1. What is required for a chemical reaction to occur?

   A) standard temperature and pressure
   B) a catalyst added to the reaction system
   C) effective collisions between reactant particles
   D) an equal number of moles of reactants and products

2. As the temperature of a chemical reaction in the gas phase is increased, the rate of the reaction increases because

   A) fewer particle collisions occur
   B) more effective particle collisions occur
   C) the required activation energy increases
   D) the concentration of the reactants increases

3. A chemical reaction between iron atoms and oxygen molecules can only occur if

   A) the particles are heated
   B) the atmospheric pressure decreases
   C) there is a catalyst present
   D) there are effective collisions between the particle

4. Why can an increase in temperature lead to more effective collisions between reactant particles and an increase in the rate of a chemical reaction?

   A) The activation energy of the reaction increases.
   B) The activation energy of the reaction decreases.
   C) The number of molecules with sufficient energy to react increases.
   D) The number of molecules with sufficient energy to react decreases.

5. A reaction is most likely to occur when reactant particles collide with

   A) proper energy, only
   B) proper orientation, only
   C) both proper energy and proper orientation
   D) neither proper energy nor proper orientation

6. Which event must *always* occur for a chemical reaction to take place?

   A) formation of a precipitate
   B) formation of a gas
   C) effective collisions between reacting particles
   D) addition of a catalyst to the reaction system

7. After being ignited in a Bunsen burner flame, a piece of magnesium ribbon burns brightly, giving off heat and light. In this situation, the Bunsen burner flame provides

   A) ionization energy
   B) activation energy
   C) heat of reaction
   D) heat of vaporization

8. Two reactant particles collide with proper orientation. The collision will be effective if the particles have

   A) high activation energy
   B) high ionization energy
   C) sufficient kinetic energy
   D) sufficient potential energy

9. A piece of Mg(s) ribbon is held in a Bunsen burner flame and begins to burn according to the equation:

   $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$.

   The reaction begins because the reactants

   A) are activated by heat from the Bunsen burner flame
   B) are activated by heat from the burning magnesium
   C) underwent an increase in entropy
   D) underwent a decrease in entropy

10. The energy needed to start a chemical reaction is called

    A) potential energy B) kinetic energy
    C) activation energy D) ionization energy

11. For a reaction at equilibrium, which change can increase the rates of the forward and reverse reactions?

    A) a decrease in the concentration of the reactants
    B) a decrease in the surface area of the products
    C) an increase in the temperature of the system
    D) an increase in the activation energy of the forward reaction

12. In most aqueous reactions as temperature increases, the effectiveness of collisions between reacting particles

A) decreases B) increases
C) remains the same

13. Given the reaction:

$$Mg + 2\ H_2O \rightarrow Mg(OH)_2 + H_2$$

At which temperature will the reaction occur at the greatest rate?

A) 25ºC B) 50ºC
C) 75ºC D) 100ºC

14. Which conditions will increase the rate of a chemical reaction?

A) decreased temperature and decreased concentration of reactants
B) decreased temperature and increased concentration of reactants
C) increased temperature and decreased concentration of reactants
D) increased temperature and increased concentration of reactants

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

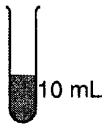
A) The reacting particles have less energy and collide less frequently.
B) The reacting particles have less energy and collide more frequently.
C) The reacting particles have more energy and collide less frequently.
D) The reacting particles have more energy and collide more frequently.

16. Which factors have the greatest effect on the rate of a chemical reaction between $AgNO_3(aq)$and Cu(s)?

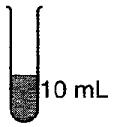
A) solution concentration and temperature
B) solution concentration and pressure
C) molar mass and temperature
D) molar mass and pressure

17. Each of four test tubes contains a different concentration of HCI(aq) at 25°C. A 1-gram cube of Zn is added to each test tube. In which test tube is the reaction occurring at the fastest rate?

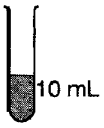
A) 1 M HCl(aq)



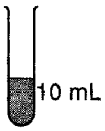
B) 0.1 M HCl(aq)



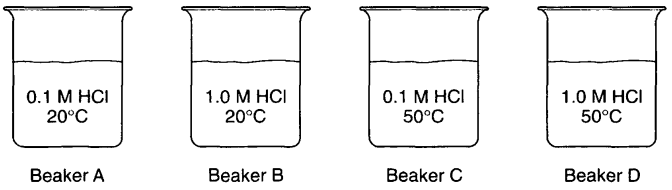
C) 0.01 M HCl(aq)



D) 0.001 M HCl(aq)



18. In each of the four beakers shown below, a 2.0-centimeter strip of magnesium ribbon reacts with 100 milliliters of HCl(aq) under the conditions shown.



In which beaker will the reaction occur at the fastest rate?

A) A B) B C) C D) D

19. A 1.0-gram piece of zinc reacts with 5 milliliters of HCl(aq). Which of these conditions of concentration and temperature would produce the greatest rate of reaction?

A) 1.0 M HCl(aq) at 20.°C
B) 1.0 M HCl(aq) at 40.°C
C) 2.0 M HCl(aq) at 20.°C
D) 2.0 M HCl(aq) at 40.°C

20. As the number of moles per liter of a reactant in a chemical reaction increases, the number of collisions between the reacting particles

A) decreases B) increases
C) remains the same

21. Given the reaction:

$A + B \rightarrow AB$

The table below shows student data obtained about the rate of reaction when the concentration of solution *A* is kept constant and the concentration of solution *B* is changed by adding H_2O. Based on the data, the student should conclude that the

Trial	Volume of Solution *A*	Volume of Solution *B*	Volume of H_2O Added	Reaction Time
1	10 mL	10 mL	O mL	2.8 sec
2	10 mL	5 mL	5 mL	4.9 sec
3	10 mL	3 mL	7 mL	10.4 sec

A) concentration has no effect on the reaction rate
B) reaction rate increased when H_2O was added
C) reaction rate increased as solution *B* was diluted
D) reaction rate decreased as solution *B* was diluted

22. As the number of effective collisions between reacting particles increases, the rate of reaction

A) decreases B) increases
C) remains the same

23. Four aluminum samples are each reacted with separate 1 M copper sulfate solutions under the same conditions of temperature and pressure. Which aluminum sample would react most rapidly?

A) 1 gram bar of Al
B) 1 gram of Al ribbon
C) 1 gram of Al pellets
D) 1 gram of Al powder

24. When a single 1-gram piece of zinc is added to 3 M hydrochloric acid at 25ºC, the reaction is slow. Which procedure would most likely increase the rate of reaction if the reaction were repeated?

A) using 1 gram of powdered zinc
B) using 1 M hydrochloric acid
C) decreasing the temperature to 20.ºC
D) decreasing the concentration of the zinc

25. Charcoal reacts with oxygen according to the equation

$C(s) + O_2(g) \rightarrow CO_2(g)$.

Which of the following changes would cause the greatest increase in the rate of reaction?

A) decreasing the concentration of $O_2(g)$
B) decreasing the pressure of $O_2(g)$
C) using charcoal in powdered form
D) using charcoal in lump form

Base your answers to questions **26** and **27** on the table below, which represents the production of 50 milliliters of CO_2 in the reaction of HCl with $NaHCO_3$. Five trials were performed under different conditions as shown. (The same mass of $NaHCO_3$ was used in each trial.)

Trial	Particle Size of $NaHCO_3$	Concentration of HCl	Temperatur (°C) of HCl
A	small	1 M	20
B	large	1 M	20
C	large	1 M	40
D	small	2 M	40
E	large	2 M	40

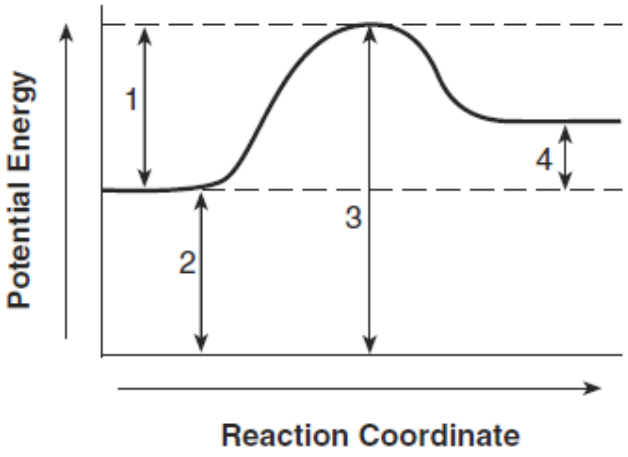
26. Which two trials could be used to measure the effect of surface area?

A) trials *A* and *B* B) trials *A* and *C* C) trials *A* and *D* D) trials *B* and *D*

27. Which trial would produce the fastest reaction?

A) trial *A* B) trial *B*
C) trial *C* D) trial *D*

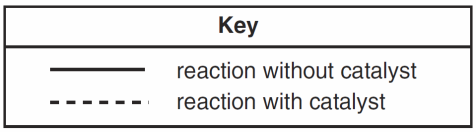
28. Given the potential energy diagram for a reaction:



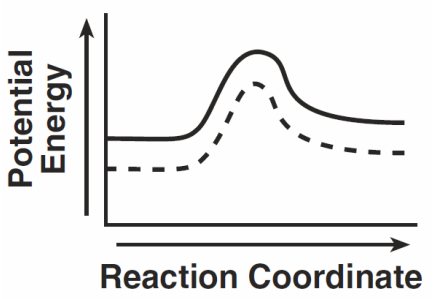
Which intervals are affected by the addition of a catalyst?

A) 1 and 2 B) 1 and 3
C) 2 and 4 D) 3 and 4

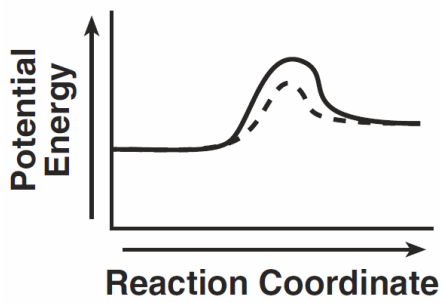
29. Which potential energy diagram represents the change in potential energy that occurs when a catalyst is added to a chemical reaction?



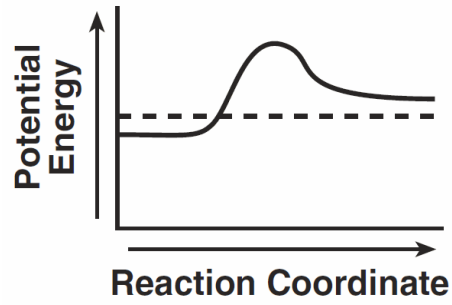
A)



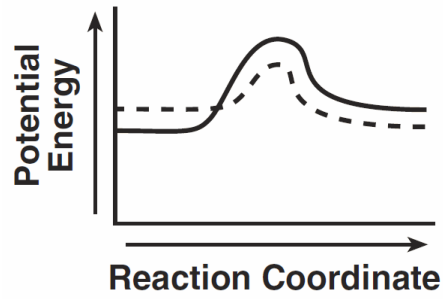
B)



C)



D)



30. For a given reaction, adding a catalyst increases the rate of the reaction by

A) providing an alternate reaction pathway that has a higher activation energy
B) providing an alternate reaction pathway that has a lower activation energy
C) using the same reaction pathway and increasing the activation energy
D) using the same reaction pathway and decreasing the activation energy