

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

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Hi, I'm Phil!

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



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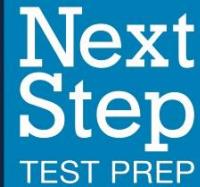
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- Focus on graduate admissions tests only
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✓ **We never stop improving our materials!**

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-
nextsteptestprep.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 any tech issues!

What are kinetics?

Kinetics are a measure of how fast a reaction occurs.

What Kinetics is not:

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

Thermodynamics!

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

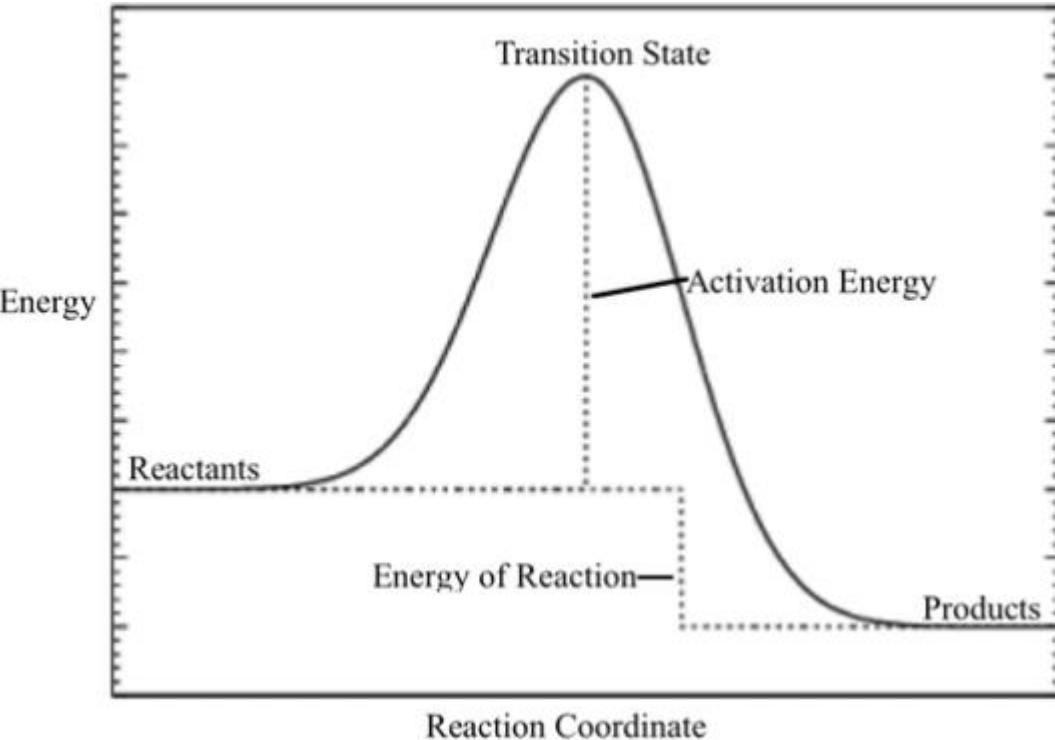
- ▶ *The energy that a reaction must overcome for it to occur.*

Energy of Reaction

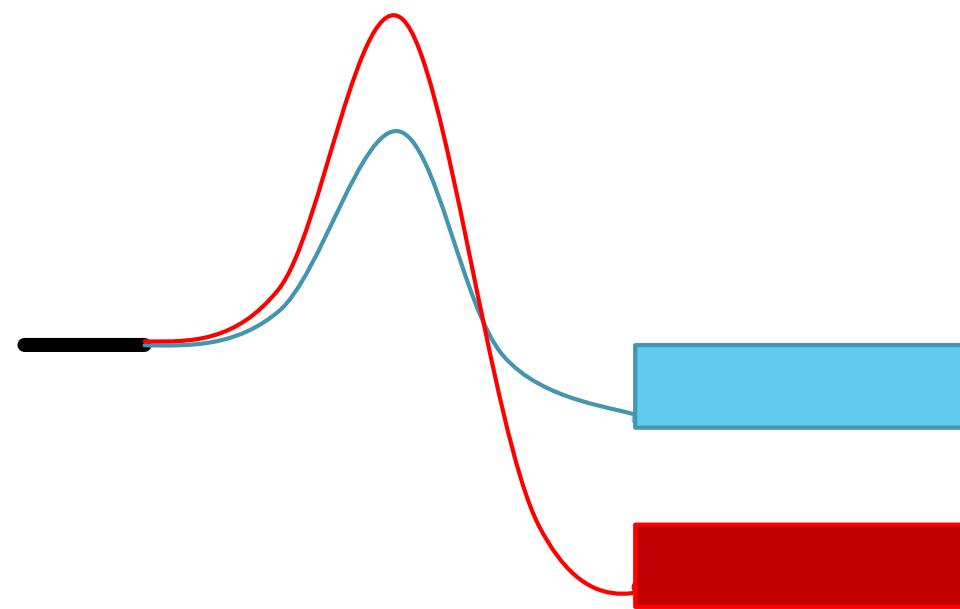
- ▶ *The change in energy from products to reactants.*

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	1.6×10^{-4}
0.5	1.65	6.4×10^{-4}
0.5	3.3	1.28×10^{-3}

What is the rate reaction for the reaction showed?

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

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

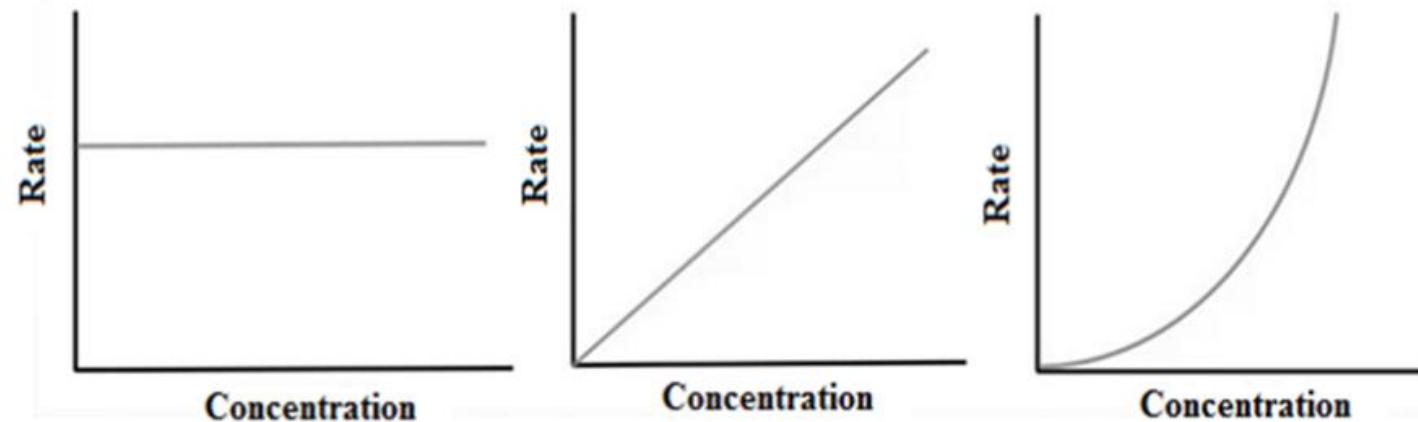
- A. M/s
- B. M
- C. 1/s
- D. 1/(M s)

#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	1.72×10^{-6}
2	0.35	0.7	0.6	3.41×10^{-6}
3	0.71	0.35	1.2	1.36×10^{-5}
4	1.05	0.35	0.6	1.54×10^{-5}

Reaction rates



Reaction order:

Zero order

First order

Second order

$$\text{Rate} =$$

$$k$$

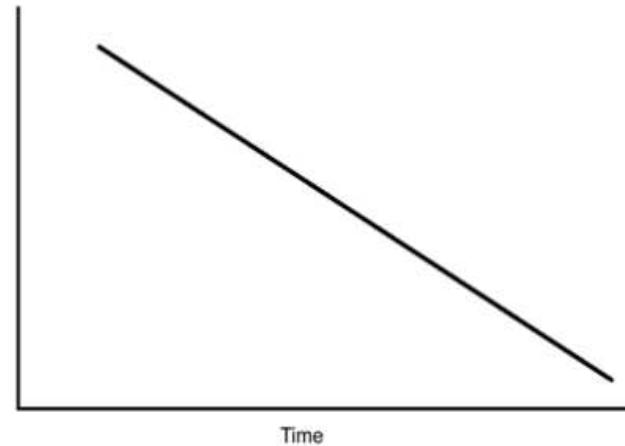
$$k[A]$$

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

Reaction



Reaction rates



Reaction order:

Zero order

First order

Second order

Rate =

k

$k[A]$

$k[A]^2$

Y axis for
Linear representation

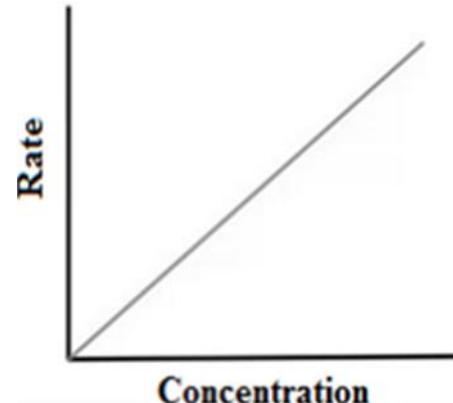
Reactant

$\ln (A)$

$1/[A]$

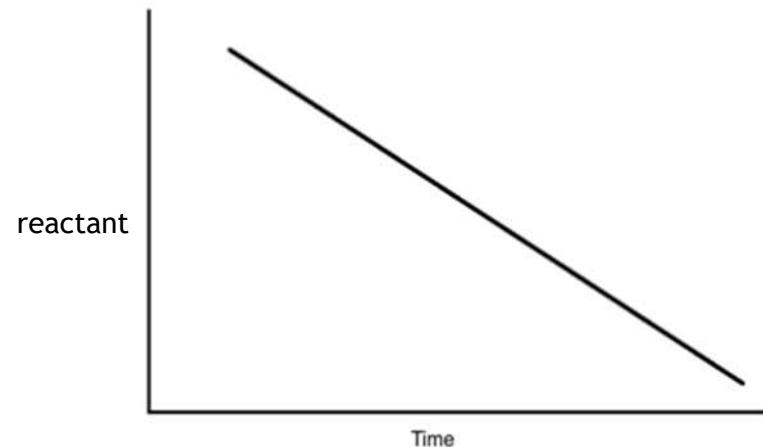
#4. The graph below indicates what order of reaction?

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



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

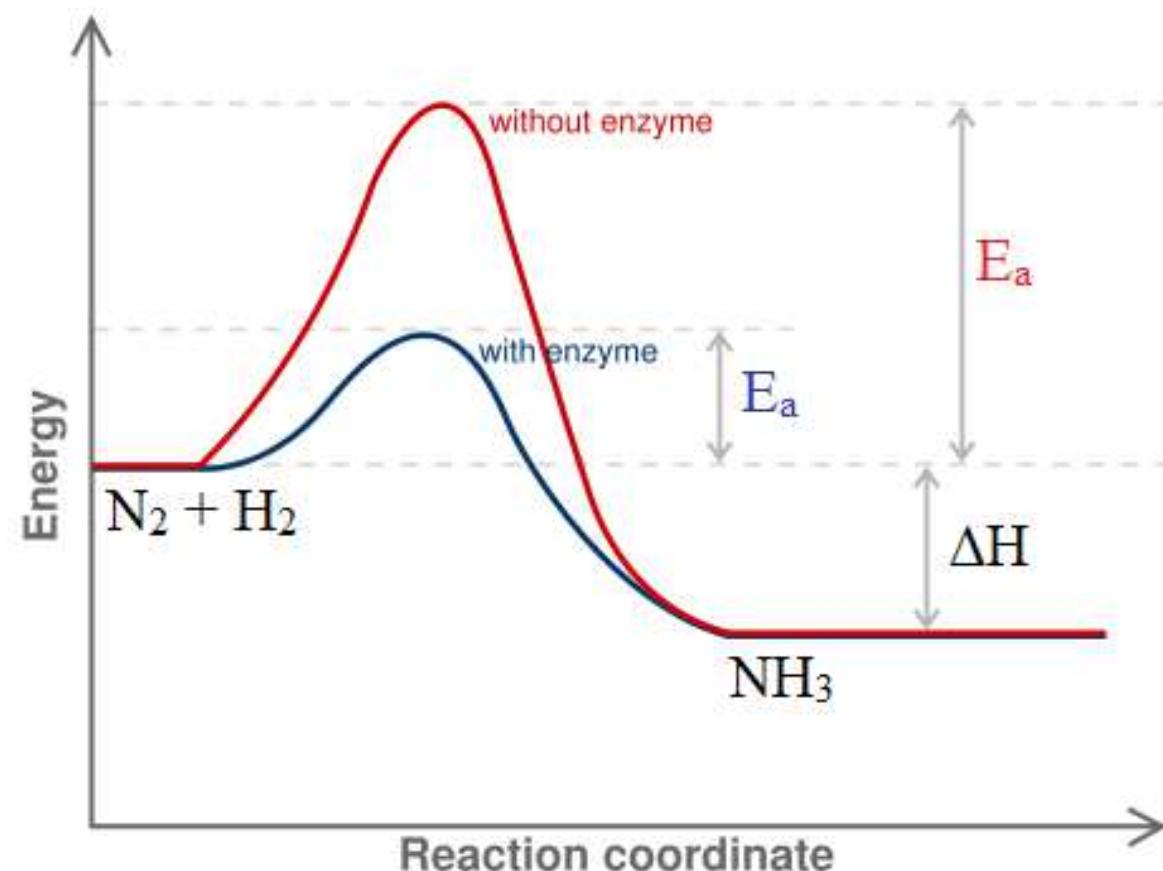
- A. zero
- B. first
- C. second
- D. third



Things that can affect reaction rates

1. Catalysts

- ▶ Lowers activation energies



Things that can affect reaction rates

2. Concentration

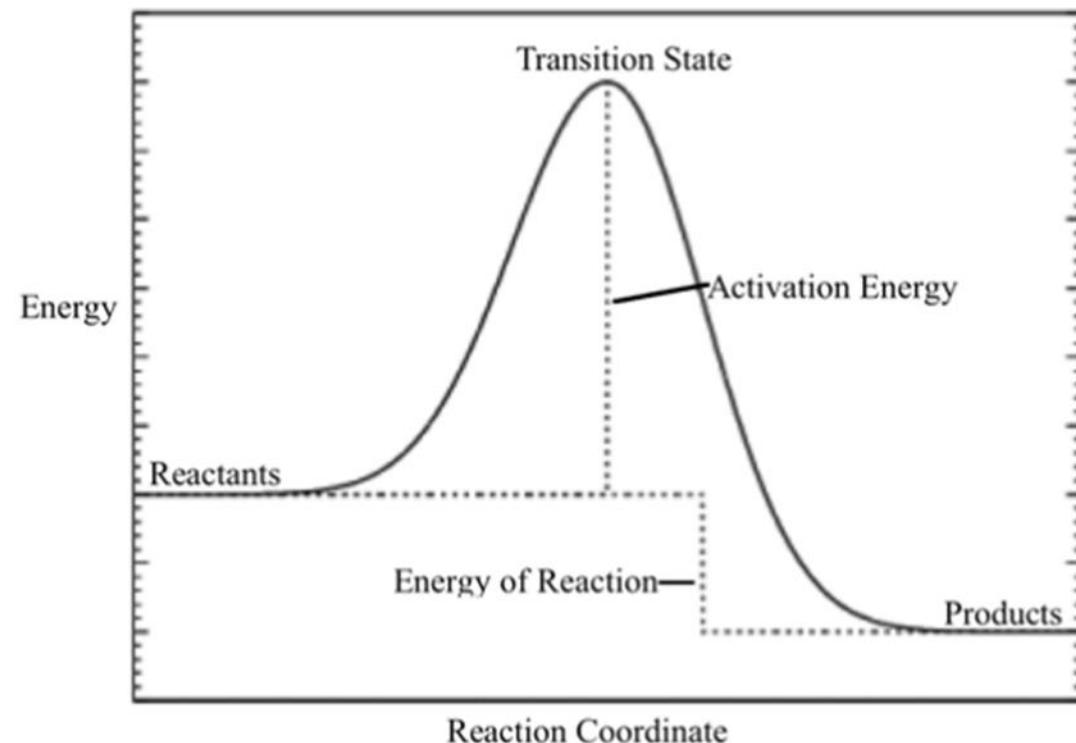
- ▶ Affects reaction rates as long as the reaction is not zero order.

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

Things that can affect reaction rates

3. Temperature

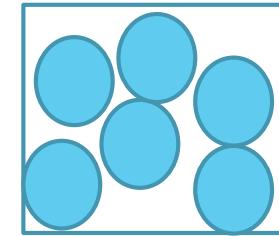
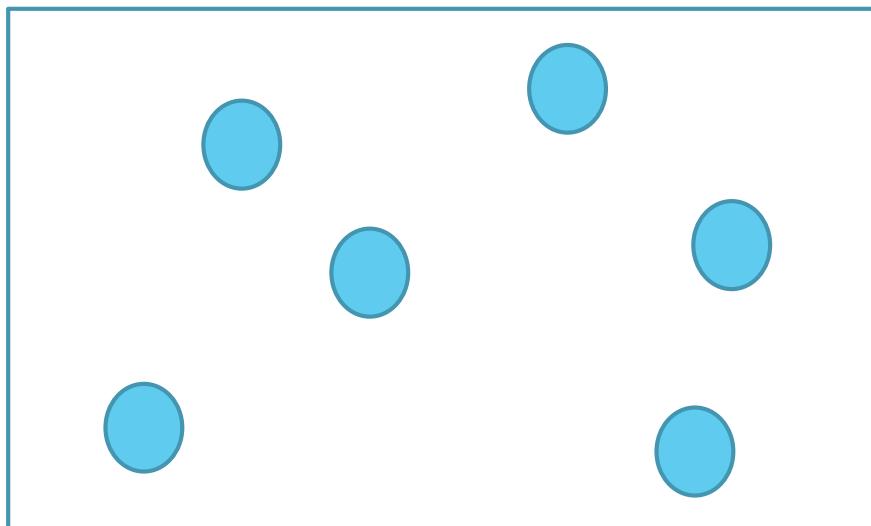
- ▶ Makes it easier to reach the activation energy



Things that can affect reaction rates

4. Pressure

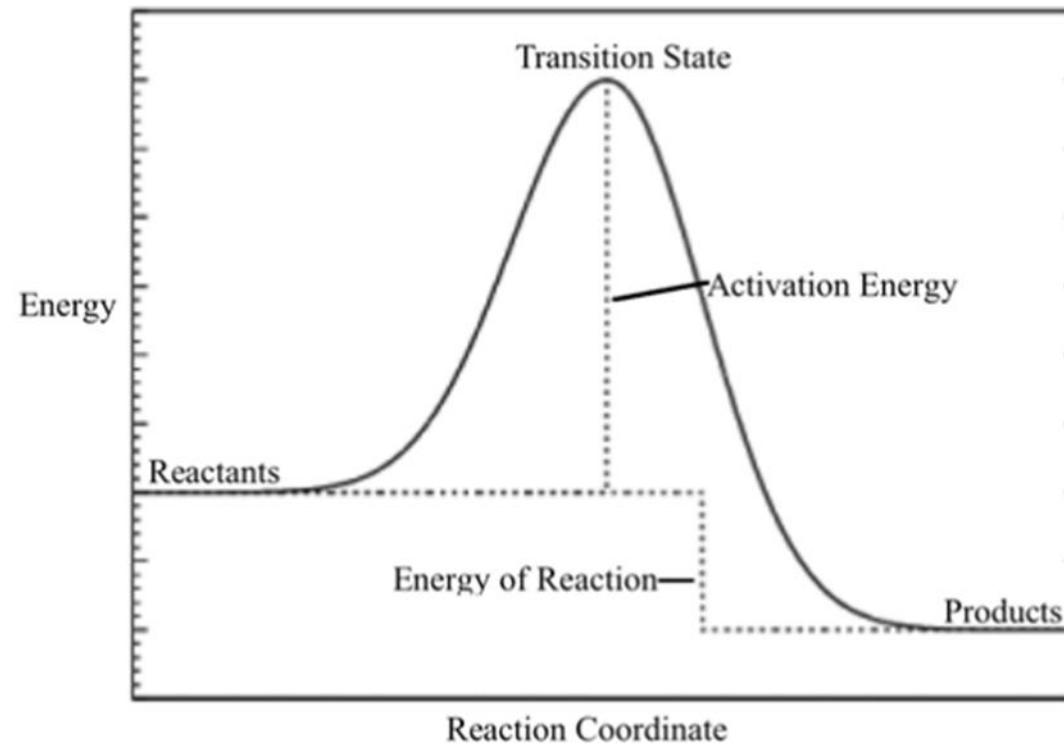
- ▶ Affects mostly gaseous reactions.



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.

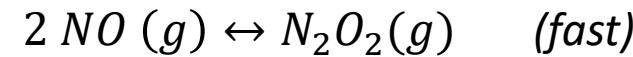
Reaction 1



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?

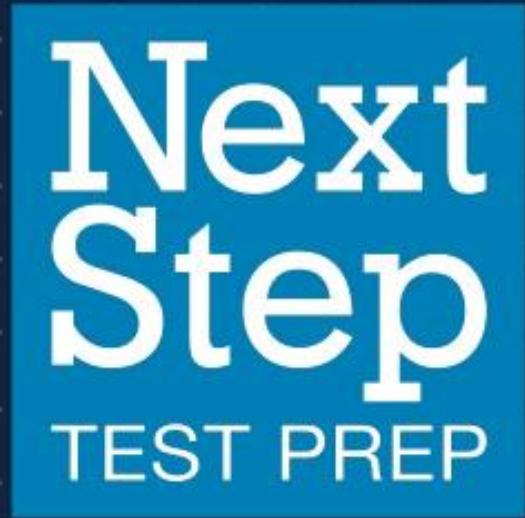
- A. Sulfonic acid
- B. Sulfurous acid
- C. Sulfuric acid
- D. Hydrosulfuric acid

#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



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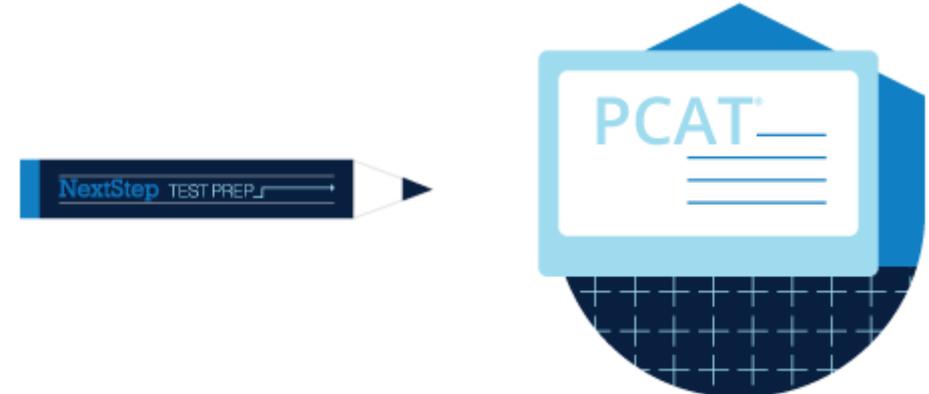


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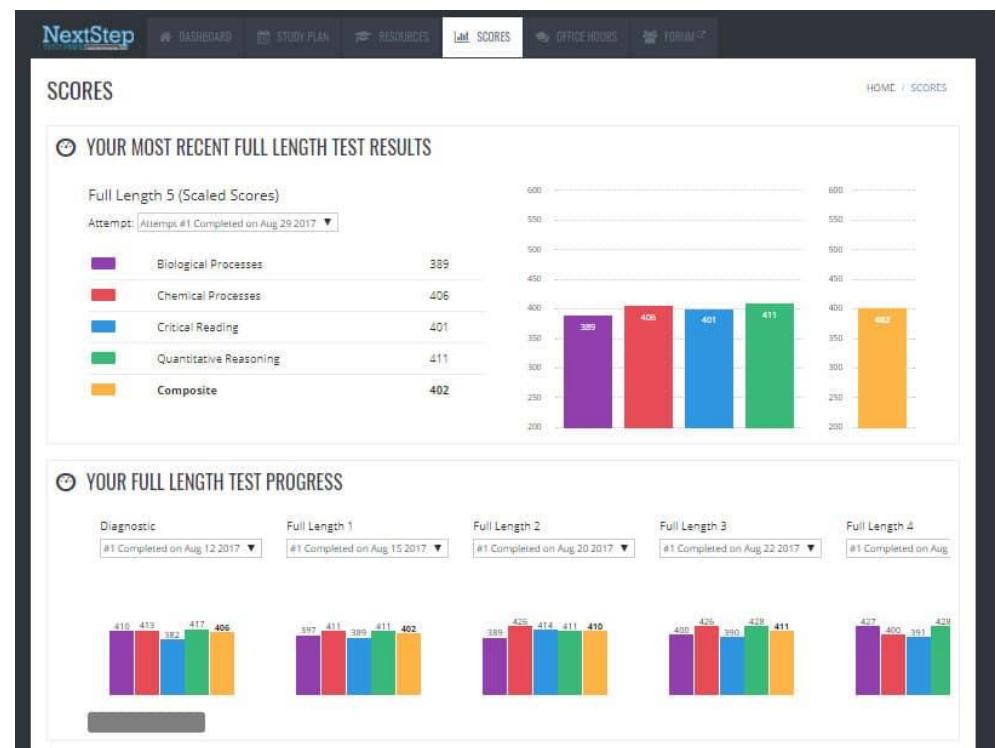
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The screenshot shows a computer screen displaying a full-length PCAT exam. At the top, there's a blue header bar with the "NextStep TEST PREP" logo and a "FALL LENGTH 1" title. Below the header, the main content area has a dark blue background with white text. It features two columns of text from a passage, followed by a question and four multiple-choice options (A, B, C, D). At the bottom of the page, there are navigation buttons for "Review Questions", "Previous", and "Next".

Passage 2

Should the State support the arts? It may be said that the arts enrich the soul, measure and continue of a nation. What would become of music if France without the Indian Music and Counterpoint, of the dramatic art, without the Théâtre-Français, of painting and sculpture, without the Louvre? It might even be asked, whether, without support of the fine arts, that famous empire taste would be developed in the French people? Would it not be important to remember that such noble contribution from the culture, which is the eyes of France, realizes the prosperity and glory?

In these arguments, which I agree with, no weaker arguments are opposed. It might be said that there is a question of democratic action. Does the right of the legislature extend to the wages of the artists, to the sale of, adding to the profits of the arts? I would answer: "If you want to expand your rights, where do you think you are necessary to add to regulate your support from the culture, where will you stop?" It might be answered, if you desire to support everything which is good, where will you stop? Will you not necessarily be led to controlling agriculture, industry, commerce, finance, science, literature? That, is it normal that the government should finance the progress of art? We see very well that the situation which propose me those which depend upon their own interests.

If not, I consider one of those who think that funding ought to come from the culture and not from the legislature, and that the opposite leads to the destruction of liberty.

But, by a sober and impartial definition, governments are supposed to disapprove of the thing itself which support is deserved, and to be the enemies of every activity, because we desire to see these activities both free and seeking their own rewards. If we think that the state should not support religious offices, we must be atheists. If we think the state should not support education, we are foolish as ignoramus. If we say that the State should not give a fair share of value to land, or to any other of industry, we are enemies to property and labor. If we think that the State should not support artists, we look upon the arts as useless.

A person from consciousness I agree with all my strength. For from understanding the absurd idea of doing away with religion, education, property, labor and the arts, when we say that the State should to protect the free development of all these kinds of human activity, instead helping some at the expense of others, we think that all these living parts of society would develop themselves more harmoniously under the influence of liberty; and that under such an influence as one of them would be a source of trouble of others, of misery, and disorder.

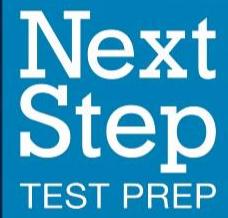
Which of the following statements is most likely to be reflected in the author of the passage?

- (A) My truth is as important, as in the legislature.
- (B) My truth is in the legislature, not as important.
- (C) An activity which is neither aided by supplies nor regulated by government, is an activity destroyed.
- (D) An activity which is aided by supplies, or regulated by government, is destroyed in fact.

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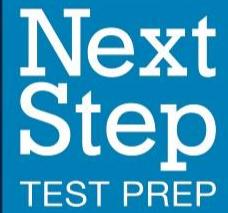
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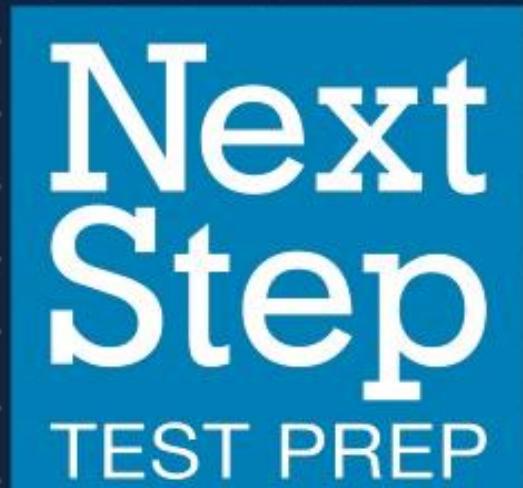
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