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**PCAT PUBLIC WEBINAR**

**Kinetics Review and Practice Passage**

# Today's Agenda

- ▶ **Welcome to Office Hours!**
- ▶ **Introduction**
- ▶ **Kinetics**
  - ▶ **Basics**
  - ▶ **Practice Passage**
- ▶ **What Next?**

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# Introduction

**Hi, I'm Phil!**

- ▶ **PCAT Content writer**
  - ▶ **Tutored and taught for 9+ years**
  - ▶ **Score 99<sup>th</sup> percentile on PCAT**
- ✓ **Next Step is a team of test prep and educational experts committed to excellence.**



# Who Is Next Step?

Next  
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TEST PREP

- Began in 2009 as a tutoring company
- Focus on graduate admissions tests only
- Team of educational experts
- Helped over 50,000 students in Pre-Health admissions preparation



✓ **We never stop improving our materials!**

STUDENTS HAVE A CHOICE

# Introduction to Kinetics

Thanks for coming to today's webinar!

These sessions are meant to be:

- ▶ Interactive
- ▶ Problem-focused

✓ **Think of a question after the webinar?**  
**Post in our forums at [forum-nextstestprep.com](http://forum-nextstestprep.com)**

## Getting Started:

1. Turn on your mic
2. Locate the hand-raise button
3. Locate the Question and Chat boxes
4. Let me know if you're having at tech issues!



# What are kinetics?

**Kinetics are a measure of how fast a reaction occurs.**

**What Kinetics is not:**

▶ *Whether a reaction will occur.*

**Thermodynamics!**



▶ *What the ratio of products to reactants will be when the reaction is done.*

**Equilibrium**



✓ **You've got to be absolutely clear on what these terms mean so that you can answer questions appropriately!**

# Some terms to know

## Activation energy

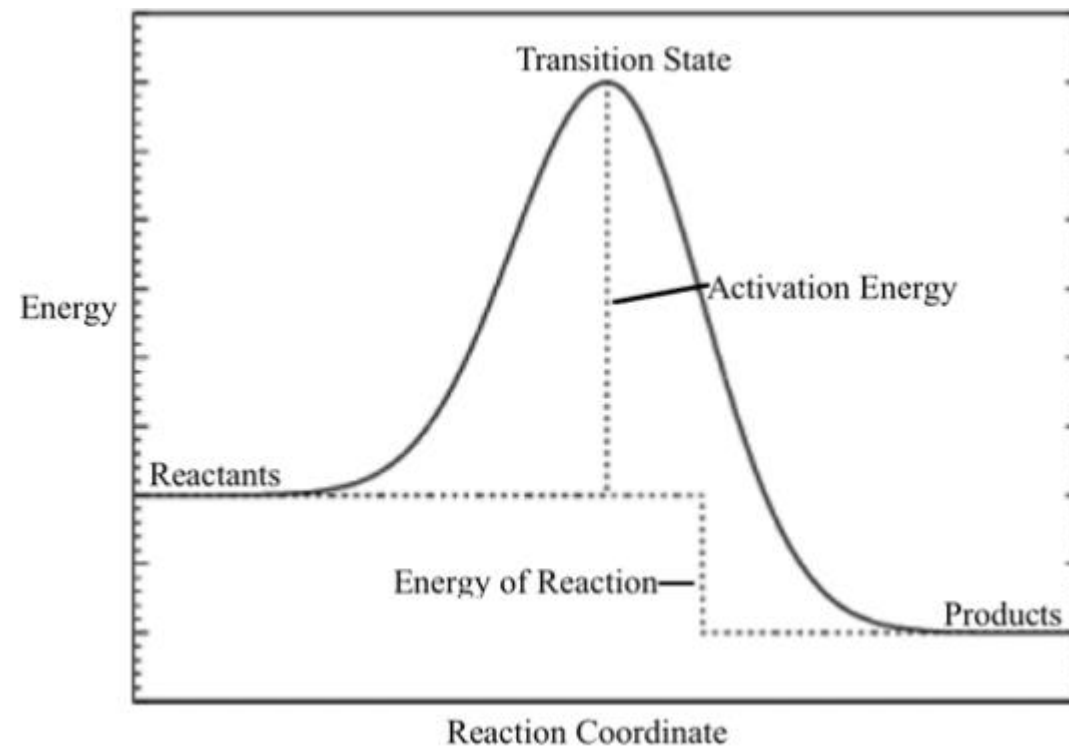
- ▶ *The energy that a reaction must overcome for it to occur.*

## Energy of Reaction

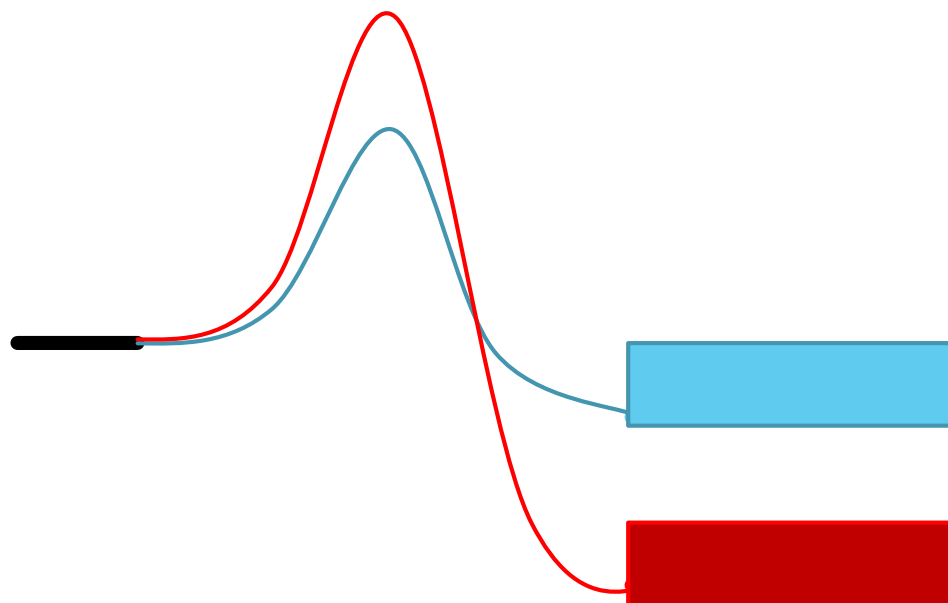
- ▶ *The change in energy from products to reactants.*

## Kinetic vs Thermodynamic

- ▶ *Kinetic product is the product that is reached the fastest and is "easiest" to achieve.*
- ▶ *Thermodynamic is the product that is most stable.*



#1. Which of the following statements are true from the figure?



- A. The Blue product is the kinetic and thermodynamic product.
- B. The Red product is the kinetic and thermodynamic product.
- C. The Red product is the thermodynamic product and the Blue is the kinetic.
- D. The Blue product is the thermodynamic product and the Red is the kinetic.



#2. You mix two reactants in a flask and a precipitate immediately forms. What can you say about the precipitate?

- A. It is the kinetic product only and not the thermodynamic product.
- B. It is the kinetic and the thermodynamic product.
- C. It is the thermodynamic product and not the kinetic product.
- D. None of the other answer choices may be correct.

# Reaction rates

**Rate = Change in concentration / time**

Units = Molarity/second

**Rate law =  $k [X]^n$**

**How do you determine the rate law?**

Given the following net reaction, what is the rate law?



**Experimentally!**

Rate =  $k [\text{N}_2\text{O}_5]$

# Reaction rates

If they break down the reaction into multiple steps, the rate determining step is the slow one. (although some reactions don't have a slow step!)



# Reaction rates

[A]	[B]	Rate
0.25	1.65	$1.6 \times 10^{-4}$
0.5	1.65	$6.4 \times 10^{-4}$
0.5	3.3	$1.28 \times 10^{-3}$

What is the rate reaction for the reaction showed?

$$\text{Rate} = k [\text{A}]^2[\text{B}]$$

#3. What are the units for  $k$  in a first order reaction?

A. M/s

B. M

C. 1/s

D. 1/(M s)

#4. What is the rate law for this reaction??

A. second

B. third

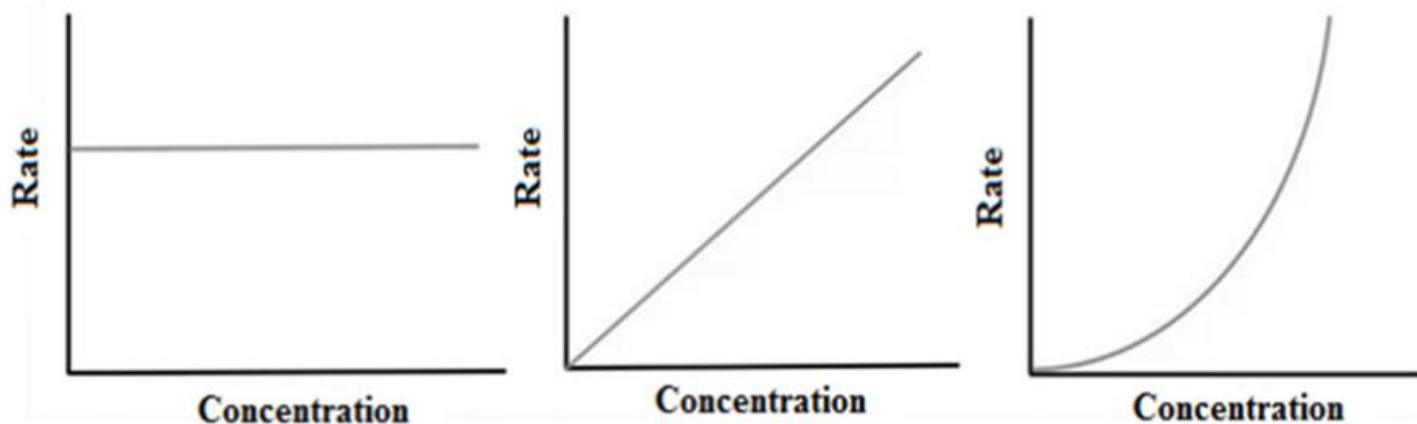
C. fourth

D. Fifth

Trial	[A]	[B]	[C]	Rate (M/s)
1	0.35	0.35	0.6	$1.72 \times 10^{-6}$
2	0.35	0.7	0.6	$3.41 \times 10^{-6}$
3	0.71	0.35	1.2	$1.36 \times 10^{-5}$
4	1.05	0.35	0.6	$1.54 \times 10^{-5}$



# Reaction rates



Reaction order:

Zero order

First order

Second order

Rate =

$k$

$k[A]$

$k[A]^2$  or  $k[A][B]$

Reaction

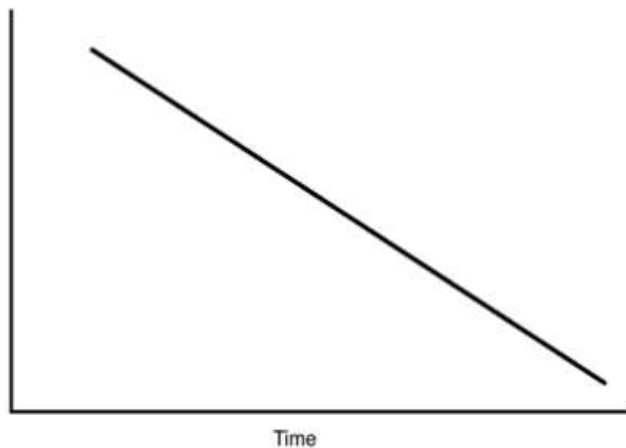
$A \rightarrow \text{Products}$

$A \rightarrow \text{Products}$

$A + A \rightarrow \text{Products}$

$A + B \rightarrow \text{Products}$

# Reaction rates



Reaction order:

Zero order

First order

Second order

Rate =

$k$

$k[A]$

$k[A]^2$

Y axis for

Reactant

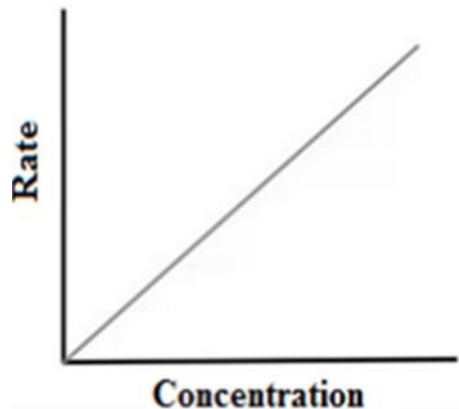
$\ln(A)$

$1/[A]$

Linear representation

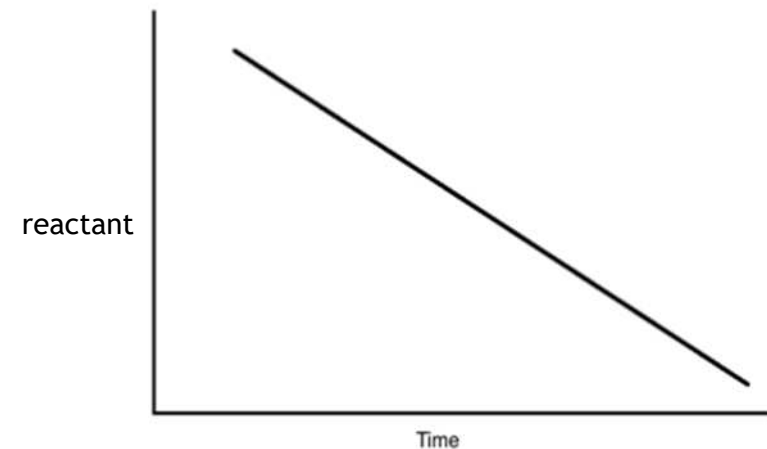
#4. The graph below indicates what order of reaction?

- A. zero
- B. first
- C. second
- D. third



#5. The graph below indicates what order of reaction?

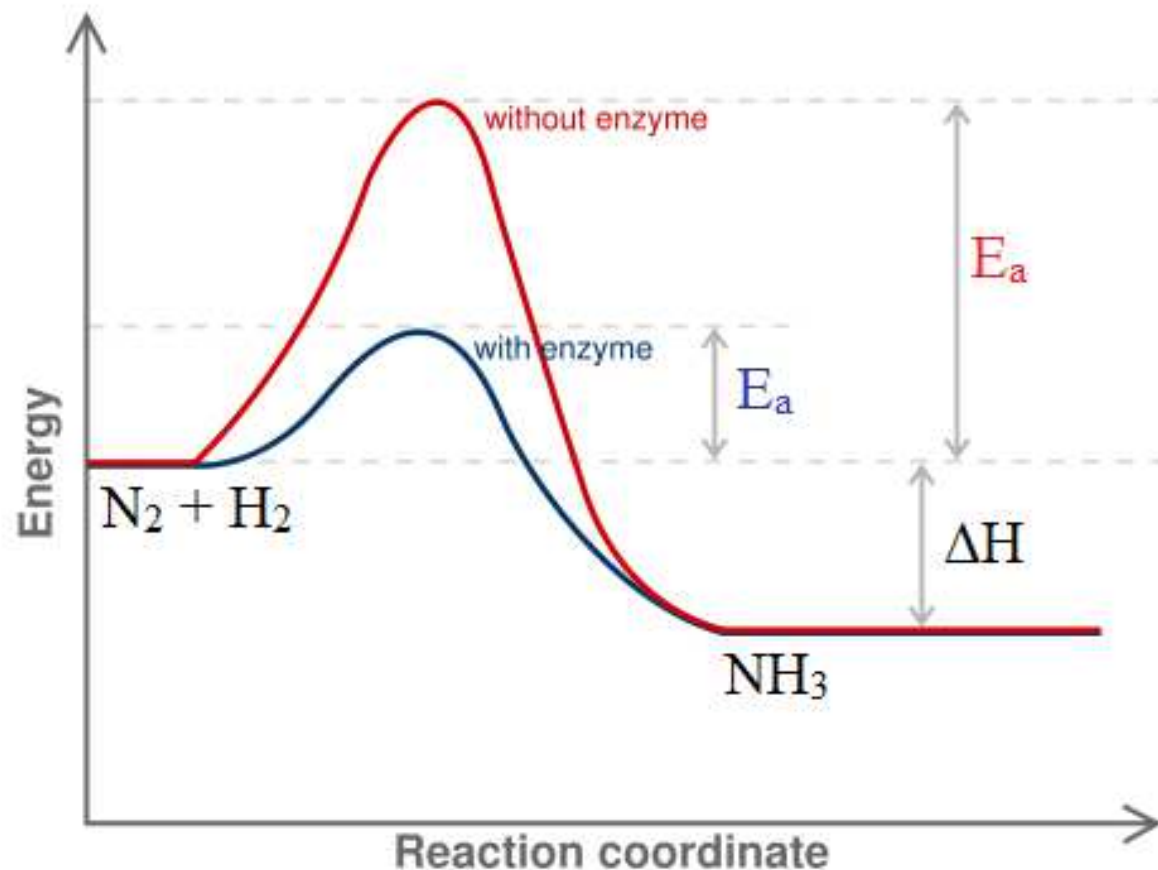
- A. zero
- B. first
- C. second
- D. third



# Things that can affect reaction rates

## 1. Catalysts

- ▶ Lowers activation energies



# Things that can affect reaction rates

## 2. Concentration

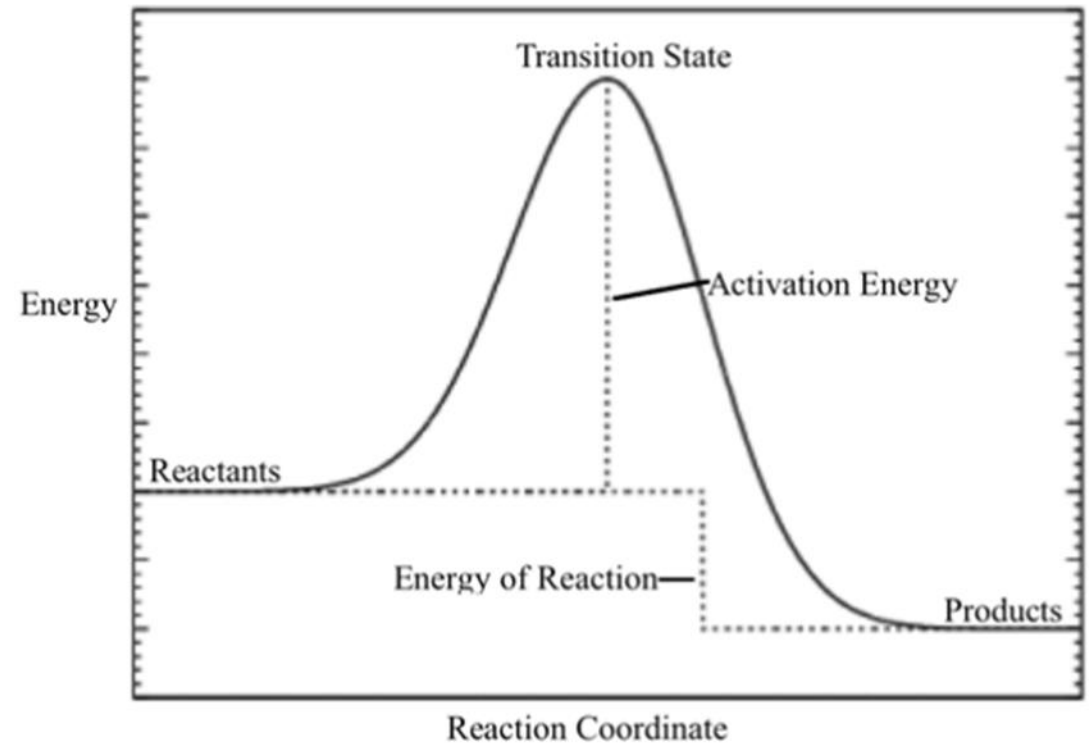
- ▶ Affects reaction rates as long as the reaction is not zero order.

Concentration only matters in some reactions. What reactions does it not affect?

# Things that can affect reaction rates

## 3. Temperature

- ▶ Makes it easier to reach the activation energy

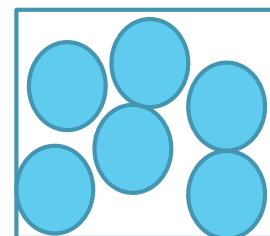
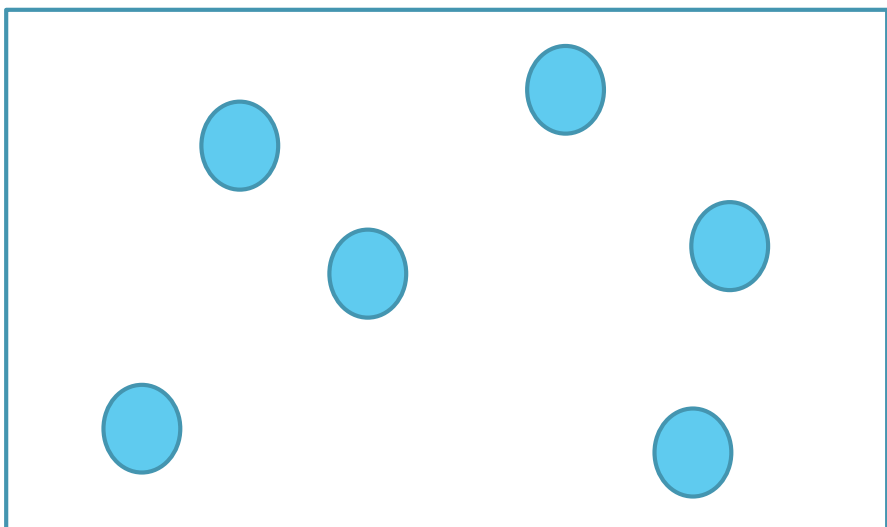




# Things that can affect reaction rates

## 4. Pressure

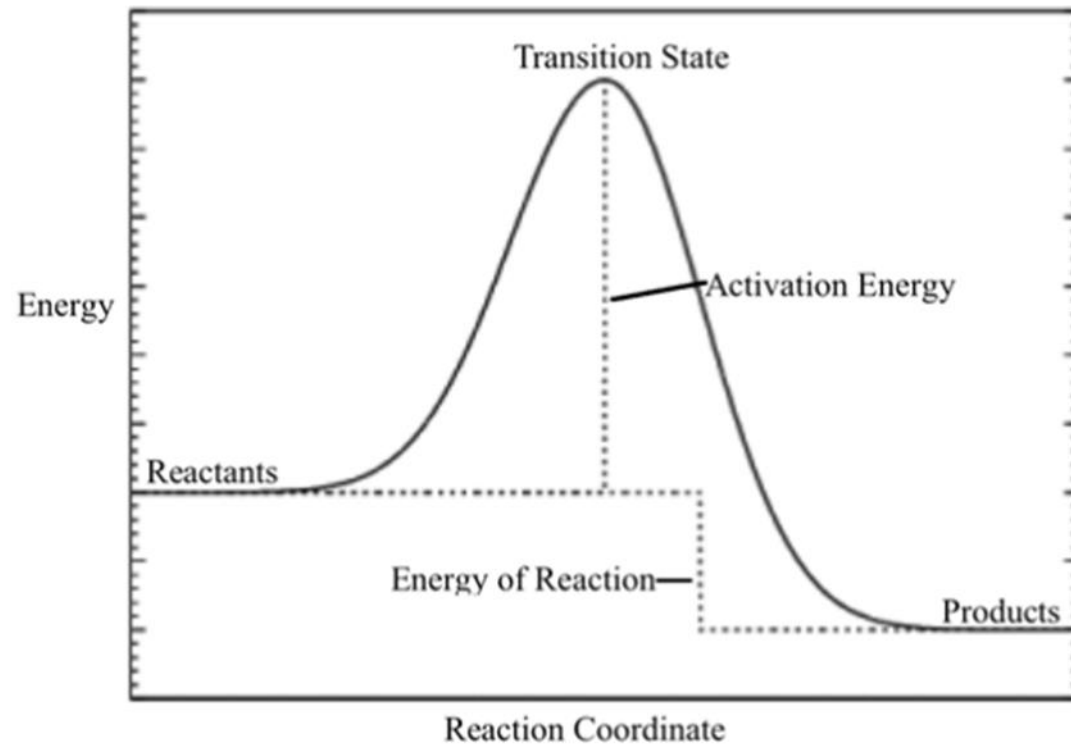
- ▶ Affects mostly gaseous reactions.



# Things that can affect reaction rates

## 5. Light

- ▶ Light is energy!

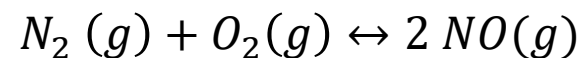


# Practice Passage

Air pollution is a major public health issue for people living in Urban regions. Burning coal for electricity produces sulfur dioxide which can contribute to particulate matter and combines with water to produce acid rain. Internal combustion engines, which break down hydrocarbon fuels, also contribute to air pollution via the release of volatile organic compounds, as well as the production of oxides, both of which contribute to the production of photochemical smog which can produce dangerous concentrations of ground level ozone.

Nitrogen oxides, both monoxide and dioxide, are formed when air is used as the source of oxygen in high temperature combustion reactions, such as in the internal combustion engine. The reaction between elemental nitrogen and elemental oxygen (Reaction 1) is thermodynamically favored, but kinetically hindered.

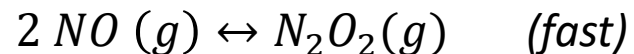
Reaction 1



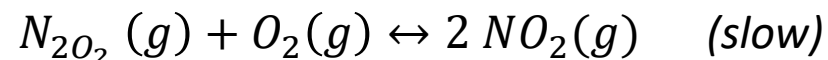
# Practice Passage

Nitrogen monoxide reacts further with elemental oxygen to form nitrogen dioxide. This reaction is thought to occur in a two step mechanism, in which two nitrogen monoxide molecules combine in a relatively fast pre-equilibrium, forming an intermediate, dinitrogen dioxide, which then reacts in a slow step with an equivalent of elemental oxygen to form two nitrogen dioxide molecules.

Mechanism 1



Mechanism 2



Nitrogen dioxide is a brown colored gas and establishes an equilibrium with the colorless gas dinitrogen tetroxide (reaction 2). The gas is manifested as seasonal smog in cities such as Los Angeles and Beijing.

Reaction 2



#1. Which of the following best describes the thermodynamic changes associated with the equilibrium of smog formation?

- A. The enthalpy change is positive and the entropy change is negative.
- B. The enthalpy change is negative and the entropy change is positive.
- C. Both are positive.
- D. Both are negative.

#2. Which of the following best describes the season in which the air above a city will be brown?

- A. Air will be brown in the summer due to the increased amounts of nitrogen dioxide formed at high temperatures because the reaction is exothermic.
- B. Air will be brown in the summer due to the increased amounts of dinitrogen tetroxide formed at high temperatures because the reaction is endothermic.
- C. Air will be brown in the winter due to the increased amounts of nitrogen dioxide formed at high temperatures because the reaction is exothermic.
- D. Air will be brown in the winter due to the increased amounts of dinitrogen tetroxide formed at high temperatures because the reaction is endothermic.



#3. Which of the following most likely describes reaction 1?

- A. The products are much lower energy than the reactants and the activation energy is low.
- B. The products are much lower energy than the reactants and the activation energy is high.
- C. The products are not much lower energy than the reactants and the activation energy is low.
- D. The products are not much lower energy than the reactants and the activation energy is high.

#4. According to the info in the passage, what is the most likely cause of the elevated hydrogen ion concentration in acid rain?

- A. Sulfonic acid
- B. Sulfurous acid
- C. Sulfuric acid
- D. Hydrosulfuric acid

#5. In a given reaction vessel, the concentrations of nitrogen dioxide and dinitrogen tetroxide are lower than the expected  $K_{eq}$ . This indicates that the reaction:

- A. will proceed forward towards equilibrium.
- B. will proceed backwards towards equilibrium.
- C. is at equilibrium.
- D. None of the above.

#6. A researcher investigating a reaction mechanism for nitrogen gases finds that the reaction is endothermic and displays a large increase in entropy. From this, the researcher can conclude that the reaction will be spontaneous under what conditions?

- A. Never
- B. Low temperature
- C. High temperature
- D. Always

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**Q&A**



# Next Step Core Values

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**Educate Daily**



**Approachability**



**Authenticity**



**Professionalism**



**Ownership**

**We are dedicated to providing personalized support, advice, and prep options that match each student's individual needs.**

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✓ **Over 50,000 students have used Next Step Test Prep in their prep journey**

- **Always up-to-date content, strategy and tests**
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- **Are ensured the most up-to-date, realistic experience...always**
- **Access to Online Forum for additional live support from fellow students and NSTP Content Team**

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# Personalized Options

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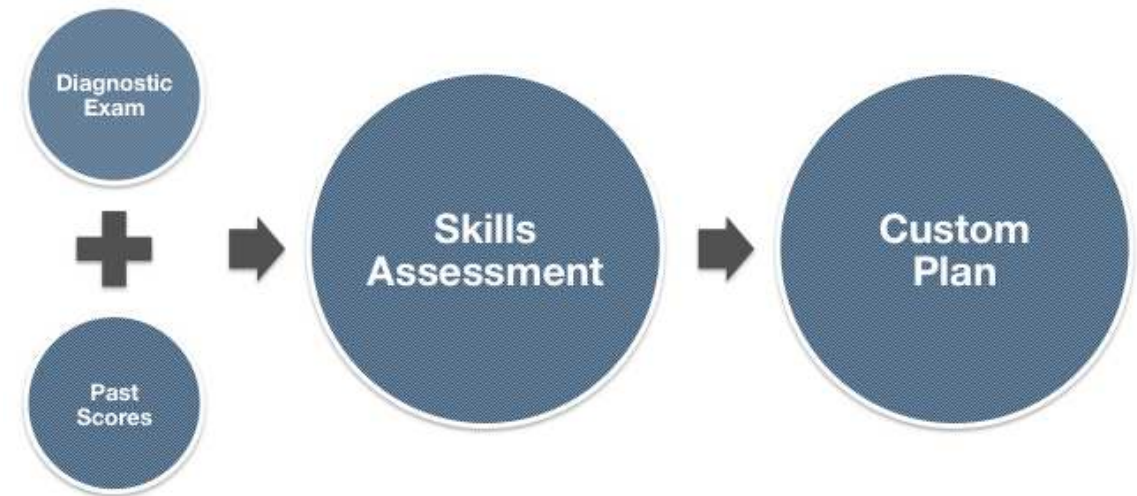
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- **Free Practice Bundle Materials**
- **Self-Prep Materials and Planning**
- **Guided Online Study with Free Extra Help**
- **One-on-One Tutoring**



# One-on-One Tutoring

- ✓ **No matter your study style, subject expertise, or PCAT goal, Next Step's Tutoring is personalized for YOU**
- **Tailored Study Plan**
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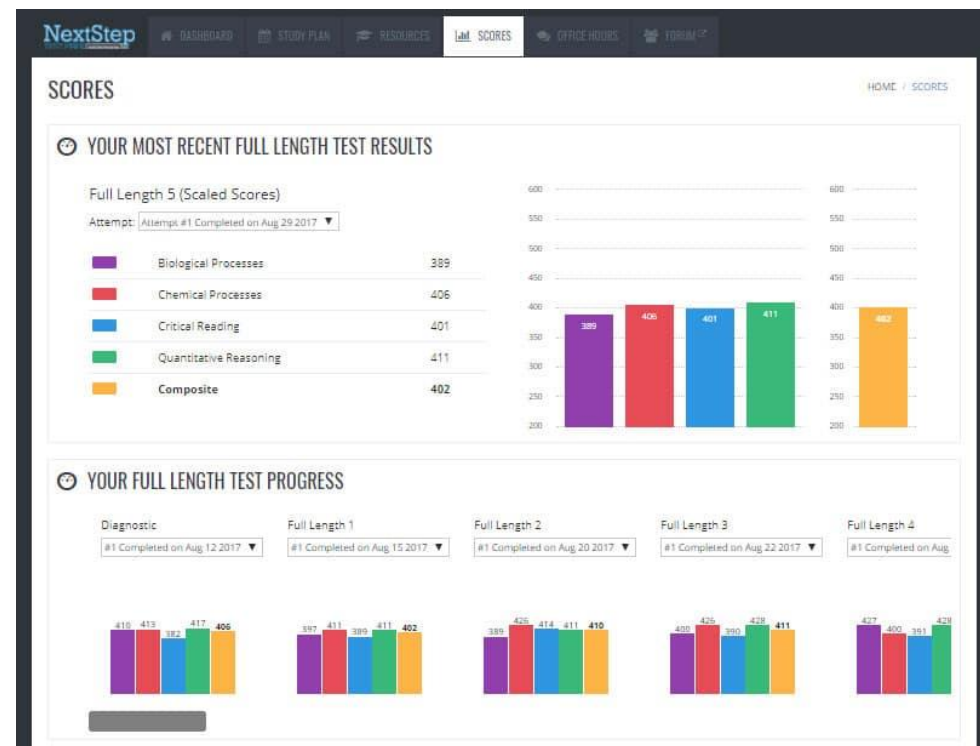


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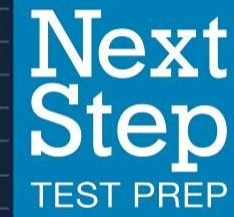
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# Take the Best Next Step



## Meet with an Academic Manager and build a strategy

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- Personalize a Study Plan for YOU
- Plan around your study style and class/work schedule
- Speak with educational pros, not a call center

## Attend free webinars

- Download the FREE PCAT BUNDLE and take the Diagnostic
- Take advantage of the free webinars and open Office Hours with a focus on PCAT subject reviews and strategy sessions

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