

4.1: Good Explanations of Chemical Change Reading

You have acted as a questioner to develop questions about how ethanol burns. Now, you are ready to act as an investigator to try to find the answers to your questions. But, what does a scientific answer to question about things burning look like? If you want to be able to explain how ethanol burns, what evidence will you need?

Ethanol burning is a *chemical change*. The chemical change that occurs when anything burns is called combustion. Elizabeth Fulhame, who you read about in Lesson 1, collected evidence about how matter moved and changed and how energy changed in her investigations in order to write explanations. She documented the appearance and mass of the materials before the chemical change and after the chemical change.

When you explain ethanol burning (or combustion), you will know something very important that Elizabeth Fulhame did not. (You learned about this from the Powers of 10 video.) Scientists in her time had microscopes that they could use to see cells and other things at the microscopic scale, but they did not have good theories about systems at smaller scales. So, scientists in Elizabeth Fulhame's day did not know about how atoms bond together to form molecules.

When scientists today explain chemical changes, they always try to do two things. First, they *trace matter and energy* through the chemical change. Second, they *connect scales*. In particular, they connect changes in materials that they observe at the macroscopic scale with changes in the atoms and molecules that the materials are made of.

You will use *The Three Questions* to help you trace matter and energy, connect scales, and write good scientific explanations. This includes four steps, numbered below.

1. The first question is the *Matter Movement Question*. Since matter moves into the flame and out of the flame, you will need to answer this question twice, at the beginning and the end of your explanation. First, you will consider: how do molecules move to the location of the chemical changes? All materials are made up of atoms that are usually bonded together in molecules, which have mass. To answer this question, you need evidence that molecules moved. *What data could you use as evidence that molecules have moved?*

2. The second question is the *Matter Change Question*. This question asks: how are atoms in molecules being rearranged into different molecules? Since atoms last forever, all atoms in the molecules at the start of the chemical change will have need to be in atoms at the end of the chemical change. In a chemical change the atoms stay the same but the molecules change. When atoms rearrange into different molecules, those molecules form different materials—solids, liquids, or gases—than were present before the chemical change. *What data could you use as evidence that atoms have been rearranged into different molecules?*

3. The third question is the *Energy Change Question*. When matter changes, energy often changes, too. Energy lasts forever and can be transformed. Energy may be in one form at the start of the chemical change and be transformed into a different form by the end of the chemical change. Some forms of energy are light energy, heat energy, motion energy, and chemical energy. *What data could you use as evidence of the types of energy at the start and end of the chemical change?*

4. To complete the story of the chemical change by tracing matter and energy, you will need to answer the *Matter Movement Question* again. Specifically, you will answer: how do molecules move away from the location of the chemical change? *What data could you use as evidence that molecules have moved away from the location of the chemical change?*

As an investigator, you will make predictions and then do an investigation to collect evidence about what is happening when ethanol burns.