

1.4: Identifying and Isolating Elements

The Greek notion of atoms and elements survived for many centuries and it was eventually fleshed out with the addition of a few more elements, mostly through the efforts of the alchemists. Some elements such as gold were discovered much earlier – mainly because they exist as elements rather than compounds. By the late eighteenth century, the idea of an element as a substance that cannot be broken down into more fundamental substances had begun to be accepted. In 1789 Antoine Lavoisier (1743–1794) produced a list of 33 elements. His list did not include earth, air, fire, and water, but it did contain light and heat, along with a number of modern elements including cobalt, mercury, zinc, and copper. It had already been established that oxygen and hydrogen were elements, while water was not. The stage was set for a rapid growth in our knowledge about the underlying structure of matter. We now know of 91 naturally occurring elements, and quite a number of unnatural, that is, human-made ones which are not found in nature because they are unstable. These human-made elements are heavier in atomic terms than the naturally occurring elements and are typically generated by smashing atoms of natural elements into one another; they break down, or decay, rapidly into atoms of other elements. As examples of how science can remove some of the mystery from the universe: our understanding of atoms and elements means that no new natural, light elements are theoretically possible. We know of all the light elements that can possibly exist anywhere in the universe, a pretty amazing fact. Similarly, our current understanding of the theory of general relativity and the laws of thermodynamics make faster-than-light travel and perpetual motion machines impossible, although it does not stop people from speculating about them.

The first modern chemical isolation of an element is attributed to the alchemist Hennig Brand (c. 1630–c. 1710).^[9] He isolated phosphorus from urine while in pursuit of the philosopher's stone.^[10] While this may seem like an odd thing to do, people have done much stranger things in pursuit of gold or cures for diseases like syphilis. Imagine his surprise when, after boiling off all the water from the urine, the residue burst into flames and gave off a gas that, when condensed, produced a solid that glowed green in the dark. It was for this reason that he named it phosphorus, from the Greek for light-bearer. Similarly, mercury was originally isolated by roasting the mineral cinnabar. Despite being quite toxic, mercury was used as a treatment for syphilis prior to the discovery of effective antibiotics.

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Questions to Answer

- Given what you know, how would you explain the difference between an atom and an element?
- What differentiates one element from another?
- What is the difference between an atom and a molecule?
- What is the difference between an element and a compound?

Questions to Ponder

- What types of evidence might be used to prove you had isolated a new element?
- When can unproven/unsubstantiated assumptions be scientific?
- Under what conditions are such assumptions useful?
- Why do you think gold was recognized as an element earlier than many others?

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