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नेत्र संबंधी प्रकाशिकी — चश्मे के लेंस —  
शब्दावली

Ophthalmic Optics — Spectacle  
Lenses — Vocabulary

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## NATIONAL FOREWORD

This Indian Standard which is identical to ISO 13666 : 2019 'Ophthalmic optics — Spectacle lenses Vocabulary' issued by the International Organization for Standardization (ISO) was adopted by Bureau of Indian Standards on the recommendation of the Ophthalmic Instruments and Appliances Sectional Committee and approval of the Medical Equipment and Hospital Planning Division Council.

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

This standard also makes a reference to the BIS certification marking of the product, details of which is given in [National Annex A](#).

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

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## Introduction

This new edition of ISO 13666 has been prepared in line with the new provisions of ISO/IEC Directives, Part 2. This led to a renumbering of all terms. All the terms are now in [Clause 3](#), "Terms and definitions", so the previous subsections have been made into full subclauses to simplify the numbering. "Notes" have been replaced by "notes to entry" — these can be normative, as opposed to notes in specification standards which are informative.

General considerations in the interpretation of this vocabulary document are:

- since this document relates to spectacle lenses, the simple word 'lens' or 'lenses' is generally used throughout (except where definitions have been quoted from other standards) instead of 'spectacle lens' or 'spectacle lenses'. The term "spectacle lens" is defined in [3.5.2](#). When "lens" means a lens in general, including but not restricted to spectacle lenses, it is not italicized in the text. When "lens" means a spectacle lens, the word "lens" is put in italics.
- the unit of focusing power, expressed in reciprocal metres ( $\text{m}^{-1}$ ), of a lens or surface is the dioptre. See [3.10.1](#) for a complete definition;
- the unit of prismatic power is the prism dioptre ( $\Delta$ ), expressed in centimetres per metre (cm/m). See [3.11.11](#) for a complete definition;
- to simplify definitions and the understanding of the optics of ophthalmic lenses, aberrations of lenses and prisms are ignored in definitions except when specifically mentioned;
- definitions are classified according to subject;
- deprecated: Some obsolete terms are listed for convenience, but are indicated as "DEPRECATED" and should not be used;
- in this document, the word "normal" (to a surface) means a line that is at  $90^\circ$  to the plane that is tangential to the surface at the point of interest, i.e. is perpendicular to the surface at that point.

*Indian Standard*

OPHTHALMIC OPTICS — SPECTACLE LENSES —  
VOCABULARY

## 1 Scope

This document defines terms relating to ophthalmic optics, specifically to blanks, finished spectacle lenses and fitting purposes.

Terms relating to processes and material for fabrication and surface treatment (other than some specific terms relating to coatings), and terms relating to defects in materials and after optical processing are given in ISO 9802.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

NOTE CIE International Lighting Vocabulary CIE S 017: 2011 is available at <http://eilv.cie.co.at/>.

### 3.1 Basic optics

#### 3.1.1

##### **optical radiation**

electromagnetic radiation at wavelengths between the region of transition to X-rays ( $\lambda \approx 1$  nm) and the region of transition to radio waves ( $\lambda \approx 1$  mm)

[SOURCE: CIE S 017:2011, 17-848]

#### 3.1.2

##### **visible radiation**

##### **light**

any *optical radiation* (3.1.1) capable of causing a visual sensation directly

Note 1 to entry: The limits of photo-detection depend upon the amount of radiant power reaching the retina and the responsivity of the observer.

Note 2 to entry: ISO 20473 specifies the spectral range of *visible radiation* to have a lower limit of 380 nm and an upper limit of 780 nm for application to Optics and Photonics standards. These limits apply to *spectacle lens* (3.5.2) standards.

[SOURCE: CIE S 017:2011, 17-1402, modified — the note has been deleted, while notes 1 and 2 to entry have been added.]

### 3.1.3

#### ultraviolet radiation

DEPRECATED: ultraviolet

*optical radiation* (3.1.1) for which the wavelengths are shorter than those for *visible radiation* (3.1.2)

Note 1 to entry: ISO 20473 specifies the spectral range of *ultraviolet radiation* for the application to Optics and Photonics standards and subdivides the UV range into:

- UV-A: 315 nm to 380 nm;
- UV-B: 280 nm to 315 nm;
- UV-C: 100 nm to 280 nm.

Other health and safety disciplines define UV-A as 315 nm to 400 nm.

[SOURCE: CIE S 017:2011, 17-1367, modified —The notes have been deleted while note 1 to entry has been added.]

### 3.1.4

#### infrared radiation

DEPRECATED: infrared

*optical radiation* (3.1.1) for which the wavelengths are longer than those for *visible radiation* (3.1.2), from 780 nm to 1 mm

Note 1 to entry: For *infrared radiation*, the range between 780 nm and 1 mm is commonly subdivided into:

- IR-A: 780 nm to 1 400 nm;
- IR-B: 1,4  $\mu\text{m}$  to 3  $\mu\text{m}$ ;
- IR-C: 3  $\mu\text{m}$  to 1 mm.

Note 2 to entry: These limits are also specified in ISO 20473.

Note 3 to entry: The solar *infrared radiation* spectrum at sea level extends to about 2 000 nm.

Note 4 to entry: The range of *infrared radiation* emitted by the source and reaching the *lens* shall be considered in the design of an *infrared radiation*-absorbing material.

[SOURCE: CIE S 017:2011, 17-580, modified — Notes 2, 3 and 4 to entry have been added.]

### 3.1.5

#### refractive index

$n(\lambda)$

ratio of the velocity of propagation of monochromatic radiation of the wavelength ( $\lambda$ ) in vacuum to its velocity of propagation in the medium

Note 1 to entry: For technical applications, the *refractive index* is given against air instead of against vacuum.

Note 2 to entry: The wavelengths to be used for the characterization of *optical materials* (3.3.1), all kinds of optical systems and instruments, and *spectacle lenses* (3.5.2), are specified in ISO 7944.

### 3.1.6

#### chromatic dispersion

change in the *refractive index* (3.1.5) of monochromatic radiation in a medium as a function of the frequency of the radiation

Note 1 to entry: The *chromatic dispersion* gives rise to chromatic aberration in a lens made from dispersive materials.

### 3.1.7

#### Abbe number

$v_d, v_e$

DEPRECATED: constringence

DEPRECATED: V-value

indicator of the *chromatic dispersion* (3.1.6) of an *optical material* (3.3.1) or component

Note 1 to entry: The *Abbe number* can be calculated as either:

$$v_d = \frac{n_d - 1}{n_F - n_C}$$

where

$n_d$  is the *refractive index* of the yellow helium d-line (wavelength: 587,56 nm);

$n_F$  is the *refractive index* of the blue hydrogen F-line (wavelength: 486,13 nm); and

$n_C$  is the *refractive index* of the red hydrogen C-line (wavelength: 656,27 nm);

or

$$v_e = \frac{n_e - 1}{n_{F'} - n_{C'}}$$

where

$n_e$  is the *refractive index* of the green mercury e-line (wavelength: 546,07 nm);

$n_{F'}$  is the *refractive index* of the blue cadmium F'-line (wavelength: 479,99 nm); and

$n_{C'}$  is the *refractive index* of the red cadmium C'-line (wavelength: 643,85 nm).

Note 2 to entry: These reference wavelengths are given in ISO 7944:1998.

### 3.1.8

#### optical axis

straight line joining the centres of curvature of both surfaces of a *lens* (3.5.2)

Note 1 to entry: This line is normal to both optical surfaces so light can pass along it undeviated.

Note 2 to entry: For *lenses* (3.5.2) with strong *prismatic power* (3.11.10), the *optical axis* can lie outside the area of the *lens*.

Note 3 to entry: *Power-variation lenses* (3.7.7) do not have a true *optical axis*.

### 3.1.9

#### vertex

point of intersection of the *optical axis* (3.1.8) with a surface of a *lens* (3.5.2)

### 3.1.10

#### power

capacity of a *lens* (3.5.2) or optical surface to change the curvature or direction of incident wavefronts by refraction

### 3.1.11

#### focal point

image point conjugate to an infinitely distant object point on the *optical axis* (3.1.8)

### 3.1.12

#### **bioactinic**

exhibiting or referring to *bioactinism* (3.1.13)

### 3.1.13

#### **bioactinism**

property of *optical radiation* (3.1.1) that enables it to cause chemical changes to biological tissues

### 3.1.14

#### **presbyopia**

reduction in the ability to accommodate through normal ageing, resulting in the inability to focus at usual near distances with any ametropia corrected

## 3.2 Lenses and their dispensing

### 3.2.1

#### **boxed lens system**

#### **boxing system**

system of measurement and definitions based on the rectangle formed by the horizontal and vertical tangents to the extremities of the *lens shape* (3.2.2)

Note 1 to entry: Because the horizontal and vertical tangents might not be in the same plane, for a *lens* (3.5.2) this can be thought of as an orthogonal projection onto a plane parallel to the *front surface* (3.2.13) at its *boxed centre* (3.2.5).

### 3.2.2

#### **lens shape**

outline of the *edged lens* (3.8.9) periphery in its intended orientation

Note 1 to entry: The nasal side should be indicated.

Note 2 to entry: *Lens shape* refers to the shape of *lenses* (3.5.2) that fit the frame with:

- for a *lens* having a bevelled edge, the outermost edge of the *lens*, the *lens* having a bevel which includes a symmetrical angle of 120° and a bevel width greater than the width of the groove in the front;
- for a *lens* having a flat or grooved edge, the outermost edge of the *lens*.

### 3.2.3

#### **horizontal centreline**

horizontal straight line located at an equal distance from the two horizontal tangents of the *boxed lens system* (3.2.1)

[SOURCE: ISO 8624:2011, A.1, modified — The words "horizontal straight" have been added and the word "(boxing)" has been deleted.]

### 3.2.4

#### **vertical centreline**

vertical straight line located at an equal distance from the vertical sides of the rectangular box that circumscribes the *lens shape* (3.2.2)

[SOURCE: ISO 8624:2011, A.2, modified — The words "vertical straight" have been added and the word "which" has been changed to "that".]

### 3.2.5

#### **boxed centre**

C

intersection of the *horizontal centreline* (3.2.3) and the *vertical centreline* (3.2.4) of the rectangular box that circumscribes the *lens shape* (3.2.2)

Note 1 to entry: This term is applied to spectacle frames and to the *edged lens* (3.8.9).



[SOURCE: ISO 8624:2011, 2.1, modified — The word "which" has been replaced by "that" and note 1 to entry has been added.]

### 3.2.6

#### **geometrical centre**

#### **geometric centre**

intersection of the *horizontal centreline* (3.2.3) and *vertical centreline* (3.2.4) of the rectangular box that circumscribes the shape of the *blank* (3.8.1) or *uncut lens* (3.8.8)

### 3.2.7

#### **nominal size**

$d_n$

dimension indicated by the manufacturer

Note 1 to entry: For round *blanks* (3.8.1) or *lenses* (3.5.2), the size is given as the diameter. Otherwise, the horizontal and vertical dimensions are given.

### 3.2.8

#### **effective size**

$d_e$

actual physical dimension

Note 1 to entry: For round *blanks* (3.8.1) or *lenses* (3.5.2), the size is given as the diameter. Otherwise, the horizontal and vertical dimensions are given.

### 3.2.9

#### **usable size**

$d_u$

dimension of the area that is optically usable

Note 1 to entry: For round *blanks* (3.8.1) or *lenses* (3.5.2), the size is given as the diameter. Otherwise, the horizontal and vertical dimensions are given.

### 3.2.10

#### **horizontal axis**

zero direction through a *reference point* (3.2.19) on the *lens* (3.5.2) for the specification of *cylinder axes* (3.13.8) and *prism base settings* (3.11.7) as defined in ISO 8429

### 3.2.11

#### **meridian**

<surface> each plane that contains the centre(s) of curvature of the surface

Note 1 to entry: See also *principal meridians* (3.4.5).

### 3.2.12

#### **meridian**

<lens> each plane that contains the *optical axis* (3.1.8) of the *lens* (3.5.2)

### 3.2.13

#### **front surface**

surface of the *lens* (3.5.2) intended to be fitted away from the eye

### 3.2.14

#### **back surface**

surface of the *lens* (3.5.2) intended to be fitted nearer to the eye

### 3.2.15

#### **optical centre**

intersection of the *optical axis* (3.1.8) with the *front surface* (3.2.13) of a *lens* (3.5.2)

### 3.2.16

#### **design reference point**

point, stipulated by the manufacturer, on the finished surface of a *blank* (3.8.1) or on the *front surface* (3.2.13) of the *finished lens* (3.8.7) at which the design specifications apply

EXAMPLE *Distance design reference point and near design reference point.*

### 3.2.17

#### **distance design reference point**

point, stipulated by the manufacturer, on the *front surface* (3.2.13) of a *finished lens* (3.8.7) or on the finished surface of a *blank* (3.8.1) at which the design specifications for the *distance portion* (3.15.1) apply

### 3.2.18

#### **near design reference point**

point, stipulated by the manufacturer, on the *front surface* (3.2.13) of a *finished lens* (3.8.7) or on the finished surface of a *blank* (3.8.1) at which the design specifications for the *near portion* (3.15.3) apply

### 3.2.19

#### **reference point**

point, stipulated by the manufacturer, on the *front surface* (3.2.13) of a *finished lens* (3.8.7) or on the finished surface of a *blank* (3.8.1) at which the *verification power* (3.10.15) of a specific portion applies

Note 1 to entry: Unless a *verification power* (3.10.15) is stated, the power is the nominal or *ordered power* (3.10.14). See note 3 to entry to *verification power*.

Note 2 to entry: This point can, in some circumstances, differ from the respective *design reference point* (3.2.16).

Note 3 to entry: For *power-variation lenses* (3.7.7), *focal power* (3.10.2) and *prismatic power* (3.11.10) are measured at different *reference points*.

EXAMPLE *Distance reference point and near reference point.*

### 3.2.20

#### **distance reference point**

#### **major reference point**

point on the *front surface* (3.2.13) of the *lens* (3.5.2) at which the *verification power* (3.10.15) for the *distance portion* (3.15.1) applies

Note 1 to entry: This point can, in some circumstances, be different from the *distance design reference point* (3.2.17).

Note 2 to entry: Unless a *verification power* (3.10.15) is stated, the power is the nominal or *ordered power* (3.10.14). See note 3 to entry to *verification power*.

### 3.2.21

#### **near reference point**

point on the *front surface* (3.2.13) of the *lens* (3.5.2) at which the *verification power* (3.10.15) for the *near portion* (3.15.3) applies

Note 1 to entry: This point can, in some circumstances, be different from the *near design reference point* (3.2.18).

Note 2 to entry: Unless a *verification power* (3.10.15) is stated, the power is the nominal or *ordered power* (3.10.14). See note 3 to entry to *verification power*.

### 3.2.22

#### **primary reference point**

point on the *front surface* (3.2.13) of a *power-variation lens* (3.7.7) at which the *verification power* (3.10.15) for the designed primary use of the *lens* (3.5.2) applies

Note 1 to entry: All *power-variation lenses* have a *primary reference point*.

Note 2 to entry: For example, the *primary reference point* for a *progressive-power lens* (3.7.8) is the *distance reference point* (3.2.20) and for a *degressive-power lens* (3.7.9) is the *near reference point* (3.2.21).

[SOURCE: ISO 21987:2017, 3.5]

### 3.2.23

#### **secondary reference point**

point on the *front surface* (3.2.13) of a *power-variation lens* (3.7.7) at which the *verification power* (3.10.15) for the designed secondary use of the *lens* (3.5.2) applies

Note 1 to entry: Some *power-variation lenses* (3.7.7) can have a *secondary reference point* that is used for the determination of the *addition power* (3.16.3) or *variation power* (3.16.4).

Note 2 to entry: For example, the *secondary reference point* for a *progressive-power lens* (3.7.8) is the *near reference point* (3.2.21).

[SOURCE: ISO 21987:2017, 3.6]

### 3.2.24

**line of sight** en: US

**visual axis** en: GB

ray path from the point of interest (i.e. point of fixation) in object space to the centre of the entrance pupil of the eye and its continuation in image space from the centre of the exit pupil to the retinal point of fixation (generally the foveola)

Note 1 to entry: These two parts of the ray path are distinct and separate segments.

### 3.2.25

#### **primary direction**

direction of the *line of sight* (3.2.24), usually taken to be the horizontal, to an object at an infinite distance measured with habitual head and body posture when looking straight ahead in unaided vision

### 3.2.26

#### **primary position**

position of the eye when looking in the *primary direction* (3.2.25)

### 3.2.27

#### **visual point**

point of intersection of the *line of sight* (3.2.24) with the *back surface* (3.2.14) of a *lens* (3.5.2)

### 3.2.28

#### **interpupillary distance**

PD

distance between the centres of the pupils when the eyes are in the *primary position* (3.2.26)

### 3.2.29

#### **monocular pupillary distance**

distance between the centre of the pupil and the mid-line of the bridge of the nose or the spectacle frame when the eye is in the *primary position* (3.2.26)

### 3.2.30

#### **centration point**

CP

point with respect to the frame at which the *optical centre* (3.2.15), *distance reference point* (3.2.20) or *fitting point* (3.2.34) is to be located in the absence of any *ordered prismatic effect* (3.11.14) and any *prism thinning* (3.16.9), or after any such *prismatic effect* (3.11.9) has been neutralized

Note 1 to entry: Which of these is relevant depends upon the type of *lens* (3.5.2), for example, the *optical centre* (3.2.15) usually applies to a *single-vision lens* (3.7.1), *distance reference point* (3.2.20) usually to an *aspheric lens* (3.6.8) or *multifocal lens* (3.7.3) and *fitting point* (3.2.34) usually to a *position-specific single-vision lens* (3.7.2) or a *power-variation lens* (3.7.7).

Note 2 to entry: When a *lens* incorporates *prismatic power* (3.11.10), a correction should be made to the position of the *centration point* (monocular *centration distance* (3.2.31) and *centration point height*) when mounting the *lens* to compensate for the change in position of the eye. This correction depends on the power of the prismatic correction needed and the *as-worn position* (3.2.36). This correction may be done when ordering the *lenses* or be done by the manufacturer.

Note 3 to entry: This point can be specified:

- in the *plane of the lens shape* (3.2.41), by its horizontal ( $u$ ) and vertical ( $v$ ) *decentrations* (3.2.33) from the *boxed centre* (3.2.5);
- in the *plane of the lens shape*, by its horizontal distance ( $x$ ) from the nasal vertical tangent of the *boxed lens system* (3.2.1) and its *centration height* ( $y$ ) above the lower horizontal tangent;
- in the *plane of the spectacle front* (3.2.42), by its *monocular centration distance* ( $z$ ) and *centration height* ( $y$ ) above the lower horizontal tangent.

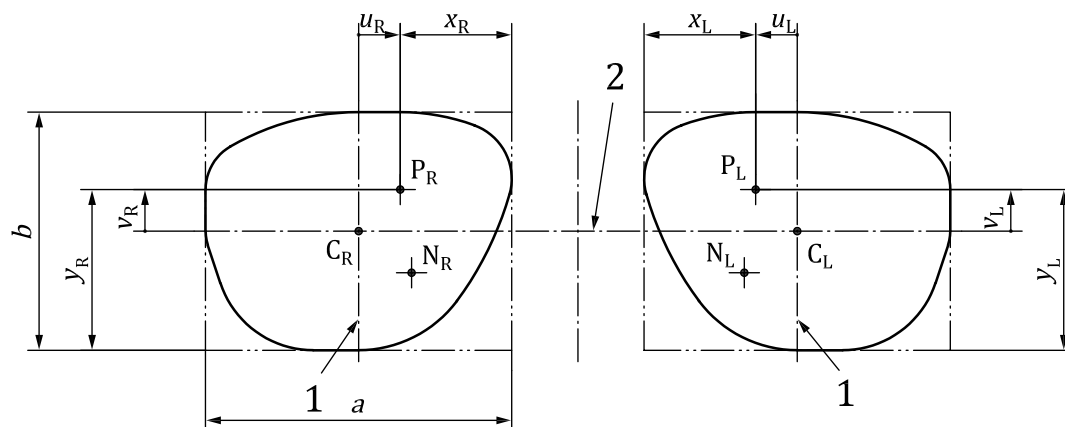
For details and sign convention, see [Figures 1](#) and [2](#).

Note 4 to entry: With the horizontal,  $a$ , and vertical,  $b$ , boxed lens sizes, the distances mentioned in note 3 to entry can be computed as  $u = x - a/2$  and  $v = y - b/2$  respectively.

Note 5 to entry: With *face form angle*  $\alpha$  and the *boxed centre distance*  $c$ , the following relation between  $u$  and the *monocular centration distance*  $z$  applies:

$$u = \frac{c - 2z}{2 \cos \alpha}$$

where  $u$  is positive if the *centration point* is nasal relative to the *vertical centreline* (3.2.4).



**Key**

- 1 vertical centreline
- 2 horizontal centreline
- $C_R$   $C_L$  right/left boxed centre
- $P_R$   $P_L$  right/left centration point
- $N_R$   $N_L$  right/left near visual point
- $x_R$   $x_L$  horizontal distance of right/left centration point
- $y_R$   $y_L$  right/left centration point height/fitting point height
- $u_R$   $u_L$  horizontal decentration of the right/left centration point position/fitting point position
- $v_R$   $v_L$  vertical decentration of right/left centration point position/fitting point position
- $a$  horizontal boxed lens size
- $b$  vertical boxed lens size

**Figure 1 — Terms relating to the centration/fitting point, measured in the planes of the lens shapes**

**3.2.31**  
**centration distance**  
**CD**

required horizontal distance between the *centration points* (3.2.30) of a pair of mounted *lenses* (3.5.2)

Note 1 to entry: The *centration distance* can be specified by monocular values, measured from the assumed centreline of the bridge of the spectacle frame, i.e. the spectacle frame's vertical symmetry axis.

Note 2 to entry: For distance vision, in the absence of any horizontal *prismatic effect* (3.11.9), the *interpupillary distance* (3.2.28) can be taken to be the *centration distance*. For intermediate and near prescriptions, the *centration distance* needs to be adjusted for binocular convergence.

Note 3 to entry: See  $z$  in [Figure 2](#).

**3.2.32**  
**optical centre distance**  
**OCD**  
**distance between centres**

DEPRECATED: optical PD

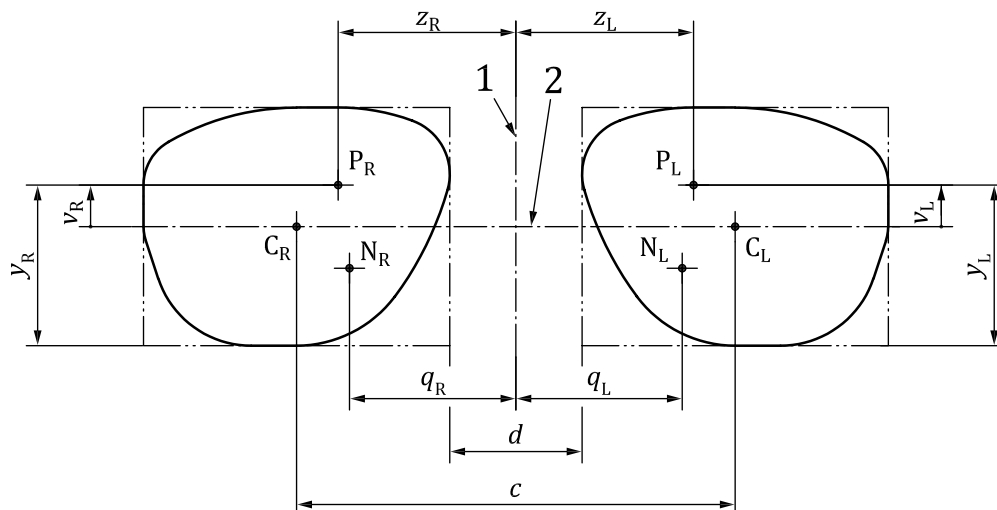
horizontal distance between the *optical centres* (3.2.15) of a pair of mounted *lenses* (3.5.2), with any *ordered prismatic effect* (3.11.14) being neutralized

Note 1 to entry: The *optical centre distance* is not applicable to *power-variation lenses* (3.7.7).

**3.2.33**  
**decentration**

displacement of the *centration point* (3.2.30) from the *boxed centre* (3.2.5) of the shape of the *edged lens* (3.8.9)

Note 1 to entry: See  $u$  and  $v$  in [Figure 1](#).



**Key**

- 1 vertical symmetry axis
- 2 horizontal centreline
- $C_R$   $C_L$  right/left boxed centre
- $P_R$   $P_L$  right/left centration point
- $N_R$   $N_L$  right/left near visual point
- $z_R$   $z_L$  right/left monocular centration distance
- $q_R$   $q_L$  right/left monocular near visual point distance
- $y_R$   $y_L$  right/left centration point height/fitting point height
- $v_R$   $v_L$  vertical decentration of right/left centration point
- $c$  boxed centre distance
- $d$  distance between lenses

**Figure 2 — Terms relating to the centration/fitting point, measured in the plane of the spectacle front**

**3.2.34 fitting point**

point on the *front surface* (3.2.13) of a *lens* (3.5.2) or *blank* (3.8.1) stipulated by the manufacturer for positioning the *lens* in front of the eye

**3.2.35 centration point position fitting point mounting position**

vertical and horizontal fitting distances and directions of the *centration point* (3.2.30) or *fitting point* (3.2.34) respectively from the *boxed centre* (3.2.5), measured in the *plane of the lens shape* (3.2.41)

Note 1 to entry: The *fitting point mounting position* relates to the ordered mounting position in the frame, not the mounted value or the height of the *fitting point* (3.2.34) in relation to the permanent *alignment reference markings* (3.15.25).

Note 2 to entry: See  $v_R$ ,  $v_L$ ,  $u_R$  and  $u_L$  in Figure 1.

**3.2.36 as-worn position position of wear**

position, including orientation, of the *lenses* (3.5.2) relative to the eyes and face during wear

Note 1 to entry: The *as-worn position* shall be measured with the habitual head and body posture. For distance vision, this is usually measured in the *primary position* (3.2.26) when looking straight ahead in unaided vision.

### 3.2.37

#### as-worn pantoscopic angle position of wear pantoscopic angle

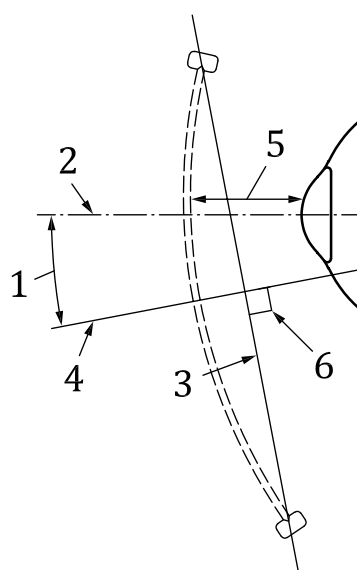
vertical angle between the horizontal and the perpendicular to a reference line passing through the apex of the grooves of the upper and lower rims of the frame in the vertical plane containing the *primary direction* (3.2.25)

Note 1 to entry: The *as-worn position* (3.2.36) shall be measured with the habitual head and body posture. For distance vision, this is usually measured in the *primary position* (3.2.26) when looking straight ahead in unaided vision.

Note 2 to entry: The angle is regarded as positive if the lower part of the *lens* (3.5.2) lies closer to the face than the upper.

Note 3 to entry: For rimless and semi-rimless frames, a comparable measurement needs to be made.

Note 4 to entry: See [Figure 3](#).



#### Key

- 1 *as-worn pantoscopic angle*
- 2 *primary direction*, taken to be horizontal
- 3 reference line through the apex of the grooves of the rims in a vertical plane passing through the pupil
- 4 perpendicular to the reference line
- 5 *vertex distance*
- 6 right angle (90°)

**Figure 3 — Illustration of as-worn pantoscopic angle and vertex distance**

### 3.2.38

#### as-worn face form angle as-worn wrap angle position of wear face form angle position of wear wrap angle

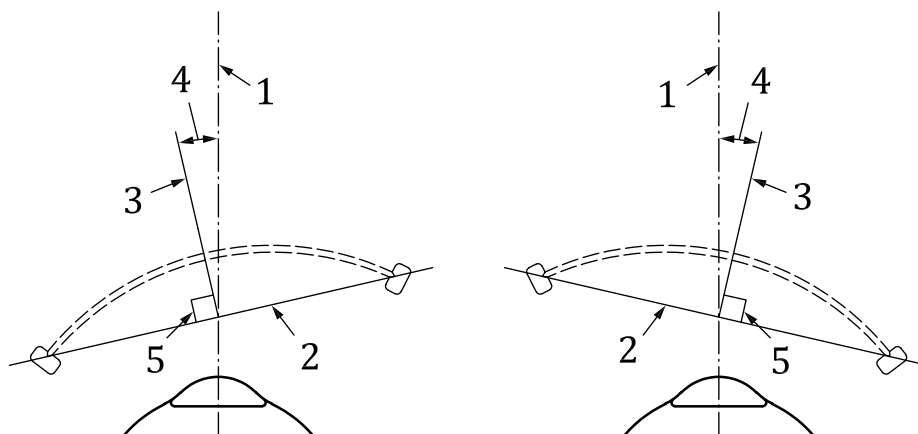
horizontal angle between the *primary direction* (3.2.25) and the perpendicular to a reference line passing through the apex of the grooves of the nasal and temporal rims of the frame in the horizontal plane containing the *primary direction*

Note 1 to entry: The right or left *as-worn face form angle* is regarded as positive if the temporal side of the *plane of the right or left lens shape* (3.2.41) is posterior to the nasal side.

Note 2 to entry: The *as-worn position* (3.2.36) shall be measured with the habitual head and body posture. For distance vision, this is usually measured in the *primary position* (3.2.26) when looking straight ahead in unaided vision.

Note 3 to entry: For rimless and semi-rimless frames, a comparable measurement needs to be made.

Note 4 to entry: See Figure 4.



**Key**

- 1 *primary direction*
- 2 *reference line*
- 3 *perpendicular to the reference line*
- 4 *right and left as-worn face form angles*
- 5 *right angle (90°)*

**Figure 4 — Illustration of as-worn face form angle**

**3.2.39  
face form angle  
wrap angle**

angle between the *plane of the spectacle front* (3.2.42) and the *right plane of the lens shape* (3.2.41) or of the *left plane of the lens shape*

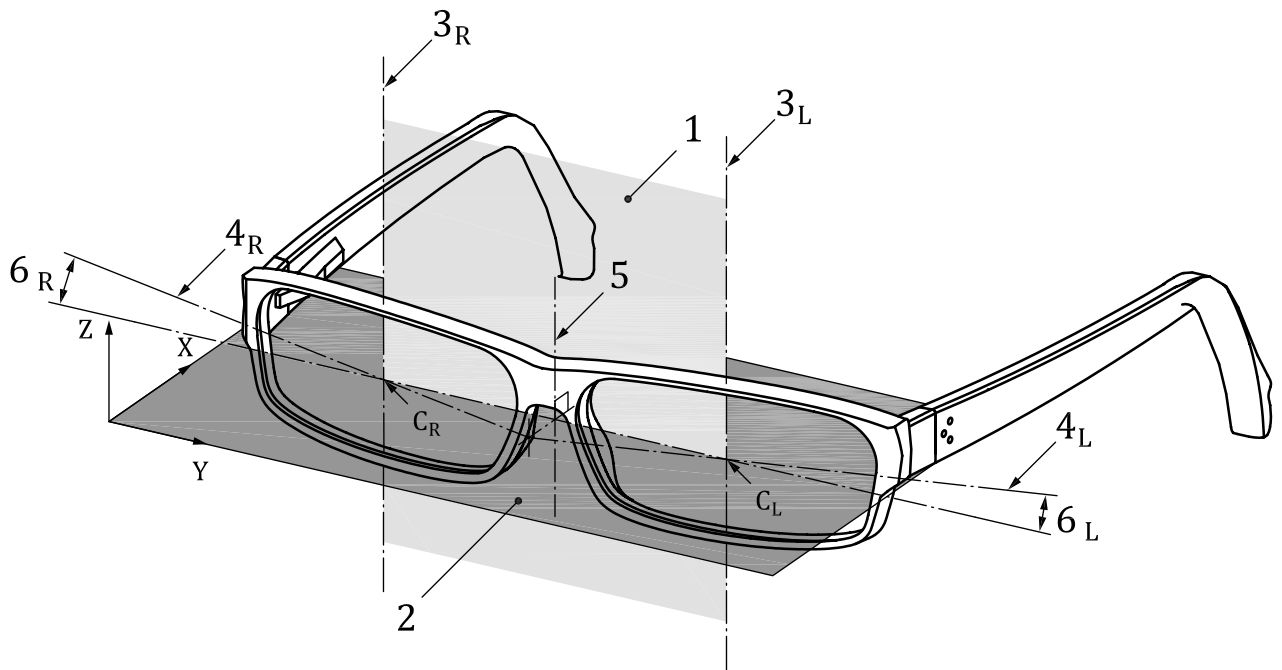
Note 1 to entry: The right or left *face form angle* is regarded as positive if the temporal side of the *plane of the lens shape* (3.2.41) is posterior to the nasal side.

Note 2 to entry: The *face form angles* are often measured and specified as the average of the right and left angles, but the frame can be adjusted for a specific wearer so that they differ, and the right and left angles should then be specified.

Note 3 to entry: This angle relates to the frame, not the *as-worn position* (3.2.36).

Note 4 to entry: See 6<sub>R</sub> and 6<sub>L</sub> in Figure 5.





**Key**

- $C_R$   $C_L$  right/left boxed centre
- 1 plane of the spectacle front
- 2 XY plane, perpendicular to plane 1
- $3_R$   $3_L$  right/left vertical centrelines
- $4_R$   $4_L$  right/left horizontal centrelines
- 5 vertical symmetry axis
- $6_R$   $6_L$  face form angle, measured in plane 2

**Figure 5 — 3D schematic representation of the plane of the spectacle front and the planes of the lens shapes of a frame**

**3.2.40  
vertex distance**

horizontal distance between the *back surface* (3.2.14) of the *lens* (3.5.2) and the apex of the cornea, measured with the eyes in the *primary position* (3.2.26)

Note 1 to entry: See [Figure 3](#).

**3.2.41  
plane of the lens shape**

plane that contains the *vertical centreline* (3.2.4) and is parallel to the *horizontal centreline* (3.2.3) of the individual *lens* (3.5.2)

Note 1 to entry: The *vertical* (3.2.4) and *horizontal centrelines* (3.2.3) are based on the apex of the groove. For rimless and semi-rimless frames, the centre of the edge of an *afocal lens* (3.6.3) mounted in the frame is to be regarded as equivalent.

Note 2 to entry: See [Figure 5](#).

**3.2.42  
plane of the spectacle front**

plane that contains the *vertical centrelines* (3.2.4) of the right and left boxed *lens shapes* (3.2.2)

Note 1 to entry: This will be an approximation if the two centrelines are not parallel to each other.

Note 2 to entry: See [Figure 5](#).

[SOURCE: ISO 8624:2011, A.11, modified — Note 2 to entry has been added.]

### 3.2.43 working distance

distance from the reference plane to the object plane

Note 1 to entry: By ophthalmic convention, this reference plane is usually taken to be *the plane of the spectacle front* ([3.2.42](#)).

### 3.2.44 near vision distance

*working distance* ([3.2.43](#)) with the individual's habitual near working plane as the object plane

Note 1 to entry: This is generally taken as the distance, often 40 cm, at which a person reads, but the task could equally be sewing or fine assembly.

### 3.2.45 intermediate vision distance

*working distance* ([3.2.43](#)) with the object plane situated further than the *near vision distance* ([3.2.44](#)) and closer than far vision distance or *indoor vision distance* ([3.2.46](#))

Note 1 to entry: Typical examples are the distance to display screen equipment or the far side of a desk, usually in the range of 50 cm to 120 cm, but this can vary widely.

### 3.2.46 indoor vision distance room distance

*working distance* ([3.2.43](#)) usually taken to be between 1,5 m and 4,0 m

### 3.2.47 centre thickness

thickness of a *blank* ([3.8.1](#)) or *lens* ([3.5.2](#)) at its *reference point* ([3.2.19](#)), measured normal to the *front surface* ([3.2.13](#))

### 3.2.48 edge thickness

thickness at a point on the edge of a *blank* ([3.8.1](#)), *uncut lens* ([3.8.8](#)) or *edged lens* ([3.8.9](#))

Note 1 to entry: The *edge thickness* of a *blank* ([3.8.1](#)) is usually measured parallel to the normal to the *front surface* ([3.2.13](#)) at its *geometrical centre* ([3.2.6](#)), of a *finished lens* ([3.8.7](#)) approximately normal to the surface at the measurement point.

Note 2 to entry: *Astigmatic-power* ([3.13.1](#)), *power-variation* ([3.7.7](#)) and *prismatic-power lenses* ([3.1.12](#)) will generally have a variable *edge thickness*.

Note 3 to entry: The measurement point for a *blank* is the point specified by the manufacturer; for measurement of a *finished lens* it is the thinnest part of the edge.

## 3.3 Lens materials

### 3.3.1 optical material

transparent material capable of being manufactured into optical components

### 3.3.2

**glass**  
**inorganic glass**  
**mineral glass**

material formed by the fusion of inorganic substances, cooled down and solidified without crystallizing

Note 1 to entry: Terms describing types of optical *glass* are given in ISO 9802.

### 3.3.3

**thermosetting hard resin**

plastic material, consisting principally of organic polymers, that has been cured into an essentially infusible and insoluble state, and cannot be usefully reshaped on heating

### 3.3.4

**thermoplastic hard resin**

plastic material, consisting principally of organic polymers, that can be repeatedly softened by heating and hardened by cooling, and in the softened state can be shaped by flow into *lenses* (3.5.2) or *blanks* (3.8.1) by moulding, extrusion or forming

### 3.3.5

**photochromic material**

DEPRECATED: photochromatic material

material that reversibly changes its *luminous transmittance* (3.17.6) depending upon the irradiance and wavelength of the *optical radiation* (3.1.1) falling upon it

Note 1 to entry: The material is designed to react to wavelengths within the solar spectral range, chiefly 300 nm to 450 nm.

Note 2 to entry: The transmittance properties are usually affected by ambient temperature.

### 3.3.6

**photochromic fatigue**

irreversible change in the *luminous transmittance* (3.17.6) of a *photochromic material* (3.3.5) with time, usually after prolonged cumulative and/or repeated exposure to *optical radiation* (3.1.1)

## 3.4 Lens surfaces

### 3.4.1

**spherical surface**

part of the inside or outside surface of a sphere

### 3.4.2

**cylindrical surface**

part of the inside or outside surface of a cylinder

### 3.4.3

**aspherical surface**

surface of revolution having continuously variable curvature over all or part of its area

Note 1 to entry: The *aspherical surface* is intended to improve the optical performance of the *finished lens* (3.8.7) away from its *optical axis* (3.1.8), and/or to improve the cosmetic performance, i.e. to reduce the sagittal depth of the surface of the *lens* (3.5.2).

### 3.4.4

**asphericity**

qualitative or quantitative term describing the departure of the curvature of a *meridian* (3.2.11) of an *aspherical surface* (3.4.3) or *atoroidal surface* (3.4.7) from that of a circle

Note 1 to entry: *Asphericity* can be described mathematically by the parameter  $p$  or eccentricity,  $e$ , of a conic section or by the coefficients of a more complex mathematical function.

### 3.4.5 principal meridians

<surface> *meridians* (3.2.11) of a surface with the maximum and minimum curvatures

Note 1 to entry: *Focal power* (3.10.2) exists in only these two *meridians*.

### 3.4.6 toroidal surface

surface having mutually perpendicular and circular *principal meridians* (3.4.5) of unequal curvature

Note 1 to entry: This is part of the surface generated by a circular arc rotating about an axis that is in the same plane as the arc but does not pass through its centre of curvature.

Note 2 to entry: It is desirable to restrict the term “toroidal” to a surface and the term “toric” to a *lens* (3.5.2) or object.

### 3.4.7 atoroidal surface

surface having mutually perpendicular *principal meridians* (3.4.5) of unequal curvature, at least one of which has *asphericity* (3.4.4)

Note 1 to entry: It is desirable to restrict the term “atoroidal” to a surface and the term “atoric” to a *lens* (3.5.2) or object.

### 3.4.8 base curve

*surface power* (3.10.4) (or curvature), generally, of the *front surface* (3.2.13)

Note 1 to entry: The nominal *base curve* is used for labelling purposes. This can also be termed nominal surface curve. For *blanks* (3.8.1), the actual *surface power* (3.10.4) (or surface curvature) is needed for surfacing calculations. This can also be termed “actual surface curve”.

Note 2 to entry: When the *base curve* is specified as a *surface power* (3.10.4), the reference index shall be stated. The curvature or radius of curvature can be stated instead of the *surface power*, but this shall be clearly identified.

Note 3 to entry: For *toroidal surfaces*, the *base curve* is the actual or *nominal surface power* (3.10.5) (or curvature) of the *principal meridian* (3.4.5) having the numerically lower value.

Note 4 to entry: For multifocal surfaces and *power-variation surfaces* (3.4.10), the *base curve* is the actual or *nominal surface power* (or curvature) of the *distance portion* (3.15.1) or zone adjacent to the *primary reference point* (3.2.22) respectively.

Note 5 to entry: For very high-powered *negative lenses* (3.10.18) and *blanks* (3.8.1) with finished *back surfaces* (3.2.14), the actual or *nominal surface power* (or curvature) of the back surface may be taken as the *base curve*.

Note 6 to entry: When specifying the approximate form of a *single-vision lens* (3.7.1) in order to duplicate its form, it is recommended that the *surface power* of the non-astigmatic surface be used.

### 3.4.9 cross curve

<*toroidal surface*> *surface power* (3.10.4) of the *principal meridian* (3.4.5) of numerically higher value

Note 1 to entry: Depending on the context, the *cross curve* can refer to the *nominal surface power* (3.10.5) (or curvature) or to the actual *surface power* (3.10.4) (or curvature).

### 3.4.10 power-variation surface

surface with a smooth variation of *surface power* (3.10.4) over part or all of its area, without discontinuity

Note 1 to entry: These surfaces are generally intended to provide increasing or decreasing *spherical power*, typically in a vertical *meridian* (3.2.11), and hence are used, for example, for *power-variation lenses* (3.7.7).

### 3.4.11 meridionally-compensated aspherical surface

lens surface of nominal spherical *surface power* (3.10.4) having different *asphericities* (3.4.4) along its two *principal meridians* (3.4.5), or, for a *blank* (3.8.1), its intended *principal meridians* (3.13.2) after surfacing

Note 1 to entry: In general, *meridionally-compensated aspherical surfaces* are designed to provide improved optical performance of the *finished lens* (3.8.7) when the other surface is *toroidal*.

Note 2 to entry: There will be a continuous variation in *asphericity* between these two *principal meridians*.

## 3.5 Classification according to function

### 3.5.1 ophthalmic lens

lens intended to be used for purposes of measurement, correction and/or protection of the eye, or for changing its appearance

### 3.5.2 spectacle lens lens

*ophthalmic lens* (3.5.1) worn in front of, but not in contact with, the eyeball

### 3.5.3 corrective lens

*lens* (3.5.2) with *dioptric power* (3.10.3)

### 3.5.4 protective lens

*lens* (3.5.2) designed to protect the eye from external hazards

### 3.5.5 absorptive lens

*lens* (3.5.2) designed to absorb a certain range or proportion of incident radiation

### 3.5.6 tinted lens

*lens* (3.5.2) (generally an *absorptive lens* (3.5.5)) having a noticeable colour (including grey) in transmission

### 3.5.7 clear lens

*lens* (3.5.2) with no intended colour/tint in transmission

### 3.5.8 uniformly tinted lens

*tinted lens* (3.5.6) made from material in which either the tint is incorporated throughout, or which, after manufacture, is surface-treated to provide a uniform tint

Note 1 to entry: Where the tint is dispersed uniformly through the material of the *spectacle lens* (3.5.2) (i.e. a solid tinted lens), the *luminous transmittance* (3.17.6) will vary with the lens thickness as a result of its *dioptric power* (3.10.3). Such a variation does not mean that the *lens* is classed as a *gradient-tinted lens* (3.5.9).

### 3.5.9 gradient-tinted lens graduated-tinted lens

*tinted lens* (3.5.6) having a controlled variation in tint (or transmittance) over the whole or part of the lens

Note 1 to entry: See *gradient-tinted direction* (3.17.10).

### 3.5.10

#### **double gradient-tinted lens**

*gradient-tinted lens* (3.5.9) in which tints of one or more colours are used, one colour fading in one direction, the other in the opposite direction, both along the same *gradient-tinted direction* (3.17.10)

Note 1 to entry: An additional uniform tint can also be applied.

### 3.5.11

#### **photochromic lens**

DEPRECATED: photochromatic lens

*lens* (3.5.2) that reversibly changes its *luminous transmittance* (3.17.6) depending upon the irradiance and wavelength of the *optical radiation* (3.1.1) to which it is exposed

Note 1 to entry: The *lens* is designed to react to wavelengths within the solar spectral range, chiefly 300 nm to 450 nm.

Note 2 to entry: The transmittance properties are usually affected by ambient temperature.

Note 3 to entry: See *faded state* (3.17.11) and *darkened state* (3.17.12).

### 3.5.12

#### **polarizing lens**

*lens* (3.5.2) showing differential absorption according to the plane of polarization of the incident *light* (3.1.2)

### 3.5.13

#### **balancing lens**

#### **matching lens**

*lens* (3.5.2) fitted to spectacles that balances the weight and/or the appearance of the other *lens*

## 3.6 Classification according to form

### 3.6.1

#### **lens form**

combination of *surface powers* (3.10.4) chosen to produce the given *focal power* (3.10.2)

### 3.6.2

#### **curved-form lens**

*lens* (3.5.2) having one surface convex in all *meridians* (3.2.11) and the other surface concave in all *meridians*

### 3.6.3

#### **afocal lens**

#### **plano lens**

DEPRECATED: plane lens

*lens* (3.5.2) with nominally zero *dioptric power* (3.10.3)

### 3.6.4

#### **spherical lens**

*lens* (3.5.2) with two *spherical surfaces* (3.4.1)

Note 1 to entry: One surface can be plane.

### 3.6.5

#### **cylindrical lens**

*lens* (3.5.2) with at least one *cylindrical surface* (3.4.2)

### 3.6.6

#### **spherocylindrical lens**

*lens* (3.5.2) with one *spherical surface* (3.4.1) and one *cylindrical surface* (3.4.2)

### 3.6.7

#### **toric lens**

*lens* (3.5.2) with at least one *toroidal surface* (3.4.6)

### 3.6.8

#### **aspheric lens**

*lens* (3.5.2) with at least one *aspherical surface* (3.4.3)

### 3.6.9

#### **atoric lens**

*lens* (3.5.2) with at least one *atoroidal surface* (3.4.7)

## 3.7 Classification according to type of lens

### 3.7.1

#### **single-vision lens**

*lens* (3.5.2) designed to provide a single *dioptric power* (3.10.3)

### 3.7.2

#### **position-specific single-vision lens**

*single-vision lens* (3.7.1), generally with complex surface geometry, that needs to be positioned accurately according to the ordered specification and bears permanent *alignment reference markings* (3.15.25)

Note 1 to entry: An example of *position-specific single-vision lenses* are those *single-vision lenses* (3.7.1) calculated to take into account the *as-worn position* (3.2.36) and therefore requiring accurate mounting in front of the wearer's eye.

[SOURCE: ISO 21987:2017, 3.4]

### 3.7.3

#### **multifocal lens**

*lens* (3.5.2) designed to provide two or more visibly divided portions of different *focal powers* (3.10.2)

### 3.7.4

#### **bifocal lens**

*multifocal lens* (3.7.3) having two portions, usually for distance and *near vision distances* (3.2.44)

### 3.7.5

#### **trifocal lens**

*multifocal lens* (3.7.3) having three portions, usually for distance, *intermediate* (3.2.45) and *near vision distances* (3.2.44)

### 3.7.6

#### **fused multifocal lens**

*multifocal lens* (3.7.3) in which a *segment* (3.15.5) of *glass* (3.3.2) of higher *refractive index* (3.1.5) than that of the main lens is fused into a depression in the main lens and surfaced so that the finished *segment side* (3.15.6) of the combined *lens* (3.5.2) forms one continuous surface

### 3.7.7

#### **power-variation lens**

*spectacle lens* (3.5.2) with a smooth variation of *focal power* (3.10.2) over part or all of its area, without discontinuity, designed to provide more than one *focal power*

Note 1 to entry: These are usually designed to provide increasing or decreasing *spherical power* (3.12.2), typically in a vertical *meridian* (3.2.11), so as to provide correction for different object distances.

Note 2 to entry: Examples of *power-variation lenses* are, but not limited to, *progressive-power lenses* (3.7.8) and *degressive-power lenses* (3.7.9).

[SOURCE: ISO 21987:2017, 3.1]



### 3.7.8

#### **progressive-power lens**

PPL

#### **progressive-addition lens**

PAL

#### **varifocal lens**

*power-variation lens* (3.7.7) with two *reference points* (3.2.19) for *focal power* (3.10.2), generally designed to provide correction for *presbyopia* (3.1.4) and clear vision from distance to near

Note 1 to entry: *Progressive-power lenses* have a *primary reference point* (3.2.22) that is the *distance reference point* (3.2.20) and a *secondary reference point* (3.2.23) that is the *near reference point* (3.2.21).

[SOURCE: ISO 21987:2017, 3.2]

### 3.7.9

#### **degressive-power lens**

*power-variation lens* (3.7.7) with a *primary reference point* (3.2.22) for near vision, generally designed to provide clear vision from near to further distances

[SOURCE: ISO 21987:2017, 3.3]

## 3.8 Classification according to state of manufacture

### 3.8.1

#### **blank**

#### **semi-finished blank**

#### **lens blank**

#### **semi-finished lens**

#### **semi-finished lens blank**

piece of *optical material* (3.3.1) with one optically finished surface for the making of a *lens* (3.5.2)

Note 1 to entry: A lens shaped piece of *optical material* (3.3.1) with neither side having finished surfaces may be referred to as a rough blank.

### 3.8.2

#### **single-vision blank**

#### **single surface-power blank**

*blank* (3.8.1) with the finished surface having a single *nominal surface power* (3.10.5)

Note 1 to entry: This includes *blanks* (3.8.1) with *aspherical surfaces* (3.4.3).

### 3.8.3

#### **multifocal blank**

*blank* (3.8.1) with the finished surface having two or more visibly divided portions of different *dioptric powers* (3.10.3) or *focal powers* (3.10.2)

Note 1 to entry: This definition includes fused *multifocal blanks* and blanks with blended *segments* (3.15.5), that is, where the *dividing line* (3.15.4) has been smoothed away.

### 3.8.4

#### **power-variation blank**

*blank* (3.8.1) with the finished surface having a smooth variation of *spherical power* (3.12.2) over part or all of its area, without discontinuity, thus giving more than one intended *focal power* (3.10.2)

Note 1 to entry: This definition includes *progressive-power blanks* (3.8.5) and *degressive-power blanks* (3.8.6).



### 3.8.5

**progressive-power blank**  
**progressive-addition blank**  
**varifocal blank**

*power-variation blank* (3.8.4) where the finished surface is a progressive-power surface

Note 1 to entry: A *progressive-power blank* is generally intended for the manufacture of a *progressive-power lens* (3.7.8).

### 3.8.6

**degressive-power blank**

*power-variation blank* (3.8.4) where the finished surface is a degressive-power surface

Note 1 to entry: A *degressive-power blank* is generally intended for the manufacture of a *degressive-power lens* (3.7.9).

### 3.8.7

**finished lens**

*lens* (3.5.2) of which both sides have their final optical surface

Note 1 to entry: The *finished lens* can be either edged (cut) or uncut.

### 3.8.8

**uncut lens**

**uncut finished lens**

*finished lens* (3.8.7) prior to edging (3.8.10)

### 3.8.9

**edged lens**

*finished lens* (3.8.7) edged to the final size and shape

### 3.8.10

**edging**

process in which the edge of the *uncut lens* (3.8.8) is profiled to the required finished size and shape and with the desired edge form, e.g. flat or bevelled

### 3.8.11

**predecentration**

distance, horizontal and/or vertical, between the *design reference point* (3.2.16) and the *geometric centre* (3.2.6) of an *uncut lens* (3.8.8)

### 3.8.12

**predecentred blank**

predecentred semi-finished lens blank

*blank* (3.8.1) with a finished surface in which the *design reference point* (3.2.16) is displaced from the *geometrical centre* (3.2.6), usually nasally, in order to provide an effectively larger *blank*

EXAMPLE The nominal diameter of 65/70 means that the *design reference point* of the *blank* of effective diameter 65 mm has been displaced by 2,5 mm to provide a larger temporal zone equivalent to a *blank* of 70 mm usable diameter.

### 3.8.13

**surfaced-to-lens-shape**

**precalibrated lens-shape**

process in which the *lens shape* (3.2.2) is taken into account when calculating the surfacing instructions in order to optimize the *lens* (3.5.2) thickness

Note 1 to entry: *Uncut lenses* (3.8.8) that are *surfaced-to-lens-shape* are often not round.

### 3.8.14

#### **safety chamfer**

small facet running round the periphery of an *edged lens* (3.8.9) between the *front* (3.2.13) or *back surface* (3.2.14) of the *lens* (3.5.2) and the edge

Note 1 to entry: This is to reduce the possibility of the *lens* chipping, and to protect the wearer from a sharp edge and reduce potential injury if the *lens* were pushed into the face.

### 3.8.15

#### **tracer**

device for measuring the *lens shape* (3.2.2) of a spectacle frame in order to edge the *uncut lens* (3.8.8) for mounting

### 3.8.16

#### **remote edging**

process in which the *uncut lenses* (3.8.8) are edged without the physical presence of the spectacle frame using tracing data that has been obtained from a database or has been transmitted electronically

### 3.8.17

#### **prescription range**

range of *lens powers* (3.1.10) and geometries (*sphere* (3.12.2), *cylinder* (3.13.7), *addition* (3.16.3) and size (3.2.7, 3.2.8 and 3.2.9)) produced by a manufacturer for a specific product

### 3.8.18

#### **prescription chart**

##### **base curve chart**

chart showing the specifications of the *lens* (3.5.2) products

Note 1 to entry: The chart can show one or several of: the *prescription range* (3.8.17), *base curve* (3.4.8), *edge thickness* (3.2.48), *centre thickness* (3.2.47), other design parameters and additional information.

## 3.9 Measurement of dioptric properties of lenses

### 3.9.1

#### **focimeter**

instrument that is used to measure *vertex powers* (3.10.7), *cylinder axes* (3.13.8) and *prismatic effects* (3.11.9) of spectacle and contact lenses, to orientate and mark *uncut lenses* (3.8.8), and to verify the correct mounting of *lenses* (3.5.2) in spectacle frames

Note 1 to entry: There are two types of *focimeter*: manual focusing and automated. See ISO 8598-1:2014 for definitions of various types of *focimeter*.

[SOURCE: ISO 8598-1:2014, 3.3, modified — In the term, "general purpose" has been deleted, in the definition, "cylinder axis" has been changed into plural, and Note 1 to entry has been added.]

### 3.9.2

#### **focal-point-on-axis focimeter**

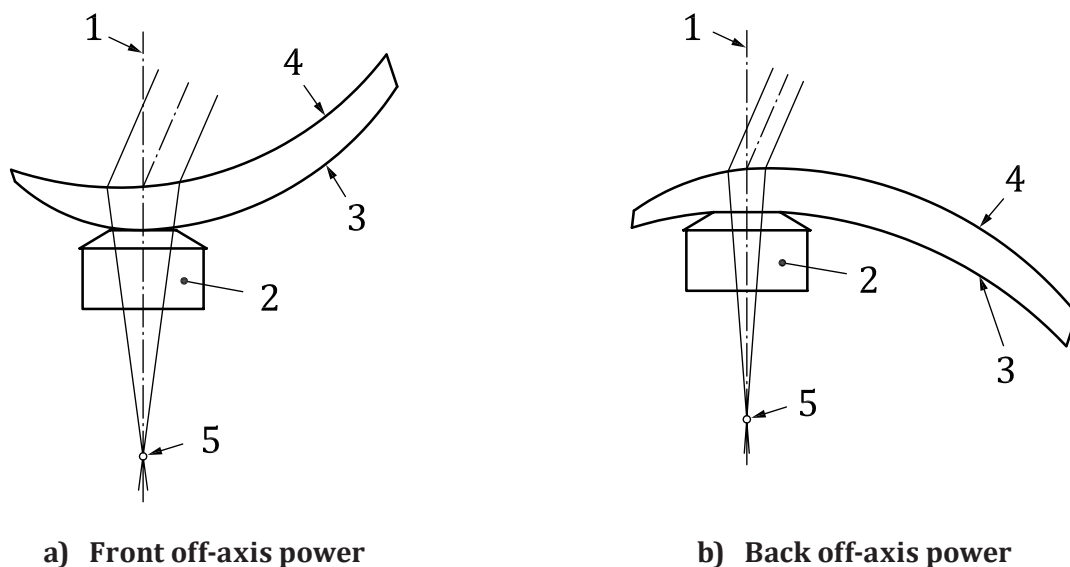
##### **FOA focimeter**

*focimeter* (3.9.1) in which the *focal point* (3.1.11) of the beam remains on the axis of the *focimeter* when the *lens* (3.5.2) under test is measured at a point of the *lens* where the *prismatic effect* (3.11.9) is not zero

Note 1 to entry: See [Figure 6](#).

Note 2 to entry: Examples of this design include all manual focusing *focimeters* (3.9.1) and some automated *focimeters*.

Note 3 to entry: Differences can occur between measurements made with *FOA* and *IOA* (3.9.3) *focimeters* at points on a *lens* where the *prismatic effect* is not zero. This is because of the different obliquity of the ray paths through the *lens* caused by the *prismatic effect* at those points.



**Key**

- 1 axis of the *focimeter*, perpendicular to the reference surface
- 2 *focimeter's lens support*
- 3 reference surface: when measuring the front *off-axis power*, this is the *front surface*; when measuring the back *off-axis power*, this is the *back surface*
- 4 opposite surface of the *lens*
- 5 *focal point* of the beam, located on the axis (1) of the *focimeter*

**Figure 6 — Illustration of a FOA focimeter showing off-axis power measurement**

**3.9.3**

**infinite-on-axis focimeter**

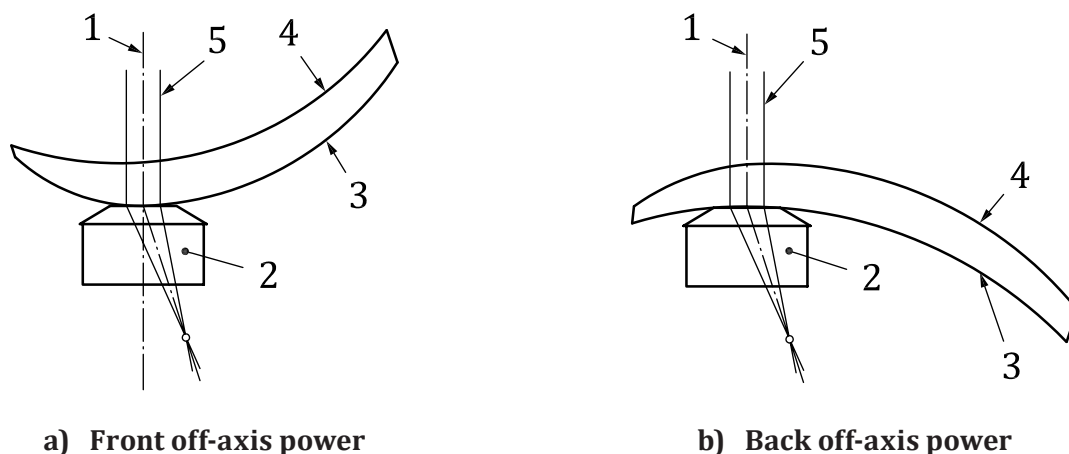
**IOA focimeter**

*focimeter* (3.9.1) in which the collimated beam coincides with the axis of the *focimeter* and the *focal point* (3.1.11) of the beam goes off the axis of the *focimeter* when the *lens* (3.5.2) under test is measured at a point of the *lens* where the *prismatic effect* (3.11.9) is not zero

Note 1 to entry: See Figure 7.

Note 2 to entry: Some automated *focimeters* (3.9.1) use this design.

Note 3 to entry: Differences can occur between measurements made with *IOA* and *FOA* (3.9.2) *focimeters* at points on a *lens* where the *prismatic effect* (3.11.9) is not zero. This is because of the different obliquity of the ray paths through the *lens* caused by the *prismatic effect* at those points.



**Key**

- 1 axis of the *focimeter*, perpendicular to the reference surface
- 2 *focimeter's lens support*
- 3 reference surface: when measuring the front *off-axis power*, this is the *front surface*; when measuring the back *off-axis power*, this is the *back surface*
- 4 opposite surface of the *lens*
- 5 parallel beam of light entering or leaving the other surface of the *lens*

**Figure 7 — Illustration of an IOA focimeter showing off-axis power measurement**

**3.9.4  
lens support**

mechanical interface (aperture) on the instrument against which the spectacle or contact lens is placed for measurement

Note 1 to entry: The *focimeter* (3.9.1) measures the *vertex power* (3.10.7) relative to the surface placed against the *lens support*.

[SOURCE: ISO 8598-1:2014, 3.7, modified — "(aperture)" has been added.]

**3.9.5  
adjusting rail**

movable rail or bar, used as the reference axis for spectacles during measurement and which is aligned perpendicularly to the *optical axis* (3.1.8) of the *focimeter* (3.9.1) and parallel to the axis direction 0° to 180°

Note 1 to entry: This is also called lens table or frame rest.

[SOURCE: ISO 8598-1:2014, 3.1]

**3.10 Focal properties**

**3.10.1  
dioptre**

unit of focusing power of a *lens* (3.5.2) or surface, or of vergence of a wavefront, when the focal length or radius of curvature, respectively, is expressed in metres

Note 1 to entry: When in air, the *power* of a *lens* is given by the reciprocal of the focal length, while vergence, in general, is given by the *refractive index* (3.1.5) divided by the radius of curvature of the wavefront.

Note 2 to entry: Commonly used symbols for *dioptre* are D and dpt.

Note 3 to entry: *Dioptries* are expressed in reciprocal metres (m<sup>-1</sup>).

### 3.10.2

#### **focal power**

general term comprising the spherical and cylindrical *vertex powers* (3.10.7) of a *lens* (3.5.2)

Note 1 to entry: For *lenses* having a specific orientation, such as *position-specific single-vision lenses* (3.7.2), *multifocal lenses* (3.7.3), *power-variation lenses* (3.7.7), *single-vision lenses* (3.7.1) with *ordered prismatic effect* (3.11.14) and mounted *single-vision lenses*, the *focal power* can include a *cylinder axis* (3.13.8).

Note 2 to entry: See also *astigmatic effect* (3.13.9), which also includes the *cylinder axis*.

### 3.10.3

#### **dioptric power**

general term comprising the *focal power* (3.10.2) and the *prismatic power* (3.11.10) of a *lens* (3.5.2)

Note 1 to entry: For *lenses* having a specific orientation, such as *position-specific single-vision lenses* (3.7.2), *multifocal lenses* (3.7.3), *power-variation lenses* (3.7.7), *single-vision lenses* (3.7.1) with *ordered prismatic effect* (3.11.14) and mounted *single-vision lenses*, the *dioptric power* can include a *cylinder axis* (3.13.8) and/or *prism base setting* (3.11.7).

### 3.10.4

#### **surface power**

local ability of a finished surface to change the vergence of a bundle of rays incident at the surface

Note 1 to entry: The *surface power* is determined from the radius or radii of the surface and the *refractive index* (3.1.5) of the *optical material* (3.3.1), and is calculated for *light* (3.1.2) incident or emergent in air. The *refractive index* may be the actual *refractive index* of the material or a nominal value.

### 3.10.5

#### **nominal surface power**

*surface power* (3.10.4) stated by the manufacturer for identification purposes

Note 1 to entry: Compare *base curve* (3.4.8).

### 3.10.6

#### **surface cylindrical power**

difference between the *surface powers* (3.10.4) in the two *principal meridians* (3.4.5) of a finished surface

Note 1 to entry: *Surface cylindrical power* is determined from the radii of the surface and the *refractive index* (3.1.5) of the *optical material* (3.3.1), and is calculated for *light* (3.1.2) incident or emergent in air. The *refractive index* may be the actual *refractive index* of the material or a nominal value.

### 3.10.7

#### **vertex power**

reciprocal of the paraxial vertex focal length

### 3.10.8

#### **back vertex power**

reciprocal of the paraxial back vertex focal length

Note 1 to entry: According to ophthalmic convention, the “*power* (3.1.10)” of a *lens* (3.5.2) is specified as the *back vertex power*.

### 3.10.9

#### **front vertex power**

reciprocal of the paraxial front vertex focal length

Note 1 to entry: The *front vertex power* is required for certain purposes, e.g. in the measurement of *addition* (3.16.3) and *variation power* (3.16.4) in some *multifocal* (3.7.3) and *power-variation lenses* (3.7.7).

### 3.10.10

#### off-axis power

*power* (3.1.10) away from the *optical axis* (3.1.8) of a *lens* (3.5.2), given by the reciprocal of the distance between the *back surface* (3.2.14) or *front surface* (3.2.13) of the *lens* and its related principal *focal point* (3.1.11) (or its related principal focal lines)

Note 1 to entry: The *power*, and possibly *cylinder axis* (3.13.8), measured will be influenced, for example, by the astigmatism generated by the *prismatic effect* (3.11.9) and the oblique incidence on the surfaces of the *lens*.

### 3.10.11

#### equivalent power

*power* (3.1.10) of an imaginary infinitely thin lens that will produce the same sized image of an infinitely distant object as that produced by the actual *lens* (3.5.2)

Note 1 to entry: This *power* is the reciprocal of the equivalent focal length in air, measured in metres, between the second principal point and its related *focal point* (3.1.11) on the *optical axis* (3.1.8).

### 3.10.12

#### effective power

adjusted *dioptric power* (3.10.3) required for the *lens* (3.5.2) at an altered *vertex distance* (3.2.40)

EXAMPLE The *effective power* of a -10,00 *dioptric spherical lens* at 15 mm *vertex distance* when positioned at 10 mm *vertex distance* is -9,52 *dioptric*.

### 3.10.13

#### prescribed power

*dioptric power* (3.10.3) specified for correction/compensation of a wearer's vision determined by refractive examination

### 3.10.14

#### ordered power

*dioptric power* (3.10.3) that is specified in the order to the manufacturer

Note 1 to entry: *Ordered power* can differ from the *prescribed power* (3.10.13), for example, in case of the corrections for a change in *vertex distance* (3.2.40) or *near vision distance* (3.2.44).

Note 2 to entry: Prescription laboratories are included within the meaning of manufacturer.

Note 3 to entry: See [Figure 8](#).

### 3.10.15

#### verification power

*dioptric power* (3.10.3) of the *lens* (3.5.2) specifically calculated and provided by the manufacturer as the reference for *focimeter* (3.9.1) verification

Note 1 to entry: This is the power that is expected to be found as the *measured power* (3.10.16) using the specified method, and to which the tolerances apply.

Note 2 to entry: The *verification power* can differ from the *ordered power* (3.10.14), for example, because the ray path through the *lens* when being measured on a *focimeter* (3.9.1) can be different from that in the *as-worn position* (3.2.36), and because of (ocular) physiological effects.

Note 3 to entry: If only one power is stated by manufacturer with the finished *uncut* (3.8.8) or mounted *lens*, then this will be the *ordered power* and is to be used for verification.

Note 4 to entry: See [Figure 8](#).

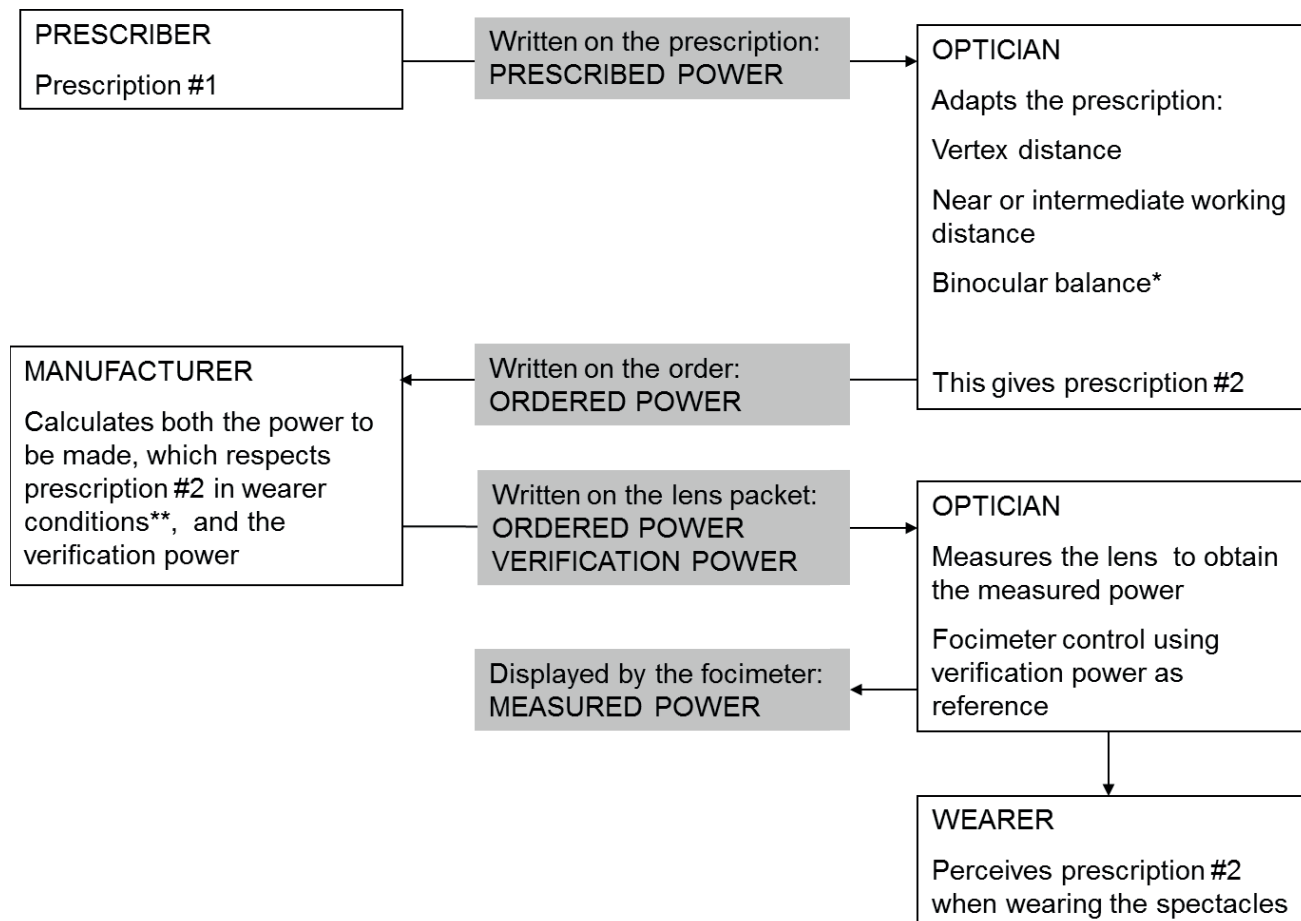
[SOURCE: ISO 21987:2017, 3.8, modified — In Note 3 to entry, the word "lenses" has been changed to "lens", since the term can apply to a single lens, and Note 4 to entry has been added.]

### 3.10.16

#### measured power

*dioptric power* (3.10.3) measured at a specified point on a *lens* (3.5.2) using a specified method

Note 1 to entry: See Figure 8.



\* In some countries, the person dispensing the spectacles is permitted to refine the *prescribed power*

\*\* *As-worn position* and other applicable parameters such as the chosen *working distance* and physiological factors

Figure 8 — The relationship between the various powers

### 3.10.17

#### plus-power lens

#### positive lens

#### converging lens

DEPRECATED: convex lens

*lens* (3.5.2) that causes parallel incident *light* (3.1.2) to converge to a real focus

### 3.10.18

#### minus-power lens

#### negative lens

#### diverging lens

DEPRECATED: concave lens

*lens* (3.5.2) that causes parallel incident *light* (3.1.2) to diverge from a virtual focus

### 3.10.19

#### **spectacle magnification**

ratio of the retinal image size in any given eye when wearing spectacles compared to that in the unaided eye

Note 1 to entry: This can be expressed by the formula:

$$SM = \frac{h'_{\text{corr}}}{h'_{\text{uncorr}}}$$

where

$SM$  is the *spectacle magnification*;

$h'_{\text{corr}}$  is the retinal image size in the corrected eye;

$h'_{\text{uncorr}}$  is the retinal images size in the uncorrected eye.

Note 2 to entry: This can be computed as the product of shape factor and power factor and in the case of near vision, the proximity factor. The shape factor is the magnification due to the form and thickness of a *lens*, the power factor is the magnification due to wearing an imaginary infinitely thin lens of the given *power* (3.1.10), and the proximity factor depends upon *lens form* (3.6.1), *power* and object distance.

## 3.11 Prismatic properties

### 3.11.1

#### **flat plano prism**

refracting element bounded by two non-parallel plane surfaces

### 3.11.2

#### **refracting edge**

line in which the two non-parallel plane surfaces of a prism meet, or would meet if produced

### 3.11.3

#### **principal section of a prism**

plane containing a normally incident ray and its emergent refracted ray

Note 1 to entry: For a *flat plano prism* (3.11.1), this is any section lying in a plane perpendicular to the *refracting edge* (3.11.2).

### 3.11.4

#### **apex**

<prism> intersection of the *refracting edge* (3.11.2) with a *principal section of a prism* (3.11.3)

Note 1 to entry: In common practice, this is defined as the thinnest part of a *principal section of a prism*.

### 3.11.5

#### **apical angle**

#### **refracting angle**

angle in a *principal section of a prism* (3.11.3) that is included between the refracting surfaces

### 3.11.6

#### **base**

#### **prism base**

thickest part of a *principal section of a prism* (3.11.3)



### 3.11.7

#### base position

#### prism base setting

DEPRECATED: base-apex direction

DEPRECATED: base-apex line

DEPRECATED: base-apex meridian

direction of the line from *apex* (3.11.4) to *base* (3.11.6) in a *principal section of a prism* (3.11.3)

Note 1 to entry: The setting position for the *prism base* (3.11.6) can be indicated by the directions “base up” or “base down” or “base in” (toward the nose) or “base out” (toward the temples). The *prism base setting* can also be indicated by the angular coordinate system specified in ISO 8429.

Note 2 to entry: The *prism base setting* of a *lens* (3.5.2) is the direction in which all rays passing through the *lens* are uniformly deviated, any *focal power* (3.10.2) having been neutralized.

### 3.11.8

#### prismatic deviation

change in direction imposed on a ray of light as a result of refraction

### 3.11.9

#### prismatic effect

collective name for the *prismatic deviation* (3.11.8) and *prism base setting* (3.11.7)

### 3.11.10

#### prismatic power

prism

magnitude of the *prismatic effect* (3.11.9)

Note 1 to entry: When verifying a *lens* (3.5.2), this shall be measured at the *reference point* (3.2.19), or for *power-variation lenses* (3.7.7), the *prism reference point* (3.16.10).

### 3.11.11

#### prism dioptre

unit of *prismatic deviation* (3.11.8) of a ray after refraction by a *lens* (3.5.2) or prism where  $x$  *prism dioptres* corresponds to a deviation of  $x$  cm measured at a distance of 1 m

Note 1 to entry: Commonly used symbols or abbreviations for the *prism dioptre* are  $\Delta$  and cm/m.

Note 2 to entry: The deviation in *prism dioptres* is equal to  $100 \tan \delta$ , where  $\delta$  is the angle of deviation. Hence for large deviations, the angle  $\delta_{x\Delta}$  corresponding to  $x$  *prism dioptres* is not equal to  $x$ -times the angle  $\delta_{1\Delta}$  corresponding to one *prism dioptre*.

### 3.11.12

#### prismatic-power lens

*lens* (3.5.2) with an *ordered prismatic effect* (3.11.14) at the *design reference point* (3.2.16) or, for *power-variation lenses* (3.7.7), at the *prism reference point* (3.16.10)

Note 1 to entry: *E-line multifocal lenses* (3.15.23) and *power-variation lenses* (3.7.7) with only *prism thinning* (3.16.9) are not regarded as *prismatic-power lenses*.

### 3.11.13

#### prism imbalance

#### relative prism error

value of the algebraic difference of any unwanted *prismatic effect* (3.11.9) between the right and left *lenses* (3.5.2) of a pair of spectacles, measured at the *centration points* (3.2.30)

Note 1 to entry: *Prism imbalance* is measured as a horizontal and a vertical imbalance.

EXAMPLE A pair of spectacles having an unintended *prismatic effect* of 0,5 *prism dioptres* base in right and 0,2 *prism dioptres* base out left has a *prism imbalance* of 0,3 *prism dioptres* horizontally.

#### 3.11.14

##### **ordered prismatic effect**

*prismatic effect* (3.11.9) that is specified in the order to the manufacturer

Note 1 to entry: The total *prismatic effect* is the combination of the *ordered prismatic effect* and any *prism thinning* (3.16.9). Corrections to the *ordered prismatic effect* to compensate for the *as-worn position* (3.2.36) can also be applied, and will be stated by the manufacturer in the *verification power* (3.10.15).

Note 2 to entry: For a *power-variation lens* (3.7.7), the total *prismatic effect* is measured at the *prism reference point* (3.16.10).

#### 3.11.15

##### **ordered distance prismatic effect**

*ordered prismatic effect* (3.11.14) that is specified for distance vision

Note 1 to entry: The total *prismatic effect* (3.11.9) is the combination of the *ordered distance prismatic effect* and any *prism thinning* (3.16.9).

#### 3.11.16

##### **ordered near prismatic effect**

*ordered prismatic effect* (3.11.14) that is specified for near vision

Note 1 to entry: For *power-variation lenses* (3.7.7) and *multifocal lenses* (3.7.3), the *ordered near prismatic effect* needs only to be stated in the absence of any *ordered distance prismatic effect* (3.11.15) or if it differs from the *ordered distance prismatic effect*.

### 3.12 Spherical-power lenses

#### 3.12.1

##### **spherical-power lens**

*lens* (3.5.2) that brings a paraxial pencil of parallel *light* (3.1.2) to a single focus

Note 1 to entry: This definition can also apply to *lenses* with *aspherical surfaces* (3.4.3).

Note 2 to entry: A *spherical-power lens* can have unintended *cylindrical power* (3.13.7). Provided this is within tolerance, such a *lens* is classified as having *spherical power* (3.12.2).

#### 3.12.2

##### **spherical power**

##### **sphere**

##### **sph**

*S*

value of the *back vertex power* (3.10.8) of a *spherical-power lens* (3.12.1) or the *back vertex power* in one of the two *principal meridians* (3.13.2) of an *astigmatic-power lens* (3.13.1), depending on the *principal meridian* chosen for reference

#### 3.12.3

##### **meniscus lens**

*lens* (3.5.2) having one convex and one concave *spherical surface* (3.4.1)

### 3.13 Astigmatic-power lenses

#### 3.13.1

##### **astigmatic-power lens**

##### **spherocylindrical-power lens**

*lens* (3.5.2) bringing a paraxial pencil of parallel *light* (3.1.2) to two separate line foci mutually at right angles and hence having *vertex power* (3.10.7) in only the two *principal meridians* (3.13.2)

Note 1 to entry: One of these *vertex powers* (3.10.7) can be zero, with the corresponding line focus at infinity.

Note 2 to entry: Lenses referred to as *cylindrical lenses* (3.6.5), *spherocylindrical lenses* (3.6.6) and *toric lenses* (3.6.7) are all *astigmatic-power* or *spherocylindrical-power lenses*.

### 3.13.2

#### **principal meridian**

<*astigmatic-power lens*> one of two mutually perpendicular *meridians* (3.2.12) of an *astigmatic-power lens* (3.13.1) that are parallel to the two line foci

### 3.13.3

#### **first principal meridian**

*principal meridian* (3.13.2) of an *astigmatic-power lens* (3.13.1) having algebraically the lower *vertex power* (3.10.7)

### 3.13.4

#### **second principal meridian**

*principal meridian* (3.13.2) of an *astigmatic-power lens* (3.13.1) having algebraically the higher *vertex power* (3.10.7)

### 3.13.5

#### **principal power**

DEPRECATED: meridional power

*back vertex power* (3.10.8) in either of the two *principal meridians* (3.13.2) of an *astigmatic-power lens* (3.13.1)

### 3.13.6

#### **astigmatic difference**

*vertex power* (3.10.7) in the *second principal meridian* (3.13.4) minus that in the *first principal meridian* (3.13.3)

Note 1 to entry: The *astigmatic difference* is always positive.

### 3.13.7

#### **cylindrical power**

#### **cylinder**

#### **cyl**

*C*

algebraic difference between the *principal powers* (3.13.5) with the power of the *principal meridian* (3.13.2) chosen for reference being subtracted from the other *principal power*

Note 1 to entry: Consequently, the *vertex power* (3.10.7) of the *principal meridian* not chosen for reference is the sum of the *spherical* (3.12.2) and *cylindrical powers*.

### 3.13.8

#### **cylinder axis**

direction of that *principal meridian* (3.13.2) of a *lens* (3.5.2) whose *vertex power* (3.10.7) is chosen for reference

Note 1 to entry: The direction of the *cylinder axis* is specified and measured according to ISO 8429.

### 3.13.9

#### **astigmatic effect**

#### **cylindrical effect**

collective description of the *cylindrical power* (3.13.7) and the *cylinder axis* (3.13.8)

### 3.13.10

#### **astigmatic lens power** **cylindrical lens power** **spherocylindrical lens power**

power (3.1.10) of an *astigmatic-power lens* (3.13.1) comprising the *vertex powers* (3.10.7) of both *principal meridians* (3.13.2) and the *cylindrical power* (3.13.7)

Note 1 to entry: This is generally written as two values; the *spherical power* (3.12.2), being that of the *principal power* (3.13.5) taken for reference, and its corresponding *cylindrical power* (3.13.7). The algebraic sum of these two powers gives the other *principal power*.

Note 2 to entry: The *cylinder axis* (3.13.8) is included in the term *astigmatic effect* (3.13.9).

### 3.13.11

#### **transposition**

process of converting a prescription from the original to an equivalent alternative formulation, especially from the plus to the minus cylinder form, and vice versa

### 3.13.12

#### **spherical equivalent power** **mean sphere**

*focal power* (3.10.2) of a *lens* (3.5.2) or surface halfway between the two *principal powers* (3.13.5)

Note 1 to entry: The *spherical equivalent power*,  $M$ , is thus expressed by the formula:

$$M = \frac{1}{2}(S_1 + S_2) = S + \frac{1}{2}C$$

where

$S_1$  and  $S_2$  are the *principal powers*;

$S$  and  $C$  are the *spherical* and *cylindrical powers* when the *focal power* is expressed in spherocylindrical form.

## 3.14 Lenticular lenses

### 3.14.1

#### **lenticular lens** **reduced-aperture lens**

*lens* (3.5.2) with a central *optical portion* (3.14.2) finished to prescription, surrounded by a supporting *margin* (3.14.4)

Note 1 to entry: This definition includes *lenses* with blended *optical portions* (3.14.2). The blending can be designed for optical reasons or solely for cosmetic purposes.

### 3.14.2

#### **optical portion**

DEPRECATED: lenticular portion  
portion of a *lenticular lens* (3.14.1) finished to prescription

### 3.14.3

#### **optical aperture**

DEPRECATED: lenticular aperture  
diameter (size) of the *optical portion* (3.14.2)

### 3.14.4

#### **margin** **carrier**

part of a *lenticular lens* (3.14.1) surrounding the *optical portion* (3.14.2)

## 3.15 General descriptive terms for multifocal and power-variation lenses

### 3.15.1

#### **distance portion**

portion of a *multifocal lens* (3.7.3) or *progressive-power lens* (3.7.8) having the *dioptric power* (3.10.3) for distance vision

### 3.15.2

#### **intermediate portion**

portion of a *trifocal lens* (3.7.5) having the *dioptric power* (3.10.3) for vision at ranges intermediate between distance and near

### 3.15.3

#### **near portion**

DEPRECATED: reading portion

portion of a *multifocal lens* (3.7.3), *progressive-power lens* (3.7.8) or *degressive-power lens* (3.7.9) having the *dioptric power* (3.10.3) for the *near vision distance* (3.2.44)

### 3.15.4

#### **dividing line**

boundary between two adjacent portions of a *multifocal lens* (3.7.3) or *lenticular lens* (3.14.1)

### 3.15.5

#### **segment**

portion or portions of a *multifocal lens* (3.7.3) with a specified difference in *dioptric power* (3.10.3) from the main lens

### 3.15.6

#### **segment side**

side of a *multifocal lens* (3.7.3) on which the *segment* (3.15.5) is situated

### 3.15.7

#### **segment diameter**

#### **segment width**

diameter of the circle of which the boundary of the finished *segment* (3.15.5) forms a part

Note 1 to entry: See *d* in [Figure 9](#).

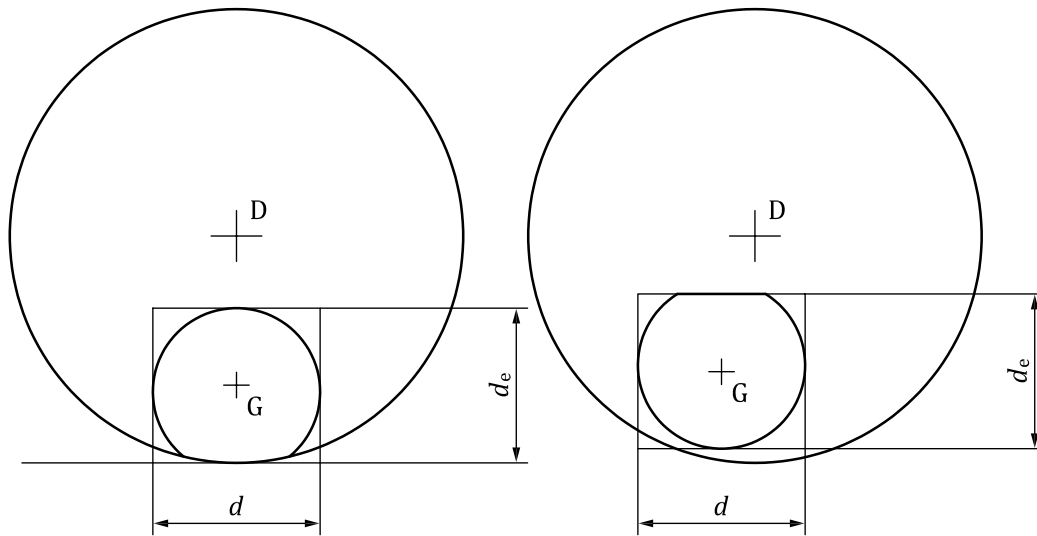
### 3.15.8

#### **segment geometric centre**

centre of the rectangle formed by the horizontal and vertical tangents to the *segment's* (3.15.5) *dividing line* (3.15.4), or *lens* (3.5.2) periphery if the *segment* (3.15.5) extends to the *lens* edge

Note 1 to entry: See *G* in [Figure 9](#).

Note 2 to entry: This applies only to a *blank* (3.8.1), or to a *lens* where no part of the *segment* (3.15.5) has been lost through surfacing or *edging* (3.8.10).



**Key**

- D distance design reference point
- G segment geometric centre
- d segment diameter
- $d_e$  segment depth

**Figure 9 — Multifocal dimensions mainly applicable to blanks**

**3.15.9**

**segment top**

highest point for a *segment* (3.15.5) mainly in the lower portion of the *lens* (3.5.2)

Note 1 to entry: See S in [Figure 10](#).

**3.15.10**

**segment bottom**

lowest point for a *segment* (3.15.5) mainly in the upper portion of the *lens* (3.5.2)

**3.15.11**

**segment extreme point**

generic term for the *segment top* (3.15.9) or *segment bottom* (3.15.10)

**3.15.12**

**segment extreme point position**

vertical distance of the *segment extreme point* (3.15.11) from the *horizontal centreline* (3.2.3) of the edged *lens shape* (3.2.2)

Note 1 to entry: See s in [Figure 10](#).

Note 2 to entry: This shall be specified as above or below the *horizontal centreline*, and applies to both non-round and *round segments* (3.15.18).

Note 3 to entry: This position is also known as the *segment top* (3.15.9) position and the *segment bottom* (3.15.10) position, as appropriate.

**3.15.13**

**inset**

**horizontal displacement of segment**

displacement of the *segment* (3.15.5) of a *multifocal lens* (3.7.3) from the *distance reference point* (3.2.20) towards the nose, usually without reference to the effect on the *near optical centre* (3.16.8)

Note 1 to entry: The purpose is generally to bring the right and left near-vision fields into coincidence.

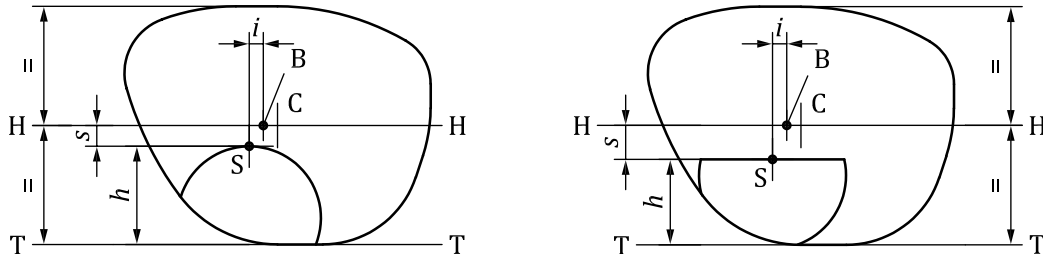
Note 2 to entry: This term shall not be used for an inward *decentration* (3.2.33) of *optical centres* (3.2.15).

### 3.15.14

#### geometrical inset

horizontal distance between the vertical line through the *distance centration point* (3.2.30) and the *segment extreme point* (3.15.11)

Note 1 to entry: See  $i$  in Figure 10.



#### Key

- H *horizontal centreline*
- T *horizontal tangent to the peak of the bevel (if any) of the edge of the lens at its lowest point*
- C *boxed centre*
- B *distance centration point*
- S *segment top*
- h *segment height*
- i *geometrical inset*
- s *segment extreme point position*

Figure 10 — Principal multifocal dimensions required for mounting

### 3.15.15

#### segment depth

vertical dimension of the *segment* (3.15.5) of a *blank* (3.8.1), measured through the *segment extreme point* (3.15.11)

Note 1 to entry: See  $d_e$  in Figure 9.

Note 2 to entry: The *segment depth* can be used for purposes of identification.

### 3.15.16

#### segment height

#### segment extreme point height

vertical distance of the *segment extreme point* (3.15.11) above the horizontal tangent to the *lens* (3.5.2) periphery at its lowest point

Note 1 to entry: See  $h$  in Figure 10.

Note 2 to entry: If the *lens* is bevelled, the periphery is taken to be the peak of the bevel.

### 3.15.17

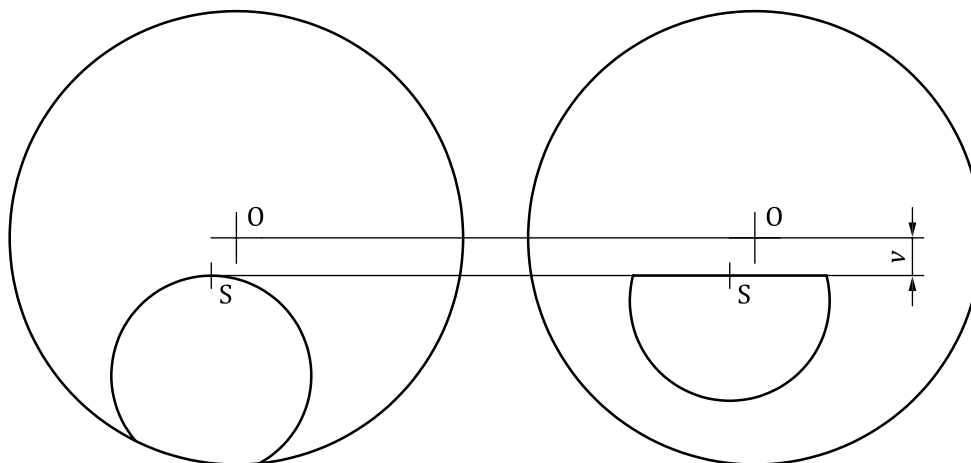
#### vertical segment displacement

#### segment drop

vertical distance between the *distance optical centre* (3.16.6) and the *segment extreme point* (3.15.11)

Note 1 to entry: See  $v$  in Figure 11.

Note 2 to entry: It is essential to specify the *vertical segment displacement* when ordering one *lens* (3.5.2) of a pair, to avoid introducing a relative *vertical prism imbalance* (3.11.13).



**Key**

O *optical centre of the distance portion*

S *segment top*

v *vertical segment displacement*

**Figure 11 — Vertical segment displacement of a multifocal lens**

**3.15.18**

**round segment**

*segment (3.15.5) whose dividing line (3.15.4) is a single circular arc*

**3.15.19**

**straight-top segment**

**D-segment**

**flat-top segment**

*mostly circular segment (3.15.5) but with the segment extreme point (3.15.11) on a straight line*

**3.15.20**

**straight-top bifocal**

*bifocal lens (3.7.4) with a straight-top segment (3.15.19)*

**3.15.21**

**curved-top segment**

**C-segment**

*mostly circular segment (3.15.5) but with the segment extreme point (3.15.11) on a shallow arc*

**3.15.22**

**curved-top bifocal**

*bifocal lens (3.7.4) with a curved-top segment (3.15.21)*

**3.15.23**

**E-line multifocal**

**E-style multifocal**

*type of multifocal lens (3.7.3) in which the portions are separated by a horizontal dividing line (3.15.4) going completely across the lens (3.5.2)*

**3.15.24**

**power-variation side**

*side of a power-variation lens (3.7.7) on which the greater change of surface power (3.10.4) is situated*



### 3.15.25

#### **alignment reference marking**

permanent markings provided by the manufacturer to establish the horizontal alignment of the *lens* (3.5.2) or *blank* (3.8.1), or to re-establish the *reference points* (3.2.9)

### 3.15.26

#### **corridor**

portion of a *power-variation lens* (3.7.7) providing the intended change in *focal power* (3.10.2)

Note 1 to entry: The *corridor* denotes either a zone in the *lens* (3.5.2) (the progression zone) or the line of minimum cylindrical *surface power* (3.10.4) on the *power-variation surface* (3.4.10), often called the “umbilical line”.

### 3.15.27

#### **prism-controlled bifocal (or multifocal)**

*lens* (3.5.2) whose method of construction permits some independent control of *prismatic effect* (3.11.9) or optical centration of the various portions of the *lens*

Note 1 to entry: This can include a “slab-off” or bi-prism *lens* where, for example, the *near portion* (3.15.3) of one *lens* of a pair contains a prism to reduce the vertical *prism imbalance* (3.11.13) that would otherwise occur in anisometropia.

## 3.16 Optical centration and focal properties of multifocal and power-variation lenses

### 3.16.1

#### **distance power**

*dioptric power* (3.10.3) for distance vision

Note 1 to entry: The *verification power* (3.10.15) can be stated for both the *distance* and *near powers* (3.16.2), if appropriate.

### 3.16.2

#### **near power**

*dioptric power* (3.10.3) for the *near vision distance* (3.2.44)

### 3.16.3

#### **addition power**

#### **addition**

difference between the *vertex power* (3.10.7) of the *near portion* (3.15.3) and the *vertex power* of the *distance portion* (3.15.1)

### 3.16.4

#### **variation power**

<*power-variation lens* (3.7.7)> difference between the *vertex powers* (3.10.7) at the *secondary reference point* (3.2.23) and the *primary reference point* (3.2.22)

Note 1 to entry: For example, for a *progressive-power lens* (3.7.8), this is the *addition power* (3.16.3), while for some *degressive-power lenses* (3.7.9), it is the *degression power* (3.16.13).

Note 2 to entry: *Variation power* is defined for *power-variation lenses* (3.7.7) only if they have both a *primary* (3.2.22) and a *secondary reference point* (3.2.23).

[SOURCE: ISO 21987:2017, 3.7, modified — the order of the primary and secondary reference points has been reversed.]

### 3.16.5

#### **intermediate addition**

<*trifocal lens* (3.7.5)> difference between the *vertex power* (3.10.7) of the *intermediate portion* (3.15.2) and the *vertex power* of the *distance portion* (3.15.1)

### 3.16.6

#### **distance optical centre**

*optical centre* (3.2.15) of the *distance portion* (3.15.1)

Note 1 to entry: See 0 in [Figure 11](#).

### 3.16.7

#### **intermediate optical centre**

*optical centre* (3.2.15) of the *intermediate portion* (3.15.2)

### 3.16.8

#### **near optical centre**

DEPRECATED: reading optical centre

*optical centre* (3.2.15) of the *near portion* (3.15.3)

Note 1 to entry: The position of the *near optical centre* is determined by the prescription, the position of the *segment* (3.15.5) and the *segment diameter* or *segment width* (3.15.7), and it can lie outside the area of the *segment*.

### 3.16.9

#### **prism thinning**

non-prescribed *prismatic effect* (3.11.9) with vertical *prism base setting* (3.11.7) applied to a *power-variation* (3.7.7) or *E-line multifocal lens* (3.15.23) to optimize its weight and thickness

Note 1 to entry: To avoid introducing vertical *prism imbalance* (3.11.13) (*relative prism error*), both *lenses* (3.5.2) of a pair should exhibit equal *prism thinning*. Therefore, the *prism thinning* value should be specified when ordering one *lens* of a pair.

### 3.16.10

#### **prism reference point**

<*power-variation lens* or *power-variation blank*> point on the *front surface* (3.2.13), stipulated by the manufacturer, at which the *prismatic effect* (3.11.9) of the *finished lens* (3.8.7) is determined

### 3.16.11

#### **power-variation lens inset**

horizontal distance between the *fitting point* (3.2.34) and the centre of the designed near zone

Note 1 to entry: The designed near zone is not always identical in position to that indicated by the near checking circle of the non-permanent marking.

### 3.16.12

#### **minimum fitting height**

minimum vertical distance specified by the manufacturer between the *fitting point* (3.2.34) and the upper and/or lower *lens* (3.5.2) edge, measured vertically above and/or below the intended position of the *fitting point*

Note 1 to entry: This is an aid to dispensing.

Note 2 to entry: The height of the *fitting point* (3.2.34) or the *fitting point mounting position* (3.2.35) is used when ordering *lenses*, because they comply with the *boxed lens system* (3.2.1).

### 3.16.13

#### **degression power**

nominal arithmetic value of the designed negative power change of a *degressive-power lens* (3.7.9) from the near zone to the upper part of the *lens* (3.5.2)

### 3.16.14

#### **vertical prismatic compensation**

*prism* (3.11.10) with a vertical *prism base setting* (3.11.7) to reduce the vertical *prism imbalance* (3.11.13) at the near *visual points* (3.2.27) of a pair of *lenses* (3.5.2) in anisometric corrections with *multifocal lenses* (3.7.3) and *progressive-power lenses* (3.7.8)

Note 1 to entry: Bi-prism (slab-off) is a technique and is not a synonym for *vertical prismatic compensation*.

Note 2 to entry: One method of providing *vertical prismatic compensation* is to use a *prism-controlled bifocal* (3.15.27).

### 3.17 Transmittance, reflectance and polarization

NOTE 1 *Absorptance* (3.17.8), reflectance and transmittance are usually expressed as percentages. The formulae in this subclause are written in this form but on the basis that the spectral values are expressed as a number with a maximum of 1,0, not as percentages.

NOTE 2 Many of the definitions in this subclause have been developed jointly with ISO/TC 94/SC 6 *Personal safety — Personal protective equipment — Eye and face protection*, with its vocabulary document ISO 4007.

#### 3.17.1 spectral transmittance

$\tau(\lambda)$

ratio of the spectral radiant or luminous flux transmitted by the material to the incident spectral radiant or luminous flux at any specified wavelength,  $\lambda$ , for a specified angle of incidence

#### 3.17.2 ultraviolet transmittance UV transmittance

general designation of the transmittance for *ultraviolet radiation* (3.1.3)

#### 3.17.3 mean UV-A transmittance

$\tau_{mUVA}$

averaged value of the *spectral transmittance* (3.17.1) in the wavelength range from 315 nm to 380 nm

Note 1 to entry: *Mean UV-A transmittance* is usually expressed as a percentage and calculated from the following formula:

$$\tau_{mUVA} = 100 \times \frac{\int_{315 \text{ nm}}^{380 \text{ nm}} \tau(\lambda) \cdot d\lambda}{\int_{315 \text{ nm}}^{380 \text{ nm}} d\lambda}$$

where

$\lambda$  is the wavelength of the *ultraviolet radiation*, expressed in nanometres;

$\tau(\lambda)$  is the *spectral transmittance*.

#### 3.17.4 solar UV-A transmittance

$\tau_{SUVA}$

normalized value of the *spectral transmittance* (3.17.1) averaged between 315 nm and 380 nm, weighted by the solar spectral power distribution at sea level for air mass 2 and the relative spectral effectiveness function for *ultraviolet radiation* (3.1.3)

Note 1 to entry: *Solar UV-A transmittance* is usually expressed as a percentage and calculated from the following formula:

$$\tau_{SUVA} = 100 \times \frac{\int_{315 \text{ nm}}^{380 \text{ nm}} \tau(\lambda) \cdot E_s(\lambda) \cdot S(\lambda) \cdot d\lambda}{\int_{315 \text{ nm}}^{380 \text{ nm}} E_s(\lambda) \cdot S(\lambda) \cdot d\lambda} = 100 \times \frac{\int_{315 \text{ nm}}^{380 \text{ nm}} \tau(\lambda) \cdot W(\lambda) \cdot d\lambda}{\int_{315 \text{ nm}}^{380 \text{ nm}} W(\lambda) \cdot d\lambda}$$

where

$\lambda$  is the wavelength of the *ultraviolet radiation* in nanometres;

$\tau(\lambda)$  is the *spectral transmittance*;

$E_s(\lambda)$  is the solar spectral power distribution at sea level for air mass 2;

$S(\lambda)$  is the relative spectral effectiveness function for *ultraviolet radiation*;

$W(\lambda)$  is the complete weighting function:  $W(\lambda) = E_s(\lambda) \cdot S(\lambda)$ .

Note 2 to entry: The weighting functions are given in [Table A.1](#).

### 3.17.5 solar UV-B transmittance

$\tau_{\text{SUVB}}$

normalized value of the *spectral transmittance* ([3.17.1](#)) averaged between 280 nm and 315 nm, weighted by the solar spectral power distribution at sea level for air mass 2 and the relative spectral effectiveness function for *ultraviolet radiation* ([3.1.3](#))

Note 1 to entry: *Solar UV-B transmittance* is usually expressed as a percentage and calculated from the following formula:

$$\tau_{\text{SUVB}} = 100 \times \frac{\int_{280 \text{ nm}}^{315 \text{ nm}} \tau(\lambda) \cdot E_s(\lambda) \cdot S(\lambda) \cdot d\lambda}{\int_{280 \text{ nm}}^{315 \text{ nm}} E_s(\lambda) \cdot S(\lambda) \cdot d\lambda} = 100 \times \frac{\int_{280 \text{ nm}}^{315 \text{ nm}} \tau(\lambda) \cdot W(\lambda) \cdot d\lambda}{\int_{280 \text{ nm}}^{315 \text{ nm}} W(\lambda) \cdot d\lambda}$$

where

$\lambda$  is the wavelength of the *ultraviolet radiation* in nanometres;

$\tau(\lambda)$  is the *spectral transmittance*;

$E_s(\lambda)$  is the solar spectral power distribution at sea level for air mass 2;

$S(\lambda)$  is the relative spectral effectiveness function for *ultraviolet radiation*;

$W(\lambda)$  is the complete weighting function:  $W(\lambda) = E_s(\lambda) \cdot S(\lambda)$ .

Note 2 to entry: The weighting functions are given in [Table A.1](#).

### 3.17.6 luminous transmittance

$\tau_v$   
ratio of the luminous flux transmitted by the *lens* ([3.5.2](#)) or filter to the incident luminous flux for a specified illuminant and photopic vision

Note 1 to entry: *Luminous transmittance* is usually expressed as a percentage and calculated from the following formula:

$$\tau_v = 100 \times \frac{\int_{380 \text{ nm}}^{780 \text{ nm}} \tau(\lambda) \cdot S_{\text{D65}}(\lambda) \cdot V(\lambda) \cdot d\lambda}{\int_{380 \text{ nm}}^{780 \text{ nm}} S_{\text{D65}}(\lambda) \cdot V(\lambda) \cdot d\lambda}$$

where

$\lambda$  is the wavelength of the *light* in nanometres;

$\tau(\lambda)$  is the *spectral transmittance*;

$S_{D65}(\lambda)$  is the spectral distribution of the incident radiation of CIE standard illuminant D65 (see ISO 11664-2);

$V(\lambda)$  is the CIE 2° spectral luminous efficiency function for daylight (see ISO 11664-1).

Note 2 to entry: The spectral values of the product  $S_{D65}(\lambda) \cdot V(\lambda)$  are given in [Table A.2](#).

Note 3 to entry: Other illuminants, e.g. CIE standard illuminant A, may also be used.

### 3.17.7

#### traffic signal light

green, yellow (amber) and red traffic lights and the flashing blue light of emergency vehicles

### 3.17.8

#### relative visual attenuation coefficient (quotient) for traffic signal light detection

##### Q-value

$Q_{\text{signal}}$

quotient of the *luminous transmittance* (3.17.6) of a *lens* (3.5.2) for the spectral radiant power distribution of the *light* (3.1.2) emitted by a *traffic signal light* (3.17.7) to the *luminous transmittance* (3.17.6) of the same *lens* for CIE standard illuminant D65

Note 1 to entry: The coefficient (quotient),  $Q_{\text{signal}}$ , is defined by the formula:

$$Q_{\text{signal}} = \frac{\tau_{\text{signal}}}{\tau_v}$$

where

$\tau_v$  is the *luminous transmittance* of the *lens* for CIE standard illuminant D65;

$\tau_{\text{signal}}$  is the *luminous transmittance* of the *lens* for the spectral radiant power distribution of the *traffic signal light*, where "signal" is green, yellow, red or blue.

Note 2 to entry:  $\tau_v$  is defined as the term "*luminous transmittance*".  $\tau_{\text{signal}}$ , expressed as a percentage, is given by the formula:

$$\tau_{\text{signal}} = 100 \times \frac{\int_{380 \text{ nm}}^{780 \text{ nm}} \tau(\lambda) \cdot E_{\text{signal}}(\lambda) \cdot V(\lambda) \cdot d\lambda}{\int_{380 \text{ nm}}^{780 \text{ nm}} E_{\text{signal}}(\lambda) \cdot V(\lambda) \cdot d\lambda}$$

where

$\lambda$  is the wavelength of the *light* in nanometres;

$\tau(\lambda)$  is the *spectral transmittance*;

$E_{\text{signal}}(\lambda)$  is the accepted measured value of the relative spectral distribution of luminance of the *traffic signal light*;

$V(\lambda)$  is the spectral visibility function for photopic vision (see ISO 11664-1).

Note 3 to entry: Modern *traffic signal lights* use quartz-halogen or LED sources. Calculations using values for quartz-halogen lamps and LED signals will give different results. The values for incandescent quartz-halogen signals are used at present.

Note 4 to entry: The spectral values for the various parameters required to calculate the *relative visual attenuation coefficients* are given in [Tables A.2](#) and [A.3](#).

### 3.17.9 solar blue-light transmittance

$\tau_{SB}$   
normalized value of the *spectral transmittance* ([3.17.1](#)) averaged between 380 nm and 500 nm, weighted by the solar spectral power distribution, at sea level for air mass 2 and the blue-light hazard function

Note 1 to entry: *Solar blue-light transmittance* is usually expressed as a percentage and calculated from the following formula:

$$\tau_{SB} = 100 \times \frac{\int_{380 \text{ nm}}^{500 \text{ nm}} \tau(\lambda) \cdot E_S(\lambda) \cdot B(\lambda) \cdot d\lambda}{\int_{380 \text{ nm}}^{500 \text{ nm}} E_S(\lambda) \cdot B(\lambda) \cdot d\lambda} = 100 \times \frac{\int_{380 \text{ nm}}^{500 \text{ nm}} \tau(\lambda) \cdot W_B(\lambda) \cdot d\lambda}{\int_{380 \text{ nm}}^{500 \text{ nm}} W_B(\lambda) \cdot d\lambda}$$

where

- $\lambda$  is the wavelength of the *light* in nanometres;
- $\tau(\lambda)$  is the *spectral transmittance*;
- $E_S(\lambda)$  is the solar spectral power distribution at sea level for air mass 2;
- $B(\lambda)$  is the blue-light hazard function;
- $W_B(\lambda)$  is the complete weighting function:  $W_B(\lambda) = E_S(\lambda) \cdot B(\lambda)$ .

Note 2 to entry: The weighting functions are given in [Table A.1](#), and can be interpolated where necessary.

### 3.17.10 gradient-tinted direction

<*gradient-tinted or double gradient-tinted lens*> direction along which the variation in tint occurs

Note 1 to entry: This is assumed to be vertical unless otherwise indicated.

### 3.17.11 faded state

condition of a *photochromic lens* ([3.5.11](#)) before exposure to *optical radiation* ([3.1.1](#)) or after it has been kept in the dark for a period of time

Note 1 to entry: For purposes of testing or reporting the properties of the *lens* ([3.5.2](#)) or material, ISO 8980-3 specifies a conditioning treatment, after which the *luminous transmittance* ([3.17.6](#)) is given the symbol  $\tau_{V0}$ .

### 3.17.12 darkened state

condition of a *photochromic lens* ([3.5.11](#)) after exposure to *optical radiation* ([3.1.1](#))

Note 1 to entry: For purposes of testing or reporting the properties of the *lens* ([3.5.2](#)) or material, ISO 8980-3 specifies defined exposures, intensities of irradiation and temperatures for testing.

Note 2 to entry: In ISO 8980-3, the *luminous transmittances* ([3.17.6](#)) in these states are given the symbols  $\tau_{V1}$ ,  $\tau_{VW}$ ,  $\tau_{VS}$  and  $\tau_{VA}$ .

### 3.17.13 infrared transmittance IR transmittance

general designation of the transmittance for *infrared radiation* ([3.1.4](#))

### 3.17.14 solar IR transmittance

$\tau_{\text{SIR}}$

normalized value of the *spectral transmittance* (3.17.1) between 780 nm and 2 000 nm, weighted by the solar spectral power distribution at sea level for air mass 2

Note 1 to entry: *Solar IR transmittance* is usually expressed as a percentage and calculated from the following formula:

$$\tau_{\text{SIR}} = 100 \times \frac{\int_{780 \text{ nm}}^{2000 \text{ nm}} \tau(\lambda) \cdot E_{\text{S}}(\lambda) \cdot d\lambda}{\int_{780 \text{ nm}}^{2000 \text{ nm}} E_{\text{S}}(\lambda) \cdot d\lambda}$$

where

$\lambda$  is the wavelength of the *infrared radiation* in nanometres;

$\tau(\lambda)$  is the *spectral transmittance*;

$E_{\text{S}}(\lambda)$  is the solar spectral power distribution at sea level for air mass 2;

Note 2 to entry: The values of  $E_{\text{S}}(\lambda)$  are given in [Table A.3](#).

### 3.17.15 spectral reflectance

$\rho(\lambda)$

ratio of the spectral radiant or luminous flux reflected by the material to the incident spectral radiant or luminous flux at any specified wavelength,  $\lambda$ , for a specified angle of incidence

Note 1 to entry: The value stated is usually that for a single surface. If the reflectance noted is that for the *lens* (3.5.2) as a whole, this shall be explicitly stated.

### 3.17.16 luminous reflectance

$\rho_{\text{v}}$

ratio of the luminous flux reflected by the material in a specified form (*lens* (3.5.2), coating or filter), to the incident luminous flux, usually for a specified illuminant and photopic vision

Note 1 to entry: *Luminous reflectance* is usually expressed as a percentage and calculated from the following formula:

$$\rho_{\text{v}} = 100 \times \frac{\Phi_{\text{R}}}{\Phi_{\text{I}}} = 100 \times \frac{\int_{380 \text{ nm}}^{780 \text{ nm}} \rho(\lambda) \cdot V(\lambda) \cdot S_{\text{D65}}(\lambda) \cdot d\lambda}{\int_{380 \text{ nm}}^{780 \text{ nm}} V(\lambda) \cdot S_{\text{D65}}(\lambda) \cdot d\lambda}$$

where

$\lambda$  is the wavelength of the *light* in nanometres;

$\Phi_{\text{I}}$  is the incident luminous flux;

$\Phi_{\text{R}}$  is the reflected luminous flux;

$\rho(\lambda)$  is the *spectral reflectance*;

$V(\lambda)$  is the spectral visibility function for photopic vision (see ISO 11664-1);

$S_{D65}(\lambda)$  is the spectral distribution of the incident radiation of CIE standard illuminant D65 (see ISO 11664-2).

Note 2 to entry: The value stated is usually that for a single surface. If the reflectance noted is that for the *lens* as a whole, this shall be explicitly stated.

Note 3 to entry: The values of  $S_{D65}(\lambda) \cdot V(\lambda)$  are given in [Table A.2](#).

### 3.17.17 mean reflectance

$\rho_M$   
mean value of the *spectral reflectance* ([3.17.15](#)) over a wavelength range from 400 nm to 700 nm

Note 1 to entry: *Mean reflectance* is usually expressed as a percentage and calculated from the following formula:

$$\rho_M = 100 \times \frac{\int_{400 \text{ nm}}^{700 \text{ nm}} \rho(\lambda) \cdot d\lambda}{\int_{400 \text{ nm}}^{700 \text{ nm}} d\lambda}$$

where

$\lambda$  is the wavelength of the *light* in nanometres;

$\rho(\lambda)$  is the *spectral reflectance*.

Note 2 to entry: This gives a physical rather than a visual quantification of the surface reflection.

Note 3 to entry: The wavelength range for the *mean reflectance* is purposely different to that for the *luminous reflectance* ([3.17.16](#)) in order to give better differentiation between types of *anti-reflective coatings* ([3.18.3](#)).

Note 4 to entry: The value stated is usually that for a single surface. If the reflectance noted is that for the *lens* ([3.5.2](#)) as a whole, this shall be explicitly stated.

### 3.17.18 absorptance

ratio of the absorbed radiant flux or luminous flux to the incident flux under specified conditions

[SOURCE: CIE S 017:2011, 17-5]

### 3.17.19 plane of transmission

<*polarizing lens* or filter> any plane intersecting the *lens* ([3.5.2](#)) or filter that contains the axis of propagation of the transmitted radiation and is parallel to the orientation of maximal transmission of the electric vector of the transmitted radiation

Note 1 to entry: See [Figure 12](#).

Note 2 to entry: *Light* ([3.1.2](#)) reflected from (near) horizontal non-metallic surfaces has, for the most part, its electric vector horizontal. In a *polarizing lens* ([3.5.12](#)) or filter designed to reduce sun glare, the *plane of transmission* is usually orientated vertically in order to attenuate preferentially the reflected *light*.

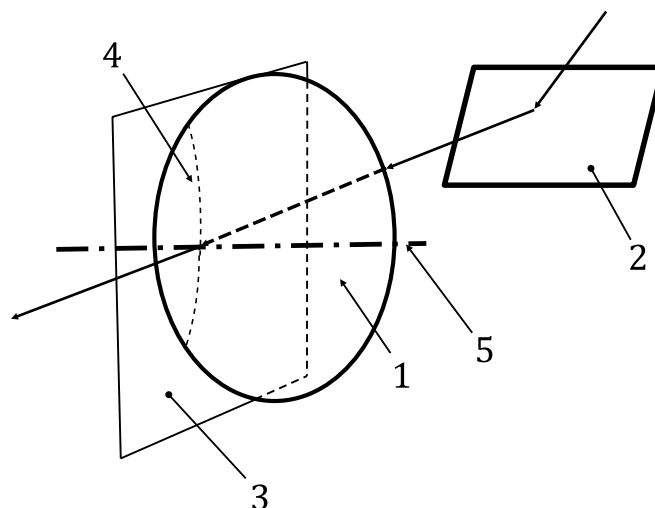


**3.17.20**  
**intended horizontal orientation**

<polarizing lens or filter> direction perpendicular to a *plane of transmission* (3.17.19) that passes through the *optical centre* (3.2.15) of a *lens* (3.5.2) (or *geometrical centre* (3.2.6) of a plano filter)

Note 1 to entry: This is generally intended to be orientated horizontally when mounting, to reduce sun glare reflected from horizontal surfaces.

Note 2 to entry: See [Figure 12](#).



**Key**

- 1 *Lens*
- 2 horizontal reflecting surface
- 3 *plane of transmission* (vertical)
- 4 intersection of the plane with the *lens*
- 5 direction of *intended horizontal orientation* of *polarizing lens*

**Figure 12 — Illustration of terms for polarizing lenses**

**3.17.21**  
**polarizing efficiency**

*P*

parameter describing the performance of a *polarizing lens* (3.5.12), determined from the maximum and minimum *luminous transmittance* (3.17.6) in 100 % linearly polarized radiation

Note 1 to entry: *Polarizing efficiency* is usually expressed as a percentage, defined by the formula:

$$P = 100 \times \frac{\tau_{P \max} - \tau_{P \min}}{\tau_{P \max} + \tau_{P \min}}$$

where

$\tau_{P \max}$  is the maximum value of *luminous transmittance* as determined with 100 % linearly polarized radiation;

$\tau_{P \min}$  is the minimum value of *luminous transmittance* as determined with 100 % linearly polarized radiation.

Note 2 to entry: *Polarizing efficiency* can also be determined by measuring the *luminous transmittance* (3.17.6) of two *polarizing lenses* (3.5.12) of the same type in series in unpolarized light (3.1.2), as:

$$P = 100 \times \sqrt{\frac{h(0) - h(\pi/2)}{h(0) + h(\pi/2)}}$$

where

$h(0)$  is the *luminous transmittance* of two *polarizing lenses* of the same type when they are orientated with their *planes of transmission* in alignment, and equals  $0,5 \cdot (\tau_{P \max}^2 + \tau_{P \min}^2)$ ;

$h(\pi/2)$  is the *luminous transmittance* of two *polarizing lenses* of the same type when they are orientated with their *planes of transmission* perpendicular to each other, and equals  $(\tau_{P \max} \cdot \tau_{P \min})$ .

### 3.17.22

#### **polarizing ratio**

$R_p$   
ratio of maximum to minimum *luminous transmittances* (3.17.6) of a *polarizing lens* (3.5.12) in 100 % linearly polarized radiation

Note 1 to entry: *Polarizing ratio* is calculated using the formula:

$$R_p = \frac{\tau_{P \max}}{\tau_{P \min}}$$

where

$\tau_{P \max}$  is the maximum value of *luminous transmittance* as determined with 100 % linearly polarized radiation;

$\tau_{P \min}$  is the minimum value of *luminous transmittance* as determined with 100 % linearly polarized radiation.

EXAMPLE This is usually expressed as a ratio, e.g. 8:1.

## 3.18 Coatings

### 3.18.1

#### **coated lens**

*lens* (3.5.2) to which one or more surface layers have been added to alter one or more properties of the *lens*

### 3.18.2

#### **hard coating**

coating on the surface of an organic *lens* (3.5.2) intended to enhance the abrasion resistance of the surface during normal use

Note 1 to entry: This may, for example, be combined with a *clean coating* (3.18.4) or an *anti-static coating* (3.18.8).

### 3.18.3

#### **anti-reflective coating**

#### **antireflection coating**

coating on the surface of a *lens* (3.5.2) intended to reduce *light* (3.1.2) reflected from its surfaces

Note 1 to entry: This may, for example, be combined with a *clean coating* (3.18.4), a *hydrophobic coating* (3.18.5) or an *anti-static coating* (3.18.8).

### 3.18.4

#### **clean coating**

coating on the surface of a *lens* (3.5.2) intended to make the surface repel dust and grease and/or to make it easier to clean

**3.18.5**

**hydrophobic coating**

coating on the surface of a *lens* (3.5.2) intended to repel water droplets

**3.18.6**

**hydrophilic coating**

coating on the surface of a *lens* (3.5.2) intended to wet very easily, so that any water droplets on it spread and coalesce to a uniform film on the surface

**3.18.7**

**anti-fog coating**

*hydrophobic* (3.18.5) or *hydrophilic coating* (3.18.6) on the surface of a *lens* (3.5.2) intended to reduce blur caused by droplets of condensed water vapour on the *lens*' surface when a relatively cold *lens* is put into a warmer, humid environment

**3.18.8**

**anti-static coating**

coating on the surface of a *lens* (3.5.2) intended to reduce static electricity on the surface, in order to reduce the attraction of dust

## Annex A (informative)

### Spectral weighting functions and spectral distributions

**A.1** Spectral weighting functions for the calculation of *ultraviolet transmittance* ([3.17.2](#)) and *solar blue-light transmittance* ([3.17.9](#)) are given in [Table A.1](#).

**A.2** Values of the product of the relative spectral distribution of radiation of CIE standard illuminant D65,  $S_{D65}(\lambda)$ , and the spectral luminous efficiency function of the average human eye for photopic vision,  $V(\lambda)$ , as specified in ISO 11664-1, are given in [Table A.2](#).

**A.3** Values of the relative spectral distribution of radiation emitted by incandescent quartz-halogen and LED signal lights,  $E_{\text{signal}}(\lambda)$ , weighted by the spectral luminous efficiency function of the average human eye for photopic vision,  $V(\lambda)$ , as specified in ISO 11664-1, are given in [Table A.3](#).

**A.4** The spectral distribution of solar spectral irradiance in the *infrared radiation* ([3.1.4](#)) spectrum is given in [Table A.4](#).

**Table A.1 — Spectral weighting functions for the calculation of ultraviolet transmittance and solar blue-light transmittance**

Wavelength nm	Solar spectral irradiance <sup>[14]</sup> $E_s(\lambda)$ $\text{mW} \cdot \text{m}^{-2} \cdot \text{nm}^{-1}$	Relative spectral effectiveness function $S(\lambda)$	Weighting function $W(\lambda) =$ $E_s(\lambda) \cdot S(\lambda)$	Blue-light hazard function $B(\lambda)$	Weighting function $W_B =$ $E_s(\lambda) \cdot B(\lambda)$
280	0	0,88	0		
285	0	0,77	0		
290	0	0,64	0		
295	$2,09 \times 10^{-4}$	0,54	0,000 11		
300	$8,10 \times 10^{-2}$	0,30	0,024 3		
305	1,91	0,060	0,115		
310	11,0	0,015	0,165		
315	30,0	0,003	0,090		
320	54,0	0,001 0	0,054		
325	79,2	0,000 50	0,040		
330	101	0,000 41	0,041		
335	128	0,000 34	0,044		
340	151	0,000 28	0,042		
345	170	0,000 24	0,041		
350	188	0,000 20	0,038		
355	210	0,000 16	0,034		
360	233	0,000 13	0,030		
365	253	0,000 11	0,028		
370	279	0,000 093	0,026		
375	306	0,000 077	0,024		
380	336	0,000 064	0,022	0,006	2
385	365			0,012	4
390	397			0,025	10
395	432			0,05	22
400	470			0,10	47
405	562			0,20	112
410	672			0,40	269
415	705			0,80	564
420	733			0,90	660
425	760			0,95	722
430	787			0,98	771
435	849			1,00	849
440	911			1,00	911
445	959			0,97	930
450	1 006			0,94	946
455	1 037			0,90	933
460	1 080			0,80	864
465	1 109			0,70	776

Table A.1 (continued)

Wavelength nm	Solar spectral irradiance <sup>[14]</sup> $E_s(\lambda)$ $\text{mW} \cdot \text{m}^{-2} \cdot \text{nm}^{-1}$	Relative spectral effectiveness function $S(\lambda)$	Weighting function $W(\lambda) =$ $E_s(\lambda) \cdot S(\lambda)$	Blue-light hazard function $B(\lambda)$	Weighting function $W_B =$ $E_s(\lambda) \cdot B(\lambda)$
470	1 138			0,62	706
475	1 161			0,55	639
480	1 183			0,45	532
485	1 197			0,40	479
490	1 210			0,22	266
495	1 213			0,16	194
500	1 215			0,10	122
505	1 211			0,079	97
510	1 206			0,063	76
515	1 202			0,050	60
520	1 199			0,040	48
525	1 193			0,032	38
530	1 188			0,025	30
535	1 193			0,020	24
540	1 198			0,016	19
545	1 194			0,013	16
550	1 190			0,010	12

**Table A.2 — Product of the relative spectral distribution of radiation of CIE standard illuminant D65,  $S_{D65}(\lambda)$ , and the spectral luminous efficiency function of the average human eye for photopic vision,  $V(\lambda)$ , as specified in ISO 11664-1**

Wavelength ( $\lambda$ )	$S_{D65}(\lambda) \cdot V(\lambda)$	Wavelength ( $\lambda$ )	$S_{D65}(\lambda) \cdot V(\lambda)$	Wavelength ( $\lambda$ )	$S_{D65}(\lambda) \cdot V(\lambda)$
380	0,000 1	515	3,058 9	650	0,405 2
385	0,000 2	520	3,520 3	655	0,309 3
390	0,000 3	525	3,987 3	660	0,231 5
395	0,000 7	530	4,392 2	665	0,171 4
400	0,001 6	535	4,590 5	670	0,124 6
405	0,002 6	540	4,712 8	675	0,088 1
410	0,005 2	545	4,834 3	680	0,063 0
415	0,009 5	550	4,898 1	685	0,041 7
420	0,017 7	555	4,827 2	690	0,027 1
425	0,031 1	560	4,707 8	695	0,019 1
430	0,047 6	565	4,545 5	700	0,013 9
435	0,076 3	570	4,339 3	705	0,010 1
440	0,114 1	575	4,160 7	710	0,007 4
445	0,156 4	580	3,943 1	715	0,004 8
450	0,210 4	585	3,562 6	720	0,003 1
455	0,266 7	590	3,176 6	725	0,002 3
460	0,334 5	595	2,937 7	730	0,001 7
465	0,406 8	600	2,687 3	735	0,001 2
470	0,494 5	605	2,408 4	740	0,000 9
475	0,614 8	610	2,132 4	745	0,000 6
480	0,762 5	615	1,850 6	750	0,000 4
485	0,900 1	620	1,581 0	755	0,000 2
490	1,071 0	625	1,298 5	760	0,000 1
495	1,334 7	630	1,044 3	765	0,000 1
500	1,671 3	635	0,857 3	770	0,000 1
505	2,092 5	640	0,693 1	775	0,000 1
510	2,565 7	645	0,535 3	780	0,000 0
—	—	—	—	<b>Total</b>	<b>100,000 0</b>

NOTE The values for  $V(\lambda)$  and  $S_{D65}(\lambda)$  may be found, in spreadsheet form, in the downloads section of the CIE website: [www.cie.co.at](http://www.cie.co.at), where  $V(\lambda) = \bar{y}(\lambda)$  for the CIE 2° observer.

**Table A.3 — Relative spectral distribution of radiation emitted by incandescent quartz-halogen and LED signal lights,  $E_{\text{signal}}(\lambda)$ , weighted by the spectral luminous efficiency function of the average human eye for photopic vision,  $V(\lambda)$ , as specified in ISO 11664-1**

Wavelength	Red	Yellow	Green	Blue	Red LED	Yellow LED	Green LED	Blue LED
$\lambda$ nm	$E_{\text{red}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{yellow}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{green}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{blue}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{red}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{yellow}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{green}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{blue}}(\lambda)$ $\bullet V(\lambda)$
380	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
385	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
390	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
395	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
400	0,000	0,000	0,000	0,010	0,000	0,000	0,000	0,000
405	0,000	0,000	0,000	0,010	0,000	0,000	0,000	0,000
410	0,000	0,000	0,000	0,030	0,000	0,000	0,000	0,000
415	0,000	0,000	0,000	0,060	0,000	0,000	0,000	0,000
420	0,000	0,000	0,000	0,120	0,000	0,000	0,000	0,000
425	0,000	0,000	0,000	0,250	0,000	0,000	0,000	0,010
430	0,000	0,000	0,000	0,440	0,000	0,000	0,000	0,050
435	0,000	0,000	0,010	0,680	0,000	0,000	0,000	0,170
440	0,000	0,000	0,020	0,970	0,000	0,000	0,010	0,550
445	0,000	0,000	0,030	1,260	0,000	0,000	0,010	1,650
450	0,000	0,000	0,050	1,600	0,000	0,000	0,020	4,470
455	0,000	0,000	0,080	1,950	0,000	0,000	0,040	9,600
460	0,000	0,000	0,120	2,350	0,000	0,000	0,090	14,170
465	0,000	0,000	0,180	2,760	0,000	0,000	0,190	13,990
470	0,000	0,000	0,270	3,230	0,000	0,000	0,450	11,180
475	0,000	0,010	0,380	3,720	0,000	0,000	1,010	9,070
480	0,000	0,010	0,540	4,240	0,000	0,000	2,130	7,370
485	0,000	0,020	0,740	4,650	0,000	0,000	4,000	5,470
490	0,000	0,040	1,020	5,080	0,000	0,000	6,530	4,210
495	0,000	0,070	1,410	5,510	0,000	0,000	9,380	3,380
500	0,010	0,120	1,910	5,870	0,000	0,000	11,340	2,690
505	0,010	0,200	2,610	6,450	0,000	0,000	11,820	2,160
510	0,010	0,320	3,430	6,800	0,000	0,000	11,150	1,760
515	0,010	0,490	4,370	6,660	0,000	0,000	9,840	1,410
520	0,010	0,760	5,320	5,950	0,000	0,010	8,220	1,140
525	0,020	1,160	6,130	5,150	0,000	0,010	6,550	0,900
530	0,020	1,700	6,860	3,960	0,000	0,020	4,890	0,690
535	0,020	2,350	7,370	3,370	0,000	0,030	3,570	0,570
540	0,020	3,060	7,700	2,650	0,000	0,050	2,630	0,480
545	0,020	3,710	7,750	2,320	0,000	0,120	1,870	0,410
550	0,020	4,260	7,340	1,940	0,000	0,240	1,290	0,330
555	0,020	4,730	6,460	1,460	0,010	0,500	0,930	0,270
560	0,030	5,050	5,480	0,970	0,020	1,000	0,630	0,220
565	0,040	5,270	4,790	0,660	0,040	1,850	0,430	0,220



Table A.3 (continued)

Wavelength	Red	Yellow	Green	Blue	Red LED	Yellow LED	Green LED	Blue LED
$\lambda$ nm	$E_{\text{red}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{yellow}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{green}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{blue}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{red}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{yellow}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{green}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{blue}}(\lambda)$ $\bullet V(\lambda)$
570	0,080	5,440	4,340	0,360	0,070	3,390	0,300	0,200
575	0,230	5,470	3,770	0,280	0,110	6,080	0,210	0,170
580	0,670	5,430	3,040	0,200	0,210	11,180	0,140	0,140
585	1,640	5,320	2,400	0,220	0,400	20,100	0,090	0,110
590	3,320	5,160	1,790	0,240	0,690	26,720	0,070	0,140
595	5,400	4,940	1,050	0,230	1,110	18,530	0,050	0,120
600	7,320	4,670	0,400	0,230	1,710	6,910	0,030	0,090
605	8,750	4,380	0,120	0,180	2,520	2,200	0,020	0,070
610	9,350	4,040	0,050	0,130	3,640	0,700	0,020	0,090
615	9,320	3,640	0,060	0,100	5,350	0,230	0,010	0,050
620	8,950	3,270	0,090	0,060	7,990	0,080	0,010	0,040
625	8,080	2,840	0,110	0,070	12,220	0,030	0,010	0,030
630	7,070	2,420	0,100	0,070	17,410	0,010	0,010	0,040
635	6,100	2,030	0,070	0,160	19,030	0,010	0,010	0,040
640	5,150	1,700	0,040	0,210	14,200	0,000	0,000	0,020
645	4,230	1,390	0,020	0,430	7,800	0,000	0,000	0,020
650	3,410	1,110	0,020	0,540	3,380	0,000	0,000	0,010
655	2,690	0,870	0,010	0,420	1,320	0,000	0,000	0,010
660	2,090	0,670	0,000	0,320	0,490	0,000	0,000	0,010
665	1,570	0,510	0,000	0,210	0,180	0,000	0,000	0,010
670	1,150	0,370	0,000	0,140	0,060	0,000	0,000	0,000
675	0,850	0,280	0,000	0,260	0,030	0,000	0,000	0,000
680	0,640	0,210	0,000	0,300	0,010	0,000	0,000	0,000
685	0,470	0,150	0,000	0,320	0,000	0,000	0,000	0,000
690	0,330	0,100	0,000	0,300	0,000	0,000	0,000	0,000
695	0,240	0,070	0,000	0,230	0,000	0,000	0,000	0,000
700	0,180	0,060	0,010	0,180	0,000	0,000	0,000	0,000
705	0,130	0,040	0,020	0,130	0,000	0,000	0,000	0,000
710	0,090	0,030	0,020	0,100	0,000	0,000	0,000	0,000
715	0,070	0,020	0,020	0,070	0,000	0,000	0,000	0,000
720	0,050	0,010	0,020	0,050	0,000	0,000	0,000	0,000
725	0,030	0,010	0,020	0,030	0,000	0,000	0,000	0,000
730	0,020	0,010	0,010	0,030	0,000	0,000	0,000	0,000
735	0,020	0,010	0,010	0,020	0,000	0,000	0,000	0,000
740	0,010	0,000	0,010	0,010	0,000	0,000	0,000	0,000
745	0,010	0,000	0,010	0,010	0,000	0,000	0,000	0,000
750	0,010	0,000	0,000	0,010	0,000	0,000	0,000	0,000
755	0,010	0,000	0,000	0,010	0,000	0,000	0,000	0,000
760	0,010	0,000	0,000	0,010	0,000	0,000	0,000	0,000
765	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
770	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

**Table A.3** (continued)

<b>Wavelength</b>	<b>Red</b>	<b>Yellow</b>	<b>Green</b>	<b>Blue</b>	<b>Red LED</b>	<b>Yellow LED</b>	<b>Green LED</b>	<b>Blue LED</b>
$\lambda$ nm	$E_{\text{red}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{yellow}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{green}}(\lambda)$ $\bullet V(\lambda)$	$E_{\text{blue}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{red}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{yellow}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{green}}(\lambda)$ $\bullet V(\lambda)$	$E'_{\text{blue}}(\lambda)$ $\bullet V(\lambda)$
775	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
780	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
<b>Total</b>	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000

**Table A.4 — Spectral distribution of solar spectral irradiance in the infrared radiation spectrum**

Wavelength $\lambda$ nm	Spectral irradiance (power per unit of area and per wavelength) $E_s(\lambda)$ $\text{mW} \cdot \text{m}^{-2} \cdot \text{nm}^{-1}$
780	907
790	923
800	857
810	698
820	801
830	863
840	858
850	839
860	813
870	798
880	614
890	517
900	480
910	375
920	258
930	169
940	278
950	487
960	584
970	633
980	645
990	643
1 000	630
1 010	620
1 020	610
1 030	601
1 040	592
1 050	551
1060	526
1070	519
1080	512
1 090	514
1 100	252
1 110	126
1 120	69,9
1 130	98,3

NOTE Taken from Reference [14], by kind permission of the publishers.

Table A.4 (continued)

Wavelength $\lambda$ nm	Spectral irradiance (power per unit of area and per wavelength) $E_s(\lambda)$ $\text{mW} \cdot \text{m}^{-2} \cdot \text{nm}^{-1}$
1 140	164
1 150	216
1 160	271
1 170	328
1 180	346
1 190	344
1 200	373
1 210	402
1 220	431
1 230	420
1 240	387
1 250	328
1 260	311
1 270	381
1 280	382
1 290	346
1 300	264
1 310	208
1 320	168
1 330	115
1 340	58,1
1 350	18,1
1 360	0,660
1 370	0
1 380	0
1 390	0
1 400	0
1 410	1,91
1 420	3,72
1 430	7,53
1 440	13,7
1 450	23,8
1 460	30,5
1 470	45,1
1 480	83,7
1 490	128
1 500	157
1 510	187
1 520	209

NOTE Taken from Reference [14], by kind permission of the publishers.

Table A.4 (continued)

Wavelength $\lambda$ nm	Spectral irradiance (power per unit of area and per wavelength) $E_s(\lambda)$ mW · m <sup>-2</sup> · nm <sup>-1</sup>
1 530	217
1 540	226
1 550	221
1 560	217
1 570	213
1 580	209
1 590	205
1 600	202
1 610	198
1 620	194
1 630	189
1 640	184
1 650	173
1 660	163
1 670	159
1 680	145
1 690	139
1 700	132
1 710	124
1 720	115
1 730	105
1 740	97,1
1 750	80,2
1 760	58,9
1 770	38,8
1 780	18,4
1 790	5,70
1 800	0,920
1 810	0
1 820	0
1 830	0
1 840	0
1 850	0
1 860	0
1 870	0
1 880	0
1 890	0
1 900	0
1 910	0,705

NOTE Taken from Reference [14], by kind permission of the publishers.

**Table A.4** (continued)

<b>Wavelength</b> $\lambda$ nm	<b>Spectral irradiance</b> <b>(power per unit of area</b> <b>and per wavelength)</b> $E_s(\lambda)$ $\text{mW} \cdot \text{m}^{-2} \cdot \text{nm}^{-1}$
1 920	2,34
1 930	3,68
1 940	5,30
1 950	17,7
1 960	31,7
1 970	22,6
1 980	1,58
1 990	2,66
2 000	

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**NATIONAL ANNEX B**

*([National Foreword](#))*

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