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AND

INTERNATIONAL FEDERATION OF CLINICAL CHEMISTRY

IUPAC SECTION ON CLINICAL CHEMISTRY
COMMISSION ON QUANTITIES AND UNITS

AND

IFCC COMMITTEE ON STANDARDS
EXPERT PANEL ON QUANTITIES AND UNITS

QUANTITIES AND UNITS IN CLINICAL CHEMISTRY RECOMMENDATION 1973

Prepared for publication by

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BUTTERWORTHS

PREFACE

The Commission on Quantities and Units in Clinical Chemistry* is a part of the Section on Clinical Chemistry of the International Union of Pure and Applied Chemistry (IUPAC). The Expert Panel on Quantities and Units† is a part of the Committee on Standards of the International Federation of Clinical Chemistry (IFCC). These two bodies, the Commission and the Expert Panel, have worked on this document—the former mainly concerned with basic philosophy, the latter with problems of implementation.

The aim has been to have clinical chemical nomenclature become a natural part of the evolving international scientific language, especially by drawing upon the recommendations of the International Committee of Weights and Measures, the International Union of Biochemistry, the Technical Committee 12 of the International Organization for Standardization, and, of course, IUPAC (see References).

The tentative version of the present publication appeared as an IUPAC–IFCC (yellow) *Information Bulletin*, Appendices on Tentative Nomenclature, Symbols, Units, and Standards, No. 20, February 1972. As a consequence of later decisions by international bodies concerned with nomenclature, a considerable number of comments, and new deliberations by the Commission and Expert Panel (see Appendix), this Recommendation 1973 contains many, mostly small modifications in comparison with the tentative version.

The Commission and Expert Panel wish to thank the numerous colleagues (cf. Appendix) who, by their knowledgeable and helpful suggestions, have contributed to these changes.

In cases of conflict, the present document supersedes the larger IUPAC–IFCC Recommendation 1966 and its translation into Spanish.

IUPAC has approved this Recommendation 1973. The IFCC Committee on Standards and Executive Board have also approved, but the document still needs the confirmation of the IFCC Council.

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CONTENTS

ABBREVIATIONS OF REFERENCES

CBN	Commission on Biochemical Nomenclature (IUPAC–IUB)
CCC	Commission on Clinical Chemistry (IUPAC; before 1967)
CGPM	Conférence Générale des Poids et Mesures
CQUCC	Commission on Quantities and Units in Clinical Chemistry (IUPAC; after 1967)
EPQU	Expert Panel on Quantities and Units (IFCC Committee on Standards)
ICSH	International Committee for Standardization in Hematology
IFCC	International Federation of Clinical Chemistry
ISO	International Organization for Standardization
IUB	International Union of Biochemistry
IUPAC	International Union of Pure and Applied Chemistry
QU-R66	Quantities and Units in Clinical Chemistry. Recommendation 1966 (IUPAC–IFCC)
SCC	Section on Clinical Chemistry (IUPAC)
WAPS	World Association of (Anatomic and Clinical) Pathology Societies

1. INTRODUCTION

Recommendation 1966 of the Commission on Clinical Chemistry of the International Union of Pure and Applied Chemistry and of the International Federation for Clinical Chemistry (8.4) was published in 1967. This was the first effort of international organizations towards a rationally standardized presentation of clinical chemical laboratory data.

At the IUPAC Conference in Prague in 1967, the newly created Section on Clinical Chemistry nominated a Commission on Quantities and Units in Clinical Chemistry (cf. footnote * on p. 519). This body was joined in 1968 by the Expert Panel on Quantities and Units created by the Committee on Standards of the International Federation of Clinical Chemistry (cf. footnote † to p. 519). One common task was the supervision of short versions of the Recommendation 1966 (8.4 = QU-R66). The present publication contains such a revised condensation in Sections 3, 4 and 5 which are now the official version in cases of conflict. Chemical background material is given in Section 2. Section 6 corresponds to the QU-R66 Part 5 with new kinds of quantities. Section 7 contains examples of clinical chemical quantities in a new generic form, which is further elaborated in a separate publication 'List of Quantities. Recommendation 1973'.

The kinds of quantities treated in this document do not by far cover all aspects of clinical chemical work. It is hoped that additional recommendations will be prepared to alleviate this defect.

2. CLINICAL CHEMICAL LANGUAGE PROBLEMS

2.1.—The main task of the clinical chemist is the measurement of the chemical, biochemical, and sometimes physical *properties of patients*. These data are used by the clinician for diagnostic and therapeutic purposes. It is of paramount importance, therefore, that the *determinations requested* by the clinician are those *performed* by the laboratory and that each *answer* is understood correctly by the clinician.

In order to avoid misunderstandings a set of rules must be observed during transmission, i.e. the 'language' must be standardized.

2.2.—At present there exists no fully accepted usage for the request and presentation of data, be it on the international, national or local level. This is, usually, *inconvenient,* time-consuming and, in some instances, dangerous to the patient.

Another, very unfortunate result of the diverse—and often quaint—usages in clinical chemistry is that a *barrier of incomprehensibility* has arisen between this discipline and the rest of science where chemistry, biochemistry, and physics have cooperated on a standardized language for some years.

2.3.—The international clinical chemical bodies now try to eliminate the language part of the barrier by *adopting pertinent parts of the communication language constructed by related international science bodies*. The *Recommendation 1966* by CCC of IUPAC and IFCC is updated and summarized in Sections 3 and 4; the assimilation may be assisted by first recapitulating some chemical concepts.

2.4.—The clinical chemical description of a patient requires initially the selection of **a system**, which may be arbitrarily chosen. *Examples:* the patient as such, his liver, blood, thrombocytes, hemoglobin.

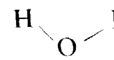
2.5.—**Transported matter** to or from the system may be regarded as a part of the system or can be considered a separate chemical system. *Examples:* food absorbed, urine excreted, blood supplied to the liver.

2.6.—In clinical chemistry, it is usually convenient or necessary to refrain from using the entire system for measurement; instead **a specimen** is obtained, i.e. a representative part of a system or, at least, a part obtained by a standardized procedure. *Examples:* specimens of 24-hour urine, of venous blood, of serum from venous blood. The actual measurement often is performed on a fully representative **sub-specimen**.

2.7.—A chemically definable substance in the form of atoms, molecules or ions is called **a chemical component of the system**. *Examples:* helium, water, and sodium ion respectively.

2.8.—**The chemical name** is a trivial or, if practical and possible, a systematic name, preferably constructed according to IUPAC rules. *Examples:* urea, or, better, carbamide, sodium ion (not 'sodium').

2.9.—**The formula for a molecule or an ion** is a symbolic representation indicating the atoms (and charges, if any) involved in the entity. *Examples:*

H_2O (sterically 

), CH_3COOH, SO_4^{2-}.

2.10.—For complicated molecules or where a name alone may signify more species of particles than intended, it is necessary to supply **an elementary entity** (a formula unit or elementary unit), i.e. a chemical symbol indicating a relevant repetitive structure of the chemical component. *Examples:* N_2, N, Ca^{2+}, COOH (carboxyl), H_2O, C_6.

2.11.—One goal of the clinical chemical description is to furnish information on the *patient's biochemical status,* be it normal or pathological. The chemical processes taking place in a living organism are governed by well-known laws, which are formulated in 'molecular' terms. Consequently, clinical chemical measurements of amounts of components or their concentrations should be *expressed preferably with reference to the groups of atoms, molecules or ions participating.*

2.12.—An evident advantage for clinical chemistry of the *'molecular' concepts* (cf. 2.13) was realized rather early for some inorganic electrolytes: sodium ion, potassium ion, chloride, and hydrogen carbonate. To-day, the concentrations of these components are usually given as 'molar concentrations' in millimoles per litre (or 'equivalents per litre'). For many organic and some inorganic substances, however, *mass concentration* is widely used, usually with 100 millilitres as the volume base (denominator) in the unit.

In the vast majority of cases, mass concentration yields no biologically useful information; in fact, biological relationships are obscured and, consequently, not often contemplated. In contrast, *'molecular' concepts immediately expose relationships on the functional level.* A few series of interdependent components† might suffice to illustrate this fact:

acetoacetate—acetone—β-hydroxybutyrate
chloride—bromide
adrenaline—noradrenaline—4-hydroxy-3-methoxymandelate
calcium ion—phosphate
copper ion—caeruloplasmin
cholesterol—cholesterol ester
creatine—creatinine
bilirubin—bilirubin glucuronide
'base excess'—lactate—glucose
cystine—cysteine
'reduced' glutathione—'oxidized' glutathione
glycerol—triglyceride
hemoglobin(Fe)—oxygen(O_2)—iron ion—transferrin
protein-bound iodine—triiodothyronine—thyroxin

2.13.—**SCC and IFCC recommend that kinds of quantities of a 'molecular' nature should be used whenever an elementary entity may be given for a component**, be it an electrolyte or a non-electrolyte, inorganic or organic.

Consequently, of the kinds of quantities listed in Section 4, the following are preferable when describing 'amount' or 'concentration' of matter:

amount of substance (mole)
  instead of mass (kilogram),
substance concentration‡ (mole per litre)
  instead of mass concentration (kilogram per litre),
mole fraction (unity)
  instead of mass fraction (unity) and volume fraction (unity), and
molality (mole per kilogram).

This recommendation is supported jointly by the 1972 Recommendation from ICSH, IFCC and WAPS (8.6).

2.14.—The *Recommendation 1966* states that **the litre is the preferred unit for volume** (cf. 4.3. Note 1). This is of special importance for concentration concepts using volume as a denominator. The present arbitrary use of microlitre, millilitre, decilitre (= 100 millilitres), and litre repeatedly results in recalculations and consequent errors.

3. DEFINITIONS OF FUNDAMENTAL CONCEPTS OF QUANTITIES

3.1.—**Quantity**: a measurable, real property, physical or chemical, of a specified system. *Example:* substance concentration of glucose in the blood plasma of a stated patient.

3.2.—**Kind of quantity**: the abstract concept of the property, common to a number of real phenomena (quantities). *Examples:* length, substance concentration, pressure.

† The names listed accord with current usage and are not those used in 'List of Quantities. Recommendation 1973'.

‡ Cf. 4.11.6.

3.3.—**Unit:** a chosen reference quantity, which may be used for comparison of quantities of the same dimension. *Examples:* millimetre (e.g. for lengths), kilogram (e.g. for masses), mole (e.g. for amounts of substance), gram per litre (e.g. for mass concentration or mass densities).
Note: The magnitude of the quantity is not influenced by the choice of unit.

3.4.—**Numerical value:** the number that gives the magnitude of the measured quantity when multiplied by the unit.

$$\text{Numerical value} = \text{quantity/unit} \qquad 3.4\text{-}1$$

Notes: 1. The magnitude of a quantity should not be expressed as a numerical value alone, except perhaps for quantities having the dimension one. cf. 3.8. *Example:* Substance concentration of sodium ion in a specified serum is not '139' but '139 millimoles per litre'. The relative density of the same serum could be adequately expressed as 1,026, but the unit '1' can be stated: 1,026 × 1.

2. The 'equal to' sign does not allow inference of the kind of quantity involved from inspection of the unit employed. *Example:* The unit, gram per litre, is common to measurements of mass concentration and mass density.

3. The meaning of the numerical value is a statistical analytical problem beyond the scope of this document. In general, it is advisable to supply information about analytic variation and reference values ('normal values').

3.5.—**Basic kind of quantity:** a kind of quantity considered mutually independent of other basic kinds of quantities. *Examples:* length, mass, amount of substance.
Note: Basic quantities are chosen arbitrarily but according to a practical plan. In clinical chemistry, eight seem practical; cf. *Table 3.5-1*. The first seven are the so-called International System of Units (SI units) (cf. 8.12).

Table 3.5-1. Basic kinds of quantities and base units

Name	Symbol	Dimension	Name	Symbol
Length	l	L	metre	m
Mass	m	M	kilogram	kg
Time	t	T	second	s
Electric current	I	I	ampere	A
Thermodynamic temperature	T	Θ	kelvin	K
Luminous intensity	I	J	candela	cd
Amount of substance	n	N	mole	mol
Catalytic amount†	z	Z	katal†	kat†

† Cf. 4.7.

3.6.—**Derived kind of quantity:** a kind of quantity characterized by an equation between basic kinds of quantities. *Example:* mass concentration = mass/(length)^3.

3.7.—**Dimension of a quantity.** Any (kind of) quantity can be analysed into a product of dimensional factors, one for each of the eight dimensions, corresponding to the eight basic kinds of quantities. *Example:* Mass concentration and density both have the dimension $L^{-3}M^{1}T^{0}I^{0}\Theta^{0}J^{0}N^{0}Z^{0}$ =

ML^{-3}, they are equidimensional; the appropriate units mg/l, g/l, kg/m^3, etc. have the same dimension.

3.8.—**Kind of quantity having the dimension one:** a kind of quantity that has the dimension unit (1). *Examples:* Number (of entities), mass fraction, relative density all have the dimension $L^0M^0T^0I^0\Theta^0J^0N^0Z^0 = 1$.

3.9.—**Base unit:** a unit defined for a basic kind of quantity. *Examples:* metre, kilogram, mole. Cf. *Table 3.5-1.*

3.10.—**Derived coherent units:** units constructed from base units, exclusively. *Examples:* mole per kilogram, kilogram per cubic metre.
Note: Dimensionless kinds of quantities have the coherent unit 'unity' (1).

3.11.—**Derived non-coherent units:** These units are constructed from base units and numerical factors, which may be named and symbolized. *Examples:* milligram, mole per litre.

3.12.—**Factors for units:** These factors which are part of the SI (8.12), create multiples or submultiples of units and are often called by a name used as a prefix or a letter symbol before the unit symbol. *Examples:* megametre (Mm) for 10^6 metre, micrometre (μm) for 10^{-6} metre; cf. *Table 3.12-1.*

Table 3.12-1. SI prefixes denoting decimal factors

Factor	Prefix	Symbol
10^{12}	tera	T
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10^1	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Notes: 1. The ten prefixes above the upper and below the lower broken lines in the table are especially recommended because the systematic use of factors that are powers of ten with exponents that are simple multiples of three facilitates conversion procedures for results in different units.

2. Unfortunately, these prefixes may not stand alone and must not be used together with the unit 'unity' (1), employed by quantities having the dimension one (cf. 3.10, Note). This is not practical and could be solved by designating a name and symbol to 'unity'.

4. KINDS OF QUANTITIES AND UNITS

4.0.—Only the most necessary information is given in connection with each *kind of quantity:* name, (type), symbol, and in some cases a definition; the *unit* name, (type), symbol, and sometimes a definition. The abbreviations for type of kind of quantity and for unit are explained in *Table 4.0-1*.

4.0.1.—In this final version, the italic symbols for a number of intensive kinds of quantities do not carry a subscript indicating the component; e.g. the former c_B for 'substance concentration of component B' is now given as c. In this context, probably, only mass density and mass concentration may be confused as both are symbolized ρ. When necessary, mass concentration is symbolized ρ_B or $\rho(B)$; other kinds of quantities may be specified analogously.

Table 4.0-1. Codes used in Sections 4 and 6

B	= basic or base
D	= derived
DC	= derived coherent
DnC	= derived non-coherent
spec.C	= special coherent

Recommended types of symbols for subunits and some corresponding, not recommended forms [in brackets] are listed. Examples are given in Section 7, with codes and abbreviations explained in *Tables 7.3-1* and *7.5-1*.

4.1.—**Length** (B) l
Metre (B) **m**

m
mm [cm]†
μm [μ, u]
nm [mμ, mu]

Notes: 1. The spelling 'metre' is recommended (8.11) in English *and* American.
2. The order of magnitude changes 10^3 between successive units listed.

4.2.—**Area** (D) A
Square metre (DC) $\mathbf{m^2}$

m^2
mm^2 [cm^2]
μm^2 [μ^2]

Note: The order of magnitude changes 10^6 between successive units listed.

† [Symbols in brackets are not recommended]

4.3.—**Volume** (D) V
Litre (DnC) **l**
Cubic metre (DC) $\mathbf{m^3}$

	m^3	
l	[dm^3]	[L, l]†
		[dl]
ml	[cm^3]	[cc, ccm]
μl	mm^3	[λ, ul]
nl		
pl		[μμl, uul]
fl	μm^3	[μ^3, u^3]

Notes: 1. The litre has been redefined (CGPM, 1964) and is now exactly equal to the cubic decimetre.

2. Although CGPM and IUPAC at one time discouraged the use of litre in connexion with precise measurements, CQUCC has decided to retain the litre as a permissible unit, especially because of the convenience of its multiples (ml, μl, etc.) and its continued use in chemistry. This decision has become 'respectable' because the International Committee of Weights and Measures (CIPM) has recognized (8.12) that the litre and a few other units 'play such an important part that they must be retained for general use with the International System of Units'. The preference of litre is supported jointly by a 1972 Recommendation from ICSH, IFCC, and WAPS (8.6). An eventual choice of 'cubic metre' as preferred unit in practice would not change the significant figures: 1,037 l = $1{,}037 \times 10^{-3}$ m^3 (= 1,037 dm^3).

3. The 'litre' and the numeral 'one' should be given distinctly different symbols: l and 1 respectively. (This type gives insufficient distinction.)

4. The order of magnitude changes 10^9 in the series m^3– mm^3– μm^3–.

4.4.—**Mass** (B) m
Kilogram (B) **kg**

kg	[Kg, K]
g	[gr., gm., gms., GR, GRM]
mg	[mgm, mgms]
μg	[γ, ug]
ng	[mμg, mug]
pg	[μμg, uug]

Notes: 1. The spelling 'kilogram' is recommended (8.12) in American *and* English.

2. 'Mass' should not be confused with 'weight' which is a derived kind of quantity. (The dimensions are M and LMT^{-2} respectively.)

4.5.—**Number (of entities)** (D) N
Unity (DC) **1**

$\times 10^9$, $\times 10^6$, $\times 10^3$, $\times 1$, $\times 10^{-3}$

Notes: 1. This kind of quantity has the dimension one (cf. 3.8 and 3.4, Note 1) and the coherent unit is 'unity' (1).

2. This kind of quantity was called 'number of particles' in QU-R66-4.5.

† [Symbols in brackets are not recommended]

4.6.—**Amount of substance** (B) *n*
Mole (B) **mol**

mol [M, *M*, eq, val, g-mol]†
mmol [mM, meq, mval]
μmol [μM, uM, μeq, μval]
nmol [nM, neq, nval]

Notes: 1. SCC and IFCC recommend that kinds of quantities of a 'molecular' nature should be used whenever an elementary entity may be given for a component, be it electrolyte or non-electrolyte, inorganic or organic (cf. 2.12).

2. 'Amount of substance' supplants the ambiguous concept 'equivalent amount'. The elementary entity (cf. 2.10) forming the basis of measurement should be indicated whenever doubt may arise. Thus 'Calcium(II) ion(Ca)' would indicate unchelated divalent ionized calcium with oxidation number + II, i.e. $Ca(II)^{2+}$. The component having the entity half as large would be 'Calcium(II) ion($Ca_{0,5}$)'.

3. The unit 'mole' is an amount of substance containing as many elementary entities as there are carbon atoms in 0,012 kg (exactly) of the pure nuclide ^{12}C. The 'mole' is not a *number* (of elementary entities). However, the amount of substance constituting one mole contains about $6{,}022\ 52 \times 10^{23}$ elementary entities.

4.7.—**Catalytic amount** (provisionally B) *z*
Katal (provisionally B) **kat**

kkat [kmol/s]
kat [mol/s]
mkat [mmol/s]
μkat [μmol/s]
[U]
nkat [nmol/s]

Notes: 1. The base unit 'katal' is the catalytic amount of any catalyst (including any enzyme) that catalyses a reaction rate of one mole per second in an assay system.

2. This unit was originally proposed by CCC (8.4) with the name 'catal', but CBN preferred the spelling 'katal'.

3. The kind of quantity 'reaction rate' is defined and discussed by IUPAC Commission on Symbols, Terminology, and Units (8.11).

If the catalysed reaction is symbolized $\nu \cdot \text{Substrate} \xrightarrow{\text{catalyst}} \text{Products}$ one 'elementary transformation' converts ν elementary entities of substrate; ν most often is one. The mean reaction rate during a certain time is the amount of substance of Substrate converted, divided by its coefficient ν and by the time.

4. A quantity of the kind 'catalytic amount' has a stated system that contains (or is identical with) a certain catalyst as a functional component. Further, the quantity name must refer to the assay method. This, by itself, requires a detailed description of the assay system with its components, temperature, pH, etc. The special quantity to be measured in the assay system is the reaction rate of a zero-order reaction.

† [Symbols in brackets are not recommended]

5. CBN has abandoned its earlier support of catalytic amount as a basic kind of quantity and now defines the derived kind of quantity *enzymic activity* as 'the rate of reaction of substrate that may be attributed to catalysis by an enzyme' (8.2), and uses katal as a special name for 'mole per second'. This approach creates a difficulty when dimensional analysis is performed, because the dimension indicated by the unit mol/s is valid only for the auxiliary quantity (reaction rate) of the assay system, but not, as it should be, for the quantity to be determined. Further, the creation of a special name for a derived unit as 'mole per second' is against current international trend, that discourages new special names for simple products or ratios of base units. (If katal is considered a base unit, as in the present Recommendation, a separate name is, of course, necessary.)

6. After much deliberation and discussion with other IUPAC experts in the field of quantities and units, CQUCC and later SCC decided that it would probably be unwise to follow the latest Recommendation of CBN. However, it should be stressed that numerical results are identical whether the basic kind of quantity 'catalytic amount' and base unit 'katal' or the derived kind of quantity 'enzymic activity' and derived unit 'katal' = 1 mol/s are used.

7. The use of the 'enzyme unit' (symbolized U) ≙ 1 μmol/min (cf. 8.9) 'should be discouraged progressively so that it may eventually be abandoned' (8.2).

8. For a given method

$$1\ \mathrm{U} \triangleq 1\,\mu\mathrm{mol/min} = 10^{-6}\ \mathrm{mol/min} = 1/(10^{6} \times 60)\ \mathrm{mol/s} = 16{,}67\,\mathrm{nmol/s} \triangleq 16{,}67\,\mathrm{nkat}$$

9. Values obtained by one method, in some cases, may be converted to those of another through the use of an *empirical* factor; great caution should be exerted on account of unknown accelerators, inhibitors, and different effects on the single catalysts in a mixture.

In fact different methods mean different quantities. The conversion is therefore merely an example of the general problem of converting the values of one quantity to those of another, based on some regression analysis.

10. If the method employed precludes the use of this kind of quantity with its unit katal, an arbitrary kind of quantity and an arbitrary unit should be defined.

4.8.—**Mass concentration** (D) ρ
Kilogram per litre (DnC) **kg/l**

kg/l	[g/ml]†
	[%, g%, %(w/v), g/100 ml, g/dl]
g/l	[‰, g‰, ‰(w/v)]
	[mg%, mg%(w/v), mg/100 ml, mg/dl]
mg/l	[ppm, p.p.m.(w/v), mg‰]
	[μg%, μg%(w/v), μg/100 ml, ug/dl]
μg/l	
ng/l	[μμg/ml, uug/ml]

Notes: 1. This kind of quantity is the mass of the component divided by the

† [Symbols in brackets are not recommended]

volume of the system. The numerical value depends on the temperature and the pressure of the system.

2. The coherent unit is 'kilogram per cubic metre', cf. 4.3, Note 2. The use of this unit does not change the significant figures or the position of the decimal sign: 0,37 mg/l = 0,37 g/m^3.

3. Use of different volume bases, e.g. microlitre, millilitre, 100 millilitres, and litre is discouraged. Only the litre should be used.

4. The symbols %, ‰, and p.p.m. are incorrect and ambiguous.

5. Components for which elementary entities can be designated, preferably are measured according to 4.11.

4.9.—**Mass fraction** (D) w

Unity (DC) **1**

× 1	[kg/kg]	[g/g]†
		[%, %(w/w)]
× 10^{-3}	[g/kg]	[‰, ‰(w/w)]
× 10^{-6}	[mg/kg]	[p.p.m., p.p.m.(w/w), ppm]
× 10^{-9}	[µg/kg]	[p.p.b., p.p.b.(w/w), ppb]
× 10^{-12}	[ng/kg]	

Notes: 1. This kind of quantity is the mass of the component divided by the mass of the system. The numerical value is independent of the temperature and the pressure of the system.

2. This kind of quantity has the dimension one (cf. 3.8 and 3.4, Note 1) and the coherent unit is 'unity' (1). The unit 'kilogram per kilogram' is a redundant alternative.

3. Owing to the indiscriminate and ambiguous use of per cent (%), per mille (‰), parts per million (p.p.m.), and parts per billion (p.p.b.) these units should be abandoned.

4. Components for which elementary entities can be designated, preferably are measured according to 4.13.

4.10.—**Volume fraction** (D) φ

Unity (DC) **1**

× 1	[l/l]	[ml/ml]
		[%, %(v/v), vol%]
× 10^{-3}	[ml/l]	[‰, ‰(v/v), vol‰]
× 10^{-6}	[µl/l]	[p.p.m., p.p.m.(v/v), ppm]

Notes: 1. This kind of quantity is the volume of the isolated component divided by the volume of the system, both volumes at specified conditions. The numerical value depends on the temperature and pressure of the component and of the system.

2. This kind of quantity has the dimension one (cf. 3.8 and 3.4, Note 1) and the coherent unit is 'unity' (1). The unit 'litre per litre' (or the derived coherent unit 'cubic metre per cubic metre') are redundant alternatives.

3. As 4.9, Note 3.

4. As 4.9., Note 4 and 4.11.

5. Giving dilution 'strength' as 1:2, 2:3, etc. is ambiguous. The use of 4.10 or a precise description of the procedure is recommended.

† [Symbols in brackets are not recommended]

4.11.—**Substance concentration** (D) *c*

Mole per litre (DnC) **mol/l**

mol/l [M, *M*, eq/l, val/l, N, *N*, n] †
mmol/l [mM, m*M*, meq/l, mval/l, etc.]
μmol/l [μM, uM, μeq/l, etc.]
nmol/l [nM, neq/l, etc.]

Notes: 1. This kind of quantity is the amount of substance of the component divided by the volume of the system. The elementary entity of the component should be stated, if doubt may occur. The numerical value depends on the temperature and pressure of the system.

2. The importance of this kind of quantity should appear from 4.6, Note 1. An alternative is 4.13.

3. Concerning the concept 'equivalent concentration', cf. the analogous 4.6, Note 2.

4. The derived coherent unit is 'mole per cubic metre', cf. 4.3, Notes 1–4, and 4.8, Note 2.

5. Concerning the volume base, cf. 4.8, Note 3.

6. In QU-R66 the name 'molar concentration' was used, but the term 'molar' is now restricted by IUPAC to kinds of quantities having in their definitions 'an extensive kind of quantity of the system divided by amount of substance of the system'. The internationally recommended term for the kind of quantity defined in Note 1 is 'concentration' or 'amount of substance concentration'. After discussions (1971) with IUPAC Commission I.1 it was agreed that CQUCC can recommend the name 'substance concentration' to avoid confusion with the word 'concentration' in the colloquial sense.

4.12.—**Molality** (D) *m*

Mole per kilogram (DC) **mol/kg**

mol/kg [m, *m*, mmol/g, μmol/mg]
mmol/kg [mm, m*m*]
μmol/kg [μm, μ*m*]

Notes: 1. This kind of quantity is the amount of substance of the component in the solution divided by the *mass* of the *solvent*. The elementary entity of the solute should be stated, if doubt may arise. The numerical value is independent of the temperature (and pressure) of the solution.

2. For another possibility, cf. 4.13.

3. The kilogram is preferred as denominator in the units.

4.13.—**Mole fraction** (D) *x*

Unity (DC) **1**

× 1	[mol/mol]	
		[%, mol%]
$\times 10^{-3}$	[mmol/mol]	[‰, mol‰]
$\times 10^{-6}$	[μmol/mol]	

† [Symbols in brackets are not recommended]

Notes: 1. This kind of quantity is the amount of substance of the component divided by the amount of substance of all components in the system. The elementary entities of the components should be stated, if doubt may arise. The numerical value is independent of the temperature and pressure of the system.

2. This kind of quantity has the dimension one (cf. 3.8 and 3.4, Note 1) and the derived coherent unit is 'unity' (1). The unit 'mole per mole' is a redundant alternative.

3. As 4.9, Note 3.

4.14.—**Number concentration** (D) — C

One per litre (DnC) — $\mathbf{l^{-1}}$ or **1/l**

$\times 10^{-3}$/l	$\times 10^{-3}\,l^{-1}$	
$\times$ 1/l	l^{-1}	
$\times 10^{3}$/l	$\times 10^{3}l^{-1}$	[$\times$ 1/ml, ml^{-1}]†
$\times 10^{6}$/l	$\times 10^{6}l^{-1}$	[$\times$ 1/μl, $\times$ 1/ul, μl^{-1}]
$\times 10^{9}$/l	$\times 10^{9}l^{-1}$	

Notes: 1. This kind of quantity is the number of stated particles or elementary entities of the component divided by the volume of the system. The numerical value depends on the temperature and pressure of the system.

2. The unit 'one per litre' is preferred to 'one per millilitre' and 'one per microlitre'.

3. The derived coherent unit is 'one per cubic metre', cf. 4.3, Notes 1–4, and $23 \times 10^{3}/l = 23 \times 10^{6}/m^{3}$.

4. This kind of quantity had the too restrictive name 'particle concentration' in QU-R66-4.14.

4.15.—**Number fraction** (D) — δ

Unity (DC) — **1**

$\times$ 1	
	[%]
$\times 10^{-3}$	[‰]
$\times 10^{-6}$	

Notes: 1. This kind of quantity is the number of defined particles or elementary entities constituting the specified component divided by the total number of defined particles in the system.

2. This kind of quantity has the dimension one (cf. 3.8 and 3.4, Note 1) and the coherent unit is 'unity' (1).

3. As 4.9, Note 3.

4. This kind of quantity had the too restrictive name 'particle fraction' in QU-R66-4.15.

4.16.—**Catalytic concentration** (D) — b

Katal per litre (DnC) — **kat/l**

kkat/l	[kmol/s/l, kmol $s^{-1}l^{-1}$]	
kat/l	[mol/s/l]	
mkat/l	[mmol/s/l]	
		[U/ml]

† [Symbols in brackets are not recommended]

μkat/l [μmol/s/l] [U/l]
nkat/l [nmol/s/l]

Notes: 1. This kind of quantity is the catalytic amount of the component (enzyme) divided by the volume of the system. The numerical value depends on the temperature and pressure of the system.

2. The system mentioned in the definition is the original system containing enzyme, *not* the reaction mixture specified by method of determination.

3. CBN recommends that the '*concentration of enzymic activity* in a solution is defined as activity divided by volume of solution', but the present CQUCC and SCC Recommendation accords with 4.7.

4. The derived coherent unit is 'katal per cubic metre', cf. 4.8, Note 2.

5. CBN also recommends the unit 'katal per litre', but as their unit 'katal' is derived they should employ 'mole per second litre' (cf. 4.7, Note 5).

6. The use of 'enzyme unit per millilitre' (symbolized U/ml) should be progressively discouraged; cf. 4.7, Note 7.

7. For a given quantity (specified by a given method) 1U/ml ≙ 16,67 μkat/l.

8. Cf. also 4.7, Notes 9 and 10.

4.17.—**Kinds of quantities of a relative nature** (D) —
Unity (DC) **1**
×1
[%]†
× 10^{-3} [‰]
× 10^{-6} [p.p.m., ppm]
× 10^{-9} [p.p.b., ppb]

Notes: 1. Such a kind of quantity is a ratio between a kind of quantity referring to a specified system and an identical kind of quantity referring to another specified 'standard' or 'reference' system.

2. This kind of quantity has the dimension one (cf. 3.8 and 3.4, Note 1) and the coherent unit is 'unity' (1).

3. As 4.9, Note 3.

4. Examples of this kind of quantity are 'relative length', 'relative substance concentration', and 'relative density' (cf. 4.25).

4.18.—**Thermodynamic temperature** (B) *T*
Kelvin (B) **K**
K [°K, °, K°, °C]
mK

Notes: 1. The prior name and symbol—as stated in QU-R66—were 'degree Kelvin' and '°K' respectively. The new forms were accepted at CGPM 1967.

2. The unit is defined as the fraction 1/273,16 of the thermodynamic temperature of the triple point of water.

4.19.—**Celsius temperature** (D) *θ*
Degree Celsius (spec. D) **°C**
°C, K [C, °, C°, centigrade]
m°C, mK

† [Symbols in brackets are not recommended]

Notes: 1. The former name 'customary temperature' (as given in QU-R66) was changed to 'Celsius temperature' by CGPM 1967. The symbol, θ is preferred over t to avoid confusion with the same symbol for 'time'.

2. The unit degree Celsius is identical with kelvin but is used only for Celsius temperatures θ defined by $\theta = T - 273{,}15$ K (exactly), where T is thermodynamic temperature.

3. As 'degree Celsius' is identical to 'kelvin', either may be used to record Celsius temperature; cf. also 4.20.

4.20.—**Temperature difference** (D) ΔT
Kelvin (DC) **K**
K [°C] [°K, C, °, C°, centigrade]†
mK [m°C] [mdeg]

Notes: 1. The unit 'degree', symbolized 'deg' (as given in QU-R66), was abandoned by CGPM 1967.

2. A temperature difference or temperature interval is preferably given in kelvins but can also be given in degrees Celsius.

4.21.—**Pressure** (D) p
Pascal (DC) **Pa**
(**Newton per square metre** (DC)) ($\mathbf{N/m^2}$)

MPa	(MN/m^2)	
		[atm]
		[bar, b]
kPa	(kN/m^2)	
		[mmHg, Torr.]
		[mbar, mb]
		[mmH_2O]
Pa	(N/m^2)	[pascal]
		[μbar, μb]

Notes: 1. This kind of quantity is the force at right angles to the surface divided by the surface area . The value depends on system temperature.

2. IUPAC has decided that the use of the unit 'bar' (1 bar $= 10^5$ Pa $= 10^5$ N/m^2) is to be progressively discouraged and CQUCC in 1969 decided that the use of bar (recommended in QU-R66) should no longer be recommended. It should be replaced by the coherent SI unit Pa (or N/m^2).

3. Both 'pascal' (Pa) and 'newton per square metre' (N/m^2) are permitted derived coherent units, but Pa is preferred due to simplicity and to avoid duplicate names for the same unit.

4. The unit 'newton' is the force that, when applied to a body having a mass of one kilogram, gives it an acceleration *in vacuo* of one metre per second squared.

5. A measured liquid height requires correction for the temperature of the liquid and the local acceleration of free fall before conversion into any of the units of pressure.

6. The numerical value of the result of a quantity measured in mbar lies close to that of the same result in mmHg, whereas kPa = kN/m^2 gives distinctly different figures: 54 mbar = 41 mmHg = 5,4 kN/m^2 = 5,4 kPa.

† [Symbols in brackets are not recommended]

4.22.—**Partial pressure** (D) p
Pascal (DC) **Pa**
(**Newton per square metre** (DC)) ($\mathbf{N/m^2}$)
Cf. 4.21.

Notes: 1. This kind of quantity is defined as the product of the mole fraction of the gaseous component and the pressure of the gaseous system. Elementary entities should be given whenever doubt may arise. The temperature of the system should be stated.

2. Cf. 4.21, Notes 2–6.

3. The *tension of a gas in a liquid* is much used by clinical chemists and physiologists and is generally understood as a kind of quantity yielding values equal to the partial pressure of the component in a gas phase in equilibrium with the same component dissolved in the liquid.

4.23.—**Time** (B) t
Second (B) **s**
Minute (DnC) **min**
Hour (DnC) **h**
Day (24 hours) (DnC) **d**
Year (DnC) **a**

	a	[yr.]†
Ms		
	d	[da.]
	h	[hr.]
ks		
	min	[min., m]
s		[sec., s.]
ms		
µs		[us]

Notes: 1. The unit 'second' permits a rational use of the decimal system. The unit 'hundredth of a minute' is discouraged; thus 0,15 min should be replaced by 9 s.

2. The designation 'time' should not be used for a specific point in a given calendar; the latter kind of quantity may be called 'calendar time'.

4.24.—**Mass density** (D) ρ
Kilogram per litre (DnC) **kg/l**

kg/l	[g/ml]
g/l	[mg/ml]
mg/l	[µg/ml]

Notes: 1. This kind of quantity is the mass of a system divided by its volume. The numerical value depends on the temperature and pressure of the system.

2. 'Mass density' should not be confused with 'weight density' ('specific weight') which is the weight of a system divided by its volume.

3. The derived coherent unit is 'kilogram per cubic metre', cf. 4.8, Note 2.

4. The name 'density' for this kind of quantity is ambiguous because it is

† [Symbols in brackets are not recommended]

also used for 'relative density' (cf. 4.25) and 'absorbance' (also called 'optical density').

4.25.—**Relative density** (D) *d*
Unity (DC) **1**
× 1
× 10^{-3}

Notes: 1. This kind of quantity is the ratio between the density of the system and the density of a 'reference' or 'standard' system under conditions that should be specified for both systems. The value depends on the temperature and pressure of each of the two systems.

2. This kind of quantity has the dimension one and is an example of the group of kinds of quantities mentioned in 4.17.

3. The term 'specific gravity', often used when water is the reference system, may be confused with 'specific weight'; cf. 4.24, Note 2.

4. A more rational name for 'relative density' would be 'relative mass density' and this name should be used in case of possible ambiguity.

4.26.—**Kinds of quantities of an arbitrary nature** (B or D) —
International unit (B or D) **int. unit**
Arbitrary unit (B or D) **arb. unit**
[iu, u, IU, I.U.]†

Notes: 1. A kind of quantity of this nature with corresponding unit may be defined when the result of a measurement is not a part of a recognized kind of quantity having a definable dimension. An indication of method should form an integral part of the name for the kind of quantity. Anyone may define an arbitrary unit; the more authoritative 'international unit' is defined by an international body.

2. Concerning 'titre', cf. QU-R66, 4.26.3.

3. So-called 'qualitative measurements' and 'semiquantitative measurements' are simply 'quantitative' measurements with restricted modes of expression. The two types may be treated as arbitrary kinds of quantities and the results given as 0 or 1 arbitrary unit and 0–1–2–3–. . . arbitrary units respectively. The symbols –, ÷, ±, ?, and + + are not recommended. The possible results may be stated as a specification to the kind of quantity (cf. *Table 7.6-1*, 4.26).

4. Immunoglobulin A is a component for which the arbitrary amount of substance is recorded in international units. The value of a 'Blood—Sedimentation reaction' as arbitrary length (Westergren 1926) may be measured in arbitrary units.

5. PRINTING RULES FOR PRESENTATION OF DATA

5.1.—**Quantity names.** The *Recommendation 1966* states that a printed quantity name should be unambiguous and contain information on *system* (e.g. Serum), *component* (e.g. Sodium ion), and *kind of quantity* (e.g. substance concentration). The specific form may vary with language and

† [Symbols in brackets are not recommended]

local requirements. Some possibilities will appear from the list of examples in Section 7. For a more thorough discussion consult QU-R66, Parts 6 and 7, and 'List of Quantities. Recommendation 1973'.

5.2.—**Printing rules for symbols of units and for numbers.** The internationally recommended rules are given in QU-R66, 3.7.2–5 and 3.8; a few are repeated here.

5.2.1.—Symbols for internationally recommended units should be printed in roman (upright) type, remain unaltered in the plural, and should be written without a final full stop. The symbols are in lower case letters, except, when derived from a proper name. *Examples:* The symbol for 'grams' is g, *not* g., gms., or G.

5.2.2.—The *factor name or symbol* is printed in roman (upright) type as a prefix without a space before the name or symbol of the unmultiplied unit which may not be omitted. Compound prefixes are to be avoided when single prefixes are available; this also applies to the factor in the base unit 'kilogram'. *Examples:* milligram (mg), *not* milli gram (m g); micrometre (µm), *not* micron (µ); picogram (pg), *not* micro-microgram (µµg).

5.2.3.—When a unit symbol carries an *exponent,* the factor symbol is raised to the same power as the unmultiplied unit symbol. *Examples:* $1\ \mathrm{mm}^2 = (10^{-3}\ \mathrm{m})^2 = 10^{-6}\ \mathrm{m}^2$; $\mu\mathrm{l}^{-1}$ means $(10^{-6}\ \mathrm{l})^{-1}$, *not* $10^{-6}\ \mathrm{l}^{-1}$.

5.2.4.—The factor symbols should not be used when the results are given for measurement of dimensionless quantities, for which the coherent unit is 'unity' (1). *Example:* A mass fraction of 20×10^{-3} or 0,020 should not be written 20 m.

Note: One way of avoiding the bothersome powers of ten would be to create a name for the unit 1.

5.2.5.—Products may be written $ab = a \cdot b = a \times b$; $a^n b^m$; $a^n \times b \times c^p$; etc. *Quotients* should be written

$$\frac{a}{b} = a/b = ab^{-1} = a \times b^{-1};\ ab/c;\ \frac{a/b}{c} = (a/b)/c = a \times b^{-1} \times c^{-1} = \frac{a}{bc}$$

Note: In no case should more than one solidus (/) be employed in a given combination, except when the use of parentheses eliminates ambiguity; e.g. *not* $a/b/c$, but $(a/b)/c = a \times b^{-1} \times c^{-1}$ or $a/(b/c) = a \times b^{-1} \times c$ as the case may be.

5.2.6.—The *decimal sign* is a comma on the line (8.7). In documents in the English language a dot on the line can be used, but the comma is preferred in this Recommendation. If the numerical value of the number is less than one, a zero should precede the decimal sign. Numbers with many digits may be written with small spaces separating groups of three, counting from the decimal sign towards the left and right; a point or comma should not be used for separation. *Example:* 6,022 52 ± 0,000 28.

6. PROPOSED NEW DERIVED KINDS OF QUANTITIES

6.0.—**Development of new kinds of quantities.** In QU-R66, Part 5, some useful kinds of quantities were proposed. Amendments were made by CQUCC in 1969, 1971, and in 1973, and the results are briefly listed here. The abbreviations for type of kind of quantity and unit are explained in *Table 4.0-1.*

6.1.—Volume content (D) V_C/m_S
litre per kilogram (DnC) l/kg

Notes: 1. This kind of quantity is the volume of the (isolated) component at specified conditions divided by the mass of the system.

2. The term 'content' is under discussion due to ambiguities.

3. 'Volume content' should not be confused with 'specific volume', which is the volume of the system divided by the mass of system.

6.2.—Substance content (D) n_C/m_S
mole per kilogram (DC) mol/kg

Notes: 1. This kind of quantity is the amount of substance of the component divided by the mass of the system. (This kind of quantity should not be confused with 'molality', cf. 4.12.).

2. Cf. 6.1, Note 2.

6.2.1.—Catalytic content (D) z_C/m_S
katal per kilogram (DC) kat/kg

Notes: 1. This kind of quantity is the catalytic amount of the component divided by the mass of the system.

2. Cf. 6.1, Note 2.

6.3.—Mean mass rate (D) $\Delta m/\Delta t$
kilogram per second (DC) kg/s
kilogram per day (DnC) kg/d

Note: This kind of quantity is the mass of the component changed in or moved to or from a system divided by the time during which the component was changed or moved.

6.4.—Mean volume rate (D) $\Delta V/\Delta t$
litre per second (DnC) l/s
litre per day (DnC) l/d

Notes: 1. As 6.3, Note, with substitution of 'volume' for 'mass'. The temperature and (for gases) the pressure of the (isolated) component should be stated.

2. The kind of quantity 'clearance' is usually defined as the product of the substance concentration of the component (or comparable derivative) in the specified output and the volume rate of that output divided by the substance concentration of the component in the specified input. Thus, this methodological definition equals 'mean volume rate' and this name is preferred.

6.5.—Mean substance rate (D) $\Delta n/\Delta t$
mole per second (DC) mol/s
mole per day (DnC) mol/d

Note: As 6.3, Note, with substitution of 'amount of substance' for 'mass'. This kind of quantity usually should be preferred for mean mass rate (6.3) or mean volume rate (6.4).

6.6.—Mean catalytic amount rate (D) $\Delta z/\Delta t$
katal per second (DC) kat/s

Note: As 6.3, Note, with substitution of 'catalytic amount' for 'mass'. (This kind of quantity should not be confused with 'rate of reaction'.)

6.7.—According to the latest views, the definitions given in QU-R66 for 'mass rate', 'volume rate', and 'mole rate' pertain to the kinds of quantities 'mean mass rate', 'mean volume rate', and 'mean substance rate' respectively. In daily practice these last three kinds of quantities are used. The definition of 'mass rate' would be: the rate of change in mass at a specified point in time of the component changed in or moved to or from a system. 'Volume rate' and 'substance rate' are defined analogously.

7. STRUCTURE OF QUANTITY NAMES

7.1.—As mentioned in 5.1. *Recommendation 1966* states that **printed quantity names should contain unambiguous information on system, component, and kind of quantity.** The specific form may vary with language and purpose. The principle is now supported by a joint Recommendation 1972 of ICSH, IFCC, and WAPS (8.6). For a thorough discussion of structure, cf. QU-R66, Parts 6 and 7. An abbreviated proposal for English names is given below.

7.2.—Lists of names may be given for systems, components, and kinds of quantities respectively. A name for each specific quantity is constructed by selecting an appropriate item from each list. In this document, they are joined together in the following way: The name of the *system*, written with an initial capital letter, is followed by a long hyphen (em dash)—; the name of the *component* also begins with a capital letter, serves for primary alphabetizing, and is followed by a comma; finally comes the name of the *kind of quantity*, written in lower case letters. Names for systems and kinds of quantities may be abbreviated; for kinds of quantities their italicized symbols may also be used.

7.3.—**System.** The name of the system, chosen as proper, stands alone. It may be preceded by an explanatory indication of a 'super' system or be followed by a 'sub' system. *Examples:* Blood, (Blood)Leukocytes, Patient (Urine). The full name is unambiguous, but possible codes in English for commonly used systems are given in *Table 7.3-1*.

7.4.—**Component.** Usually, chemical names should conform with IUPAC nomenclature, whether the names be systematic or trivial. Elementary entities must be appended (in parentheses) when necessary to avoid ambiguity. Enzyme names should conform with IUPAC–IUB Recommendations 1972 (8.2). Names of methods should not supplant the component name, but—when necessary—should be placed in parentheses as an explanation after the name of the kind of quantity. Abbreviations should be avoided. *Examples:* Nitrogen(N), Calcium(II) ion(Ca), Calcium(II) ion$(Ca^{2+})_{0,5}$ or Calcium(II) ion(positive charge), Fatty acid(carboxyl), Phosphate(P), Chloride, Alanine—meaning the sum of negative, ampho-ionic, and positive particles, Alanine aminotransferase, Fluid(filtrated)—e.g. from the renal glomeruli.

Table 7.3-1. Possible codes for systems (in English)

a	arterial	(used as a prefix)
B	Blood	
c	capillary	(used as a prefix)
d	24-hour	(used as a prefix)
Ex	Expectoration	
Erc	Erythrocyte	(or E)
(B)Erc	Erythrocyte (from blood)	(or (B)E)
Ercs	Erythrocytes	(or Es)
fPt	fasting patient	
F	Faeces	
Lkc	Leukocyte	
Lkcs	Leukocytes	
P	Plasma	
Pt	Patient	
S	Serum	
Sf	Spinal fluid	
U	Urine	
v	venous	(used as a prefix)

7.5.—**Kind of quantity.** The names may be abbreviated as suggested in *Table 7.5-1* or given as their italicized symbols. Necessary specifications are placed in parentheses. *Examples:* relative substance concentration(Pt/Norm), viscosity (4,0 °C), catalytic concentration (King and King 1954).

Table 7.5-1. Abbreviations for kinds of quantities

ams.	amount of substance
arb.	arbitrary
catc.	catalytic concentration
(cont.	content)
dens.	density
diff.	difference
massc.	mass concentration
massfr.	mass fraction
molal.	molality
molfr.	mole fraction
(or substfr.	substance fraction)
numc.	number concentration
numfr.	number fraction
rel.	relative
spec.	specific
substc.	substance concentration
temp.	temperature
vol.	volume
volfr.	volume fraction

7.6.—**Systematic names.** Examples of quantity names, constructed according to the above rules, are given in *Table 7.6-1*. They illustrate the use of different kinds of quantities and are mostly chosen to show a solution to the more difficult problems, rather than the easy. A presumably normal value is given, employing a recommended unit. For more—and often more simple—examples, cf. QU-R66, 7.3 and 'List of Quantities. Recommendation 1973'.

Table 7.6-1. Systematic quantity names

Cf. Section	Quantity System—Component, kind of quantity	Reference value num. val. × unit
4.16	S—Acid phosphatase, catc.(Jacobsson 1960)	= 65 nkat/l
4.8	S—Albumin, massc.	= 42 g/l
4.9	(S)Protein—Albumin, massfr.(method)	= 0,69 = 0,69 kg/kg
4.11	S—Albumin(68 000), substc.	= 618 μmol/l
4.11	(fPt)S—Bilirubins, substc.	= 14 μmol/l
4.3	Pt—Blood, vol.	= 4,90 l
4.6	dU—Calcium(II), ams.	= 4,3 mmol
4.11	P—Carbonate + carbon dioxide, substc.	= 28 mmol/l
4.14	Sf—Cells, numc.	= 2×10^6/l
4.23	B—Coagulation, time (Biggs *et al.* 1957)	= 1,3 ks
4.17	fPt—Dioxygen(absorb.), rel. subst. rate(rest; Pt/Norm)	= 1,00
4.10	B—Erythrocytes, volfr.	= 0,43
4.26	U—Glucose, arb. substc. (Clinistix®; 0–1)	= 0 arb. unit
4.6	(B)Erc(mean)—Hemoglobin(Fe), ams.†	= 2,0 fmol
4.15	(B)Lkcs—Lymphocytes, numfr.	= 0,3
4.4	Pt—Patient, mass	= 70,8 kg
—	aB—Plasma, pH(37,0 °C)	= 7,39
4.25	B—Serum, rel. dens.(S, 20 °C/H_2O 20 °C)	= 1,026

† Known as 'MCH' or 'mean cell hemoglobin'

8. REFERENCES

(Abbreviations on p. 523)

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8.5. International Committee for Standardization in Hematology, Implications of IUPAC–IFCC Recommendations for Hematology, 17 pp, unpublished working document.

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APPENDIX

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