The History of Ancient Chemistry

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It is said that science began with the Greeks. However, development of science in Greece drew on the older, more mature cultures of Egypt and Babylonia. Scientific thought advanced and literature flourished in Babylon under King Hammurabi (1792-1750 BC) due to the stability of his reign. Babylonian astrologers kept records of the movement of planets and made detailed lists of stars and constellations. Known metals such as gold, silver, mercury, lead, tin, iron, and copper were matched with the brightest heavenly bodies: sun, moon, Mercury, Saturn, Jupiter, Mars, and Venus respectively. Symbols assigned to these metals by the ancient Babylonians are used today by astronomers as the symbols for the planets.

The early Greek (Presocratic) philosophers were particularly concerned about the origin of the universe and began to explain natural phenomenon by natural causes rather than supernatural acts. Philosophers who lived in Miletus (on the coast of modern-day Turkey) were the most influential early thinkers. Thales of Miletus (582 BC) suggested that water was the basic substance from which the universe is composed and thought the earth floated on water. Anaximander of Miletus (555 BC) challenged Thales' work, wondering how fire, which is opposed to water, could have come into existence. He suggested the world was born when hot and cold separated from the "boundless," and air separated from the cold and the hot. He thought the earth floated freely, countering Thales by asking, "If water held up the earth, what holds up the water?" Anaximenes of Miletus (535 BC) tried to answer that question, proposing that air was the basic substance. He suggested the processes of rarefaction and condensation for change from one form to another. For example, air condenses into water, and air is formed by rarefaction from water (evaporation).

Empedocles of Acragas (445 BC) believed that there were four elements— earth, air, water, and fire. He thought these elements could combine in fixed proportions under the influence of higher forces of Love and Strife to form common substances. For example, he said that bone was composed of fire, air, and earth in the ratio 4:2:2. Empedocles had a better understanding than his four elements imply. He applied the term "earth" to a wide variety of solid substances and used the idea of "water" to indicate liquids as well as metals, since they could be fused. "Air" was a Greek term for all gases. However, Empedocles did think of fire as an element rather than a process.

Leucippus of Miletus (435 BC) built on the ideas of Empedocles, and Democratis of Abdera further developed these ideas into an early atomic theory. He said the elements were composed of tiny indivisible corpuscles called atoms (atomom is Greek for indivisible) that moved in empty space. He believed atoms varied in shape and size and combined in various ways to produce different substances. How these combinations are perceived is due to the properties of atoms. For example, substances that have a sour taste are composed of angular, small, thin atoms while substances that taste sweet are round, moderate-sized atoms. He also associated certain shapes and arrangements of atoms with the primary colors and thought of other colors as compounds of the four primary colors. Epecurus wrote a poem on Democratis' ideas that was found and translated more than 2000 years later. His poem brought the ideas of the ancient Greeks to early modern scientists in the 1600s and exerted an extraordinary influence on their thinking.

Just as true scientific thinking began to develop, it was drastically set back by Aristotle (384-323 BC). Aristotle developed the idea of properties of the elements, saying different types of matter depend on a specific balance of the qualities of hot, cold, wet, and dry. He reasoned that there must be a way to change one element into another by modifying its balance. The idea really caught on, especially that of changing cheap metals to gold, and persisted for nearly 2,000 years.

A group called alchemists (320 BC-300 AD), sprang up in the Greek-speaking world of Greece, China, India, Persia, and Egypt. The alchemists of this period were the most intellectual people of their time. Influenced by Aristotle's ideas, alchemists explored the idea that there might be a substance which could be found or made in the laboratory that would transmute cheap metals to gold. This substance became known as the Philosopher's Stone. Alchemists began to devise methods for making the philosopher's stone. Salt, sulfur, and mercury were some of the main ingredients they used.

By the 13th century, alchemy and gold making were practiced all over Europe. The famous alchemist, Raymundus Lullus, was called to make gold for the King of England. In 1317, Pope John XXII issued an edict against gold making. The kings of France and England followed suit, but laws could not stop efforts to transform cheap metals into gold. In the 15th century, instructions for making gold were printed and widely distributed. Unfortunately, the recipes did not work. Even so, alchemists still believed that cheap metals could be transformed into gold but thought their methods were wrong. I saw samples of gold made by 13th century alchemists in a museum in Munich. The samples look like gold, but they have densities around 12 g/mL, not 19.3 g/mL.

The alchemists were also interested in finding the elixir of life which would cure all ailments and enable people to live forever. In 1520, Philippus Aureolus Paracelsus, an alchemist who was working to find the elixir, turned from alchemy to the production of chemical remedies to cure diseases. He was the first European to use alchemy for medicinal purposes, although his cures more often killed than cured the patients.

In the Arab world, the Muslims were translating the works of the ancient Greeks into Arabic and were experimenting with scientific ideas. Their experiments led to sophisticated medical practices that were far superior to the barbaric medicine practiced in Europe at that time. Thomas Aquinas read the works of the Muslims and learned of their ideas of faith and reason. This thinking led to the Renaissance in Europe ("Islam: Empire of Faith").

But, the Renaissance did not bring chemistry got back on track. The theories of early chemists were often based more on speculation than on facts. Once a theory was generally accepted, it was hard to dislodge. The Phlogiston Theory (1700-1790) is a good example of a faulty theory in chemistry that was not easily given up by those who believed in it.

Scientists of the day noted that when a substance called calx of mercury was heated, it turned into mercury. They noted the mercury weighed less than the original calx of mercury. So, they proposed that when the calx of mercury absorbed phlogiston, the resulting product weighed less because phlogiston weighed less than nothing. Some scientists thought that if phlogiston could be isolated, it could be used to levitate objects.

calx of mercury + phlogiston —> mercury

192 grams -32 grams? 160 grams

Joseph Priestley (1733-1804), an English clergyman, helped to disprove the Phlogiston Theory. In August of 1774, Priestley heated calx of mercury. The powder gave off a colorless gas which Priestley collected and called "dephlogisticated air." He burned different substances in the "dephlogisticated air" and noticed that they burned brighter and better than in plain air. He had discovered oxygen, but he didn’t know it. He thought the gas was just air that had lost all its phlogiston.

It was Antoine Lavoisier (1743-1794) who disproved the Phlogiston Theory. He was a brilliant Frenchman whose accomplishments were many. He figured out Priestley’s experiment and renamed "dephlogisticated air" oxygen. He realized that oxygen was the part of air that combines with substances as they burn. Because of his work, Lavoisier is known as the Father of Modern Chemistry. On May 7, 1794, the Father of Modern Day Chemistry lost his head on a French guillotine because he was an aristocrat.