Proposal for the Universal Unit System*

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1 Introduction

A unit of measure is "a quantity that is used as the basis for expressing a given quantity, and is of the same type[1] as the quantity that is to be expressed".(1) As evidenced by the term "weights and measures", the history of units began from the simple stage of using familiar quantities such as the weight of grain or the lengths of the human hand and foot as units to express the quantities that we deal with in daily life such as length, volume, and weight.

A unit that is used in exchanges between people must be guaranteed to have a constant magnitude within the scope of that exchange. Quantities that can, by consensus, serve as common standard over a broad scope were sought and selected to serve as units. The ultimate such quantity is an entity common to all of humankind, the earth itself, which was selected as the foundation for the metric system. Specifically, $1/86400^{\text{th}}$ of the period of the earth's rotation is defined as one second, $1/40,000,000^{\text{th}}$ of the total length of the earth's meridian is defined as one meter, and the mass of a cubic $1/10^{\text{th}}$ meter of water is defined as one kilogram. [2]

The history of units of measure, on the other hand, is the history of the establishment of new concepts that have accompanied the development of natural science. The laws of nature describe the 'relationship' between 'a given quantity' and 'another quantity' specified as mathematical expressions. The 'given quantity' and 'another quantity' referred to here are often quantities that correspond to 'newly established or greatly transformed concepts' that are born of new discoveries, as occurred with mass, energy, and electrical charge. As this process goes on, the need arises to deal with quantities of a new concept and a quantity is selected as a standard for that purpose. That quantity becomes a new unit.

A system of units is a set of multiple units that are related on the basis of these kinds of laws and systematically organized. Consider, for example, the units for length and volume. It is, of course, possible to define virtually unrelated units for length and volume, such as we have with the units foot and gallon. However, by making use of the law which states that "the volume of a cube is proportional to the third power of the length of its side" to relate these two units, we can say that "the volume of a one-meter cube is the unit 1 meter^3 " which is a more systematic approach. In this way, a number of base units and a relationship formula that describes a natural law can be used to define all other units (which is referred to as "deriving" units in the terminology of units) and so obtain what is called a coherent unit system. In a coherent unit system, there is only one unit for one type of quantity. Thus,

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[1] For more information, see Appendix A, "Basic approach to units".

[2] Currently, this basis is being replaced by definition methods in which the magnitudes of the units are virtually invariable, providing better reproducibility.