The Mass of Matter

Matter may change from a solid to a liquid. Elements may react together to form compounds. What happens to the mass of matter in a bowl of water when it is left to stand in the hot sun? What happens to the mass of matter in a piece of paper when it is burned? Sometimes in situations like this it seems as if matter is disappearing. But the disappearance of matter is an illusion.

Matter may change from one form into another. For example, when the water in the bowl absorbs energy from the sun and evaporates, it becomes water vapor in the atmosphere. The piece of paper gives off heat and light energy as it burns, and the matter in it is converted into carbon dioxide, water vapor, and other gases that escape into the atmosphere. Some of the mass will remain behind as ash. In both cases, the matter changes its form, but its total mass stays the same. The same mass of each element is present before and after the change. Matter is neither created nor destroyed during these changes.

It took early scientists hundreds of years of scientific study before the law of conservation of mass became accepted. For a long time, scientists had suspected that matter could not be created or destroyed, but nobody had performed an experiment that proved it. During the late 18th century, French chemist Antoine Lavoisier and his wife Marie-Anne conducted several experiments that demonstrated the conservation of mass. Antoine was famous for his accurate observations and insistence on careful measurements. He used accurate balances that could measure very small changes in mass during his experiments. Many of the Lavoisiers' experiments were conducted in sealed glass containers from which matter could not escape or enter. For example, in one experiment, Antoine put fruit into a sealed container, measured its mass, and then left it in a warm place for a few days. The fruit rotted and changed into a putrid mess. Gas was released from the decomposing fruit and droplets of water formed on the glass, but nothing escaped from the container. Lots of changes had taken place, but the mass of the sealed container and the rotten fruit was equal to the mass measured at the beginning of the experiment. In other experiments, Antoine heated elements in enclosed containers with air inside them. He discovered that new substances were formed but that the container and its contents had the same mass as they did before heating. When he measured the mass of the new solid substances he had made, he discovered that they were heavier than the original elements he heated. In this way, he determined that they must have gained their mass from the air. On the basis of these experiments, he also concluded that air contained several gases, one of which reacted with the elements in the experiment. He called this gas oxygen (which had previously been discovered and described—but not named—by Carl Wilhelm Scheele and by Joseph Priestley). In 1789, Antoine wrote the best textbook on chemistry

the world had seen. In it, he introduced a new scientific law that he called the **law of conservation of mass (matter)**. This law stated that in any closed system (as small as a sealed container or as big as the whole universe!) the total mass remains the same, regardless of what changes take place inside.

Question
Imagine you are Antoine Lavoisier. How could you design an experiment to investigate what happens to the total mass of matter when a caterpillar eats a leaf? Draw a picture of the equipment you would use and write a short description of the procedure you would follow. Remember that Antoine Lavoisier did not have electronic balances.