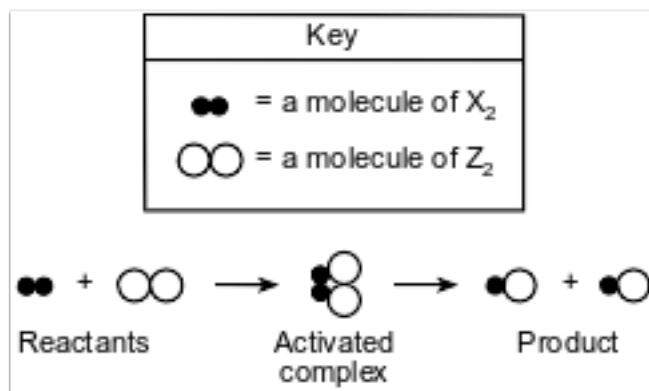


Kinetics Equilibrium

- Hydrochloric acid reacts faster with powdered zinc than with an equal mass of zinc strips because the greater surface area of the powdered zinc
 - decreases the frequency of particle collisions
 - decreases the activation energy of the reaction
 - increases the frequency of particle collisions
 - increases the activation energy of the reaction
- According to which theory or law is a chemical reaction most likely to occur when two particles with the proper energy and orientation interact with each other?
 - atomic theory
 - collision theory
 - combined gas law
 - law of conservation of matter
- The equation below represents a reaction between two molecules, X_2 and Z_2 . These molecules form an "activated complex," which then forms molecules of the product.



Which diagram represents the most likely orientation of X_2 and Z_2 when the molecules collide with proper energy, producing an activated complex?

- | | |
|------------|------------|
| <p>(1)</p> | <p>(3)</p> |
| <p>(2)</p> | <p>(4)</p> |

- A chemical reaction occurs when reactant particles
 - are separated by great distances
 - have no attractive forces between them
 - collide with proper energy and proper orientation
 - convert chemical energy into nuclear energy
- Given the balanced equation representing a reaction:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + \text{energy}$$
 Which change in reaction conditions will increase the frequency of effective collisions between reactant molecules?
 - decreasing the pressure of the reactants
 - decreasing the temperature of the reactants
 - increasing the concentration of the reactants
 - increasing the volume of the reactants
- A chemical reaction is most likely to occur when the colliding particles have the proper
 - energy and orientation
 - solubility and density
 - ionic radii and mass
 - atomic radii and volume
- A reaction is most likely to occur when the colliding particles have proper orientation and

(1) mass	(3) half-life
(2) volume	(4) energy
- As the temperature of a reaction increases, it is expected that the reacting particles collide
 - more often and with greater force
 - more often and with less force
 - less often and with greater force
 - less often and with less force

9 The collision theory states that a reaction is most likely to occur when the reactant particles collide with the proper

- | | |
|----------------------|----------------------------|
| (1) formula masses | (3) density and volume |
| (2) molecular masses | (4) energy and orientation |

10 A reaction will most likely occur if the colliding particles have the proper

- | | |
|---------------------|----------------------------|
| (1) mass, only | (3) orientation, only |
| (2) mass and volume | (4) orientation and energy |

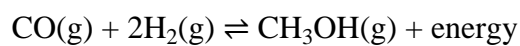
11 Which statement explains why increasing the temperature increases the rate of a chemical reaction, while other conditions remain the same?

- (1) The reacting particles have less energy and collide less frequently.
- (2) The reacting particles have less energy and collide more frequently.
- (3) The reacting particles have more energy and collide less frequently.
- (4) The reacting particles have more energy and collide more frequently.

12 Explain, in terms of collisions, why increasing the surface area of the hot carbon increases the rate of the forward reaction.

Base your answers to questions 13 on the information below and your knowledge of chemistry.

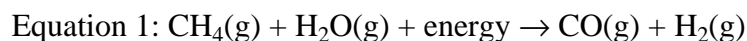
Methanol can be manufactured by a reaction that is reversible. In the reaction, carbon monoxide gas and hydrogen gas react using a catalyst. The equation below represents this system at equilibrium.



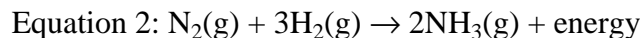
13 Explain, in terms of collision theory, why increasing the concentration of $\text{H}_2\text{(g)}$ in this system will increase the concentration of $\text{CH}_3\text{OH(g)}$.

Base your answers to questions 14 on the information below and on your knowledge of chemistry.

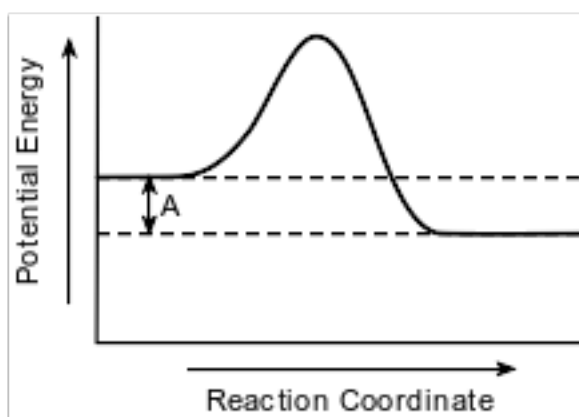
Millions of tons of ammonia are produced each year for use as fertilizer to increase food production. Most of the hydrogen needed to produce ammonia comes from methane gas reacting with steam. This reaction, which occurs in a container under controlled conditions, is shown below in unbalanced equation 1.



The reaction that produces ammonia is represented by balanced equation 2, shown below. A catalyst can be used to increase the rate of the reaction.



A potential energy diagram for equation 2 is shown below.



- 14 Explain, in terms of collision theory, why an increase in temperature increases the rate of reaction between methane gas and steam.

Base your answers to questions 15 on the information below and on your knowledge of chemistry.

Carbon monoxide, $\text{CO}(\text{g})$, is a toxic gas found in automobile exhaust. The concentration of $\text{CO}(\text{g})$ can be decreased by using a catalyst in the reaction between $\text{CO}(\text{g})$ and $\text{O}_2(\text{g})$. This reaction is represented by the balanced equation below.



- 15 Explain, in terms of collision theory, why an increase in temperature increases the rate of the reaction.

Answer Keys

- 1 3
- 2 2
- 3 2
- 4 3
- 5 3
- 6 1
- 7 4
- 8 1
- 9 4
- 10 4
- 11 4
- 12 Allow 1 credit. Acceptable responses include, but are not limited to:
 - Increasing the surface area of the hot carbon increases the frequency of effective collisions, which increases the rate of the forward reaction.
 - More collisions between C atoms and H_2O molecules speed up the reaction.
 - More effective collisions occur.
- 13 Allow 1 credit. Acceptable responses include, but are not limited to:
 - More $\text{H}_2(\text{g})$ molecules collide with $\text{CO}(\text{g})$ molecules, producing more $\text{CH}_3\text{OH}(\text{g})$.
 - Adding H_2 increases the number of effective collisions to produce more methanol.
 - A greater number of effective collisions occur.
- 14 Allow 1 credit. Acceptable responses include, but are not limited to:
 - An increase in temperature causes a greater number of effective collisions between methane and water molecules to occur.
 - A greater number of collisions per second make the reaction rate faster.
 - More molecules collide with sufficient energy.
- 15 Allow 1 credit. Acceptable responses include, but are not limited to:
 - The rate of the chemical reaction increases because the reactant molecules move faster and collide with more kinetic energy.
 - Increasing the temperature causes more frequent collisions.
 - As molecules acquire more kinetic energy, the probability of effective collisions increases.
 - More reactant molecules collide with sufficient energy.