6.1 The History of Chemistry

LEARNING TIP

Skim through the Key Ideas (on the previous page), headings, diagrams, photographs, and words in bold to get an idea of what you will be learning in Chapter 6. What do you think you will be learning?

How do you know that gold, silver, carbon, and oxygen are elements? How do you know that air is a mixture or that salt is a compound?

What people know can have a powerful influence on how they view the world. Sometimes, when new ideas are formed, a time of great learning and activity occurs. The beginnings of modern chemistry replaced the beliefs of the alchemists and created a revolution in understanding that created much of the chemistry we use today.

Ancient Chemistry

Ancient chemistry's purpose was to find and purify new substances for as many uses as possible. Metals were probably the first substances to be discovered. The earliest metals used were those that could be found naturally in their pure form. Copper and gold have been found in very ancient remains of both Egypt and Mesopotamia. Can you imagine what it must have been like to discover pure gold and copper in a world of rocks and trees?

As methods for making hotter fires were discovered, metals could be obtained from ore and purified. This science, known as metallurgy, became an important part of the culture of Egypt and Babylon, and a close association between metals and the priests, temples, and gods was established. Other examples of ancient chemistry include the following:

- making and colouring glass
- colouring textiles using dyes from plants and animals
- making inks
- manufacturing bricks and ceramic products
- producing charcoal and lime
- using fermentation to make alcoholic beverages
- preserving food
- making perfumes and ointments or salves

The Alchemists

To many of us, the word "alchemy" calls up a picture of a medieval laboratory in which an aged, black-robed wizard mixes strange potions in search of the philosopher's stone—the legendary substance that was believed to change common metals to gold, cure all diseases, and prolong life indefinitely. In reality, alchemy was a reflection of the serious religious beliefs of the Middle Ages. Alchemy flourished in Chinese, Hindu, Arabic, and European cultures. It was a study of the natural world in an attempt to blend the natural world with the spiritual world—a search for perfection. Much of the study of alchemy was very secretive. There was little sharing

Did You KNOW?

Fact and Fiction

Nicholas Flamel, a character in *Harry Potter and the Philosopher's Stone*, was based on a real French alchemist of the same name, who claimed to have found the philosopher's stone and made gold.

among alchemists. In fact, the symbols for what we now know as elements were chosen to prevent knowledge about the elements from becoming known and shared (Table 1).

Table 1 Alchemy Symbols of Some Elements

antimony	arsenic	copper
gold	iron	lead
magnesium	silver	sulfur or brimstone

In Europe, alchemy contributed to the manufacture of amalgams (alloys of mercury and other metals) and to advances in many other chemical processes and the apparatus required for them. It failed to create, however, any new understanding of matter. The alchemists still believed, as the Greeks had, that all the substances in the world were composed of some combination of the four basic elements: fire, earth, air, and water (Figure 1).

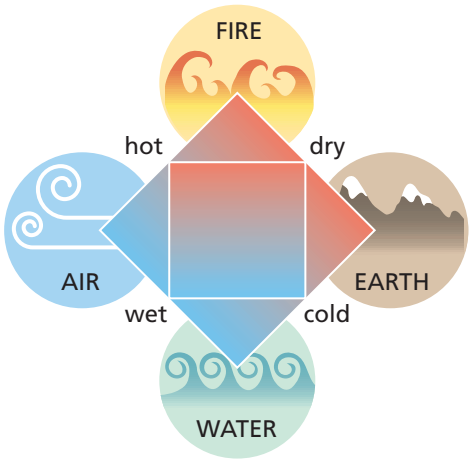

Figure 1 The four elements: Fire is both hot and dry. Earth is both cold and dry. Air is both hot and wet. Water is both cold and wet.

By the 16th century, the alchemists in Europe had separated into two groups. One group continued to look at the more spiritual side of alchemy—the search for immortality and the ability to change common metals into gold. This led to the modern-day idea of alchemy. The second group, including such great scientists as Sir Isaac Newton and Sir Robert Boyle, focused on the discovery of new compounds and their reactions, leading to what is now the science of chemistry.

Did You KNOW?

A Little Luck

Hennig Brand was one of the last alchemists. Using the model of the alchemists, he was searching for gold by condensing urine when he discovered something that glowed in the dark. He had discovered phosphorus, the last of the elements discovered by alchemy, although Brand did not know that it was an element. This story gives some insight into the role of luck or serendipity in the study of science.

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Figure 2 Robert Boyle said that a scientist should doubt the universal laws unless there was experimental evidence of them. He used equipment like this for his experiments.

LEARNING TIP

Share your thinking with a partner. How did the introduction of experimental investigations and observation changes the face of modern chemistry?

The Beginnings of Modern Chemistry

The early chemists began to question the alchemists' use of a model without testing it in the real world. Experimentation and observation became important. Robert Boyle (1627–1691) told the chemists of his day to be skeptics or doubters (Figure 2). As chemists recognized the existence of two types of pure substances (compounds and elements), they began to test many substances to see if the substances could be broken down into simpler substances. If a substance could be broken down, they measured the proportions (ratios) and described a new compound. If a substance could not be broken down, they had discovered a new element! These scientists began to forge a new chemistry, different from that of the alchemists—what is referred to as "the reformed chemistry movement."

Elements began to be discovered at a rapid pace. Between the time of the Greeks and the discovery of true elements, a period of about 1800 years, only four new elements had been discovered. The early chemists, armed with their new knowledge of elements and compounds, discovered 20 new elements during the 1700s and 51 during the 1800s. Suddenly, they had a new challenge. The large increase in the number of elements and the discovery of proportion in compounds required a new system of names and symbols so that chemists could describe and discuss their findings with others. This was another great change from the secrecy of the alchemists' period. With scientific societies arising in many countries, it became very important to develop ways to improve communication. Naming and organizing the elements and compounds was an important task that early chemists needed to accomplish.

TRY THIS: Getting the Message Across

Skills Focus: communicating, analyzing

In today's world of the Internet, e-mail, and text messaging, the power of a few letters to act as a symbol is not surprising. In this activity you will explore the process of symbolic communication.

1. With a partner, translate the meaning of these common abbreviations that are used in text messaging: LOL, THX, 14AA41, BCNU, CUL, GFN, ICBW, SFETE.
2. Write a note to your partner using text messaging abbreviations and/or symbols. See if your partner can "get the message."
3. With your partner, create some secret symbols to use in a text message. Write a second message with your secret symbols and share it with another pair of students. Can they figure out your message? Can you decipher their message?

A. What is the difference between the messages used in the first two steps above and in the last step?

B. Describe a situation in which it might be important to build a good code. When might it be important to break a code?

C. Which approach did the alchemists take? Why? Which approach did early chemists take? Why? What effect do you think the new approach had on the development of the understanding of matter?

6.1 CHECK YOUR Understanding

1. When you use different materials, what are they most likely to be made from: elements, compounds, or mixtures? Which of the three is the most rare?
2. The alchemists were looking for control over their world. What would the philosopher's stone enable them to do? How would this give them control?
3. In ancient Greece, what were the only pure elements? What was everything else?
4. Which of the alchemy symbols is used today with a completely different meaning? What does the symbol mean today?
5. What effect did the belief that most matter was mixtures have on chemistry?
6. When an alchemist did an experiment that did not create gold, was it considered a success or a failure? Was the production of gold a good criterion for an experiment? Explain.
7. What stimulated the rapid discovery of new elements during the 1700s?
8. What was different about how the alchemists and early chemists communicated their knowledge?
9. Do you think there is very much practical chemistry in today's world? Can you give any examples?
10. When is it beneficial to have a language that can only be understood by a few people? What is the benefit of having an open language that everyone can use and access?
11. Is the world flat? How do you know? Is your knowledge based on believing a model someone told you about or is it based on some observation you have made. Share your thinking.
12. Observation became the most important skill of the early chemists, and it is still the most important skill in science. Divide a sheet of paper into two columns. In the left column, accurately record five observations you have made in one day. In the right column, add any ideas, inferences, or speculations based on your observations. Be careful to write clearly so you will be able to read and understand your notes in a few days, weeks, or months.
13. In the Middle Ages, education was mainly based on the beliefs and rules handed down from the Church and the ancient Greeks. One of the great breakthroughs of the early scientists was the concept of doubt. The great scientist and mathematician Rene Descartes told his pupils to "doubt everything." What do you think is the purpose of doubting something in science?
14. You have learned about many models, including the kinetic molecular theory. Should you, like the early chemists, doubt these models or just accept them as fact? Explain your thinking.
15. The alchemists started with knowledge and applied it to the world, often ignoring their own observations. Scientists start by observing and experimenting and end by creating new knowledge. Describe the differences between these two approaches. Give an example of each approach that you have taken lately.
16. If practising science is a struggle between models and new observations, how do experiments fit in? Is their purpose to support theories or is it to prove theories wrong? Explain your thinking.