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EDITORIAL

What is our best measurand when measuring "something" in "something"?

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Chemical analytical measurements are about measuring "something" in "something".

More specifically, they are about measuring how much there is of a specified substance (chemical element, molecular species) in a simple, complex or very complex material (ranging from water to sediment to soil to blood). Over the last few centuries we have learned many basic insights about the structure of matter—and verified them—and we know that the origin of specific properties such as taste, smell, toxicity, nutritional value, colour, etc is seated in very specific elemental or molecular structures. That results in the sobering (because simple) knowledge that the effect of these properties is roughly proportional to the number of atoms, ions, molecules, etc (in general called "entities") which carry these properties.

Usually these entities are embedded in a complex material, mentioned above and conveniently referred to as "matrix" or "chemical matrix". The specified entities are, e.g., atoms of a specified toxic element, or molecules of a specified molecular structure with a useful pharmaceutical function. The complex chemical matrix in which these specified entities are embedded, can be tremendously complicated, the details of which we mostly do not need to know in the context of asking the question in the title above.

For short: the one "something" is constituted by atoms or molecules carrying properties we are interested in, the other "something" is a complex material, the detailed properties of which we may not be particularly interested in. Since we want to know how much of the one "something" is there in the other "something", it is a matter of convenience to measure *two measurands*: a suitable one related to the specified entities such as their number (i.e., an "amount"), and a suitable one related to the complex material as a whole, such as its mass. That mass does not distinguish the large number of entities in the material. [Anticipating a bit our end conclusion, we note that, in the end, we can reduce the two quantities to *one measurand*: amount per mass].

Let us start with the easiest of the two: the measurand related to the complex material, or rather, to a sample of that material (for the sake of brevity in our attempt to answer the question in the title, we do not elaborate on the representativeness of the sample for the whole of the material batch which is a separate problem: the degree of homogeneity of the material).

The matrix material

The (sample of the) material can consist of an incredible combination of atoms, molecules, crystallographic or amorph structures in the form of a soil or sediment from nature, an edible and tasty product from a natural production process such as a juice or vegetable, a useable product from a technological process such as a plastic or ceramic, or a life-essential blood of a living organism. These may have a number of interesting physico-chemical properties we may or may not be interested in for various reasons, or which are forced upon us by the circumstances. The variety of "complex" materials is almost infinite.

Recognising the particulate nature of any matter in nature was not evident during centuries, although individual philosophical ideas about it were circulating at all times (think of Demokritos' "atoms"). But, for answering the question at stake here, we just need a convenient property

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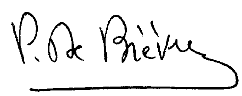
of matter as basis for a measurement of the whole material sample in order to characterise how much we have used in our (consumptive) measurement. The simplest property we can choose is mass. Mass is a property common to all matter including all constituents of these complex materials. We do not need to distinguish the constituting atoms, molecules, or complex structures. We just need a simple measurement to characterise the sample which we take as representative of the material. Mass is the simplest property to use in the application we need here.

We are very well equipped to measure mass: we use the phenomenon of gravity to compare the mass of a sample of the complex material to a known mass by means of a balance the two arms of which are subject to the same gravitational force (modern mass measurements are performed with electronic balances functioning on the same principle, but the old balances are more “transparent” to describe the measuring process). The known mass on one of the arms is our agreed base unit of measurement for any mass measurement: *the* kilogram, or a known submultiple of it. The mass of the kilogram comes to us via a carefully controlled chain of calibrations of artifact weights starting from the artifact weight which is our common base unit, called the kilogram, and making use of submultiples of that unit, which are units by themselves since, by definition, they are exact fractions (milli-, micro-, nano-, …) or multiples (mega-, giga-, tera-, …) of that chosen base unit.

Hence we measure the mass of any unknown material sample in a commonly agreed measurement unit. Our results will be “traceable” to that common unit. This common reference ensures a priori that our measurement result will be comparable to any other mass measurement result for any other material sample anywhere any time.

(to be continued)



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