Tables

This section lists various tables which contain useful dispensing information.

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Tables

Compensated Power for Altered Vertex Distance

Plus lenses: increase in vertex distance (mm) Minus lenses: decrease in vertex distance (mm)					**Plus lenses: decrease in vertex distance (mm) Minus lenses: increase in vertex distance (mm)**			
8	**6**	**4**	**2**	**Original Power**	**2**	**4**	**6**	**8**
4.34	4.38	4.42	4.46	**4.50**	4.54	4.58	4.62	4.67
4.81	4.85	4.90	4.95	**5.00**	5.05	5.10	5.15	5.21
4.27	5.32	5.38	5.44	**5.50**	5.56	5.62	5.69	5.75
5.73	5.79	5.86	5.93	**6.00**	6.07	6.15	6.22	6.30
6.18	6.26	6.34	6.42	**6.50**	6.59	6.67	6.76	6.86
6.63	6.72	6.81	6.90	**7.00**	7.10	7.20	7.31	7.42
7.08	7.18	7.28	7.39	**7.50**	7.61	7.73	7.85	7.98
7.52	7.63	7.75	7.87	**8.00**	8.13	8.26	8.40	8.55
7.96	8.09	8.22	8.36	**8.50**	8.65	8.80	8.96	9.12
8.40	8.54	8.69	8.84	**9.00**	9.17	9.34	9.51	9.70
8.83	8.99	9.15	9.32	**9.50**	9.68	9.88	10.07	10.28
9.26	9.43	9.62	9.80	**10.00**	10.20	10.42	10.64	10.87
9.69	9.88	10.08	10.28	**10.50**	10.73	10.96	11.21	11.46
10.11	10.32	10.54	10.76	**11.00**	11.25	11.51	11.78	12.06
10.53	10.76	10.99	11.24	**11.50**	11.77	12.05	12.35	12.67
10.95	11.19	11.45	11.72	**12.00**	12.30	12.61	12.93	13.27
11.36	11.63	11.90	12.20	**12.50**	12.82	13.16	13.51	13.89
11.78	12.06	12.36	12.67	**13.00**	13.35	13.71	14.10	14.51
12.18	12.49	12.81	13.15	**13.50**	13.87	14.27	14.69	15.13
12.59	12.92	13.26	13.62	**14.00**	14.40	14.83	15.28	15.77
12.99	13.34	13.71	14.09	**14.50**	14.93	15.39	15.88	16.40
13.39	13.76	14.15	14.56	**15.00**	15.46	15.96	16.48	17.05
13.79	14.18	14.60	15.03	**15.50**	16.00	16.52	17.09	17.69
14.18	14.60	15.04	15.50	**16.00**	16.53	17.09	17.70	18.35
14.58	15.01	15.48	15.97	**16.50**	17.06	17.67	18.31	19.01
14.96	15.43	15.92	16.44	**17.00**	17.60	18.24	18.93	19.68
15.35	15.84	16.36	16.91	**17.50**	18.13	18.82	19.55	20.35
15.73	16.25	16.79	17.37	**18.00**	18.67	19.40	20.18	21.03
16.11	16.65	17.23	17.84	**18.50**	19.21	19.98	20.81	21.71
16.49	17.06	17.66	18.30	**19.00**	19.75	20.56	21.44	22.41
16.87	17.46	18.09	18.77	**19.50**	20.29	21.15	22.08	23.10
17.24	17.86	18.52	19.23	**20.00**	20.83	21.74	22.73	23.81

Other powers and vertex distance changes (Δd) can be evaluated by interpolation for values within the table or by using the well-known expression

$$F_{\text{new}} = \frac{F_{\text{old}}}{1 + \Delta d \cdot F_{\text{old}}}$$

where Δd is positive for an increase and negative for a decrease in vertex distance.

Note that Δd is entered in metres.

An approximate expression for finding the change in power is $\Delta F = -\Delta d \times F^2$. The same conventions apply to Δd.

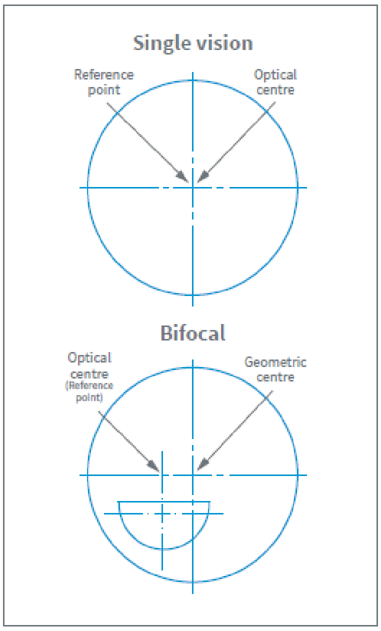
Tolerances on the power of lenses*

The tolerances apply to the back vertex power and should be measured at the optical centre of a single vision lens, distance centre of a bifocal or the distance checking circle of a varifocal lens. The tolerance for the power of each meridian is determined by the highest absolute meridian power. Use column A to check that the meridians are within tolerance (e.g. single vision lens power Sph -4.75 Cyl -2.25, highest meridian is -7.00.) The tolerance on -7.00 is +/- 0.12: tolerance on -4.75 is +/- 0.12.

To check that the cylinder power is within tolerance, use column B (e.g. single vision lens power Sph -4.75 Cyl -2.25 highest meridian is -7.00, cylinder power is -2.25 and the tolerance is +/- 0.18)

*ISO 8980 parts 1 & 2

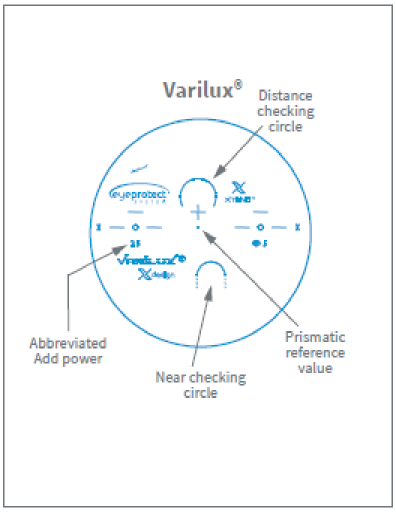
Single vision and bifocal



Power of meridian with highest absolute power

<table>
<tr><th></th><th>COLUMN A</th><th colspan="4">COLUMN B</th></tr>
<tr><td>> 20.00</td><td>± 0.37</td><td>± 0.25</td><td rowspan="2">± 0.25</td><td>± 0.37</td><td>± 0.37</td></tr>
<tr><td>20.00</td><td>± 0.25</td><td>± 0.18</td><td rowspan="2">± 0.25</td><td rowspan="5">± 0.25</td></tr>
<tr><td>12.00</td><td>± 0.18</td><td rowspan="3">± 0.12</td><td rowspan="2">± 0.18</td></tr>
<tr><td>9.00</td><td rowspan="3">± 0.12</td><td rowspan="3">± 0.18</td></tr>
<tr><td>6.00</td><td rowspan="2">± 0.12</td></tr>
<tr><td>3.00</td><td>± 0.09</td></tr>
<tr><td>Sph / Cyl</td><td>Pl</td><td>0.75</td><td>4.00</td><td>6.00</td><td>> 6.00</td></tr>
<tr><td></td><td>Tolerance on the power of each meridian</td><td colspan="4">Tolerance on the cylinder</td></tr>
</table>

Varifocal



Power of meridian with highest absolute power

<table>
<tr><th></th><th>COLUMN A</th><th colspan="4">COLUMN B</th></tr>
<tr><td>> 20.00</td><td>± 0.37</td><td>± 0.25</td><td rowspan="2">± 0.25</td><td>± 0.37</td><td>± 0.37</td></tr>
<tr><td>20.00</td><td>± 0.25</td><td rowspan="3">± 0.18</td><td rowspan="2">± 0.25</td><td rowspan="4">± 0.25</td></tr>
<tr><td>12.00</td><td rowspan="2">± 0.18</td><td rowspan="3">± 0.18</td></tr>
<tr><td>9.00</td><td rowspan="2">± 0.18</td></tr>
<tr><td>6.00</td><td>± 0.12</td><td>± 0.12</td></tr>
<tr><td>Sph / Cyl</td><td>Pl</td><td>0.75</td><td>4.00</td><td>6.00</td><td>> 6.00</td></tr>
<tr><td></td><td>Tolerance on the power of each meridian</td><td colspan="4">Tolerance on the cylinder</td></tr>
</table>

Accuracy of optical centration and prismatic power should be assessed at the nominal geometric centre of a single vision lens, the distance optical centre of a bifocal lens or the prism reference point of a varifocal lens. NOTE: Most varifocal lenses incorporate a base down thinning prism equal to two thirds of the reading addition. This should be taken into account when checking any prescribed prism.

Prescriptions compensated for the 'as worn' position

Certain varifocal lens designs have lens prescriptions modified for the 'as worn' position when fitted to the frame or mount. With such lenses the prescription when measured on a focimeter differs from the ordered prescription. Lenses with compensated prescriptions should be supplied in lens packets displaying the ordered prescription first and the compensated prescription below.

For example:	**Ordered**	Sph +3.75 Cyl +0.75 Axis 30
	Compensated	Sph +3.71 Cyl +0.61 Axis 39

The prescription measured at the power checking circle is a combination of the compensation and the prescribed power. The wearer will perceive the prescription as the prescriber intended it. It is recommended that the lens packets should be forwarded to the final point of checking in the practice so the measured values are visible for this purpose. When the measured cylinder value is 0.20D or less the axis becomes impractical to measure and is often not displayed.

Tolerances on the direction of cylinder axis - all lens types*

CYLINDER POWER (D)	<=0.50	>0.50 <=0.75	>0.75 <=1.50	>1.50
TOLERANCE ON AXIS (DEG)	± 7°	± 5°	± 3°	± 2°

Tolerances on the addition power - Bifocal and varifocal lenses*

VALUE OF ADD (D)	<=4.00	>4.00
TOLERANCE (d)	± 0.12	± 0.18

The addition power of bifocal and varifocal lenses is expressed as the difference between the front vertex distance power and the front vertex near power

Tolerances on optical centration prismatic power*

PRISMATIC POWER	HORIZONTAL	VERTICAL
>0.00 and =/<2.00	± (0.25 + 0.1 x ^{S}max)	± (0.25 + 0.05 x ^{S}max)
>2.00 and =/<10.00	± (0.37 + 0.1 x ^{S}max)	± (0.37 + 0.05 x ^{S}max)
>10.00	± (0.50 + 0.1 x ^{S}max)	± (0.50 + 0.05 x ^{S}max)

NOTE: ^{S}max is the focal power in dioptres in the meridian of higher absolute power.

An example of applying the above tolerances to a distance power of +0.50/-2.50 axis 20 in a varifocal prescription with a prismatic power of not greater than 2 prism is as follows. For this prescription , the principle powers are +0.50D and -2.00D so that the meridian of higher absolute power is 2.00D.

For a power 2.00D the horizontal tolerance is:- +/-(0.25 +0.10 x 2.00) = +/- 0.45 prism

The vertical tolerance is:- +/-(0.25 +0.05 x 2.00) = +/- 0.35 prism

Pages on Optical Tolerances extracted courtesy of Essilor from their Product Information Guide 2019

Tables

Ophthalmic Standards and Driving Regulations

Driving

Lenses are not suitable for driving if the light transmission is less than 8% or if the tint influences colour perception and recognition of traffic signals. The transmission should not be less than 75% for night driving. Tints are classified into five groups according to their tint transmission

Class	Category	Usage	Transmission %	Driving
0	Clear or very lightly tinted	Indoors or overcast	80	No restrictions
1	Light tint	Low sunlight	75	Not suitable for night driving
2	Medium tint	Medium sunlight	25	Not suitable for night driving
3	Dark tint	Bright sunlight	15	Not suitable for night driving
4	Very dark tint	Very bright sunlight	8	Not suitable for driving

Ophthalmic Standards

There are a number of ISO Standards that apply directly to spectacle lenses. Looking on the British Standards Institute website there are currently around 40 BS/EN/ISO standards listed under Ophthalmic Optics which cover spectacle lenses, frames and contact lenses. More can be found covering ophthalmic instruments. The titles of these standards make interesting reading in their own right. For example, BS EN ISO 11381:1997 covers screw threads and did you know about BS EN 14139:2010 that gives standardised specifications for ready to wear spectacles?

The full list can be found by typing in the following links:- http://www.standardsuk.com/shop/products_list.php?page=1 or http://www.bsi-publications.com/search

Out of these 40 we find 12 that relate directly to spectacle lenses.

REFERENCE	TITLE	STATUS
ISO 8980-1:2004	Ophthalmic optics – Uncut finished spectacle lenses – Part 1 : Specifications for single-vision and multifocal lenses	IS published on 2004-02-01
ISO 8980-2 :2004	Ophthalmic optics – Uncut finished spectacle lenses – Part 2 : Specifications for progressive power lenses	IS published on 2004-02-01
ISO 8980-3:2013	Ophthalmic optics – Uncut finished spectacle lenses – Part 3 : Transmittance specifications and test methods	IS published on 2013-10-01
ISO 8980-4:2006	Ophthalmic optics – Uncut finished spectacle lenses – Part 4 : Specifications and test methods for anti-reflective coatings	IS published on 2006-08-15 *Systematic review in 2016*
ISO 8980-5 : 2005	Ophthalmic optics – Uncut finished spectacle lenses - Part 5 : Minimum requirements for spectacle lens surfaces claimed to be abrasion resistant	IS published on 2005-08-1
ISO 10322-1:2016	Ophthalmic optics – Semi-finished spectacle lens blanks - Part 1 : Specifications for single-vision and multifocal lens blanks	IS published on 2016-02-01
ISO 10322-2:2016	Ophthalmic optics – Semi-finished spectacle lens blanks - Part 2 : Specifications for progressive-power and degressive-power lens blanks	IS published on 2016-02-01
ISO 13666 : 2012	Ophthalmic optics – Spectacle lenses - Vocabulary	IS published on 2012-10-22
ISO 14889:2013	Ophthalmic optics – Spectacle lenses – Fundamental requirements for uncut finished lenses	IS published on 2013-10-01
ISO 16034:2002	Ophthalmic optics – Specifications for single-vision ready-to-wear near-vision spectacles	IS published on 2002-02-01

REFERENCE	TITLE	STATUS
ISO 21987:2009	Ophthalmic optics – Mounted spectacle lenses	IS published on 2009-10-01
ISO/TR 29980 : 2007	Parameters affecting lens power measurement	TR published on 2007-01-15

For semi finished spectacle lens blanks used within the production industry there is BS EN ISO 10322-1:2006 that covers specifications for single vision and multifocal lenses and BS EN ISO 10322-2:2006 that covers the specifications for progressive power lenses. Standards can be purchased directly from ABDO College Bookshop, the British Standards Insitute or if you are a member of the FMO (Federation of Manufacturing Opticians) standards can be purchased at a

Working with anti-reflection coated plastic lenses

Due to the difference between the thermal coefficient of expansion of the lens material and the coating, it is necessary to take special care to avoid coating cracks and lens deformation when putting organic lenses into frames.

- Do not expose lenses to high temperatures when fitting and adjusting with the frame heater.
- Do not heat the first lens when fitting the second one.
- Adjust the frame curve as much as possible before fitting the lens.
- Use accurate formers and check for excessive strain.
- Check the surface curves of glazed lenses for warping caused by glazing strain.
- Advise patients not to leave the lenses in direct sunlight, such as on a dashboard.
- Advise patients not to wear the lenses in a sauna.

UV Absorbing Tints

For general use, a tint will be regarded as UV absorbing when its transmittance does not exceed 10% at 380 nm and attenuates at shorter wavelengths. For complete UV absorption in plastic lenses use a UV blocker combined with a tint to reduce the transmittance. Note that 1.6 to 1.74 plastics are intrinsically UV absorbing, within the definition above.

Relative Curvature

RC is relative curvature where $RC = (1.523 - 1) / (n_m - 1)$. If n_m, the material refractive index, is greater than 1.523, RC gives the relative thickness compared with the same lens in 1.523 index. For example, if $n_m = 1.700$, then $RC = 0.75$ and the lens will be 0.75 or 75% of the thickness of the equivalent lens in 1.523 material. Examples are given below.

Optical properties of white mid- and high-index glasses compared with spectacle crown

Refractive index	V-value	Specific gravity	Relative curvature
1.523	58.9	2.54	1.00
1.601	42.2	2.67	0.87
1.604	43.8	2.67	0.87
1.701	31.0	2.99	0.75
1.702	40.2	2.99	0.75
1.800	35.4	3.62	0.65
1.806	33.3	3.47	0.65
1.885	30.6	3.99	0.59

Optical properties of white plastic lenses (Relative Curvature is compared with spectacle crown glass)

Refractive index	V-value	Specific gravity	Relative curvature
1.498	58.0	1.32	1.05
1.53	45.0	1.11	0.99
1.555	36.0	1.24	0.93
1.557	43.0	1.16	0.93
1.561	37.0	1.23	0.93
1.586	30.0	1.20	0.89
1.592	36.0	1.42	0.88
1.597	40.5	1.30	0.87
1.600	42.0	1.30	0.87
1.600	37.0	1.34	0.87
1.67	32.0	1.35	0.79
1.71	36.0	1.40	0.75
1.74	33.0	1.46	0.71

Edge thickness of full aperture minus spectacle lenses at various semi-diameters.
Centre thickness 1.5mm, except for CR39 (1.498) material lenses, where 2mm was chosen.

Lens	Refractive	Semi-diameters of lens (mm)								
Power	index	24	26	28	30	32	34	36	38	40
-2.00	1.498	3.2	3.4	3.7	4.0	4.3	4.6	4.9	5.3	5.7
-2.00	1.523	2.7	2.9	3.1	3.3	3.6	3.9	4.3	4.6	5.0
-2.00	1.600	2.5	2.7	2.9	3.2	3.4	3.7	4.0	4.3	4.7
-2.00	1.700	2.4	2.5	2.7	2.9	3.1	3.4	3.6	3.9	4.3
-2.00	1.800	2.3	2.4	2.6	2.7	2.9	3.2	3.4	3.6	3.9
-4.00	1.498	4.4	4.9	5.4	5.9	6.5	7.2	7.9	8.7	9.5
-4.00	1.523	3.8	4.2	4.7	5.2	5.8	6.4	7.0	7.7	8.6
-4.00	1.600	3.5	3.9	4.3	4.8	5.3	5.8	6.4	7.1	7.8
-4.00	1.700	3.2	3.6	3.9	4.3	4.7	5.2	5.7	6.3	6.9
-4.00	1.800	3.0	3.3	3.6	4.0	4.3	4.8	5.2	5.7	6.2
-6.00	1.498	5.7	6.4	7.1	8.0	8.9	9.9	11.0	12.3	13.6
-6.00	1.523	5.0	5.6	6.3	7.1	8.0	8.9	10.0	11.1	12.3
-6.00	1.600	4.5	5.1	5.7	6.4	7.2	8.0	8.9	9.9	11.0
-6.00	1.700	4.1	4.6	5.1	5.7	6.4	7.1	7.9	8.8	9.7
-6.00	1.800	3.8	4.2	4.7	5.2	5.7	6.3	7.0	7.7	8.5
-8.00	1.498	7.0	7.9	8.9	10.1	11.4	12.8	14.5		
-8.00	1.523	6.2	7.1	8.1	9.2	10.4	11.7	13.2	14.9	
-8.00	1.600	5.6	6.3	7.2	8.1	9.2	10.3	11.6	12.9	14.5
-8.00	1.700	5.0	5.6	6.4	7.2	8.0	9.0	10.1	11.2	12.5
-8.00	1.800	4.5	5.1	5.7	6.4	7.2	8.0	8.9	9.9	10.9
-10.00	1.498	8.3	9.5	10.8	12.3	14.1				
-10.00	1.523	7.5	8.6	9.9	11.3	12.9	14.7			
-10.00	1.600	6.7	7.6	8.7	9.9	11.3	12.8	14.5		
-10.00	1.700	5.9	6.7	7.6	8.6	9.7	11.0	12.3	13.8	15.5
-10.00	1.800	5.3	6.0	6.8	7.7	8.6	9.7	10.8	12.1	13.5
-12.00	1.498	9.8	11.3	13.1	15.2					
-12.00	1.523	8.8	10.2	11.9	13.7	15.9				
-12.00	1.600	7.8	9.0	10.3	11.9	13.6	15.6			
-12.00	1.700	6.8	7.8	8.9	10.2	11.5	13.1	14.8		
-12.00	1.800	6.1	7.0	7.9	9.0	10.2	11.4	12.9	14.5	
-14.00	1.498	11.4	13.4	15.7						
-14.00	1.523	10.3	12.1	14.3						
-14.00	1.600	9.0	10.4	12.1	14.1					
-14.00	1.700	7.7	8.9	10.3	11.8	13.5	15.4			
-14.00	1.800	6.9	7.9	9.1	10.3	11.8	13.3	15.1		
-16.00	1.498	13.3								
-16.00	1.523	12.0	14.4							
-16.00	1.600	10.2	12.0	14.1						
-16.00	1.700	8.7	10.2	11.8	13.6	15.7				
-16.00	1.800	7.7	8.9	10.3	11.8	13.5	15.4			
-18.00	1.498	15.9								
-18.00	1.523	14.3								
-18.00	1.600	11.7	14.0							
-18.00	1.700	9.8	11.5	13.4	15.7					
-18.00	1.800	8.6	10.0	11.5	13.3	15.3				
-20.00	1.600	13.5								
-20.00	1.700	11.0	13.1	15.5						
-20.00	1.800	9.5	11.1	12.9	15.0					
-22.00	1.700	12.4	15.0							
-22.00	1.800	10.5	12.4	14.7						
-24.00	1.700	14.1								
-24.00	1.800	11.7	14.0							
-26.00	1.800	13.0	15.8							

Bifocal inset as a function of distance Rx (lens power), mono PD and working distance.
The distance from the back vertex of the spectacle lens to the eye's centre of rotation is taken as 27mm.
The inset is given to the nearest 0.5mm.
The inset required for coincident right and left fields of view through the segments.

Working distance 25cm

Lens Power	Mono PD (mm) 28	30	32	34	36
−20.00	2.0	2.0	2.0	2.0	2.5
−16.00	2.0	2.0	2.0	2.5	2.5
−12.00	2.0	2.5	2.5	2.5	2.5
−8.00	2.5	2.5	2.5	3.0	3.0
−4.00	2.5	2.5	3.0	3.0	3.0
0.00	2.5	3.0	3.0	3.5	3.5
+4.00	3.0	3.0	3.5	3.5	4.0
+8.00	3.5	3.5	4.0	4.0	4.5
+12.00	4.0	4.0	4.5	5.0	5.0
+16.00	4.5	5.0	5.0	5.5	6.0

Working distance 35cm

Lens Power	Mono PD (mm) 28	30	32	34	36
−20.00	1.5	1.5	1.5	1.5	1.5
−16.00	1.5	1.5	1.5	1.5	2.0
−12.00	1.5	1.5	2.0	2.0	2.0
−8.00	1.5	2.0	2.0	2.0	2.0
−4.00	2.0	2.0	2.0	2.0	2.5
0.00	2.0	2.0	2.5	2.5	2.5
+4.00	2.0	2.5	2.5	2.5	3.0
+8.00	2.5	2.5	3.0	3.0	3.0
+12.00	3.0	3.0	3.5	3.5	3.5
+16.00	3.5	3.5	4.0	4.0	4.5

Working distance 45cm

Lens Power	Mono PD (mm) 28	30	32	34	36
−20.00	1.0	1.0	1.0	1.5	1.5
−16.00	1.0	1.0	1.5	1.5	1.5
−12.00	1.0	1.5	1.5	1.5	1.5
−8.00	1.5	1.5	1.5	1.5	1.5
−4.00	1.5	1.5	1.5	1.5	2.0
0.00	1.5	1.5	2.0	2.0	2.0
+4.00	2.0	2.0	2.0	2.0	2.5
+8.00	2.0	2.0	2.5	2.5	2.5
+12.00	2.5	2.5	2.5	3.0	3.0
+16.00	2.5	3.0	3.0	3.0	3.5

<table>
<tr><th colspan="4">Near Vision Effectivity compensation:
order value = trial lens near Rx + correction value*</th></tr>
<tr><th rowspan="2">Trial lens
Rx for near</th><th colspan="3">Correction value for the stated Add</th></tr>
<tr><th>Add 2.00</th><th>Add 2.50</th><th>Add 3.00</th></tr>
<tr><td>+8.00</td><td rowspan="13">+0.25</td><td rowspan="9">+0.25</td><td rowspan="5">+0.25</td></tr>
<tr><td>+8.50</td></tr>
<tr><td>+9.00</td></tr>
<tr><td>+9.50</td></tr>
<tr><td>+10.00</td></tr>
<tr><td>+10.50</td><td rowspan="10">+0.50</td></tr>
<tr><td>+11.00</td></tr>
<tr><td>+11.50</td></tr>
<tr><td>+12.00</td></tr>
<tr><td>+12.50</td><td rowspan="8">+0.50</td></tr>
<tr><td>+13.00</td></tr>
<tr><td>+13.50</td></tr>
<tr><td>+14.00</td></tr>
<tr><td>+14.50</td><td rowspan="4">+0.50</td></tr>
<tr><td>+15.00</td></tr>
<tr><td>+15.50</td><td rowspan="2"></td></tr>
<tr><td>+16.00</td></tr>
</table>

* Rodenstock values for which the trial lenses are convex-plane. For plano-convex trial lenses increase the correction value by about 50%.

Near Centration Distance (*NCD*) as a function of interpupillary distance (*PD*) and Working Distance (to nearest 0.5mm).

PD	***Working Distance*** **(cm)**						
	20	**25**	**30**	**35**	**40**	**45**	**50**
54	48	49	50	50	61	51	51
56	49	51	51	52	52	53	53
58	51	52	53	54	54	55	55
60	53	54	55	56	56	57	57
62	55	56	57	58	58	58	59
64	56	58	59	59	60	60	61
66	58	60	61	61	62	62	63
68	60	61	62	63	64	64	65
70	62	63	64	65	66	66	66
72	63	65	66	67	67	68	68
74	65	67	68	69	69	70	70
76	67	69	70	71	71	72	72

Distance Minimum Tangential Error best form minus spheric lenses in various refractive indices

Lens Power	Front surface sphere power for the refractive indices below				
	1.498	1.523	1.600	1.700	1.800
−1.00	+5.00	+5.00	+7.00	+8.50	+9.67
−2.00	+4.25	+4.25	+6.00	+7.25	+8.50
−3.00	+3.75	+3.75	+5.25	+6.37	+7.67
−4.00	+3.25	+3.25	+4.50	+5.75	+6.87
−5.00	+2.62	+2.75	+4.00	+5.25	+6.12
−6.00	+2.37	+2.37	+3.50	+4.75	+5.50
−7.00	+2.00	+2.00	+3.00	+4.25	+4.87
−8.00	+1.62	+1.75	+2.50	+3.62	+4.37
−9.00	+1.00	+1.25	+2.12	+3.00	+3.87
−10.00	+0.75	+1.00	+1.75	+2.62	+3.50
−11.00	+0.62	+0.75	+1.50	+2.25	+3.00
−12.00	+0.50	+0.50	+1.12	+1.75	+2.62
−13.00	+0.25	+0.37	+0.75	+1.50	+2.25
−14.00	+0.12	+0.25	+0.62	+1.12	+1.87
−15.00	0.00	0.00	+0.37	+0.87	+1.62
−16.00	0.00	0.00	+0.12	+0.50	+1.12
−17.00	0.00	0.00	0.00	+0.25	+0.75
−18.00	+0.12	+0.12	0.00	+0.12	+0.50
−19.00	+0.50	+0.50	0.00	0.00	+0.25
−20.00	+0.75	+0.75	0.00	0.00	0.00
−21.00	+1.00	+1.25	0.00	0.00	0.00
−22.00		+2.00	+0.50	0.00	0.00
−23.00			+1.50	0.00	0.00
−24.00				0.00	0.00
−25.00				+0.50	0.00
−26.00				+1.00	0.00
−27.00				+2.00	0.00
−28.00				+3.00	0.00
−29.00				+2.00	+0.50
−30.00				+1.50	+0.75
−31.00					+1.75
−32.00					+3.00
−33.00					+3.00

Note that a −4.75D Sph back surface produces a Minimum Tangential Error best form spheric in 1.523 index for BVPs from plano to +8.00. Aspheric lenses in this range are usually ‘2.00 to 3.00 dioptres flatter’.

Distance best form minus torics for *n* = 1.523. All lenses have a minus base barrel toroidal surface and the numbers shown in the table are the front surface sphere powers (to the nearest 0.12 D).

	Rx cylinder					
	−1.00	**−2.00**	**−3.00**	**−4.00**	**−5.00**	**−6.00**
Rx sphere	Front surface sphere power					
0.00	+7.00	+5.75	+5.00	+3.75	+3.00	+2.50
−1.00	+6.37	+5.50	+4.75	+4.00	+3.37	+2.75
−2.00	+5.62	+5.00	+4.37	+3.75	+3.25	+2.75
−3.00	+5.00	+4.50	+4.00	+3.50	+3.00	+2.50
−4.00	+4.50	+4.00	+3.50	+3.12	+2.62	+2.50
−5.00	+4.00	+3.50	+3.12	+2.75	+2.25	+2.00
−6.00	+3.37	+3.00	+2.62	+2.25	+2.00	+1.75
−7.00	+3.00	+2.50	+2.25	+1.87	+1.62	+1.37
−8.00	+2.50	+2.12	+1.87	+1.50	+1.37	+1.12
−9.00	+1.87	+1.62	+1.37	+1.00	+0.87	+0.62
−10.00	+1.50	+1.25	+1.00	+0.75	+0.62	+0.37
−11.00	+1.25	+1.00	+0.75	+0.50	+0.37	+0.25
−12.00	+0.87	+0.75	+0.50	+0.25	+0.12	0.00
−13.00	+0.62	+0.37	+0.25	0.00	0.00	0.00
−14.00	+0.37	+0.25	0.00	0.00	0.00	0.00
−15.00	0.00	0.00	0.00	0.00		
−16.00	0.00	0.00	0.00			
−17.00	0.00	0.00	0.00			
−18.00	0.00	0.00				
−19.00	0.00					

Note that if a lens is not indicated in the table then it is not recommended in this refractive index. For example, no value occurs for −19.00 DS / −2.00 DC, so this should be made in a higher refractive index for good oblique visual performance.

Distance best form minus torics for *n* = 1.700. All toric lenses have a minus base barrel toroidal surface and the numbers shown in the table are the front surface sphere powers (to the nearest 0.12 D).

	Rx cylinder						
	0.00	**−1.00**	**−2.00**	**−3.00**	**−4.00**	**−5.00**	**−6.00**
Rx sphere	Front surface sphere power						
0.00	+8.50	+9.00	+8.25	+7.25	+6.50	+5.75	+5.00
−1.00	+8.50	+9.00	+8.25	+7.25	+6.50	+5.75	+5.00
−2.00	+7.25	+8.50	+7.75	+7.00	+6.25	+5.62	+5.00
−3.00	+6.37	+8.00	+7.25	+6.50	+6.00	+5.37	+4.75
−4.00	+5.75	+7.25	+6.62	+6.12	+5.50	+5.00	+4.50
−5.00	+5.25	+6.62	+6.00	+5.62	+5.12	+4.62	+4.25
−6.00	+4.75	+6.12	+5.62	+5.12	+4.75	+4.25	+3.87
−7.00	+4.25	+5.62	+5.12	+4.75	+4.25	+3.87	+3.50
−8.00	+3.62	+5.00	+4.62	+4.25	+3.87	+3.50	+3.12
−9.00	+3.00	+4.25	+3.87	+3.50	+3.12	+2.75	+2.50
−10.00	+2.62	+3.75	+3.37	+3.00	+2.75	+2.37	+2.12
−11.00	+2.25	+3.25	+3.00	+2.62	+2.37	+2.12	+1.87
−12.00	+1.75	+2.87	+2.50	+2.25	+2.00	+1.75	+1.50
−13.00	+1.50	+2.50	+2.12	+1.87	+1.62	+1.25	+1.12
−14.00	+1.12	+2.12	+1.75	+1.50	+1.25	+1.12	+0.87
−15.00	+0.87	+1.50	+1.25	+1.00	+0.75	+0.62	+0.50
−16.00	+0.50	+1.25	+0.87	+0.75	+0.50	+0.37	+0.25
−17.00	+0.25	+0.87	+0.62	+0.50	+0.25	+0.12	0.00
−18.00	+0.12	+0.62	+0.50	+0.25	+0.12	0.00	0.00
−19.00	0.00	+0.37	+0.25	0.00	0.00	0.00	0.00
−20.00	0.00	+0.25	0.00	0.00	0.00	0.00	0.00
−21.00	0.00	0.00	0.00	0.00	0.00	0.00	
−22.00	0.00	0.00	0.00	0.00	0.00		
−23.00	0.00	0.00	0.00	0.00			
−24.00	0.00	0.00	0.00				
-25.00	+0.50						

Lens measure conversion table.
Surface powers on lenses with refractive indices differing from 1.523

Lens Measure Reading	Powers for the refractive indices below					
	1.498	**1.560**	**1.580**	**1.600**	**1.700**	**1.800**
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.50	0.48	0.54	0.55	0.57	0.67	0.76
1.00	0.95	1.07	1.11	1.15	1.34	1.53
1.50	1.43	1.61	1.66	1.72	2.01	2.29
2.00	1.90	2.14	2.22	2.29	2.68	3.06
2.50	2.38	2.68	2.77	2.87	3.35	3.82
3.00	2.86	3.21	3.33	3.44	4.02	4.59
3.50	3.33	3.75	3.88	4.02	4.68	5.35
4.00	3.81	4.28	4.44	4.59	5.35	6.12
4.50	4.28	4.82	4.99	5.16	6.02	6.88
5.00	4.76	5.35	5.54	5.74	6.69	7.65
5.50	5.24	5.89	6.10	6.31	7.36	8.41
6.00	5.71	6.42	6.65	6.88	8.03	9.18
6.50	6.19	6.96	7.21	7.46	8.70	9.94
7.00	6.67	7.50	7.76	8.03	9.37	10.71
7.50	7.14	8.03	8.32	8.60	10.04	11.47
8.00	7.62	8.57	8.87	9.18	10.71	12.24
8.50	8.09	9.10	9.43	9.75	11.38	13.00
9.00	8.57	9.64	9.98	10.33	12.05	13.77
9.50	9.05	10.17	10.54	10.90	12.72	14.53
10.00	9.52	10.71	11.09	11.47	13.38	15.30
10.50	10.00	11.24	11.64	12.05	14.05	16.06
11.00	10.47	11.78	12.20	12.62	14.72	16.83
11.50	10.95	12.31	12.75	13.19	15.39	17.59
12.00	11.43	12.85	13.31	13.77	16.06	18.36
12.50	11.90	13.38	13.86	14.34	16.73	19.12
13.00	12.38	13.92	14.42	14.91	17.40	19.89
13.50	12.85	14.46	14.97	15.49	18.07	20.65
14.00	13.33	14.99	15.53	16.06	18.74	21.41
14.50	13.81	15.53	16.08	16.63	19.41	22.18
15.00	14.28	16.06	16.63	17.21	20.08	22.94
15.50	14.75	16.60	17.19	17.78	20.75	23.71
16.00	15.24	17.13	17.74	18.36	21.41	24.47
16.50	15.71	17.67	18.30	18.93	22.08	25.24
17.00	16.19	18.20	18.85	19.50	22.75	26.00
17.50	16.66	18.74	19.41	20.08	23.42	26.77
18.00	17.14	19.27	19.96	20.65	24.09	27.53
18.50	17.62	19.81	20.52	21.22	24.76	28.30
19.00	18.09	20.34	21.07	21.80	25.43	29.06
19.50	18.57	20.88	21.63	22.37	26.10	29.83
20.00	19.04	21.41	22.18	22.94	26.77	30.59

The methods of eliminating vertical differential prismatic effect at the NVPs are well-known. They are mentioned here for completeness.

1. Single vision lenses for relatively lengthy periods of close-work. May be combined with bifocals for general use.

2. Unequal bifocal round segments.
   (There is insufficient difference in the vertical positioning of the optical centres of D-segments to use this type).

3. Prism segment bifocals or slab-off (bi-prism, bi-centric).

4. Fresnel prism segments.

5. Franklin split bifocals.

6. Contact lenses!

Where prism-compensated bifocals are to be dispensed, there are several choices. Generally, slab-off combined with a straight-top segment has the best cosmesis, especially with an E-type segment when the appearance is no different from the uncompensated lens.

Trial prism compensation with Fresnel prisms

Fresnel prisms are thin polyvinyl chloride sheets, about 1mm thick, which can be cut to fit over the reading area. Since they reduce visual acuity by about 1 to 2 rows of letters on the Snellen chart, they should be used only for temporary experimentation, using one in front of each eye. This removes the patient's objection to reduced acuity in one eye alone which would be more objectionable if prism were used in front of one eye only. The effect of prism compensation on the comfort of binocular vision when reading can be judged by the patient before permanent lenses are dispensed. One advantage of this type of prism compensation is that a blind experiment can be run in which the patient does not know when prism compensation is occurring. This is done by having both Fresnel prism bases up or down for a period, then one up and one down for a similar time. In the latter case the vertical differential prism is neutralised. The patient then reports the effect on symptoms during the two periods. If the patient is symptom-free in the prism compensated period, but not during the uncompensated trial, then one can confidently dispense prism compensated lenses.

Tables

Prism Compensation with Unequal Segment Diameters

Methods of calculating the prismatic effect at the NVP are considered in ophthalmic lenses text-books. In practice one tends to use a table for this purpose. The prismatic effects obtained are described in the table heading below.

Vertical prismatic effect at the NVP, 10mm down and 2mm in from the distance optical centre due to a +1.00 D cylinder. All base directions are UP. Reverse the base direction for minus cylinders. Values for other cylinder powers can be obtained by multiplying by that cylinder power.

Axis	RE	LE	Axis	RE	LE
5	1.00	0.97	95	0.00	0.02
10	1.00	0.93	100	0.00	0.06
15	0.98	0.88	105	0.01	0.11
20	0.94	0.81	110	0.05	0.18
25	0.89	0.74	115	0.10	0.25
30	0.83	0.66	120	0.16	0.33
35	0.76	0.57	125	0.23	0.42
40	0.68	0.48	130	0.31	0.51
45	0.60	0.40	135	0.39	0.60
50	0.51	0.31	140	0.48	0.68
55	0.42	0.23	145	0.57	0.76
60	0.33	0.16	150	0.66	0.83
65	0.25	0.10	155	0.74	0.89
70	0.18	0.05	160	0.81	0.94
75	0.11	0.01	165	0.88	0.98
80	0.06	0.00	170	0.93	1.00
85	0.02	0.00	175	0.97	1.00

Method

The vertical prismatic effect at the NVP of a lens can be obtained by considering the spherical component and the cylindrical component separately. The cylinder's contribution will be found from the table, but the spherical components can be found from the well-known Prentice's Rule which gives the prismatic effect as $P = c\,|F|$, where c is the distance from the optical centre to the NVP in cm, and F is the lens power, here the power of the sphere. Because the distance c = 1cm here, the spherical component's contribution to the prismatic effect at the NVP is numerically equal to the sphere power. The base direction will be up for a plus sphere and down for a minus sphere.

As an example of its use, consider the anisometropic prescription R. −1.00 / −2.25 x 35 L. −3.00 / −3.75 x 120

Due to the spheres, the prismatic effects at the NVPs are R. 1^{Δ} base down L. 3^{Δ} base down.

The prismatic effects due to the cylinders, obtained from the table above are:

R. $2.25 \times 0.76 \Rightarrow 1.71^{\Delta}$ base down L. $3.75 \times 0.33 \Rightarrow 1.24^{\Delta}$ base down.

Adding the respective spherical and cylindrical contributions, the resultant vertical prismatic effects are:

R. 2.71^{Δ} base down and L. 4.24^{Δ} base down

The differential prismatic effect between the two NVPs is therefore $4.24^{\Delta} - 2.71^{\Delta} = 1.53^{\Delta}$ base down left lens.

With round segment solid bifocals, it now remains to decide on the segment diameters to neutralise this vertical differential prism. The difference (Δd) in segment diameters is given by

$$\Delta d = 20 \frac{\Delta P}{Add} \qquad \text{(mm)}$$

where ΔP is the differential prismatic effect at the NVPs.

In the current example, suppose the patient is to have prism compensated bifocals and the *Add* = +2.50, then the difference between round segment diameters must be

$$\Delta d = 20 \frac{\Delta P}{Add} = 20 \times \frac{1.53}{2.50} = 12.24 \text{ mm.}$$

Round segment diameters are available in solid bifocals in the sizes 22, 24, 25, 30, 38 and 45mm. Any two with a difference most nearly equal to 12.24mm will suffice to neutralise the vertical differential prism. 25 and 38 come nearest, although 30 and 45 are very nearly as good. In the present example, we need to add extra base down to the lens providing the smaller base down effect, so the larger segment will be placed in the right lens.

Vertical differential prism compensation with D35 and D40 segments

Most D-segment bifocals have their segment optical centres very nearly the same distance from the segment top. However, a small amount of prism compensation can be obtained with Sola's 35 and 40 mm D-segments. The D35 has its segment optical centre 5 mm below the segment top, whilst the D40 has its segment OC at the segment top. This 5 mm difference introduces 0.5^{Δ} of vertical prism compensation per dioptre of *Add*. In the example above, with a 2.50 *Add*, the prism compensation would be $2.50 \times 0.50 = 1.25^{\Delta}$, which may be just as effective in this case.

The larger segment produces relative base up prism at the NVPs. Again, in the example, the D40 segment would be used for the L.E. to neutralise the extra base down from the distance portion of this lens.

Note that a D45 segment is also available (see the Plastic Lenses section in the Availability Index).

Range of clear vision for some ages, Adds and working distances

Age	Add	W.D. (cm)	Range of clear vision (cm)
45	+0.50	40	200 to 29
	+1.00	35	100 to 25
	+1.25	30	80 to 24
50	+1.00	40	100 to 33
	+1.50	35	67 to 29
	+2.00	30	50 to 25
55	+1.50	40	67 to 33
	+2.00	35	50 to 29
	+2.25	30	44 to 27
60	+1.75	40	57 to 36
	+2.25	35	44 to 31
	+2.75	30	36 to 27
70	+2.50	35	40 to 33
	+3.00	30	33 to 29
	+3.75	25	27 to 24