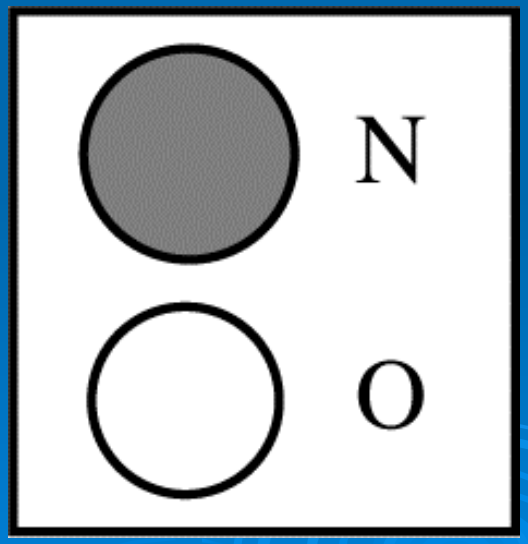


c.



d.





Activation Energy 300

Step 1 of a proposed mechanism involves the collision between NO_2 and F_2 molecules. This step is slow although such collisions occur frequently.

a. One factor that affects whether a collision will result in a reaction is the magnitude of the collision energy. Explain.

b. Identify and explain one other factor that affects whether the collision will result in a reaction.

a. Molecules must collide with enough energy to overcome the activation energy barrier in order to react.

b. Molecules must collide with the correct orientation to react.

Activation Energy 400 b

To catalyze a biochemical reaction, an enzyme typically

a. Drives the reaction to completion by consuming byproducts of the reaction
b. Binds temporarily to reactant molecules to lower the activation energy of the reaction
c. Dissociates into additional reactant molecules, thereby increasing the reaction rate
d. Decomposes and releases energy to increase the number of successful collisions between reactant molecules

Activation Energy 500

The oxidation of SO_2 to SO_3 is catalyzed by NO_2. The reaction proceeds as follows:

$$NO_2 + SO_2 \rightarrow NO + SO_3$$

$$2NO + O_2 \rightarrow 2NO_2$$

Why do we consider NO_2 a catalyst and not an intermediate in this reaction?

NO_2 is present at the beginning and end of the reaction. Intermediates are formed during the reaction and used during the reaction.

Surprise 100 C

What effect will increasing $[H^+]$ at constant temperature have on the reaction represented below?

$$Cl^-_{(Aq)} + ClO^-_{(aq)} + 2\ H^+_{(aq)} \rightarrow Cl_{2(g)} + H_2O_{(l)}$$

a. The activation energy of the reaction will increase.
b. The activation energy of the reaction will decrease.
c. The frequency of collisions between $H^+_{(aq)}$ ions and $ClO^-_{(aq)}$ ions will increase.
d. The value of the rate constant will increase.

Surprise 200 B

A sample of N_2O_5 was placed in an evacuated container, and the reaction represented below occurred. The value of P_{N2O5}, the partial pressure of $N_2O_{5(g)}$, was measured during the reaction and recorded in the table below. Which of the following correctly describes order of the reaction?

$$2\ N_2O_{5(g)} \rightarrow 4\ NO_{2(g)} + O_{2(g)}$$

Time (min)	P_{N2O5} (atm)	$\ln(P_{N2O5})$	$1/P_{N2O5}$ (atm^{-1})
0	150	5.0	0.0067
100	75	4.3	0.013
200	38	3.6	0.027
300	19	2.9	0.053

a. 0 b. 1 c. 2 d. 3

Surprise 300

A proposed mechanism for destruction of ozone gas is represented below. Which of the following is evidence that the mechanism is occurring?

Step 1: $Cl_{(g)} + O_{3(g)} \rightarrow ClO_{(g)} + O_{2(g)}$

Step 2: $ClO_{(g)} + O_{(g)} \rightarrow Cl_{(g)} + O_{2(g)}$

a. $Cl_{(g)}$ increases the rate of the reaction.
b. $Cl_{(g)}$ decreases the rate of the reaction.
c. $Cl_{(g)}$ increases the equilibrium constant for the reaction.
d. $Cl_{(g)}$ decreases the equilibrium constant for the reaction.

a

Surprise 400

The rate law for the reaction represented by the equation below is rate = $k[NO_2][F_2]$. Which of the following could be the first elementary step of a two-step mechanism if the first step is slow and the second step is fast?

$$2\ NO_{2(g)} + F_{2(g)} \rightarrow 2\ NO_2F_{(g)}$$

a. $F_{2(g)} \rightarrow 2\ F_{(g)}$

b. $NO_{2(g)} + F_{2(g)} \rightarrow NO_2F_{(g)} + F_{(g)}$

c. $NO_{2(g)} + F_{(g)} \rightarrow NO_2F_{(g)}$

d. $2\ NO_{2(g)} + F_{2(g)} \rightarrow 2\ NO_2F_{(g)}$

b

Surprise 500

b

The decomposition of $O_{3(g)}$ is represented below and the graph show two reaction profiles. Which of the following mechanisms for the catalyzed reaction is consistent with he equation and the diagram below?

$$O_{3(g)} + O_{(g)} \rightarrow 2\ O_{2(g)}$$

a. $2\ O_{3(g)} + 2\ NO_{(g)} \rightarrow 4\ O_{2(g)} + N_{2(g)}$ slow

b. $O_{3(g)} + NO_{(g)} \rightarrow NO_{2(g)} + O_{2(g)}$ slow

$NO_{2(g)} + O_{(g)} \rightarrow NO_{(g)} + O_{2(g)}$ fast

c. $NO_{2(g)} + O_{3(g)} \rightarrow NO_{(g)} + 2\ O_{2(g)}$ slow

$NO_{(g)} + O_{(g)} \rightarrow NO_{2(g)}$ fast

d. $NO_{2(g)} + O_{(g)} \rightarrow NO_{3(g)}$ slow

$NO_{3(g)} + O_{3(g)} \rightarrow NO_{2(g)} + 2\ O_{2(g)}$ fast