

Why think philosophically about chemistry?

by Vanessa A. Seifert

Whether one realises it or not, chemistry is everywhere. In our everyday lives, chemistry is vital to ensure that what we eat is nutritious and safe, that the medicine we take will cure us of our ailments, and that the detergents we use to clean things will do the job. From a collective perspective, chemistry is vital to our societal growth: from tackling climate change to understanding brain activity, there isn't much which is not somehow affected by chemistry.

Given this, it should not come as a surprise that phenomena that standardly belong to the subject matter of chemistry have drawn the interest of philosophers. In ancient times, Aristotle did a systematic analysis of phenomena and concepts that nowadays are regarded within the purview of chemistry [1]. Alchemists, at least from the time of ancient Egypt up until Renaissance Europe, built entire metaphysical worldviews based on the study of chemical phenomena [2].

However, the philosophy of chemistry as an organised research study is relatively new. Its first official society was the International Society for the Philosophy of Chemistry (ISPC) which organises annual conferences since 1997 and publishes the journal *Foundations of Chemistry* since 1999. Books and collections of papers are published by publishing houses such as Oxford University Press, Springer and Cambridge University Press, and articles are regularly published in general philosophy of science journals such as *Philosophy of Science (PSA)* and the *British Journal for the Philosophy of Science (BJPS)*. The presence of the philosophy of chemistry has also expanded online. *Hyle*, which is published in printed and online form since 1997, was the first international journal on philosophy of chemistry. A more recent online contribution is *Jargonium* and there are also entries on philosophy of chemistry in the *Stanford Encyclopedia of Philosophy* [3] and in the *Internet Encyclopaedia of Philosophy* [3].

But what sort of questions does the philosophy of chemistry examine? There are a variety of issues which occupy philosophers with respect to chemistry. One is chemical classification. Chemists organise elements and substances, but also their properties into different classes. For example, they group elements into alkalis and halogens, substances into acids and bases, and even have different types of bonds such as covalent, ionic, and metallic bonds. In light of this, philosophers are interested in spelling out the scope and limits of these classifications. How precise are they? Do they

capture everything they are meant to? Moreover, do they correspond to structures that are out there in nature or are they—at least to some extent—inventions? How are they used for the explanation and understanding of chemical and other phenomena? These questions are valuable not just in their own right but because they can impact how we teach chemistry.

To appreciate the importance of philosophical thought to chemical education, consider another issue, that of models. How scientific models are developed and used is a tricky thing to teach. The use of idealisations and approximations, but also the development of models that are *prima facie* inconsistent to each other raises important challenges when attempting to explain their scientific role to students. Philosophy can help disambiguate this by spelling out models' scope and limitations and by offering useful classifications of different types of models in science, depending on their characteristic use.

The history of chemistry has also been of particular interest to philosophers. A favourite example is of course the study of the periodic table. In the 19th century there were several classifications of elements proposed and it was, for some time, an open question which proposal should be adopted. Philosophers are interested in this episode from the history of chemistry because it illustrates, among other things, the different values chemists thought as important when evaluating different classificatory schemes [4]. Another very important episode from the history of chemistry is the so-called Chemical Revolution in the 18th century which refers to the period during which chemists rejected the received view that phlogiston accounts for phenomena such as combustion, eventually substituting it with Lavoisier's oxygen theory. This is a central case study for the philosophy of science which examines how scientists reject previously accepted scientific theories to adopt new ones.

But philosophy is not only valuable to how chemists practice, teach, or understand the history of their discipline. It also informs how the wider public perceives chemistry and its societal value. Take for instance the issue of how to build public trust towards chemistry. Unfortunately, that science in general is humanity's most reliable source of knowledge is no longer evident to all. People do not trust what scientists say about climate change nor do they always follow the recommendations of international organisations regarding healthcare or disease control. There is a general mistrust which is partially based on misconceptions or ignorance regarding how science is actually done. Philosophers can help overcome this because part of



its studies involves spelling out how scientific practice is realised and how knowledge is tested and developed, illuminating the importance of experimentation and observation. Scientific hypotheses are not accepted without sufficient empirical evidence backing them up. Whenever an experiment contradicts scientific hypotheses, scientists re-examine if not revise them completely. These are some of the features that render chemistry trustworthy and philosophy has extensively worked on illuminating them correctly.

All in all, even though philosophy as a whole is (to some extent correctly!) thought of as a practice that is very abstract and detached from the way scientists think about the world, this is not true with respect to the philosophy of science. A close study of the sciences, including chemistry, is vital in order to pose questions that pertain to how scientific knowledge is developed and to how we understand nature through science. I encourage you all to explore it! 🧪

References

1. See in particular the following works of Aristotle: *On Generation and Corruption*, *Meteorology*, *Physics*, and *On the Heavens* (Barnes 1984).
2. See for example Principe, L. M. (2020). *The secrets of alchemy*. University of Chicago Press.
3. Hendry Robin F., Needham Paul, Weisberg Michael, *Philosophy of Chemistry*, (2011), <<https://plato.stanford.edu/entries/chemistry/>>, 3/11/2017. Seifert, V., *Reduction and Emergence in Chemistry*, (2019) <<https://iep.utm.edu/reduction-and-emergence-in-chemistry/>>
4. E.g. Pulkkinen, K. (2020). Values in the Development of Early Periodic Tables. *Ambix*, 67(2), 174–198. <https://doi.org/10.1080/00026980.2020.1747325>

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Check out Vanessa's recorded presentation from the D-UST Conference 2025; see report on p. 20, about the chemical progress in the age of AI.