

8. A catalyst makes it possible for reactions to occur with less energy than reactions that do not have a catalyst. The catalyst helps molecules line up better so that, when they collide with each other, the reaction takes place with less energy than would otherwise be required.

Understanding Key Ideas

9. (a) Raising the temperature, increasing the concentration
(b) Raising the temperature, adding a catalyst
(c) Raising the temperature increases the number of collisions and also makes them more effective because the collisions happen with greater energy.
10. Raising the temperature increases the number of collisions and also gives the collisions a greater amount of energy.
11. Increasing the surface area gives greater opportunity for reactant particles to collide. This increases the rate of reaction.
12. Increasing the concentration of a reactant gives a greater opportunity for reactant particles to collide. This increases the rate of a reaction.
13. A catalyst helps reactant molecules to line up more effectively than without a catalyst. This allows the reaction to happen with less energy.

Pause and Reflect Answer

Students could cover some of these points.

- Throwing the wrapper back into the original box makes it harder to find wrapped chocolates, so this slows down the rate of chocolate eating.
- As the reaction proceeds, the reactants become mixed with the products, so the chance of the catalyst finding the reactants decreases, slowing down the reaction.

Other Assessment Opportunities

- BLM 2-42, Chapter 6 Quiz
- Assessment Checklist 4, Laboratory Report
- Assessment Checklist 25, Safety Checklist
- Process Skills Rubric 7, Predicting
- Process Skills Rubric 8, Interpreting Data
- Process Skills Rubric 10, Measuring and Reporting
- Assessment Rubric 5, Conduct an Investigation Rubric
- Assessment Rubric 11, Communication Rubric
- Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric

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■ PREPARE YOUR OWN SUMMARY

Student summaries should incorporate the following main ideas.

1. Many Chemical Reactions Can Be Classified into One of Six Types
 - Synthesis refers to the reaction of two elements to form a compound.
 - Decomposition refers to the chemical separation of a binary compound into two pure elements.
 - Single replacement is a reaction in which an element replaces another element in a compound, to form a new element and compound.
 - Double replacement reactions involve two ionic compounds that swap ions to form new combinations, such that the new compounds still each have one positive ion and one negative ion.
 - Neutralization reactions involve the reaction of an acid with a base to produce a salt and water.
 - Combustion refers to the reaction of an organic compound to produce carbon dioxide and water.
 - Each of the six reaction types can be recognized by looking only at the reactants, making it possible to predict the products of any of these types of reactions.
2. Certain Factors Affect the Rate of Chemical Reactions
 - Reaction rates are affected by temperature, concentration, surface area, and the presence of a catalyst.
 - Increasing the temperature increases reaction rate because reacting particles collide more frequently and with greater energy.
 - Increasing the concentration or surface area increases reaction rate because reacting particles collide more frequently.
 - A catalyst speeds up a reaction by lowering the energy needed for the reaction to occur; this is done by helping reactant molecules line up effectively.
 - A catalyst is present in the same amount at the end of the reaction as it was at the beginning.

■ CHAPTER REVIEW ANSWERS

Checking Concepts

1. (a) Neutralization
(b) Synthesis
(c) Synthesis

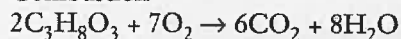
Key Ch 6
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- (d) Decomposition
 (e) Neutralization
 (f) Double replacement
 (g) Single replacement
 (h) Single replacement
 (i) Double replacement
 (j) Combustion
2. (a) $\text{Al} + \text{F}_2 \rightarrow \text{AlF}_3$
 (b) $\text{K} + \text{O}_2 \rightarrow \text{K}_2\text{O}$
 (c) $\text{C}_2\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
 (d) $\text{C}_6\text{H}_{12}\text{O}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
 (e) $\text{Rb}_2\text{O} \rightarrow \text{Rb} + \text{O}_2$
 (f) $\text{Sr} + \text{F}_2 \rightarrow \text{SrF}_2$
 (g) $\text{BaCl}_2 + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{Ba}(\text{NO}_3)_2 + \text{PbCl}_2$
 (h) $\text{AgNO}_3 + \text{K}_2\text{Cr}_2\text{O}_7 \rightarrow \text{KNO}_3 + \text{Ag}_2\text{Cr}_2\text{O}_7$
 (i) $\text{Br}_2 + \text{NiI}_3 \rightarrow \text{NiI}_3 + \text{Br}_2$
 (j) $\text{Cl}_2 + \text{Mg}_3\text{N}_2 \rightarrow \text{MgCl}_2 + \text{N}_2$
 (k) $\text{HCl} + \text{Mo}(\text{OH})_2 \rightarrow \text{MoCl}_2 + \text{H}_2\text{O}$
 (l) $\text{Sn}(\text{OH})_2 + \text{HClO}_3 \rightarrow \text{Sn}(\text{ClO}_3)_2 + \text{H}_2\text{O}$
 (m) $\text{Al} + \text{CuI}_2 \rightarrow \text{AlI}_3 + \text{Cu}$
 (n) $\text{Mg} + \text{FeF}_2 \rightarrow \text{MgF}_2 + \text{Fe}$
3. (a) Decomposition
 (b) Synthesis
 (c) Neutralization
 (d) Single replacement, combustion
 (e) Combustion
 (f) Double replacement, neutralization
 (g) Single replacement
4. (a) Concentration
 (b) Surface area
 (c) Temperature
 (d) Concentration
 (e) Concentration
 (f) Catalyst
 (g) Surface area
 (h) Concentration

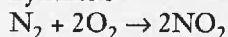
Understanding Key Ideas

5. (a) Synthesis
 $4\text{Li} + \text{O}_2 \rightarrow 2\text{Li}_2\text{O}$
 (b) Single replacement
 $3\text{Mg} + 2\text{AlCl}_3 \rightarrow 3\text{MgCl}_2 + 2\text{Al}$
 (c) Combustion
 $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$
 (d) Neutralization
 $\text{HCl} + \text{LiOH} \rightarrow \text{LiCl} + \text{H}_2\text{O}$
 (e) Decomposition
 $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$
 (f) Single replacement
 $3\text{Sn} + 4\text{Au}(\text{NO}_3)_3 \rightarrow 3\text{Sn}(\text{NO}_3)_4 + 4\text{Au}$
 (g) Double replacement
 $2\text{Ba}(\text{OH})_2 + \text{PbBr}_4 \rightarrow 2\text{BaBr}_2 + \text{Pb}(\text{OH})_4$

(h) Combustion



(i) Synthesis



6. Reaction systems that do not have a surface, such as between two gases or between two liquids that completely mix into each other, are not affected by surface area considerations. If the reaction system has two or more distinct regions, such as a solid placed in a liquid, then there is a surface and surface area is a factor.

Applying Your Understanding

7. Surface area > temperature > concentration

Pause and Reflect Answer

Students' answers may include some of these points.

- Kitchen chemistry involves reaction rates: heating speeds up the decomposition of foods, while cooling slows it down.
- The reaction of gasoline with air in a car's engine is sped up by increasing the temperature inside the engine. A catalytic converter in the automobile's exhaust system speeds the decomposition of air pollutants leaving the engine.