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COMMITTEE ON QUANTITIES AND UNITS†

NOMENCLATURE OF DERIVED QUANTITIES

(Recommendations 1991)

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Nomenclature of derived quantities (Recommendations 1991)

Historically, two approaches have been used to name quantities: firstly use of words to denote the property or process (trivial name) and secondly to denote the mathematical definition of the quantity (systematic name). Current usage provides words that can be used for the systematic naming of quantities defined from two quantities of the same kind (e.g. $\underline{x} = \underline{y}_1/\underline{y}_2$), but is inadequate for quantities defined by division of one quantity by another of a different kind (i.e. $\underline{x} = \underline{y}/\underline{z}$). The recommendation introduces rules for naming derived kinds of quantities. It is envisaged that the nomenclature of quantities must be dualistic, to exploit the advantages and deficiencies of each approach.

1. INTRODUCTION

1.1 Names of quantities have evolved with the development of languages and with advances in knowledge and technology. Common names which can be found in general dictionaries, for example activity, strength, load, level, density, differ from language to language, and often have a variety of meanings and associations. Thus, differences exist in the nomenclature of quantities between countries, between different scientific disciplines, and between different branches of the same scientific discipline.

1.2 In the preparation of general recommendations on quantities and units in clinical chemistry, the IUPAC Commission on Quantities and Units in Clinical Chemistry - IFCC Expert Panel on Quantities and Units (CQUCC/EPQU) encountered several common kinds of quantity which had no international or interdisciplinary names (CQUCC/EPQU 1978, 1979). We have worked on the principle that nomenclature of quantities should be international and interdisciplinary, resorting to the specialized nomenclature of particular disciplines only for the specifications of the system studied and of relevant components.

1.3 A survey of existing nomenclature showed that derived kinds of quantities may have names without intrinsic meaning, names that indicate the property or process studied or names that indicate the mathematical definition. For example, a word like absorption indicates a process. In the name of a quantity, it is ambiguous because spectroscopists would take it to refer to absorption of radiation, while a surface chemist might assume absorption (or adsorbtion) of a gas onto a solid. In the nineteenth century, the word-endings '-ance' and '-ivity' were substituted for '-ion' and '-ing' in words for processes to indicate a property reflecting that process, for example absorbance, absorptance and absorptivity. Even this range of word-endings is not sufficient to distinguish all the kinds of quantity describing absorption, and compound terms were coined, for example mass absorptivity, specific absorptivity, and molar absorptivity. Such names, however, may not indicate all the terms in the logical definition of the quantity.

1.4 Other names for derived kinds of quantity only partially indicate the mathematical definition. Traditional words like density and specific are used for various quantities with different numerator terms and denominator terms. The user may feel that they imply a particular denominator term, for example 'divided by mass' for specific, and 'divided by volume' for density. However, these words are also used for quantities with other denominator terms in the definition, for example, density may imply:

- divided by length, as in linear density,
- divided by area, as in population density,
- divided by volume, as in mass density or electron density,
- divided by an interval of a fixed variable, as in probability density,
- the ability of a system to obstruct transmission or flow, as in optical density.

1.5 More certain in meaning, but again indistinctive, are the words factor and coefficient, which are similar in meaning to the word-endings '-ance' and '-ivity', respectively. Both words indicate quantities used in equations of proportionality; 'factor' if the quantity has dimension one and 'coefficient' in other instances. Coefficient or '-ivity' may also indicate a material property, in contrast to '-ance' which denotes a sample property.

1.6 Sometimes the names of derived quantities include the names, or adjectives, for terms used in their definition, for instance 'mass absorptivity' and 'mass density', and 'linear density' and 'linear expansion'. Such names indicate only one term of the definition and do not indicate whether that term forms part of the numerator or part of the denominator.

1.7 For quantities derived from two or more quantities of different kinds (i.e. $\underline{x} = \underline{y}/\underline{z}$), few current names indicate the full meaning. Thus, the International Union of Pure and Applied Physics (IUPAP 1978) and the IUPAC Commission on Physicochemical Symbols, Terminology and Units (IUPAC 1988) recommend that 'molar' be used for 'divided by amount of substance' (e.g. molar mass), and 'specific' for 'divided by mass' of the same system. However, practical usage is not limited to this recommendation, for example as in the use of specific gravity which contains volume in the denominator.

1.8 For quantities of dimension 1 (i.e. $\underline{x} = \underline{y}_1/\underline{y}_2$), many existing names express the mathematical definition, for example mass fraction, volume ratio, relative length.

1.9 French usage has introduced the word-ending '-ique' systematically to denote 'divided by...', for example surfacique - divided by surface area, volumique - divided by volume. This practice avoids the difficulty of existing adjectives like 'linear' or 'thermal' that may indicate a numerator or denominator term. Based on the French model, the nomenclature proposed here rests on the premise that the systematic name of a derived kind of quantity should indicate, unambiguously, the kinds of quantity in the numerator and the denominator of the definition.

2. RECOMMENDATIONS

Names of quantities should indicate their logical meaning.

2.1 The recommendations are based on the premise that systematic names should distinguish between quantities in the numerator and denominator in the definition of a derived quantity.

2.2 The quantity in the numerator is designated by a word from the name of the quantity, as indicated by the following examples:

2.2.1 **NUMBER (OF ENTITIES)**

2.2.2 **LENGTH**

2.2.3 **AREA**

2.2.4 **VOLUME**

2.2.5 **MASS**

2.2.6 **TIME**

2.2.7 **AMOUNT OF SUBSTANCE**
IUPAC Commission on Physicochemical Symbols Terminology and Units has recently adopted "amount" as the short term in contrast to amount of substance used here.

2.2.8 **(THERMODYNAMIC) TEMPERATURE**

2.2.9 **ENERGY**

2.3 The systematic name of a quantity ($\underline{x}$) derived from the quotient (the relationship between quantities obtained by division) of two quantities ($\underline{y}$) of the same kind (i.e. $\underline{x} = \underline{y}_1/\underline{y}_2$) includes:

- a word from the name of the numerator quantity ($\underline{y}$) (e.g. mass, volume),
- a word denoting the nature of the quotient (e.g. fraction).

The words recommended are in current use, and definitions are closely aligned to current usage.

2.3.1 **RELATIVE** The quotient of quantities having the same kind of quantity, and preferentially the same component, in different systems. The denominator quantity is often called the reference quantity. Note: relative change (increment) in a quantity is denoted by $\Delta\underline{x}/\underline{x}$ or $d\underline{x}/\underline{x}$.

2.3.2 **RATIO** The quotient of quantities of the same kind for different components within the same system.

2.3.3 **FRACTION** A quotient where the numerator quantity refers to a component while the denominator is a quantity of the same kind for the whole system. From the definition, a fraction has a value between zero and one.

2.4 The systematic name of a quantity derived from the quotient of two quantities of different kinds (i.e. $\underline{x} = \underline{y}/\underline{z}$), includes:

- a word, or words, from the name for each kind of quantity in the numerator (i.e. $\underline{y}$),
- a word for each defining kind of quantity in the denominator (i.e. $\underline{z}$).

Except for rate and molar the proposed words, meaning "divided by ...", are new to the English language, because the names of the kinds of quantity (e.g. length, area) need to be reserved for the numerator terms (Section 2.2). For example, the word area should be used in the name of a quantity with area as a numerator term ($\underline{y}$) but not as a denominator term ($\underline{z}$). Suitable words can be coined with the adjectival ending '-ic' to a word indicating the defining kind of quantity in the denominator. (ISO-31.0 1991). This was not possible for (divided by) number (of entities), for which the word "entitic" has been introduced instead.

2.4.1 Terms derived from denominator quantity:

2.4.1.1 **LINEIC**
Divided by length.

2.4.1.2 **AREIC**
Divided by area.

2.4.1.3 **VOLUMIC**
Divided by volume of the system. The numerator term of the definition must refer to the same (total) system. **Concentration** is used if the numerator refers to a component of the system.

2.4.1.4 **MASSIC**
Divided by mass of the system. The numerator term of the definition must refer to the same (total) system. **Content** is used if the numerator refers to a component of the system.

2.4.2 Current terms recommended because of wide usage:

2.4.2.1 **RATE**
Divided by time

2.4.2.2 **MOLAR**
Divided by amount of substance.

2.4.3 By analogy, a word is proposed for divided by number of entities.

2.4.3.1 **ENTITIC**
Divided by number of entities.

2.5 Examples of conventional names used for quantities and their systematic names are given in Section 4.

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3.5 ISO-31.0 1991: International Standards Organization. Quantities and Units Part 0 General Principles. Obtainable from National Standards Institutions.

4. APPENDIX

Examples of Systematic Names and Some Related Conventional Names

	Systematic Name	Conventional Name
$\underline{N}_B/\underline{V}_1$	**number** (of entities) concentration (of component B in system 1)	count
$\underline{m}_B/\underline{V}_1$	**mass** concentration (of component B in system 1)	concentration
$\underline{n}_B/\underline{m}_1$	**amount of substance** content (of component B in system 1)	content
$\underline{n}_B/\underline{V}_1$	**amount of substance** concentration (of component B in system 1)	molar concentration
$\underline{l}_B/\underline{l}_C$	**length ratio** (of component B to component C)	relative length relative distance
$\underline{m}_B/\underline{m}_C$	**mass ratio** (of component B to component C in system 1)	ratio (B:C)
$\underline{m}_B\cdot\underline{V}_1/\underline{m}_C\cdot\underline{V}_1$	**mass concentration ratio**	relative concentration partition coefficient
$\underline{t}_B/\underline{t}_C$	**time ratio** (of component B to component C)	relative rate
$\underline{N}_B/\underline{N}_1$	**number (of entities) fraction** (of component B in system 1)	percent(age) (of B)/100
$\underline{m}_B/\underline{m}_1$	**mass fraction** (of component B in system 1)	percent(age) (of B)/100
$\underline{n}_B/\underline{n}_1$	**amount of substance fraction** (of component B in system 1)	mole fraction (of B)
$\underline{A}_B/l_1$	**lineic** (decadic) absorbance	linear (decadic) absorptivity linear (decadic) absorption coefficient
$\underline{N}_B/\underline{A}_1$	**areic** number (of entities)	count, (number) density population density
$\underline{m}_1/\underline{V}_1$	**volumic** mass (of system 1)	(mass) density
$\underline{m}_1\cdot\underline{V}_2/\underline{m}_2\cdot\underline{V}_1$	**relative volumic** mass	relative density
$\underline{V}/\underline{m}_1$	**massic** volume (of system 1)	specific volume
$\underline{m}_B/\underline{t}$	mass **rate** (of substance B)	
$\underline{V}/\underline{t}$	volume **rate**	clearance flow rate
$\underline{n}_B/\underline{t}$	amount of substance **rate** (of substance B)	reaction rate transfer rate activity rate
$\underline{m}_B/\underline{n}_B$	**molar** mass (of substance B)	
$\underline{V}_B/\underline{N}_B$	**entitic** volume (of component B)	molecular volume atomic volume particle volume (mean) cell volume
$\underline{m}_B/\underline{N}_B$	**entitic** mass (of substance B)	molecular mass atomic mass

Note: Examples of components and systems are given in bibliography 3.2