



# Resolution 1 of the 26th CGPM (2018)

- On the revision of the International System of Units (SI)

*“By this action you will set up a measurement system that will rely entirely on the fundamental constants of nature.*

*The benefits of this choice can only favour new technologies.”*

*Professor Sébastien Candell,  
President of the Académie des sciences de Paris and President of the CGPM for its 26th meeting*



# 27th meeting of the CGPM

## 15-18 November 2022

<https://www.bipm.org/en/cgpm-2022>

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Please see the BIPM website for the full text of the resolutions.

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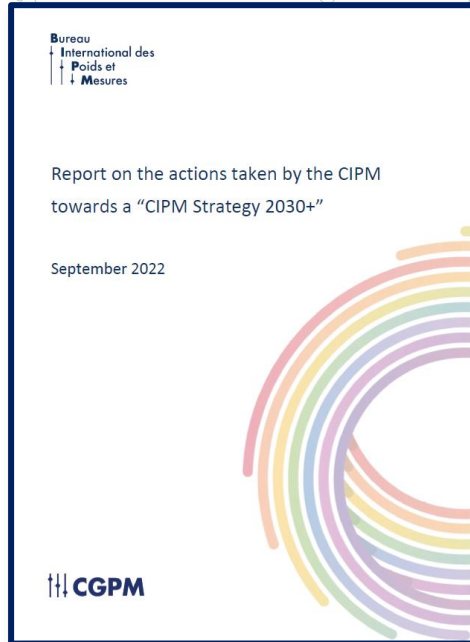
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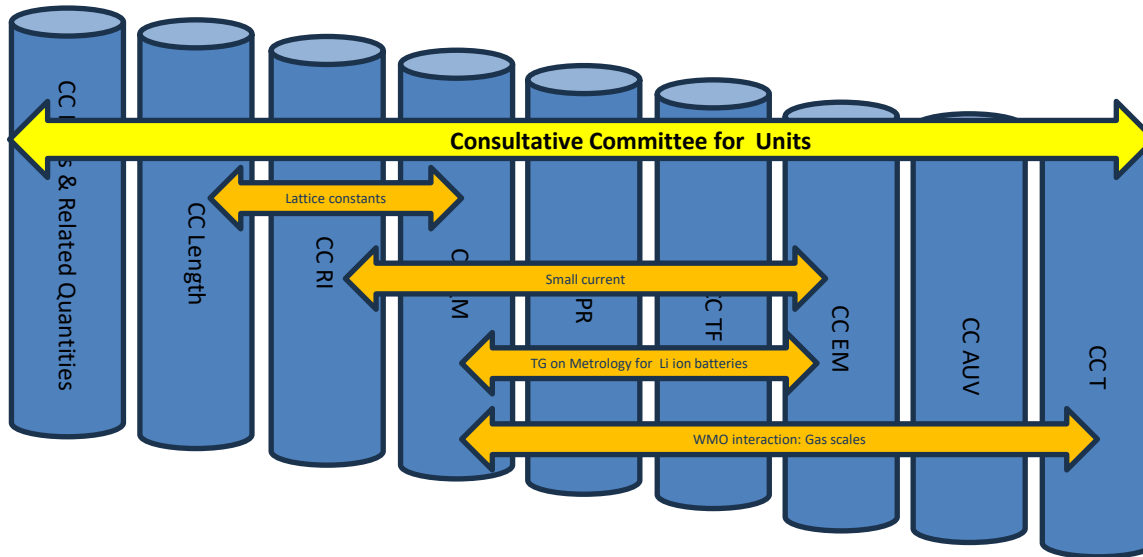
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# The System in Place by 2018

## The Consultative Committees 1952-1995





**EURAMET**

European Association  
of National  
Metrology Institutes

**COOMET**

Euro-Asian Co  
Natio



**Universal  
Adherence**



Coordination of  
metrology globally

Sound technical basis

Inter-Americ  
Metrolo



1875

[www.bipm.org](http://www.bipm.org)



Intra-Africa  
Metrology System



Gulf Association  
for Metrology

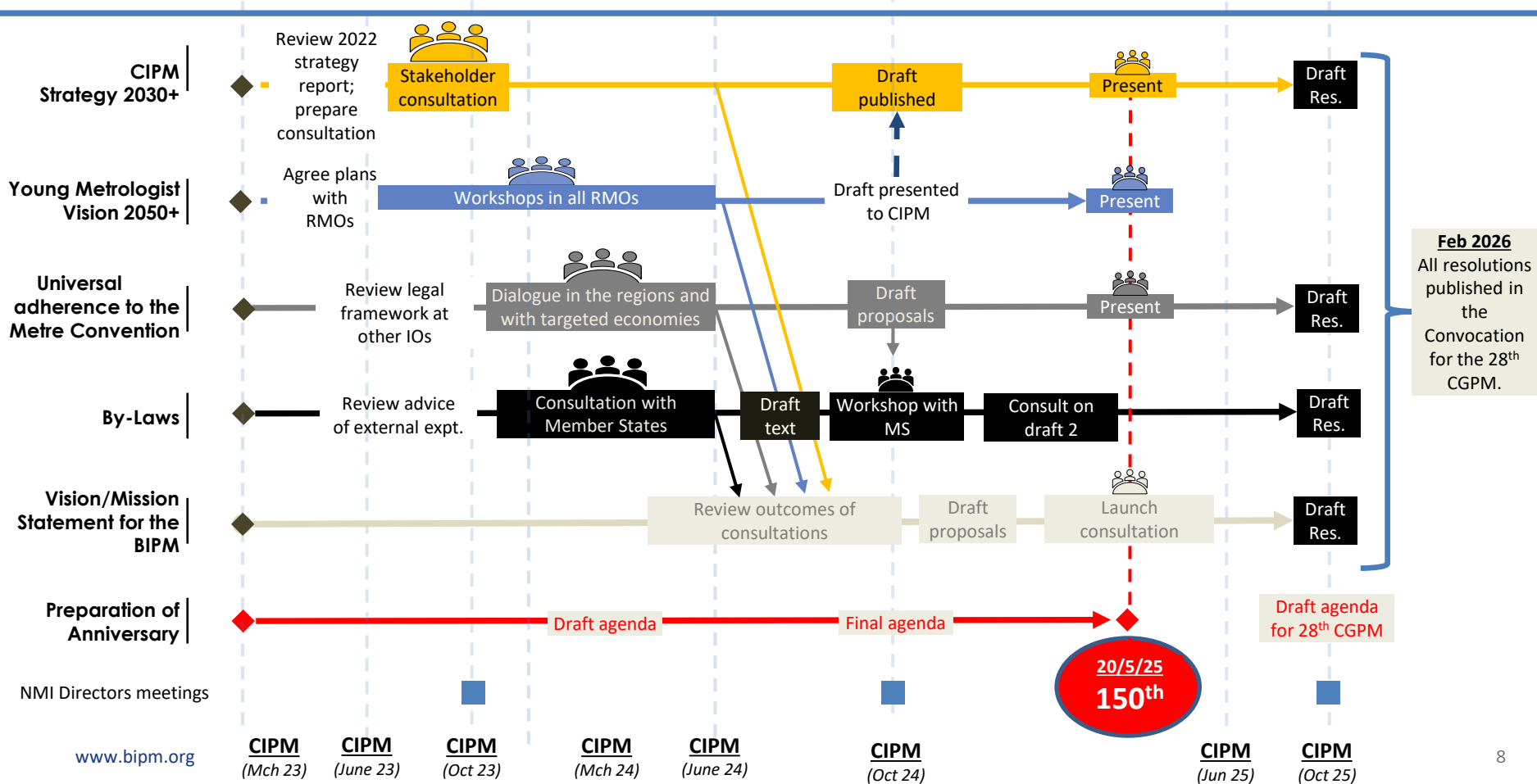


Asia Pacific  
Metrology  
Programme



**The CIPM at work, March 2023-October 2024**

# Timelines for external actions: consultations, publications and presentations





## **Decision CIPM/112-11 (2023)**

Following Decision CIPM/110-10 (2021) to start the Sectorial Task Group on Climate Change and Environment (STG-CENV), the CIPM approved the structure, terms of reference, membership and work plan.

## **Decision CIPM/112-9 (2023)**

The CIPM decided to establish a CIPM Sub-Committee on Governance to execute the mandate given by the CGPM at its 27th meeting (2022) to modernize the organization, and appointed Dr P. Richard as the Chair. Dr V.G. Achanta, Dr D. del Campo Maldonado, Dr W. Louw, Ms G. Macdonald and Dr T. Usuda agreed to be members. The terms of reference of the CIPM Sub-Committee on Governance were approved.

## **Decision CIPM/112-12 (2023)**

The CIPM approved the establishment of a forum on metrology in the digital world and noted the draft mission and structure proposed by the CIPM Task Group on the SI Digital Framework. It requested the Task Group to propose a name for the forum.

The CIPM adopted the updated Grand Vision for the SI Digital Framework.

The CIPM endorsed the swift further development and implementation of the SI Reference Point (SIRP, working title) by the BIPM Headquarters in close coordination with the Task Group on the SI Digital Framework and its Expert Group.

The CIPM endorsed the SIRP to become the unit representation system for the digital products of the BIPM, including the SI Brochure, the mises en pratique, the KCDB and the JCTLM database

## **Decision CIPM/112-23 (2023)**

The CIPM approved the Final Draft of the document JCGM GUM-1:202X (Guide to the expression of uncertainty in measurement — Part 1: Introduction).

## **Decision CIPM/112-14 (2023)**

The CIPM noted that the trend projected by the International Earth Rotation and Reference Systems Service (IERS) would lead to a negative leap second for the first time before 2035 and asked the CCTF to identify the best way forward and the necessary steps to allow a timely application of Resolution 4 adopted by the CGPM at its 27th meeting (2022) working together with the International Telecommunication Union (ITU).

### **Decision CIPM/112-25 (2023)**

The CIPM adopted “Forum on Metrology and Digitalization” as the name for the horizontal forum on digitalization. It adopted the mission and structure of the forum and approved the BIPM Headquarters’ updated workplan on digitalization for 2023 and 2024.

### **Decision CIPM/112-24 (2023)**

The CIPM approved the renewal of the BIPM-ILAC Memorandum of understanding with an amendment to the renewal period from 3 years to 5 years.

## **Decision CIPM/113-13 (2024)**

The CIPM appointed R.J.C. Brown (NPL, UK) as President of the Consultative Committee for Units (CCU).

## **Decision CIPM/113-21 (2024)**

The CIPM approved a new version of the 9th edition of the SI Brochure (v3.01) incorporating the changes suggested by the CCU Task Group and Focus Group considering angles, dimensionless quantities, counting and number quantities, and the associated revision of the Concise Summary



## **Draft Decision CIPM/113-29 (2024)**

The CIPM endorsed *Metrologia* as its journal of choice for reporting advances in pure and applied metrology at the highest level, including the best research work undertaken by NMIs and under the auspices of the CIPM's Consultative Committees and Forums/STGs.

The CIPM asked the Consultative Committees and Forums/STGs each to nominate one or more ambassadors to *Metrologia*, to strengthen the link between these bodies and *Metrologia* and identify topics of interest for Focus Issues.

*In the interest of the whole metrology community, the CIPM asked the BIPM to pursue an Open Access publishing model for the journal.*

*The CIPM recommended the creation of a separate entity for the publication of comparison reports and asked the BIPM to identify and implement an appropriate mechanism for this.*

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## Workshop on the Future of the Candela

### Half-day Tuesday

What is the  
*Annette Ko*

CCU intere  
*Richard Br*

No changes  
*Arming Sp*

Adopt Con  
*Yoshi Ohnc*

Bring phot  
value for ex  
*Gael Obeir*

A qu  
ques

### Considering implementation of cone-fundamental-based spectral luminous efficiency functions

In the current SI, the candela is defined with a fixed defining constant,  $K_{cd}$  (683 lm/W), without reference to any spectral luminous efficiency functions. Thus, only changing the  $V(\lambda)$  would not require revision of the candela definition in the SI.

However, changing the  $V(\lambda)$  would result in change of photometric values of real lighting sources.

Such changes of photometric values (like lumen rating of lamps) could be a serious problem for the industry and market

#### Approach

(1) Revising the value of  $K_{cd}$

(2) Re-scaling the  $V_F(\lambda)$ ,  $V_{F10}(\lambda)$  functions

(3) Correction factor

(2) will not be a viable option because there is a convention in CIE/CIPM that all action spectra (including spectral luminous efficiency functions) must be normalized to 1 at peak.

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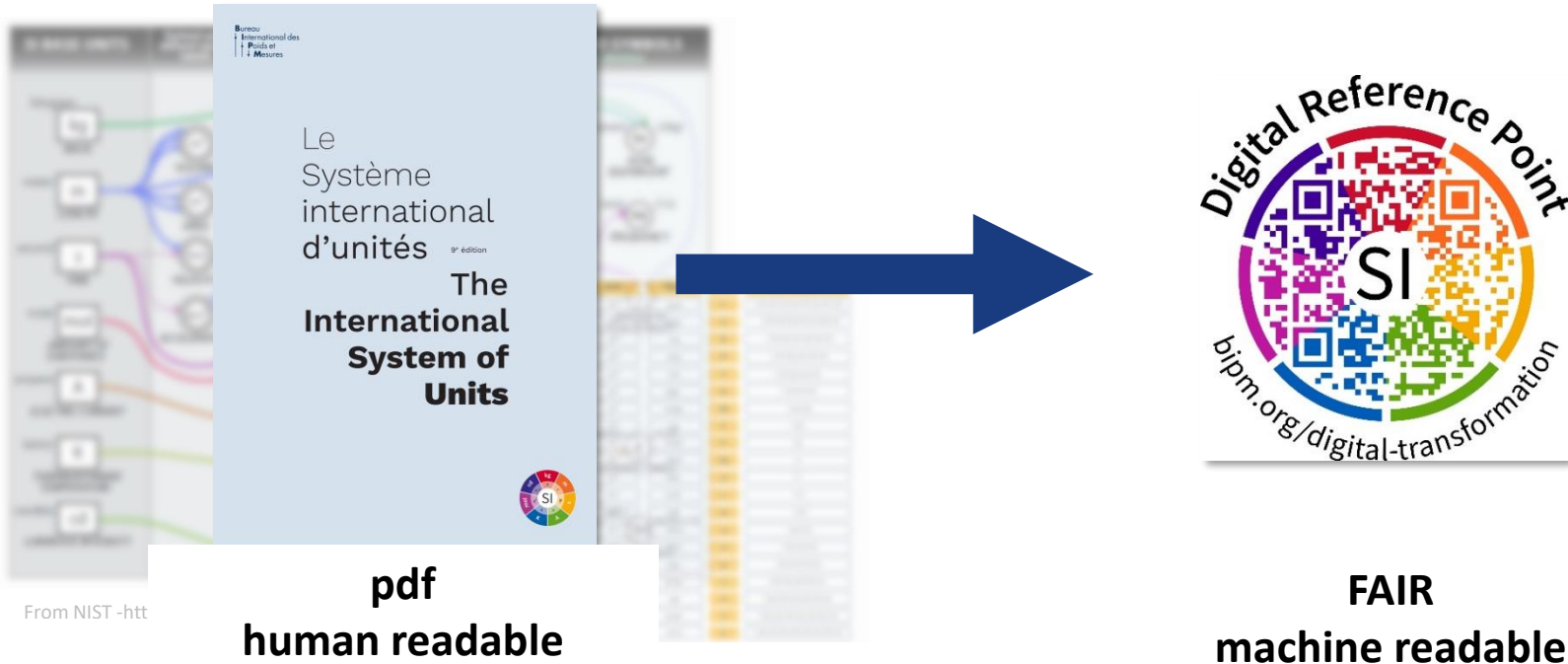
27th meeting  
of the General Conference  
on Weights and Measures

27<sup>e</sup> réunion  
de la Conférence générale  
des poids et mesures



# The SI Digital Framework provides a fully digital representation of the SI

- Provide the globally accepted anchor of trust for metrology in the digital era
- Facilitate the use of digital certificates and the adoption of the FAIR principles



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# CCU Presidents



**1967 – 1995**



**1995 – 2013**



**2013 – 2024**



**2024 –**

“The SI has developed not only through technological advance but also as a result of cultural and political compromise. It must continue to evolve to meet stakeholder needs whilst recognizing that its most important qualities are stability and consistency.” *President’s Report to 26<sup>th</sup> CCU, April 2024*

# 9<sup>th</sup> Edition of the SI Brochure: version 3.01



The BIPM has published a new version of the SI Brochure

This update gives an improved description of units for angles and quantities with the unit one.

- Better recognition of the complexity and nuance of angle
- Better description of the types of quantity with the unit one
- Simplification & removing duplication

## Preface to version 3.01 of the 9th edition

The move to digital publishing has made it simpler for updates to the SI Brochure to be made without issuing a new edition. In most cases these simply correct typographical errors or improve formatting, and the CCU President and Executive Secretary will continue to implement such editorial changes that improve the text of the SI Brochure without affecting its meaning. Larger improvements or technical changes result in the production of a new version of the current edition. Since the 9th edition was first published in 2019, two new versions have been produced. In 2022, version 2.01 was published and contained the new SI prefixes approved by the 27th CGPM. This current document, version 3.01, was published in 2024 and incorporates several improvements to the descriptions of angle and quantities with the unit one, recommended by the CCU and approved by the CIPM, to improve the understanding of these quantities.

August 2024

W. Louw

R.J.C. Brown

M.J.T. Milton

President, CIPM

President, CCU

Director, BIPM

# Important changes in version 3.01

## 2.3.4 Derived units

Table 4. The 22 SI units with special names and symbols

Derived quantity	Special name of unit	Symbol	Unit expressed in terms of base units <sup>(a)</sup>	Unit expressed in terms of other SI units
plane angle	radian <sup>(b)</sup>	rad	<sup>(b)</sup>	1
solid angle	steradian <sup>(c)</sup>	sr	<sup>(c)</sup>	1

- (b) The radian is the coherent unit for plane angle. One radian is the angle subtended at the centre of a circle by an arc that is equal in length to the radius. This suggests  $\text{rad} = \text{m/m}$  but this representation is not intrinsic and may be misleading since angle is not the same kind of quantity as other length ratios. An alternative definition is that a right angle is equal to  $\pi/2$  rad. The radian is also the coherent unit for phase angle. For periodic phenomena, the phase angle increases by  $2\pi$  rad in one period.

## 5.4.7 Quantities with the unit one

As discussed in Section 2.3.3, values of quantities with the unit one can be expressed simply as numbers. The unit symbol 1 or unit name “one” are rarely explicitly written. SI prefix symbols can neither be attached to the symbol 1 nor to the name “one”, therefore powers of 10 are used to express particularly large or small values.

Quantities that are ratios of quantities of the same kind (for example length ratios and amount fractions) have the option of being expressed with units (m/m, mol/mol) to aid the understanding of the quantity being expressed and also allow the use of SI prefixes, if this is desirable ( $\mu\text{m/m}$ ,  $\text{nmol/mol}$ ). Quantities that are a number of entities do not have this option.

Whilst not part of the SI, descriptive terms are commonly used in place of the unit one to indicate the entities being considered when expressing the values of quantities that are a number of entities. If this is done, the definitions of such terms and the conventions for their use must be clearly documented. The general principles of Section 5 should also be followed.



# Version 3.02: the dalton

- A small editorial update will be required, probably in late 2024 / early 2025

**Table 8. Non-SI units accepted for use with the SI units**

Quantity	Name of unit	Symbol for unit	Value in SI units
mass	tonne <sup>(e)</sup>	t	1 t = 10 <sup>3</sup> kg
	dalton <sup>(f)</sup>	Da	1 Da = 1.660 539 066 60(50) × 10 <sup>-27</sup> kg
			1 Da = 1.660 539 068 92(52) × 10 <sup>-27</sup> kg

- The new 2022 CODATA adjustment is due to be published soon

# Version 3.02: marginal note in section 3

- ◆ A small editorial update will be required, probably in late 2024 / early 2025

- A new version of IEC 80000-13 is due to be published soon
- It will contain the new binary prefixes stemming directly from the new SI prefixes approved at the 27<sup>th</sup> CGPM

The SI prefixes refer strictly to powers of 10. They should not be used to indicate powers of 2 (for example, one kilobit represents 1000 bits and not 1024 bits). The names and symbols for prefixes to be used with powers of 2 are recommended as follows:

kibi	Ki	$2^{10}$
mebi	Mi	$2^{20}$
gibi	Gi	$2^{30}$
tebi	Ti	$2^{40}$
pebi	Pi	$2^{50}$
exbi	Ei	$2^{60}$
zebi	Zi	$2^{70}$
yobi	Yi	$2^{80}$
robi	Ri	$2^{90}$
quebi	Qi	$2^{100}$

# Thinking ahead – towards a 10<sup>th</sup> edition of the SI brochure

- How to deal with non-SI units in future, what does ‘accepted for use with the SI’ mean?
- *(The distinction between base and derived units)*

CCU TG-KTSIB is considering this: first meeting in Nov 2024

- Reviewing marginal notes and footnotes: deleting, rationalising, or integrating these into the text, to aid digitalisation

CCU President and Executive Secretary will make proposals

- Representing a redefined SI second in the SI Brochure

CCU will continue to liaise with CCTF

# CCU Task Group on Fundamental Concepts in Metrology

- The working group on core metrological terms has reformed as a task group
- Considering a draft mathematical model of quantities
- Outputs relevant to JCGM-WG2:VIM and digitalisation communities

## Draft of the mathematical model

The basic elements of the model [we are presenting here](#) are the following.

1. A set of objects,  $\mathcal{O}$ .
2. A set of general quantities,  $\mathcal{Q}$ .
3. For each general quantity  $Q \in \mathcal{Q}$ :
  - (a) the set  $\{q_i\}_{i \in I}$  of the individual quantities that are instance of  $Q$ ;
  - (b) the subset  $\mathcal{O}_Q \subseteq \mathcal{O}$  of the objects having an instance of  $Q$ ;
  - (c) a function  $f_Q : \mathcal{O}_Q \rightarrow \{q_i\}_{i \in I}$  assigning an individual quantity of kind  $Q$  to each object in  $\mathcal{O}_Q$ ;
  - (d) the group  $\{s_j\}_{j \in J}$  of the scales for  $Q$ , where a scale is a function  $s : \{q_i\}_{i \in I} \rightarrow \mathbb{R}$  assigning a non-negative number to each quantity in  $\{q_i\}_{i \in I}$ .

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