

Photometry — The CIE system of physical photometry

ICS 17.180.01

National foreword

This British Standard reproduces verbatim ISO 23539:2005 and implements it as the UK national standard.

The UK participation in its preparation was entrusted by Technical Committee CPL/34, Lamps and related equipment, to Subcommittee CPL/34/5, Photometry and light classifications, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii and iii, a blank page, pages 1 to 18, an inside back cover and a back cover.

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Photometry — The CIE system of physical photometry

Photométrie — Le système CIE de photométrie physique



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

ISO 23539 was prepared as Standard CIE S 010/E by the International Commission on Illumination, which has been recognized by the ISO Council as an international standardizing body. It was adopted by ISO under a special procedure which requires approval by at least 75 % of the member bodies casting a vote, and is published as a joint ISO/CIE edition.

The International Commission on Illumination (abbreviated as CIE from its French title) is an organization devoted to international cooperation and exchange of information among its member countries on all matters relating to the science and art of lighting.

ISO 23539 was prepared by CIE Technical Committee 2-35 *CIE Standard for $V(\lambda)$ and $V'(\lambda)$* .

PHOTOMETRY - THE CIE SYSTEM OF PHYSICAL PHOTOMETRY

INTRODUCTION

The visual brightness of a light source depends not only on the amount of radiation it emits but also on its spectral composition and on the visual response function of the observer viewing it. Because human visual response varies at different light levels and from person to person, precise photometry requires the definition of representative standard observers. The CIE system of physical photometry specifies procedures for the quantitative evaluation of optical radiation in terms of the spectral luminous efficiency functions of two such standard observers. One, $V(\lambda)$, represents photopic vision and the other, $V'(\lambda)$, scotopic vision. Used in conjunction with the SI photometric base unit, the candela, these functions constitute a system that enables the values of photometric quantities for all types of luminous source to be precisely determined, regardless of the spectral composition of the radiation emitted.

1. SCOPE

This international Standard specifies the characteristics of the system of physical photometry established by the CIE and accepted as the basis for the measurement of light. It defines the photometric quantities, units and standards that make up the CIE system of physical photometry and that have been officially accepted by the Comité International des Poids et Mesures (CIPM). They comprise:

- the definition of photometric quantities and units,
- the definition of CIE standard spectral luminous efficiency functions for photopic and scotopic vision,
- the definition of a CIE standard photometric observer that conforms to these functions,
- the definition of maximum luminous efficacies for photopic and scotopic vision.

An informative annex provides a vocabulary of related terms.

2. PHOTOMETRIC QUANTITIES

Photometric quantities are defined in the International Lighting Vocabulary (ILV) (CIE, 1987a).

2.1 Luminous flux

The fundamental physical quantity used in optical radiometry is the radiant flux or radiant power, Φ_e , measured in watts, which is emitted by a source of radiation, transmitted by a medium of propagation, or received at a surface. The corresponding photometric quantity is:

luminous flux (Φ_v) (see ILV 845-01-25)

quantity derived from radiant flux Φ_e by evaluating the radiation according to its action upon the CIE standard photometric observer

The procedure for deriving Φ_v from Φ_e is defined in 4.3, below.

2.2 Other quantities

The following are the photometric quantities that correspond to the most important radiometric quantities defined in the International Lighting Vocabulary.

luminous energy (also known as **quantity of light**) (Q_v) (see ILV 845-01-28)

time integral of the luminous flux Φ_v over a given duration Δt

$$Q_v = \int_{\Delta t} \Phi_v dt$$

luminous intensity (of a source in a given direction) (I_v) (see ILV 845-01-31)

quotient of the luminous flux $d\Phi_v$ leaving the source and propagated in the element of solid angle $d\Omega$ containing the given direction, by the element of solid angle

$$I_v = \frac{d\Phi_v}{d\Omega}$$

luminance (in a given direction, at a given point of a real or imaginary surface) (L_v) (see ILV 845-01-35)

quantity defined by the formula

$$L_v = \frac{d\Phi_v}{dA \cdot \cos\theta \cdot d\Omega}$$

where $d\Phi_v$ is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $d\Omega$ containing the given direction; dA is the area of a section of that beam containing the given point; θ is the angle between the normal to that section and the direction of the beam

illuminance (at a point of a surface) (E_v) (see ILV 845-01-38)

quotient of the luminous flux $d\Phi_v$ incident on an element of the surface containing the point, by the area dA of that element

$$E_v = \frac{d\Phi_v}{dA}$$

luminous exitance (at a point of a surface) (M_v) (see ILV 845-01-48)

quotient of the luminous flux $d\Phi_v$ leaving an element of the surface containing the point, by the area dA of that element

$$M_v = \frac{d\Phi_v}{dA}$$

3. PHOTOMETRIC UNITS

3.1 Candela

The SI photometric base unit is the candela (cd), the unit of luminous intensity. It was defined by the Conférence Générale des Poids et Mesures (CGPM) in 1979 (CGPM, 1979), as follows:

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of $(1/683)$ watt per steradian.

This definition of the candela applies equally to photopic, scotopic, and mesopic vision.

3.2 Other units

The SI units of other photometric quantities can be derived from the candela and the SI units of length (m), solid angle (sr) and time (s). Thus:

Quantity	Symbol	SI Unit
Luminous flux	Φ_v	lm = cd·sr
Luminous energy	Q_v	cd·sr·s
Luminance	L_v	cd·m ⁻²
Illuminance	E_v	lx = cd·sr·m ⁻²
Luminous exitance	M_v	cd·sr·m ⁻²