Conservation of Matter A candle may seem to "go away" when it is burned, or water may seem to "disappear" when it changes to a gas. However, scientists long ago proved otherwise. In the 1770s, a French chemist, Antoine Lavoisier, carried out experiments in which he made accurate measurements of mass both before and after a chemical change. His data showed that no mass was lost or gained during the change. The fact that matter is not created or destroyed in any chemical or physical change is called the **law of conservation of matter.** Remember that mass measures the amount of matter. So, this law is sometimes called the law of conservation of mass.

Suppose you could collect all the carbon dioxide and water produced when methane burns, and you measured the mass of all of this matter. You would find that it equaled the mass of the original methane plus the mass of the oxygen that was used in the burning. No mass is lost, because during a chemical change, atoms are not lost or gained, only rearranged. A model for this reaction is shown in Figure 15.

Reading Checkpoint **Why is combustion classified as a chemical change?**

FIGURE 14
Using Methane
Natural gas, or methane, is the fuel used in many kitchen ranges. When it burns, no mass is lost.

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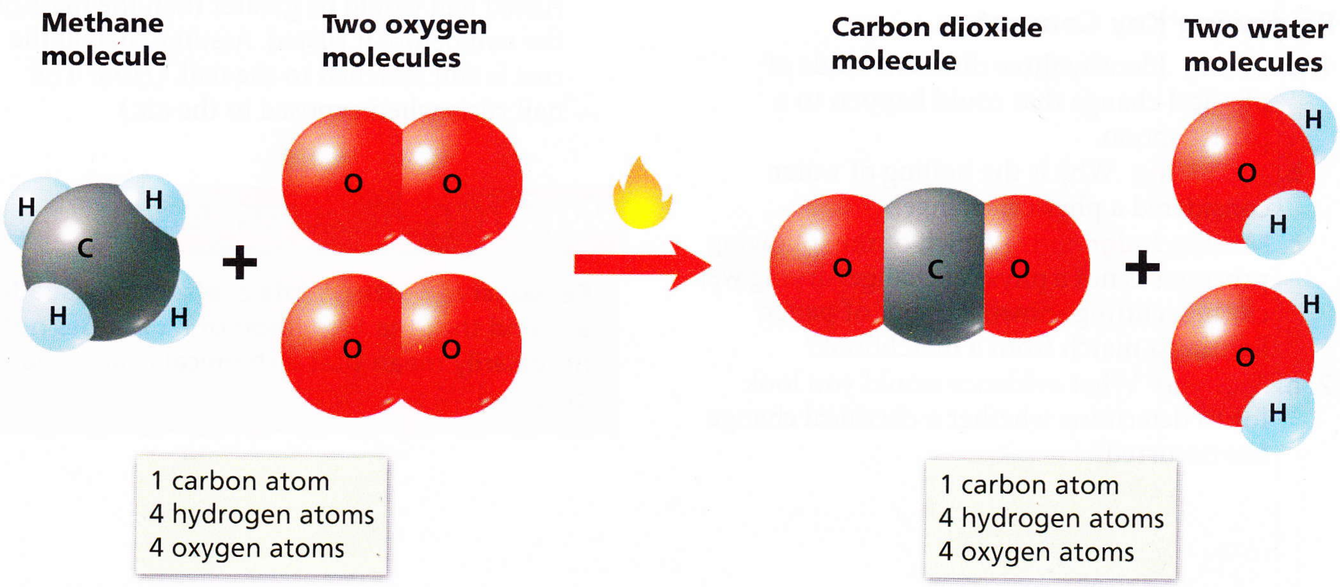
FIGURE 15
Conserving Matter
The idea of atoms explains the law of conservation of matter. For every molecule of methane that burns, two molecules of oxygen are used. The atoms are rearranged in the reaction, but they do not disappear.



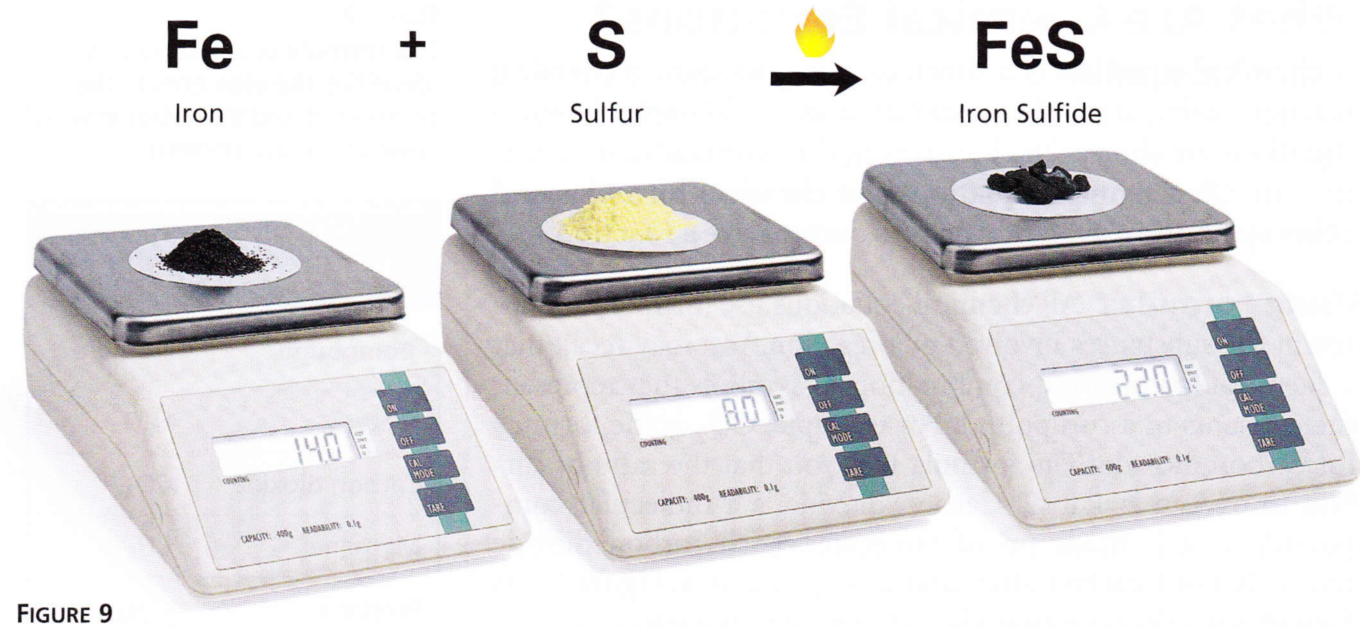


FIGURE 9
Conservation of Matter
Matter is conserved in chemical reactions.

Conservation of Matter

Look closely at the values for mass in Figure 9. Iron and sulfur can react to form iron sulfide. The photograph represents a principle first demonstrated by the French chemist Antoine Lavoisier in 1774. This principle is called **conservation of matter.** It states that, during a chemical reaction, matter is neither created nor destroyed. The total mass of the reactants must equal the total mass of the products.

Conservation of Atoms The idea of atoms explains the conservation of matter. **In chemical reactions, the number of atoms stays the same no matter how they are arranged. So, their total mass stays the same.** Look again at Figure 9. Suppose one atom of iron reacts with one atom of sulfur. At the end of the reaction, you have one iron atom bonded to one sulfur atom in the compound FeS. All the atoms present at the start of the reaction are present at the end of the reaction. The amount of matter does not change. The total mass stays the same before and after the reaction.

Open and Closed Systems At first glance, some reactions may seem to violate the principle of conservation of matter. It's not always easy to measure all the matter involved in a reaction. For example, if you burn a match, oxygen comes from the surrounding air. But how much? Likewise, the products escape into the air. Again, how much?

Lab zone Try This Activity

Is Matter Conserved?

1. Add water to a small, sealable container until it is one-third full.
2. Measure the combined mass of the partially filled container, its screw-on cap, and one quarter of an effervescent tablet.
3. Drop the tablet into the water, and immediately screw on the cap.
4. After the fizzing stops, measure the mass of the sealed container.
5. Remove the cap. Measure the combined mass of the unsealed container, its contents, and the cap.

Interpreting Data How did the mass measured in Step 2 compare to the masses measured in Steps 4 and 5? Was matter conserved?

A burning match is an example of an open system. In an **open system,** matter can enter from or escape to the surroundings. The burned out fire in Figure 10 is another example of an open system. If you want to measure all the matter before and after a reaction, you have to be able to contain it. In a **closed system,** matter is not allowed to enter or leave. The pear decaying under glass in Figure 10 is a closed system. So is a chemical reaction inside a sealed plastic bag.

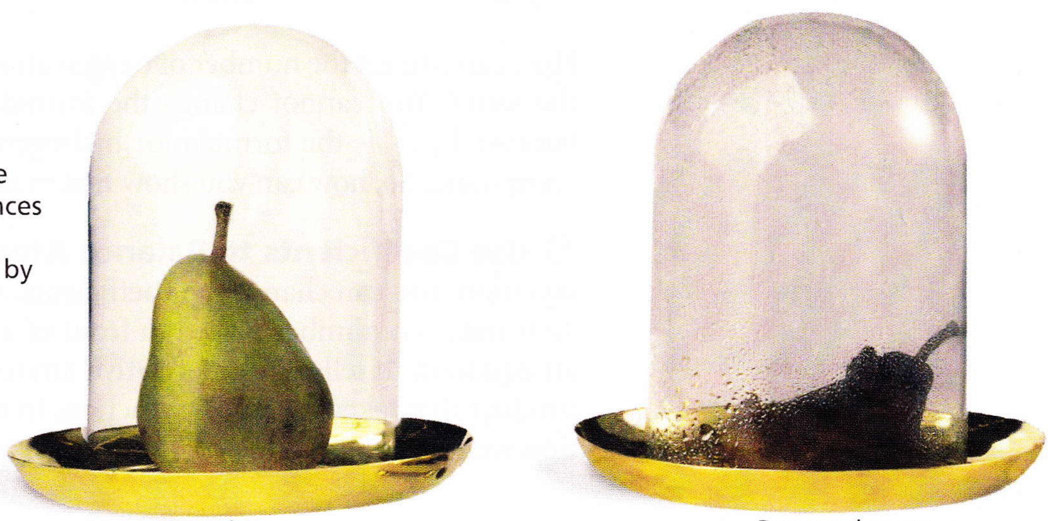
Reading Checkpoint **What is a closed system?**

FIGURE 10
Open and Closed Systems

A wood fire is an open system because gases escape into the air. A pear in a glass dome is a closed system because the reactants and products are contained inside the dome.
Problem Solving *What masses would you need to measure before and after a wood fire to show conservation of mass?*

Open System
Except for the ash, products of the wood fire have escaped up the chimney or into the room.

Closed System
The total mass of the pear and the substances produced during its decay are contained by the glass dome.



Fresh pear

Decayed pear