GUIDELINE 3  Many compounds are not usually referred to by their systematic names. Instead, they are assigned common names that are more convenient or have been used traditionally for many years. Some common names are water for H₂O, ammonia for NH₃, and methane for CH₄.

CHECK POINT

What is the systematic name for NaF?

Was this your answer?

This compound is a cavity-fighting substance added to some toothpastes—sodium fluoride.

SUMMARY OF TERMS

Basic research A branch of scientific research that focuses on a greater understanding of how the natural world operates.

Applied research A branch of scientific research that focuses on developing applications built on the principles discovered through basic research.

Molecule A submicroscopic particle consisting of a group of atoms.

Submicroscopic On the scale of atoms and molecules, which are so small that we cannot observe them directly with optical microscopes.

Physical property Any physical attribute of a substance, such as color, density, or hardness.

Physical change A change in which a substance changes one or more of its physical properties without transforming into a new substance.

Chemical property A property that characterizes the ability of a substance to undergo a change that transforms it into a different substance.

Chemical bond The force of attraction between two atoms that holds them together. As discussed in Chapter 19, the nature of this force is electrical.

Chemical change A change in which the atoms of one or more substances are rearranged into one or more new substances.

Chemical reaction Synonymous with chemical change.

Elemental formula A notation that uses the atomic symbol and (sometimes) a numerical subscript to denote how atoms of the element are bonded together.

Compound A material in which atoms of different elements are bonded to one another.

Chemical formula A notation used to indicate the composition of a compound, consisting of the atomic symbols for the different elements of the compound and numerical subscripts indicating the ratio in which the atoms combine.

REVIEW QUESTIONS

14.1 Chemistry: The Central Science

1. What is the difference between basic research and applied research?
2. Why is chemistry often called the central science?
3. What do members of the American Chemistry Council pledge in the Responsible Care program?

14.2 The Submicroscopic World

4. Are atoms made of molecules or are molecules made of atoms?
5. How are the particles in a solid arranged differently from those in a liquid?
6. How does the arrangement of particles in a gas differ from the arrangements in liquids and solids?
7. Which occupies the greatest volume: 1 g of ice, 1 g of liquid water, or 1 g of water vapor?

14.3 Physical and Chemical Properties

8. What is a physical property?
9. What doesn’t change during a physical change?
10. What is a chemical property?
11. What is a chemical bond?
12. What changes during a chemical reaction?

14.4 Determining Physical and Chemical Changes

13. Why is the freezing of water considered a physical change?
14. Why is it sometimes difficult to decide whether an observed change is physical or chemical?
15. Why is the rusting of iron considered a chemical change?
16. What are some clues that help us determine whether an observed change is physical or chemical?
14.5 Elements to Compounds

17. Distinguish between an atom and an element.
18. How many atoms are in a sulfur molecule that has the elemental formula \( \text{S}_2 \)?
19. What is the difference between an element and a compound?
20. How many atoms are there in one molecule of \( \text{H}_3\text{PO}_4 \)? How many atoms of each element are there in one molecule of \( \text{H}_3\text{PO}_4 \)?
21. Are the physical and chemical properties of a compound necessarily similar to those of the elements from which it was composed?

14.6 Naming Compounds

22. Which element within a compound is shown first within the compound’s name?
23. What is the IUPAC systematic name for the compound \( \text{KF} \)?
24. What is the chemical formula for the compound titanium dioxide?
25. Why are common names often used for chemical compounds instead of systematic names?

EXERCISES

1. While you are visiting a foreign country, a non-English-speaking citizen tries to give you verbal directions to a local museum in that country’s language. After multiple attempts he is unsuccessful. An onlooker sees your frustration and concludes that you are not smart enough to understand simple directions. Another onlooker sympathizes with you because he knows how difficult it is to navigate through an unfamiliar city. Which onlooker is correct?

2. If someone else can explain an idea to you using small familiar words, what does this say about how well that person understands the idea?

3. Person A can explain an idea to a group of college students. Person B can explain the same idea, to the same depth, to a group of elementary school students. Who has demonstrated a greater command of the idea?

4. What is the best way to really prove to yourself that you understand an idea?

5. In what sense is a color computer monitor or television screen similar to our view of matter? Place a drop (and only a drop) of water on your computer monitor or television screen for a closer look.

6. Of physics, chemistry, and biology, which science is the most complex?

7. Is chemistry the study of the submicroscopic, the microscopic, or all three? Defend your answer.

8. A cotton ball is dipped in alcohol and wiped across a tabletop. Explain what happens to the alcohol molecules deposited on the tabletop. Is this a physical or chemical change?

9. A skillet is lined with a thin layer of cooking oil followed by a layer of unpopped popcorn kernels. Upon heating, the kernels all pop, thereby escaping the skillet. Identify any physical or chemical changes.

10. A cotton ball dipped in alcohol is wiped across a tabletop. Would the resulting smell of the alcohol be more or less noticeable if the tabletop were much warmer? Explain.

11. Use Exercise 9 as an analogy to describe what occurs in Exercise 10. Does it make sense to think that the alcohol is made of very tiny particles (molecules) rather than being an infinitely continuous material?

12. Alcohol wiped across a tabletop rapidly disappears. What happens to the temperature of the tabletop? Why?

13. Red Kool-Aid crystals are added to a still glass of water. The crystals sink to the bottom. Twenty-four hours later the entire solution is red, even though no one stirred the water. Explain.

14. Red Kool-Aid crystals are added to a still glass of hot water. The same amount of crystals is added to a second still glass filled with the same amount of cold water. With no stirring, which would you expect to become uniform in color first: the hot water or the cold water? Why?

15. With no one looking, you add 5 ml of a cinnamon solution to a blue balloon, which you tie shut. You then add 5 ml of fresh water to a red balloon, which you also tie shut. You heat the two balloons in a microwave until they each inflate to about the size of a grapefruit. Your brother then comes along, examines the inflated balloons, and tells you that the blue balloon is the one that contains cinnamon. How did he know?


17. The leftmost diagram shows the moving particles of a gas within a rigid container. Which of the three boxes on the right—(a), (b), or (c)—best represents this material after the addition of heat?

18. The leftmost diagram shows two phases of a single substance. In the middle box, draw what these particles would look like if heat were taken away. In the box on the right, show what they would look like if heat were added. If each particle represents a water molecule, what is the temperature of the box on the left?