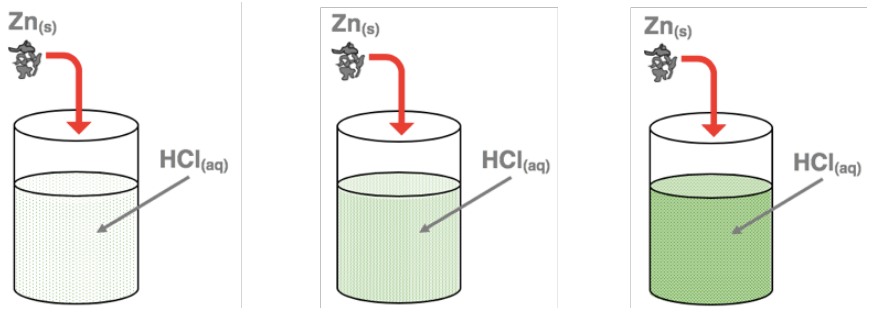
Collision Model or Reaction Rates

Activity 1: Reaction Rate

Question Group 1

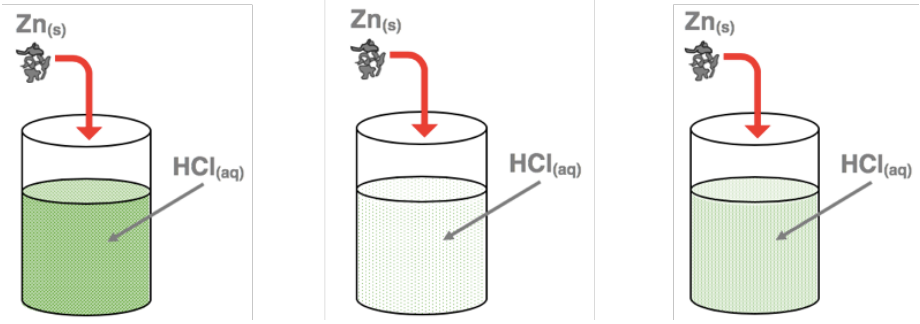
Question 1

Zinc reacts with aqueous hydrochloric acid in a single replacement reaction to produce hydrogen gas. Three trials are conducted with varying HCl concentration. Rank the three trials in order of increasing rate of hydrogen gas production.



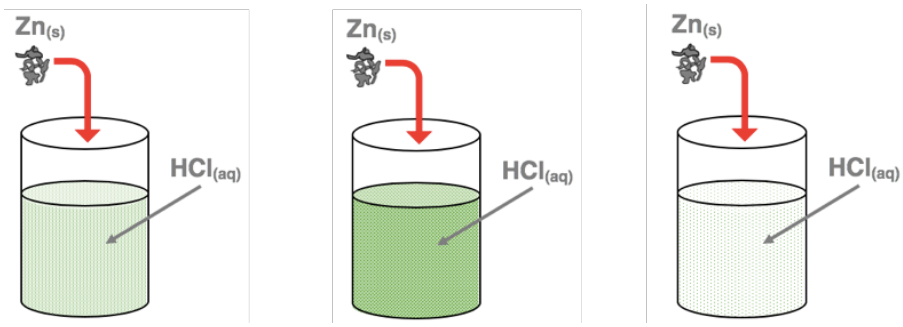
Question 2

Zinc reacts with aqueous hydrochloric acid in a single replacement reaction to produce hydrogen gas. Three trials are conducted with varying HCl concentration. Rank the three trials in order of increasing rate of hydrogen gas production.



Question 3

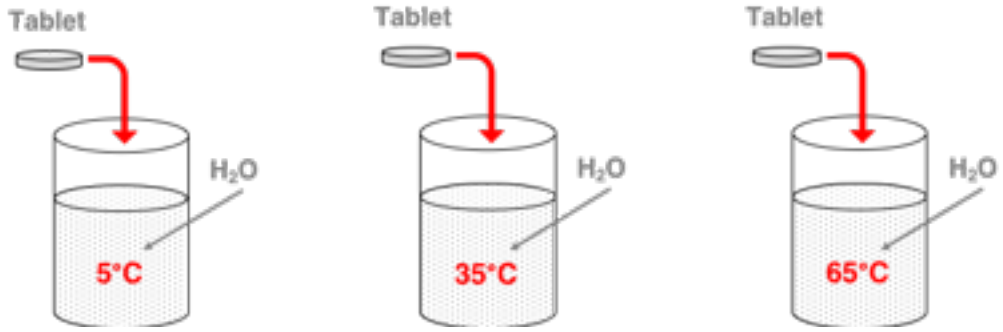
Zinc reacts with aqueous hydrochloric acid in a single replacement reaction to produce hydrogen gas. Three trials are conducted with varying HCl concentration. Rank the three trials in order of increasing rate of hydrogen gas production.



Question Group 2

Question 4

As an Alka Seltzer® dissolves in water, a reaction occurs to produce carbon dioxide gas. Three trials are conducted with varying water temperatures. Rank the three trials in order of increasing rate of carbon dioxide gas production.



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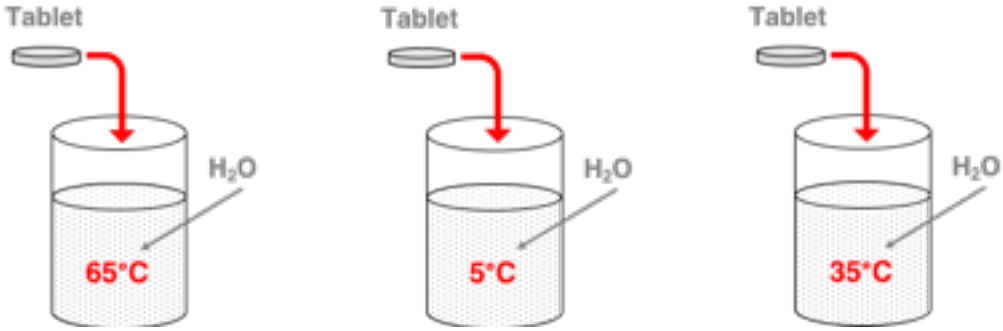
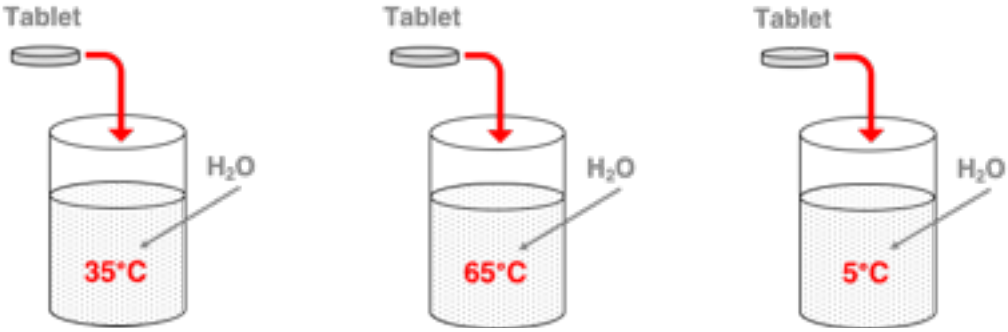


Question 6

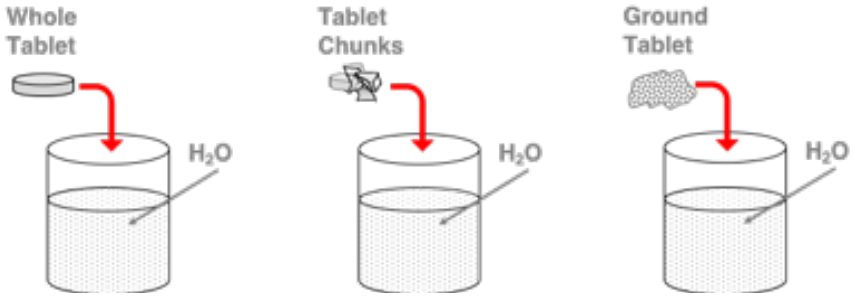
As an Alka Seltzer® dissolves in water, a reaction occurs to produce carbon dioxide gas. Three trials are conducted with varying water temperatures. Rank the three trials in order of increasing rate of carbon dioxide gas production.



Question Group 3

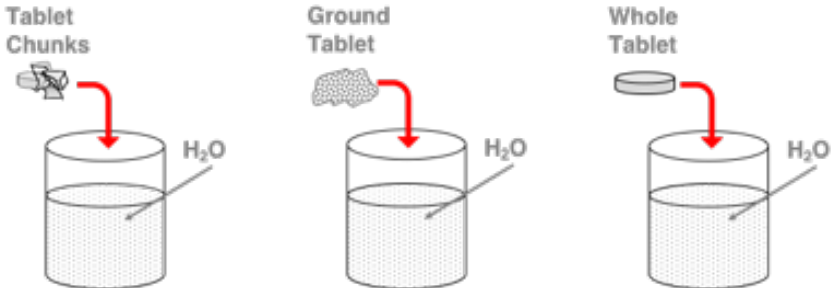
Question 7

As an Alka Seltzer® dissolves in water, a reaction occurs to produce carbon dioxide gas. Three trials are conducted with a single tablet in a beaker of 300 mL of water. The dependent variable between trials is the degree to which the tablet is ground up - whole tablet (unground), several chunks, and finely ground. Rank the three trials in order of increasing rate of carbon dioxide gas production.



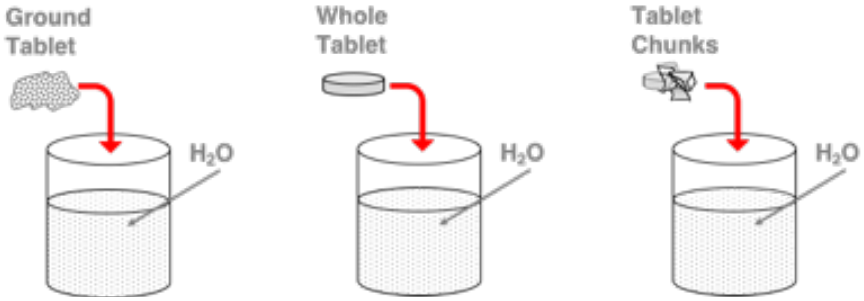
Question 8

As an Alka Seltzer® dissolves in water, a reaction occurs to produce carbon dioxide gas. Three trials are conducted with a single tablet in a beaker of 300 mL of water. The dependent variable between trials is the degree to which the tablet is ground up - whole tablet (unground), several chunks, and finely ground. Rank the three trials in order of increasing rate of carbon dioxide gas production.



Question 9

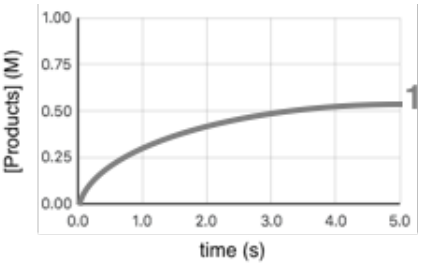
As an Alka Seltzer® dissolves in water, a reaction occurs to produce carbon dioxide gas. Three trials are conducted with a single tablet in a beaker of 300 mL of water. The dependent variable between trials is the degree to which the tablet is ground up - whole tablet (unground), several chunks, and finely ground. Rank the three trials in order of increasing rate of carbon dioxide gas production.

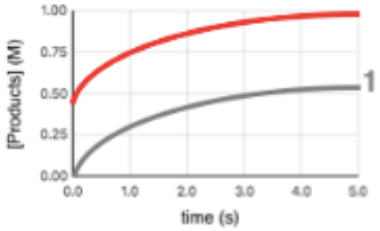


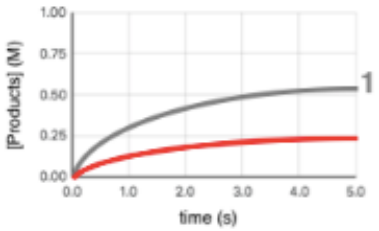
Question Group 4

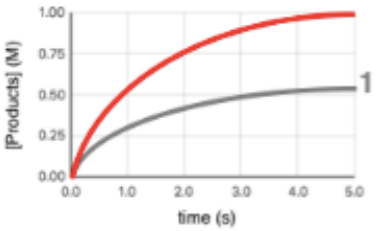
Question 10

Line 1 on the graph at the right represents the changes in product concentration as a reaction takes place over the course of time. If a **catalyst** is added to the reactants, then one would expect the graph to look like ...



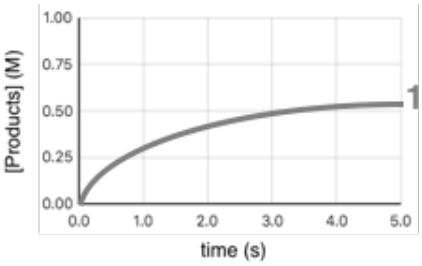


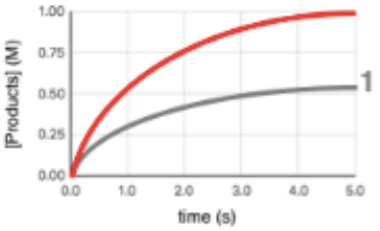


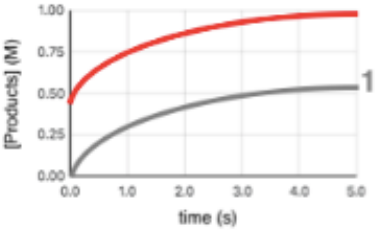


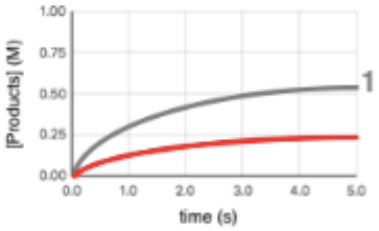
Question 11

Line 1 on the graph at the right represents the changes in product concentration as a reaction takes place over the course of time. If a **catalyst** is added to the reactants, then one would expect the graph to look like ...









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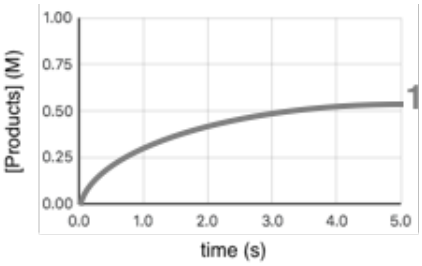
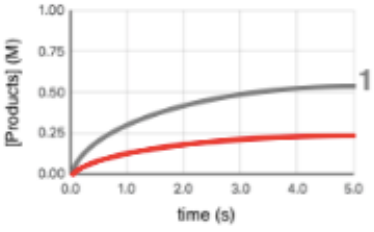
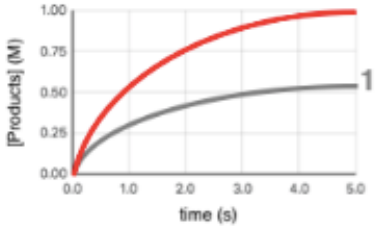
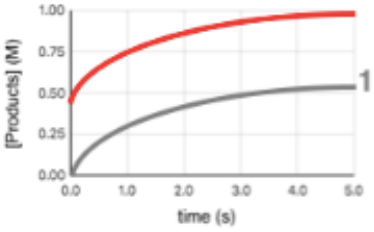
Line 1 on the graph at the right represents the changes in product concentration as a reaction takes place over the course of time. If a **catalyst** is added to the reactants, then one would expect the graph to look like ...









Question Group 5

Question 13

Consider the four different variable changes made below. Identify any change that would not result in an increase in the reaction rate. Select all that apply.

- Increase the temperature of reactants.
- Add a catalyst to the reactant mixture.
- Decrease the concentration of reactants.
- Increase the surface area of solid reactants.

Question 14

Consider the four different variable changes made below. Identify any change that would not result in an increase in the reaction rate. Select all that apply.

- Increase the concentration of reactants.
- Decrease the surface area of solid reactants.
- Remove a catalyst from the reactant mixture.
- Increase the temperature of reactants.

Question 15

Consider the four different variable changes made below. Identify any change that would not result in an increase in the reaction rate. Select all that apply.

- Increase the concentration of reactants.
- Add a catalyst to the reactant mixture.
- Decrease the temperature of reactants.
- Increase the surface area of solid reactants.

Question Group 6

Question 16

Consider the four different variable changes made below. Identify any change that would not result in an increase in the reaction rate. Select all that apply.

- Run the reaction at a higher temperature.
- Remove a catalyst from the reactant mixture.
- Dilute the reactant mixture.
- Increase the surface area of solid reactants.

Question 17

Consider the four different variable changes made below. Identify any change that would not result in an increase in the reaction rate. Select all that apply.

- Add a catalyst to the reactant mixture.
- Run the reaction at a lower temperature.
- Increase the surface area of solid reactants.
- Decrease the concentration of reactants.

Question 18

Consider the four different variable changes made below. Identify any change that would not result in an increase in the reaction rate. Select all that apply.

- Grind up solid reactants into a fine powder.
- Run the reaction at a higher temperature.
- Decrease the concentration of reactants.
- Add a catalyst to the reactant mixture.

Activity 2: Collision Theory
Question Group 7
Question 19
Grinding solid reactants into a fine power will increase reaction rates. Which statement best describes the reason for this increase in reaction rate?

Grinding increases surface area and exposes a greater portion of the reactants to potential collisions.
Grinding reactants makes reactant particles more energetic resulting in more particles meeting the energy requirement.
Grinding increases the activation energy for the reaction, resulting in more particles meeting the energy requirement.
Grinding the solid results in a reaction pathway that has a lowered activation energy.

Question 20
Grinding solid reactants into a fine power will increase reaction rates. Which statement best describes the reason for this increase in reaction rate?

Grinding the solid results in a reaction pathway that has a lowered activation energy.
Grinding reactants makes reactant particles more energetic resulting in more particles meeting the energy requirement.
Grinding increases surface area and exposes a greater portion of the reactants to potential collisions.
Grinding increases the activation energy for the reaction, resulting in more particles meeting the energy requirement.

Question 21
Grinding solid reactants into a fine power will increase reaction rates. Which statement best describes the reason for this increase in reaction rate?

Grinding increases the activation energy for the reaction, resulting in more particles meeting the energy requirement.
Grinding reactants makes reactant particles more energetic resulting in more particles meeting the energy requirement.
Grinding the solid results in a reaction pathway that has a lowered activation energy.
Grinding increases surface area and exposes a greater portion of the reactants to potential collisions.

Question Group 8
Question 22
Using a catalyst causes the reaction rate to increase. Which statement best explains why the use of a catalyst increases reaction rate?

Catalysts cause increases in reactant concentrations and a higher frequency of collisions.
Using a catalyst alters the reaction pathway, resulting in one with a lower activation energy.
Catalysts increase the temperature of a reaction vessel, resulting in more energetic reactant particles.
Catalysts increase the energy of activation, thus causing a higher frequency of collisions.

Question 23
Using a catalyst causes the reaction rate to increase. Which statement best explains why the use of a catalyst increases reaction rate?

Catalysts increase the energy of activation, thus causing a higher frequency of collisions.
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Using a catalyst alters the reaction pathway, resulting in one with a lower activation energy.
Catalysts increase the temperature of a reaction vessel, resulting in more energetic reactant particles.

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Catalysts increase the energy of activation, thus causing a higher frequency of collisions.
Catalysts increase the temperature of a reaction vessel, resulting in more energetic reactant particles.
Using a catalyst alters the reaction pathway, resulting in one with a lower activation energy.

Question Group 9
Question 25
Reactions occur more rapidly at higher temperatures. Which <u>two</u> statements best explain why increasing temperatures increase reaction rates? Pick two statements.

A greater number of particles meet the energy requirement for an effective collision.
Particle speeds increase, resulting in a higher collision frequency.
Solid reactants assume larger grain size (less powdery) with greater surface area.
Higher temperatures cause reactant particles to become more concentrated.
The activation energy is lowered by increasing temperatures.

Question 26
Reactions occur more rapidly at higher temperatures. Which two statements best explain why increasing temperatures increase reaction rates? Pick two statements.

Higher temperatures cause reactant particles to become more concentrated.
Particle speeds increase, resulting in a higher collision frequency.
The activation energy is lowered by increasing temperatures.
Solid reactants assume larger grain size (less powdery) with greater surface area.
A greater number of particles meet the energy requirement for an effective collision.

Question 27
Reactions occur more rapidly at higher temperatures. Which two statements best explain why increasing temperatures increase reaction rates? Pick two statements.

Particle speeds increase, resulting in a higher collision frequency.
Solid reactants assume larger grain size (less powdery) with greater surface area.
A greater number of particles meet the energy requirement for an effective collision.
Higher temperatures cause reactant particles to become more concentrated.
The activation energy is lowered by increasing temperatures.

Question Group 10
Question 28
Increasing reactant concentrations cause reaction rates to increase. Which statement best explains why increases in concentrations cause reactions to run faster?

At higher concentrations, reactant particles collide more frequently.
Particles *feed off of each other's energy* and become more energetic at high concentrations.
Surface area increases as reactant concentration increases, thus increasing the collision frequency.
High concentrations cause decreases in the average activation energy.

Question 29
Increasing reactant concentrations cause reaction rates to increase. Which statement best explains why increases in concentrations cause reactions to run faster?

High concentrations cause decreases in the average activation energy.
Surface area increases as reactant concentration increases, thus increasing the collision frequency.
Particles *feed off of each other's energy* and become more energetic at high concentrations.
At higher concentrations, reactant particles collide more frequently.

Question 30
Increasing reactant concentrations cause reaction rates to increase. Which statement best explains why increases in concentrations cause reactions to run faster?

Surface area increases as reactant concentration increases, thus increasing the collision frequency.
At higher concentrations, reactant particles collide more frequently.
High concentrations cause decreases in the average activation energy.
Particles *feed off of each other's energy* and become more energetic at high concentrations.

Question Group 11
Question 31
Three characteristics of reactants or reactions are described below. Which one would **not** result in an increase in the rate of reaction?

Particles collide with one another at a more frequent rate.	The activation energy of the reaction is lower.	The activation energy of the reaction is higher.

Question 32
Three characteristics of reactants or reactions are described below. Which one would **not** result in an increase in the rate of reaction?

Particles collide with one another at a less frequent rate.	The collision frequency is increased.	On average, particles are moving at greater speeds.

Question 33
Three characteristics of reactants or reactions are described below. Which one would **not** result in an increase in the rate of reaction?

The average kinetic energy of particles is increased.	The average kinetic energy of particles is decreased.	The energy of activation for the reaction is decreased.

Question Group 12
Question 34
Three characteristics of reactants or reactions are described below. Which one would result in an increase in the rate of reaction?

On average, particles are moving at greater speeds.	Particles collide with one another at a less frequent rate.	The activation energy of the reaction is higher.

Question 35
Three characteristics of reactants or reactions are described below. Which one would result in an increase in the rate of reaction?

The collision frequency is decreased.	The collision frequency is increased.	On average, particles are moving at lower speeds.

Question 36
Three characteristics of reactants or reactions are described below. Which one would result in an increase in the rate of reaction?

The energy of activation for the reaction is increased.	The average kinetic energy of particles is decreased.	The energy of activation for the reaction is decreased.

Activity 3: Orientation and Energy
Question Group 13
Question 37
According to the Collision Model of Reaction Rates, reactant particles must collide in order for bonds to break and products to form. But not every collision results in a reaction. The model proposes that a collision will effecively form products if it meets two requirements. Which statements describe those requirements? Pick two

The colliding particles must have the proper geometric orientation.
The energy of colliding particles must exceed the activation energy.
The reactants must have a lower bond energy than that of the products.
The reaction must be exothermic and release energy to the surroundings.
The number of bonds in reactant particles must be less than that of products.

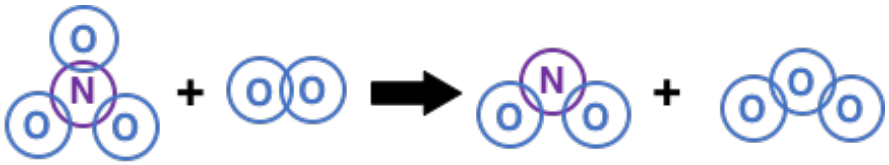
Question 38
According to the Collision Model of Reaction Rates, reactant particles must collide in order for bonds to break and products to form. But not every collision results in a reaction. The model proposes that a collision will effecively form products if it meets two requirements. Which statements describe those requirements? Pick two

The reaction must be exothermic and release energy to the surroundings.
The number of bonds in reactant particles must be less than that of products.
The energy of colliding particles must exceed the activation energy.
The reactants must have a lower bond energy than that of the products.
The colliding particles must have the proper geometric orientation.

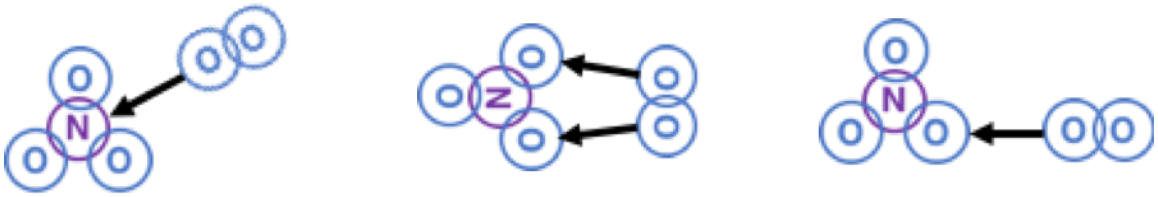
Question 39
According to the Collision Model of Reaction Rates, reactant particles must collide in order for bonds to break and products to form. But not every collision results in a reaction. The model proposes that a collision will effecively form products if it meets two requirements. Which statements describe those requirements? Pick two

The number of bonds in reactant particles must be less than that of products.
The colliding particles must have the proper geometric orientation.
The reactants must have a lower bond energy than that of the products.
The reaction must be exothermic and release energy to the surroundings.
The energy of colliding particles must exceed the activation energy.

Question Group 14
Question 40
A particle representation of a reaction step is shown.



Which one of the collision orientations would most likely result in the breaking of a N-O bond and the formation of a new O-O bond?



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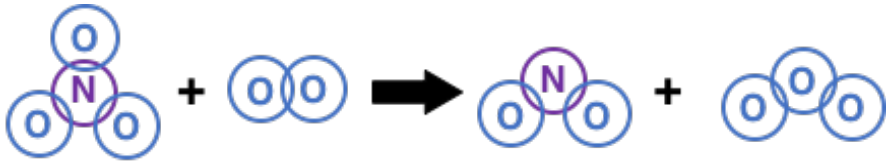
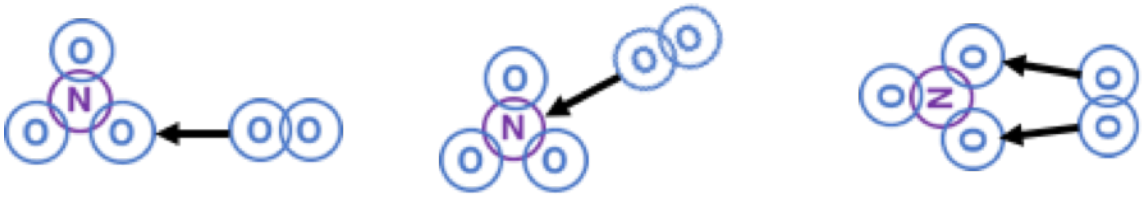
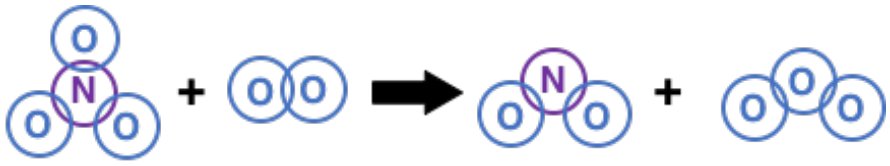
A particle representation of a reaction step is shown.



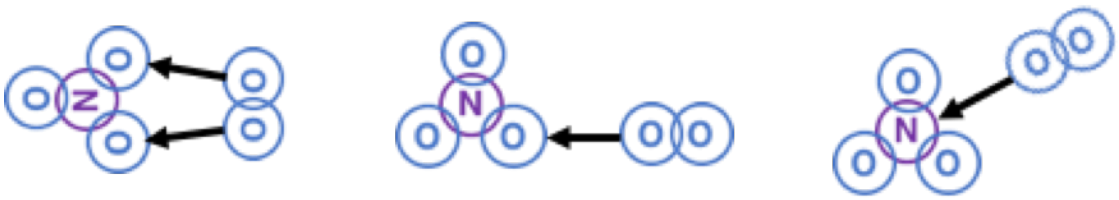
Which one of the collision orientations would most likely result in the breaking of a N-O bond and the formation of a new O-O bond?



Question 42
A particle representation of a reaction step is shown.

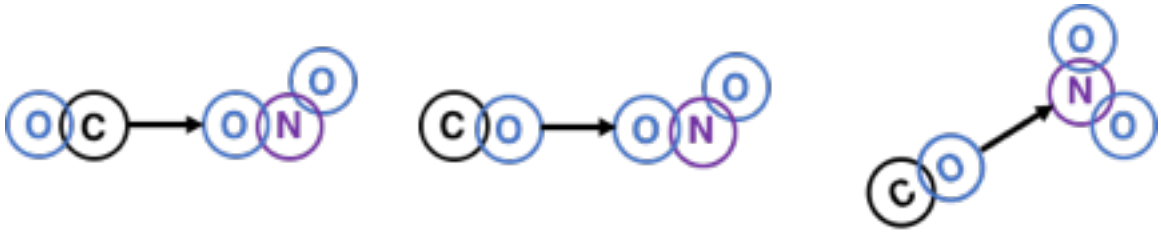


Which one of the collision orientations would most likely result in the breaking of a N-O bond and the formation of a new O-O bond?



Question Group 15
Question 43
Carbon monoxide reacts with nitrogen dioxide to produce carbon dioxide and nitrogen monoxide. A particle representation of the reaction is shown.

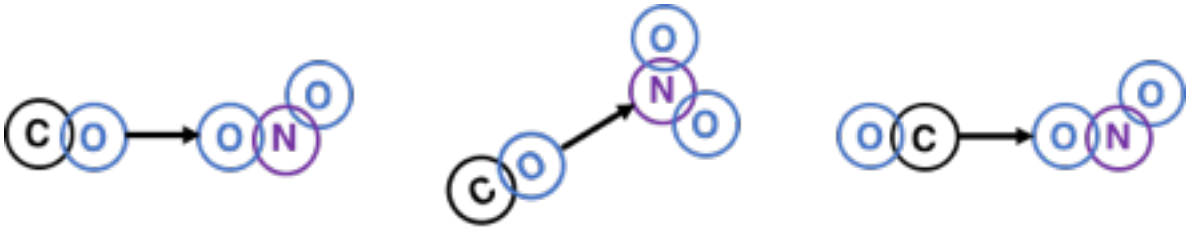
Which one of the collision orientations would most likely result in the breaking of a N-O bond and the formation of a new C-O bond?



Question 44

Carbon monoxide reacts with nitrogen dioxide to produce carbon dioxide and nitrogen monoxide. A particle representation of the reaction is shown.

Which one of the collision orientations would most likely result in the breaking of a N-O bond and the formation of a new C-O bond?



Question 45

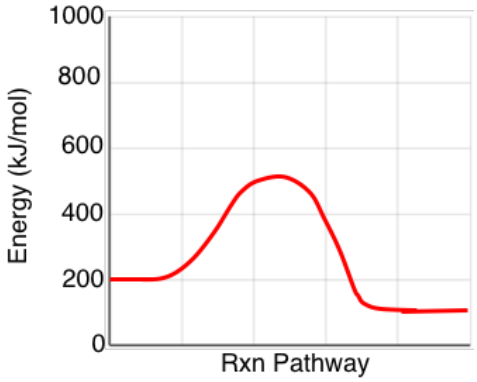
Carbon monoxide reacts with nitrogen dioxide to produce carbon dioxide and nitrogen monoxide. A particle representation of the reaction is shown.

Which one of the collision orientations would most likely result in the breaking of a N-O bond and the formation of a new C-O bond?

Question Group 16

Question 46

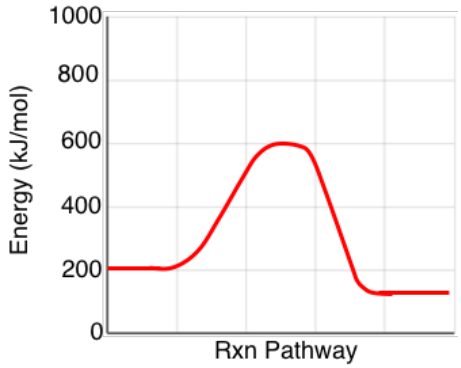
The energy profile for reactants turning into products is shown. The activation energy (E_a) for this reaction is _____ kJ/mol.



100
200
300
400
500

Question 47

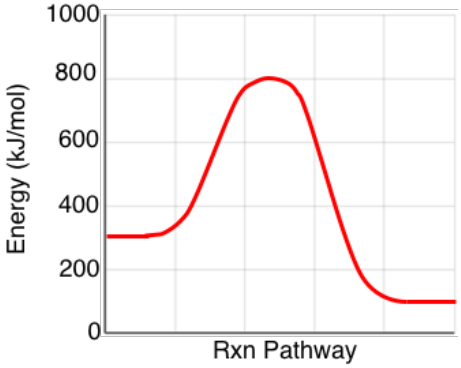
The energy profile for reactants turning into products is shown. The activation energy (E_a) for this reaction is _____ kJ/mol.



100
200
400
500
600

Question 48

The energy profile for reactants turning into products is shown. The activation energy (E_a) for this reaction is _____ kJ/mol.

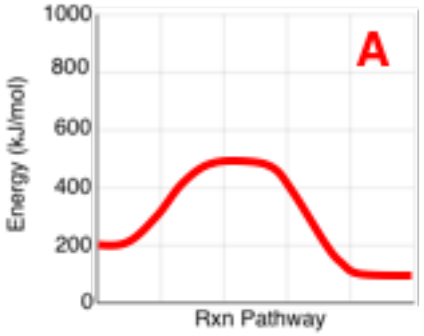


200
300
500
700
800

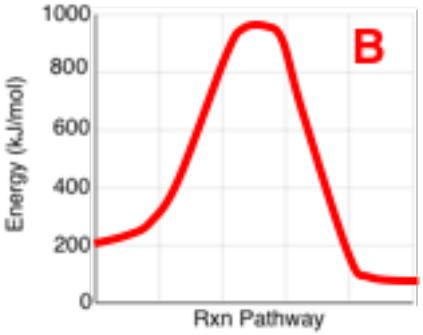
Question Group 18

Question 49

A reaction can take place by two different mechanisms or pathways - referred to as **Pathway A** and **Pathway B**. The energy profile for each pathway is shown. When comparing **Pathway A** to **Pathway B**, one would conclude that ...



A. ... the enthalphy change is ....
- the same for each pathway
- greater for Pathway A
- greater for Pathway B

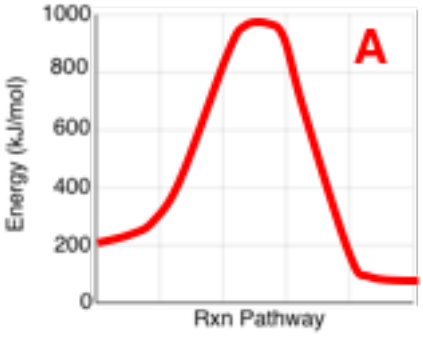


B. ... the activation energy is ...
- the same for each pathway
- greater for Pathway A
- greater for Pathway B

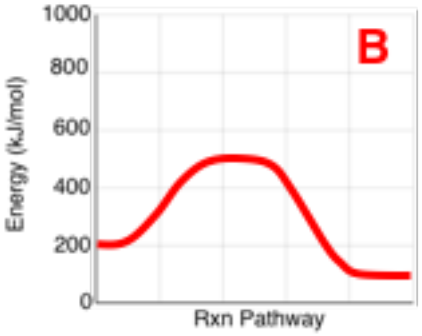
C. ... the catalyzed pathway is ...
- Pathway A
- Pathway B.

Question 50

A reaction can take place by two different mechanisms or pathways - referred to as **Pathway A** and **Pathway B**. The energy profile for each pathway is shown. When comparing **Pathway A** to **Pathway B**, one would conclude that ...



A. ... the enthalphy change is ....
- the same for each pathway
- greater for Pathway A
- greater for Pathway B

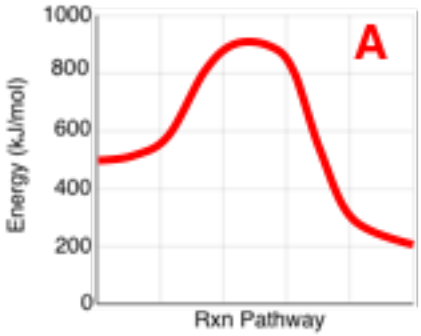


B. ... the activation energy is ...
- the same for each pathway
- greater for Pathway A
- greater for Pathway B

C. ... the catalyzed pathway is ...
- Pathway A
- Pathway B.

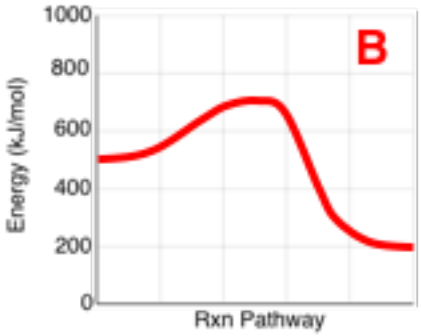
Question 51

A reaction can take place by two different mechanisms or pathways - referred to as **Pathway A** and **Pathway B**. The energy profile for each pathway is shown. When comparing **Pathway A** to **Pathway B**, one would conclude that ...



A. ... the enthalphy change is ....
- the same for each pathway
- greater for Pathway A
- greater for Pathway B

B. ... the activation energy is ...
- the same for each pathway
- greater for Pathway A
- greater for Pathway B



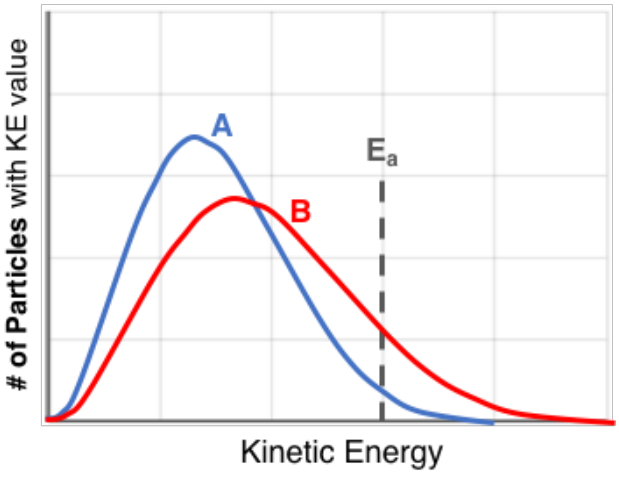
C. ... the catalyzed pathway is ...
- Pathway A
- Pathway B.

Question Group 18
Question 52
Not every particle in a sample has the same kinetic energy (KE). There is a distribution of KE values within the sample. The graphs are KE distribution curves for two samples - **Sample A** and **Sample B** - of the same reactants at two different temperatures. The activation energy (**Ea**) is marked on the graph. When comparing the curves for the two samples, one can conclude that ...

A. ... the number of particles whose KE exceeds the activation energy is
- the same in each sample
- greater in Sample A
- greater in Sample B

B. ... the temperature is greatest in
- sample A
- sample B

C. ... the reaction will occur at a greater rate in
- sample A
- sample B



Question 53

Not every particle in a sample has the same kinetic energy (KE). There is a distribution of KE values within the sample. The graphs are KE distribution curves for two samples - **Sample A** and **Sample B** - of the same reactants at two different temperatures. The activation energy (**Ea**) is marked on the graph. When comparing the curves for the two samples, one can conclude that ...

A. ... the number of particles whose KE exceeds the activation energy is
- the same in each sample
- greater in Sample A
- greater in Sample B

B. ... the temperature is greatest in
- sample A
- sample B

C. ... the reaction will occur at a greater rate in
- sample A
- sample B