

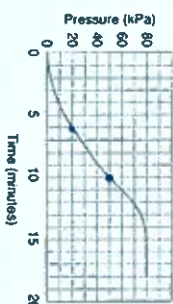
Reaction Rates

Part I

Select the response that best completes each statement or answers each question. Write the letter of each answer in the space provided on the left.

- C 1. Which of the following units does NOT express a rate?
a. m/hr b. mL/min c. g/cm³ d. m/s
- C 2. To determine the rate of a change, you must know _____
a. the extent of the change c. both of these
b. the time over which the change occurs d. neither of these
- B 3. On a graph that shows a rate, the x-axis generally shows _____
a. speed b. time c. distance d. none of these
- D 4. If a factory produces aspirin tablets and packages them in 100-tablet bottles, how might the rate of production be expressed?
a. tablets per bottle c. grams per tablet
b. tablets per kilogram d. bottles per day
- A 5. Which of the following descriptions applies to the rates of most reactions?
a. There is a decrease toward the end because most reactants have been used up.
b. There is an increase toward the end because remaining reactants combine faster.
c. The rate of reaction alternately increases and decreases throughout the duration of the reaction.
d. The rate of reaction is constant until the reaction stops.

Refer to the graph below to answer question 6. The graph shows the rate of a specific reaction.



$$\frac{60-20}{10-0} = \frac{30}{4}$$

- D 6. The graph shown above represents the rate of a reaction in which the pressure of a gas being produced is measured each minute. What is the rate of reaction between the sixth and tenth minutes?
a. 20 kPa/min b. 50 kPa/min c. 13 kPa/min d. 8 kPa/min

- C 7. During which interval is the rate of reaction fastest?
a. 1 min to 2 min c. 10 min to 11 min
b. 4 min to 5 min d. 13 min to 14 min

- C 8. At what time did the reaction stop?
a. 5 min b. 10 min c. 15 min d. 20 min

Questions 9–11: Write the correct answer in the space provided.

- X 9. How can the color of a reactant or product in solution be used to measure the progress of a reaction?

- X 10. What reactant or product would you use to measure the rate of this reaction? How would you make these measurements?
 $\text{Mg(s)} + 2 \text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$

Critical Thinking

- X 11. When a strip of copper is placed into a solution of silver nitrate, silver is deposited on the piece of copper. The reaction that takes place is shown below. How could you use the deposition of silver to measure the rate of this reaction?



Part II

Select the response that best completes each statement or answers each question. Write the letter of each answer in the space provided on the left.

A 12. How does changing the surface area of a solid reactant affect the rate of a reaction?

- a. Increasing surface area increases the rate of reaction.
- b. Increasing surface area decreases the rate of reaction.
- c. Decreasing surface area increases the rate of reaction.
- d. Changing the surface area has no effect on the rate of reaction.

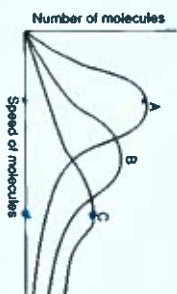
B 13. How does the collision theory explain the effect of changing the concentration of reactants on the rate of a reaction?

- a. Increasing the concentration decreases the rate of reaction because reactants are too crowded to collide.
- b. Increasing the concentration increases the rate of reaction because there are more reactant particles to take part in collisions.
- c. Decreasing the concentration increases the rate of reaction because there is more room for particles to rebound after colliding.
- d. The collision theory cannot explain the effect of changing the concentration of reactants.

A 14. How does the collision theory explain the effect of temperature on the rate of a reaction?

- a. Increasing the temperature increases the rate of reaction because particles move faster at higher temperatures.
- b. Increasing the temperature decreases the rate of reaction because fewer collisions occur at high temperatures.
- c. Decreasing the temperature increases the rate of reaction because particles are closer together at lower temperatures.
- d. The collision theory cannot explain the effect of changing the temperature.

Refer to the graph below to answer questions 15–16. The graph plots numbers of molecules versus molecular speed for the same substance at three different temperatures, A, B, and C.



A 15. Which of the curves shown represents the lowest temperature conditions?

- a. A
- b. B
- c. C
- d. All three curves represent the same temperature.

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D 16. The graph shows that an increase in temperature causes _____.

- a. all particles to move faster
- b. many particles to move faster
- c. a greater number of particles to reach the activation energy
- d. both b and c to occur

A 17. Which of the following statements about catalysts is true?

- a. A catalyst can increase the rate of a reaction.
- b. All catalysts are enzymes.
- c. Catalysts are consumed more slowly than other reactants.
- d. All catalysts are metals.

Critical Thinking

An automobile's catalytic converter, which controls the release of carbon monoxide and other harmful gases into the air, is designed to not have to be refilled or replaced. Explain why.

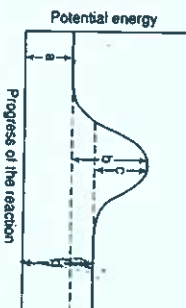
Because catalysts are not involved in the actual reaction.

Part III

Select the response that best completes each statement or answers each question. Write the letter of each answer in the space provided on the left.

Refer to the figure at the right to answer questions 19–23.

The graph plots potential energy versus the progress of a reaction.



D 19. Which measurement represents the potential energy of the products?

- a. a
- b. b
- c. c
- d. d

A 20. Which measurement represents the potential energy of the reactants?

- a. a
- b. b
- c. c
- d. d

B 21. Which measurement represents the activation energy for these reactants?

- a. a
- b. b
- c. c
- d. d

B 22. Which equation would be used to calculate ΔH ?

- a. $\Delta H = a - d$
- b. $\Delta H = b - c$
- c. $\Delta H = d - b$
- d. $\Delta H = d - a$

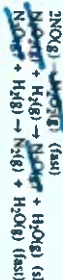
23. If a catalyst were added, which quantity shown in the graph would decrease?

- a. Δ
b. b
c. d
d. All quantities would decrease.

Questions 24–27. Write the correct answer in the space provided.

24. In a fast-food restaurant, there are many steps in preparing a hamburger. First the meat is cooked. It is then placed on the bottom half of a roll, toppings are added, and the top of the roll is put in place. The hamburger is wrapped and then served. What is the rate-determining step in this process? Explain your answer, and tell how the rate of this step could be increased.

25. The three equations shown below are a mechanism for the reaction in which nitric oxide reacts with hydrogen to produce nitrogen and water. Identify the rate-determining step, and write the equation for the overall reaction.



→ rate determining step



Critical Thinking

26. The reaction in question 25, would increasing the partial pressure of NO gas increase the rate of the overall reaction? Explain your answer.

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Laboratory Investigation

27. In laboratory investigations on rate of reaction, flasks must often be swirled to mix the reactants. If several reactions are being run simultaneously, why must the force and rate of swirling be standardized?
