On behalf of Vision Expo, we sincerely thank you for being with us this year.

Vision Expo Has Gone Green!

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Education Planning Committee considers content and speakers for future meetings to provide you with the best education possible.



ABO Basic Exam Review

Domain I: Ophthalmic Optics

National Federation of Opticianry Schools Formal Opticianry Education.... We teach the Why

Presented by Tracy E Bennett, LDO, ABO-AC, NCLEC



Content Outline

ABO Test Content Outline	Weight	Approximate number of questions	
I. Ophthalmic Optics	34%	39	
A. Terminøløgy		4	
B. Prescriptions		5	
C: Lens Characteristics		4	
D. Lens powers and formulas		7	
E. Multifocals		aj	
F. Lens Materials		8	
G. Prism		8	
II. Ocular Anatomy, Physiology and Pathology	7%	8	-
A: Structure of the eye and function		5	
B. Refractive errors		3	
III. Ophthalmic Products	23%	27	
A: Frames		8	NF
B. Lenses		9	I VI
C. Applying produce Knowledge		5	-
D. Recognizing specific product availability		ay	

OVERVIEW OF CONTENTS

- TERMINOLOGY
- PRESCRIPTIONS
- LENS CHARACTERISTICS
- LENS POWERS AND FORMULAS
- LENS MATERIALS
- MULTIFOCALS
- **OBLIQUE CYLINDER POWER**
- PRISM



DIOPTER SYSTEM (DIOPTIC POWER)

- **DIOPTER:** An optical unit of measure that describes the deviation of light after it passes thru a lens.
- Lens power, lens surface or curve power, and prism power are all measured and expressed in diopters.
- One diopter lens power will focus parallel light rays one meter from the back vertex of a lens.
- **DIOPTRIC INCREMENTS:**

0.00, 0.12, 0.25, 0.37, 0.50, 0.62, 0.75, 0.87, 1.00...



DIOPTRIC INCREMENTS

- DIOPTRIC INCREMENTS:
 - 0.00, <u>0.12</u>, 0.25, <u>0.37</u>, 0.50, <u>0.62</u>, 0.75, <u>0.87</u>, 1.00, ...

• Quarter diopters:

- 0.00, 0.25, 0.50, 0.75, 1.00, ...
- Four steps between increments (four increments in a diopter)
- Prescriptions written in quarter diopter increments

• Eighth diopters:

- 0.00, 0.12, 0.25, 0.37, 0.50, 0.62, 0.75, 0.87, 1.00, ...
- Eight steps between increments (eight increments in a diopter)
- Powers read in eighth diopter increments



Focal Length

• The distance from the back of a lens to the retina is called focal length.



• The point at which rays of light converge is called the focal point.





FOCAL LENGTH

• The distance from the back vertex of a lens to the focal point. Focal length is the inverse of the dioptric power of the lens.

FL = <u>1 METER</u> (or 10 dm or 100 cm or 1000 mm or 39.37") DIOPTER

D = <u>1 METER</u> FL



• $D = \underline{1} = \underline{100} = \underline{1000} = \underline{39.37}$ FL(m) FL(cm) FL(mm) FL(in)

The Power of the lens is equal to the reciprocal of the focal length of lens in meters

Ex. What is the focal length of a + 2.00 D

lens?
$$FL = 1 = 1$$

D +2.00
FL = 0.5 m or 50 cm or 500 mm

NFOS

- A "+" or "-" of the same power will give the same focal length
- Ex. What is the focal length of a 5.00 D

```
lens? FL = 1 = 1
D 5.00
```

FL = 0.2 m or 20 cm or 200 mm

Remember: The point at which rays of light converge is called the focal point.

A function of the distance between surface of the lens and the focal point is called <u>vertex power!</u>



•
$$D = \underline{1} = \underline{100} = \underline{1000} = \underline{39.37}$$

FL (m) FL(cm) FL (mm) FL (in)

The Power of the lens is equal to the reciprocal of the focal length of lens in meters

Ex. What is the power of a lens that has a focal length of +.5 m?

$$D = 1 = 1$$

FL .5m = +2.00 D



OPTICAL CENTER

The OC is the point on the lens where a ray of light will pass through without any deviation. The OC must be aligned properly in front of the patient's eye in order for them to see clearly & without strain – in most



<u>GEOMETRIC CENTER</u>



A POINT EQUIDISTANT FROM THE LENS EDGE; "DEADCENTER"



Box-o-Graph



- Is a device to measure edged lenses. It consists of a ruler scale in two directions
- It allows for the exact dimensions of a lens replacement when a frame has already had lenses in it.



Frame Measurements and Markings

- "A" Measurement the horizontal distance between the furthest temporal and nasal edges of the lens shape or the distance between the vertical sides of the box
- "B" Measurement the vertical distance between the furthest top and bottom edges of the lens shape or the distance between the horizontal sides of the box





Review of Frame Measurements and Markings

- Datum Line The horizontal line that runs through the vertical center of the frame. Commonly referred to as the frame midline. Found by dividing the B dimension in half.
- Geometric Center (GC) The intersection of the Datum Line and horizontal centers of the lens shape (at the intersection of half the A and half the B).
- Distance Between Lenses (DBL) The shortest distance between the nasal edges of each lens or the distance between the boxes. DBL is also known as bridge size.





Frame Measurements and Markings

- Distance Between Centers (DBC) The horizontal distance between the geometric centers of the lenses. DBC is also referred to as the boxing center distance, geometrical center distance, or Frame PD.
- Geometric Center Distance (GCD), but more commonly referred to as Frame PD. The DBC can be calculated by adding the "A" to the "DBL". It can also be measured from one A dimension across the DBL.





Frame Measurements and Markings

- Seg height measured from the top of the segment to the bottom of the boxed lens. Seg height is often used to refer to any vertical fitting heights (PAL fitting cross height and MRP fitting height, OC height).
- Seg drop measured from the frame midline (Datum line) to the top of the seg. (Referred to as seg drop when below frame midline or seg raise when above the frame midline.)







- Temple Length (OTL) The running distance between the middle of the center barrel screw hole and the end of the temple
- Length to Bend (LTB) The distance between the center of the barrel and the middle of the temple bend
- Front to Bend (FTB) The distance between the plane of the front of the frame and the temple bend.



Conversion Chart (inches to MM)



Practical Application

If a temple is marked 5.0 inches, what mm length temple would be equivalent?

Answer: 25.4 x 5.0 = 127 mm

If a temple is marked 150 mm, what temple length in inches would be equivalent? Answer: .0394 x 150 = 5.91 or 6 in



<u>MECHANICAL CENTER</u> (working center)



The point around which a lens is edged – the new center after decentration



CENTRATION

 Ordinarily, we want the OC'S of the lenses placed directly in front of the patient's pupil. This will only occur if the center of the frame matches the ocular measurement (PD) & it rarely does. Therefore, we DECENTER the lenses to achieve the proper location of the OC's. We need to learn how to measure the FRAMES PD.



FRAME PD: boxing center to boxing center



So we measure this distance. This is the **Frame PD (boxing center distance)**



FRAME PD: Boxing System



DECENTRATION

A lens decentered will look like this when viewed from the rear or concave side:



DECENTRATION EXAMPLES

- FPD 70, PPD 65/ = 2.5 mm in
- FPD 73, PPD 62/ = 5.5.mm in
- FPD 71, 35.5/35.5 PPD 32/34 = 3.5 mm in; 1.5 mm in
- FPD 68, 34/34 PPD 33/35 = 1mm in; 1mm out
- Oc's needed at 24 mm; B = 38 = 24 19 = 5 mm
 up
- Oc's needed at 21; B = 48 = 21 24 = 3mm down



Effective Diameter (ED)

 Is twice the distance from the geometric center of the lens to the apex of the lens bevel farthest from it.





Effective Diameter - ED

- ED is used in combination with distance decentration to select the minimum lens blank size required to fit a given frame
- MBS = ED + 2 (decentration per lens) or
- MBS = ED + 2 (decentration per lens) + 2 mm
- The addition of the 2 mm is to account for lens imperfections and possible chipping. Add 2mm for chipping if indicated in the question.



Example # 1

• What would the MBS be for a finished, single vision lens that is to be placed in a frame having the following dimensions?

Patient PD = 62 mm

MBS = 2 (decentration per lens)

FPD = 70, Patient PD = 62

Decentration is 4 mm in for each eye or total

decentration of 8 mm

MBS = ED + 2 (decentration per lens)

MBS = ED + 2(4) = 8 ED = 57

57 + 8 = 65 MBS



Example # 2

• What would the MBS be for a finished, single vision lens that is to be placed in a frame having the following dimensions? (Use Brooks Formula)

Patient PD = 62 mm

MBS = 2 (decentration per lens)

FPD = 70, Patient PD = 62

Decentration is 4 mm in for each eye or total

decentration of 8 mm

MBS = ED + 2 (decentration per lens) + 2 mm

MBS = ED + 2(4) = 8 ED = 57

57 + 8 = 65 MBS + 2 mm = 67 mm



<u>SPHERICAL LENS</u>

• IDENTICAL CURVATURE IN ALL MERIDIANS.



<u>CYLINDRICAL LENS: + or -</u>

- UNEQUAL CURVATURE IN ALL MERIDIANS
- Two Points of FOCUS.



PRESCRIPTIONS

- Ophthalmic RX's are written by optometrist's and ophthalmologists. They are in a more or less standard format and <u>may</u> contain a sphere, cylinder, axis, prism, base direction, and/or an add power and perhaps, special instructions.
- Rx's should have Date of Exam, Dr's Name and Signature, Location, Exp Date



PRESCRIPTION FORMAT

- SphcylaxisprismbaseODOculus Dexter
- **OS** Oculus Sinister
- **ADD** Additional power required for near tasks -
- **OD** generally O.U. (oculi uterque)**OS**



PRESCRIPTION FORMAT: sphere only

	Sph	cyl	axis	prism	base	
OD	-3.00	sphere				
OS	-2.50	sphere	The word 'sphere' may or not be written. The other spots may be blank or have a line			
ADI OD OS	כ		drav	vn throug	h them.	


RX FORMAT: Sphero-cylinder

Sph cyl axis prism base

OD +2.50 +0.50X 90 If the Rx has a cylinder, it must also have an axis. The axis dictates where we put the **OS** +3.00 +0.25 X 95 cylinder power – 90 degrees away from the axis. The sign of the cylinder, like the sphere, **ADD** can be + or -. OD's tend to OD write in minus cylinder & OS **MD's tend to write in plus** cylinder.



Prescription Format: Prism & Near



TRANSPOSITION OF RX

- Expression of the prescription with a plus or a minus cylinder value.
- Does not alter power... just alters its written form.
- Steps:
 - ALGEBRAICALLY ADD SPHERE & CYLINDER
 - CHANGE THE SIGN OF THE CYLINDER
 - CHANGE THE AXIS BY 90 DEGREES (stay within a 0-180 axis)



TRANSPOSITION: Minus Cyl to Plus Cyl

Prescription \rightarrow OD -2.00 -1.00 x 030

Step 1 – Algebraically add sphere and cylinder (-2.00) + (-1.00) = -3.00 new sphere power Step 2 – Change sign of cylinder -1.00 becomes ± 1.00 new cylinder power Step 3 – Change axis by 90 (0-180 range) $30 \pm 90 = 120$ new axis meridian

Transposed Rx \rightarrow OD -3.00 +1.00 x 120



TRANSPOSITION: Plus Cyl to Minus Cyl

Prescription \rightarrow OD -3.00 +1.00 x 120

Step 1 – Algebraically add sphere and cylinder (-3.00) + (+1.00) = -2.00 new sphere power Step 2 – Change sign of cylinder +1.00 becomes -1.00 new cylinder power Step 3 – Change axis by 90 (0-180 range) 120 - 90 = 30 new axis meridian

Transposed Rx \rightarrow OD -2.00 -1.00 x 030



TRANSPOSITION OF RX

- +3.25 +1.25 X 100 ----- +4.50 -1.25 X 10
- -4.75 -1.75 X 75 ----- -6.50 +1.75 X 165
- -1.00 -1.00 X 80 ----- ???
- +2.25 1.50 X 170 ----- ???
- -3.00 + 1.25 X 110 ----- ???



TRANSPOSITION OF RX

- +3.25 +1.25 X 100 ----- +4.50 -1.25 X 10
- -4.75 -1.75 X 75 ----- -6.50 +1.75 X 165
- -1.00 -1.00 X 80 ----- -2.00 +1.00 X 170
- +2.25 1.50 X 170 ----- +0.75 +1.50 X 80
- -3.00 + 1.25 X 110 ----- -1.75 -1.25 X 20



Refractive Errors and Solutions





<u>HYPEROPIA</u> Farsightedness

- THE REFRACTIVE CONDITION OF THE HUMAN EYE THAT WILL NOT ALLOW PARALLEL RAYS OF LIGHT TO FOCUS ON THE RETINA. RATHER, THERE IS A VIRTUAL FOCUS BEHIND THE RETINA.
- IN EFFECT, THE EYE IS TOO WEAK ----OR---- THE GLOBE IS TOO SHORT.



Hyperopia





Correction for Hyperopia





<u>PLUS LENSES</u>

- Thicker at the center
- Magnifies images
- Has AGAINST motion
- Converges incident light rays
- Real Image
- Corrects for hyperopia





Plus or Converging Lens

 Prisms placed base to base will converge light passing through them



Plus or Converging Lens

 Light is bent toward the base of the prism





Plus or Converging Lens

• Image formed is a Real Image



Characteristics of a Plus Lens

- Thicker at the center than at the edges
- Converges light rays
- Has a real focus (Real Image)
- Magnifies objects
- Against Motion





Characteristics of a Plus Lens

 When and object is viewed through a plus lens, and when the lens is moved, the object moves in the opposite direction





MYOPIA

- Nearsightedness The refractive condition of the human eye where parallel rays of light are focused in front of the retina.
- In effect, the eye is too strong --- or--- the globe is too long.



Myopia





Correction for Myopia





MINUS LENSES

- Thicker at the edge
- Minifies images
- Has WITH motion
- Diverges incident light rays
- Virtual Image
- Corrects for myopia



Minus or Diverging Lens

 Prisms placed apex to apex will diverge light rays passing through them





Minus or Diverging Lens

 Prisms placed apex to apex will diverge light rays passing through them



Minus or Diverging Lens

 Image formed is called a Virtual Image





Characteristics of a Minus Lens

- Thinner at the center then at the edge
- Diverges light rays
- Has a virtual focus (Virtual Image)
- Minifies objects
- With Motion



Characteristics of a Minus Lens

• When and object is viewed through a minus lens, and when the lens is moved, the object moves in the same direction





<u>meridian/axis</u>



- Lens meridians are numbered from 0 and go up to 360 degrees.
- Meridian extends across entire surface of lens in every meridian.
 0 extends to 180, 90 extends to 270, 135 extends to 315,...
- 0-180 meridians are prescribers notation
- 180-360 meridians used for lab notation



RX ANALYSIS for Total Power

- OD 4.00 + 2.25 x 090 Only SPHERE Power at axis
- Cylinder Power is always 90 degrees away from the axis

• Total Power @ 180 = -4.00 plus + 2.25 = -1.75

- OD 2.00 -1.25 x 180 Only SPHERE Power at axis
- Cylinder Power is always 90 degrees away from the axis

• Total Power @ 090 = -2.00 plus - 1.25 = -3.25

OPTICAL CROSS

- A TECHNIQUE USED TO SHOW THE RX OF AN OPHTHALMIC LENS IN ITS PRIMARY MERIDIANS
- **PRIMARY MERIDIANS:** THE AXIS OF THE RX AND 90 DEGREES AWAY



Vertometer Readings

2 Ρ В 75 L U S A 75 С K 25 0 25 М R 5 Е 1 Ν D U S 2





OPTICAL CROSS









RX: +2.00 -.75 X 90





RX: -3.00 -1.00 X 180





RX: -3.00 -1.00 X 180





BASE CURVES

- THAT CURVE FROM WHICH ALL OTHER CURVES ARE DETERMINED
- FOR A CYLINDRICAL SURFACE, THE FLATEST (LOWEST) CURVE ON THAT SURFACE
- IN A SINGLE VISION LENS, THE FLATEST CURVE ON THE FRONT SURFACE
- IN BIFOCALS, THE ONLY CURVE ON THE SAME SIDE AS THE SEGMENT (ALWAYS A SPHERE)


- USED TO SHOW THE CURVATURE OF AN OPHTHALMIC LENS NEEDED TO ARRIVE AT THE RX
- For our purposes now, we will simply subtract the front power from the back power to get the RX



















Optical Cross







<u>+13.00</u> -6.00 - 10.00



Axis is located at meridian of least power or lowest curve

on toric surface









Curve Illustration

<u>+4.00</u> -6.00 - 10.00



Rx -2.00 - 4.00 x 180

Axis is located at meridian of least power or lowest curve

on toric surface



Dispersion Through a Prism







Newton's experiment

- The breaking up of white light into its component colors --- roy g. biv
- All lenses have dispersion; crown glass, at 58.6, is the best so far.
- The lower the number the more the dispersion.
- Patient complaint of seeing "rainbows".
- Polycarbonate, at 30, is the worst offender so far.
- Dispersion is a function of MATERIAL, not Index "N"



Abbe Value

- White light is composed of the visible spectrum of wavelengths each corresponding to a different color.
 When light enters a prism it is bent toward the base of the prism
- Shorter wavelengths (e.g., violet) are bent at a greater angle than longer wavelengths (e.g., red)
- Since a lens is like to two prisms (apex to apex for a minus lens and base to base for a plus lens), light passing through a lens has a tendency to disperse into its respective colors as its varying wavelengths are focused at differing points.

Abbe Value

- The tendency to of a material to separate light in this manner is called **chromatic aberration** and is measured by its **Abbe value**.
- The Abbe value of a material is inversely proportional to the chromatic aberration induced as light passes through it.
- In other words, the higher the abbe value, the lower the amount of chromatic aberration.
- Inn general, the **higher the index** of a lens material, the **higher the chromatic aberration**, and the **lower the Abbe value**.

REFRACTION

- DEFINITION: The bending of light as it passes obliquely from one medium to another of a different index of refraction (N).
- The amount of refraction depends on the incident angle & the index of the media.
- SNELL'S LAW
- DENSE TO DENSER = TOWARD THE NORMAL
- DENSE TO LESS DENSE = AWAY FROM THE NORMAL
- DENSER MATERIAL (n) = GREATER REFRACTION



• SNELL'S LAW

REFRACTION = TOWARD THE NORMAL

- DENSE TO LESS DENSE = AWAY FROM THE NORMAL
- DENSER MATERIAL (n) = GREATER REFRACTION





Refractive Index

- Refractive index: indicates how much the material will refract or bend light as it enters the material from air
- Compares the speed of light in a given material to the speed of light in air (186,000 mps)
- The higher the index number of a given material, the more the light will refract as it enters the material
- If a material has a greater ability to refract light, less of a curve is required to obtain a specific power, resulting in a thinner lens.
- Plastic (CR-39) and Crown Glass are considered base index with indices of 1.498 and 1.52 respectively.
- Materials with an index between 1.53 and 1.57 are considered mid-index
- Materials with an index of 1.58 and greater are considered high-index
- More frequently, however, anything over 1.53 is called highindex.

REFRACTION

N = <u>SPEED OF LIGHT IN AIR</u> (186,000 mps) SPEED OF LIGHT IN MEDIUM

- THE MORE LIGHT SLOWS DOWN IN A MEDIUM, THE GREATER THE REFRACTION
- Example: IF LIGHT TRAVELS AT 124,000 MILES/SECOND IN A MEDIUM, FIND N.
- 186,000/124,000 = N = 1.50 Cr-39
- Example: IF LIGHT TRAVELS AT 121,569 MILES/SECOND IN A MEDIUM, FIND N.
- 186,000/121,569 = N = 1.53 Trivex



Specific Gravity

- Specific gravity describes the density of a lens material by comparing its density to the density of water
- The higher the specific gravity of a lens material, the higher the density, and consequently, the heavier a lens of that material will be for a given power and size.



Lens Materials

Index	Mater Density	ial Clarity	
1.49	Cr-39 Plastic	Abbe V 58	SG 1.32
1.523	Crown Glass	Abbe V 59	SG 2.54
1.53	Trivex	Abbe V 43	SG 1.11
1.58	Poly	Abbe V 30	SG 1.21
1.60	High Index	Abbe V 36	SG 1.30
1.67	High Index	Abbe V 32	SG 1.32
1.71	High Index	Abbe V 36	SG 1.35
	1.74 SG 1	High Index L.40	Abbe V 33



LIGHT PROPERTIES

- LIGHT STRIKING A TRANSPARENT MEDIUM WILL BE:
 - ABSORBED
 - REFLECTED
 - REFRACTED
- ABSORPTION VARIES WITH LENS MATERIAL
- REFLECTION: 3.5% TO 4% of a LENS SURFACE
 - also varies with Index "N"









- WHEN THE FRAME DOES NOT SIT AT THE SAME VERTEX DISTANCE AS THE PHOROPTER/TRIAL FRAME DID DURING THE EXAMINATION
- RULES
 - + MOVED AWAY GETS STRONGER
 - + MOVED CLOSER GETS WEAKER
 - MINUS MOVED AWAY GETS WEAKER
 - MINUS MOVED CLOSER GETS STRONGER







MANIPULATION of FOCAL LENGTH





MANIPULATION of FOCAL LENGTH



MULTI-FOCALES SELECTION

Reading Section



• THE NEAR DESIGN SHOULD REFLECT THE AN Distance Section T SPENDS AT NEAR TASKS

> ID, EXECUTIVE - AKA FRANKLIN; ULTEX A LENDED; PROGRESSIVE













PROGRESSIVE DESIGN • Generic progressive design





Basic Marking Layout of a progressive design PROGRESSIVE DESIGN



OD – rear view minimum heights 13 mm to 24 mm – most insets 2

OBLIQUE CYLINDER POWER

- TO DETERMINE THE PORTION OF CYLINDER POWER AWAY FROM THE AXIS
- 90 DEGREES = FULL CYLINDER POWER
- 60 DEGREES = 75%
- 45 DEGREES = 50%
- 30 DEGREES = 25%
- 0 DEGREES (at axis) = 0%
- Works in either direction



Alternate Method

 -1.00 – 2.00 x 60. What is approximate power in 90th meridian?

90 – 60 = 30 degrees

30 degrees is 25% of cylinder power

25% x -2.00 = -.50

The 90th meridian is 30 degrees away from the axis of the cylinder, thus the power in the 90th meridian is 25% of the cylinder power only!

Add algebraically this percentage of the cylinder power (-.50) to the sphere power to obtain the total power in the 90th meridian

(-.50) + (-1.00) = -1.50



Rule of Thumb

5°.01	50°.09
.02	.08
.04	.08
.05	.07
.06	.06
.07	.05
.08	.04
↓ .08	.02
45°.09	90°.01



What is approximate total power along the vertical meridian (90) for the Rx -1.00 -2.00 x 60

• 30 degrees away from the axis

.01	Power of cylinder = -2.00 (.25)
00	

- .02 = -.50 D
- .04 -.50 + -1.00 = -1.50 D

.05 .06 <u>.07</u>

.25



Example #1

- Rx of +2.50 100 x 10
- What is the approximate power at 0 meridian?
- Remember Rule of Thumb?
- The difference between $0^{\circ} \& 10^{\circ} = 10^{\circ}$
- Rule of Thumb 5 °=.01 &10°= .02
- .01 + .02 = .03
- Power of the cylinder = 1.00 (.03)

-.03 + +2.50 = +2.47


- Rx of +2.50 100 x 10
- What is the approximate power at 180 meridian?
- Remember Rule of Thumb?
- The difference between 180° & 10° = 10°
- Rule of Thumb 5 °=.01 &10°= .02
- .01 + .02 = .03
- Power of the cylinder = 1.00 (.03)

$$-.03 + +2.50 = +2.47$$



- Rx is -5.50 -2.25 x 130
- What is the power at 180 meridian?
- Remember Rule of Thumb?
- $180^{\circ} 130^{\circ} = 50^{\circ} = .59$
- Power of the cylinder = 2.25 (.59)

= -1.32

-1.32 + -5.50 = -6.82



Rule of Thumb

	5°.01		50°.09
	.02		.08
	.04		.08
	.05		.07
	.06		.06
	.07		.05
	.08		.04
\downarrow	.08	\checkmark	.02
	45°.09		90°.01



- Rx is -3.00 -2.00 x 30 What is the power at 90 meridian?
- Remember Rule of Thumb?
- $90^{\circ} 30^{\circ} = 60^{\circ} = 75\%$ of the cylinder power
- Power of the cylinder = 2.00 (75%)

-1.50 + -3.00 = -4.50



- Rx +1.50 +2.00 x 30. What is the power at 180 meridian?
- Remember Rule of Thumb?
- 30° = 25% of the cylinder power
- Power of the cylinder = +2.00 (25%)

= +.50

+1.50 + .50 = +2.00



- OD 1.00 1.00 x 45 What is the power at 90 meridian?
- Remember Rule of Thumb?
- 45° = 50% of the cylinder power in OD
 OD -1.00 -1.00 x 45
 OD -D fill of (50%)

OD - Power of the cylinder = -1.00(50%) = -.50

-1.00 + -.50 = -1.50



PRISM

• CHARACTERISTICS

- SHAPE / DEFINITION
- LIGHT DEVIATION
- WANTED AND UNWANTED
- BASE DIRECTION & RULES



Prism Diopter Δ

- Prisms were first measured to the degree of the apical angle
- Prism diopter is denoted by the Greek letter delta Δ
- C.F. Prentice in 1890, advocated a metric system of numbering prisms
- A 1 prism diopter lens will deviate a ray of light exactly one cm, 10 mm or .1 m on a screen one meter away



Use of Prisms

- Prisms are commonly prescribed by eye doctors in conjunction with lens prescriptions to alleviate the symptoms which occur in muscle imbalance
- Prisms are routinely used during eye examinations to dissociate the eyes in order to temporarily interrupt fusion



Ophthalmic Prism Visualizations Patient View





Ophthalmic Prism Base Directions

- A prism is placed before the eye with reference to the base.
- Ex. Base In BI
 - Base Up BU Base Out – BO Base Down - BD



Point to Remember!

• BI and BO Prism are referenced in relation to the nose of the patient, regardless of minus or plus power

















Effect of Prism on Light

 A prism deviates light toward its <u>base</u> but the apparent displacement of objects is toward the <u>apex</u>



Ray of Light Deviated Towards Prism Base

• Objects seen through a prism are d





Effect of Prism on Light

- A prism separates light into its "rainbow" spectrum
- Dispersion breaking up of light into its component colors
- ROYGBIV or ROY G. BI





Effect of Light on Prism

- A prism has no focal length
- A prism deviates light toward the base
- An object viewed through a prism will appear to be in a different place than viewed without a prism
- The <u>greater</u> the angle of the apex (Apical Angle), the <u>thicker</u> the prism and therefore, the greater the dioptric power. The <u>stronger</u> the prism, the <u>more</u> it will bend light.





Deviation vs. Displacement

- Deviation in prism is similar to angle of deviation as discussed in refraction.
- The <u>stronger</u> the prism the <u>more</u> the light will <u>deviate</u> and the <u>more</u> the image will be <u>displaced</u>



Deviation by Weak and Strong Prisms



Prism Diopter Δ







Strabismus (Heterotropia)

- Is when one eye is not aligned with the other eye causing the other eye to look in a different direction.
- Result: Diplopia or Double Vision since two objects are imaged onto the maculas of both eyes.
- In order to see, the person's brain learns to "suppress" the image in the turned eye.



Amblyopia (Lazy Eye)

- When an eye is suppressed (turned off) for too long, the visual acuity in the "Lazy eye" is no longer good. Due to the lack of use, the lazy eye shuts down and decreases the patient vision in that eye.
- The Angle of Deviation of strabismus is measured in "prism diopters"
- Strabismus occurs in about 2% of children
- Esophoria or Exophoria tendency for the eye to turn
- Esotropia or Exotropia a fixed turning of the eye



Most common type of Strabismus

- Esotropia
- Exotropia
- Vision Therapy maybe indicated where complete suppression has not occurred. (Use of prism and eye patching)
- Surgical Correction is the other alternative
- Surgery corrects the deviation, however binocular vision will not usually result







Normal Eye Alignment





Left Eye Esotropia

 The left eye is turned in so the macula in the left eye is turned outward





Relieving Prism

- Is placed in front of the eye with a weak or paralyzed muscle to displace the image in the same direction that the eye turns
- It reduces the distance the muscles have to turn the eye to aim it correctly
- Rule: Point prism in the direction of the tropia (Exotropia – out, Esotropia – in)



Relieving Prism – Esotropia O.S.

• The reason the apex of the pirsm is pointed toward the deviation is that the light is deviated toward the base of the prism. In the case of esotropia, the eye is turned in. The macula is turned out. A prism with the apex toward the nose will bend light outward to strike the macula which in this case is positioned outward





Relieving Prism – Esotropia O.S.



Relieving Prism – Esotropia O.D.

 In a person with a right esotropia, the right fovea is turned temporally. To focus light on the right fovea, a prism base (apex in) is placed in front of the right eye



Adverse Prism

- Is prescribed to stimulate an eye muscle and to make it work harder.
- The technique may be used during eye exercises designed to strengthen the weak muscle



Fresnel Prism

- The French physicist, Augusti-Jean Fresnel is credited with the invention of the concept of this form of lens. Their initial use was primarily to replace the very thick lenses used in lighthouses. To obtain lenses powerful enough for lighthouses, massive heavy lenses were required. By designing the lens as a series of small segments, rather than one large lens, the great weight could be removed.
- The first Fresnel lens was placed in the Cordouan Lighthouse at the mouth of the Gironde estuary in 1823.





Fresnel Prisms

 The Fresnel Press-on lenses used in ophthalmic care today are wafer thin lenses. They are manufactured by the 3M company. 3M Press-on Optics are fabricated from flexible static vinyl which allows them to be easily cut to fit on ophthalmic eyewear lenses. They are available in both lenses and prisms, and available in prism powers up to 40 prism diopters.





CONVENTIONAL OPHTHALMIC PRISM





Fresnel Press-On Prism Applied to OS



Advantages and Disadvantages

- The main advantage of 3M Press-ons Optics is that they are wafer thin compared to a normal ophthalmic prism.
- The disadvantage is that the flexible static vinyl material that gives these lenses the ability to be easily cut to custom shapes, unfortunately, reduces the contrast of objects viewed through the lens.



Prismatic Effect and Eyeglasses

- When inspecting a pair of eyeglasses, the optical centers should be located and measured prior to dispensing
- After fabrication, the dotted PD's from the lensometer should be the same as the patient PD given? YES or NO?



 Patient PD should match the dotted PD's after markup on the lensometer




PRISM

- Thin Edge = Apex
- Thick Edge = Base
- Prism Diopters = 1cm deviation / 1 M Distance
- Light directed toward the BASE
- Image directed toward the APEX



Prismatic Effect

- The visual center of a lens is the point through which the patient actually sees through the lens. Also called the optical center
- If prismatic effect is desired, the visual center and optical center of the lens will not coinside





Prentice Formula

 $\Delta = D x$ Decentration (in mm) 10 D = Power in the specific meridian Δ = Prism Diopters or The formula can be written to find the amount of decentration needed to obtain a given prism value $Dec = 10 \times \Delta$ D



• Compute the amount of prism by decentering a -5.00 D lens 5 mm.

$$\Delta = \underline{D \times Decentration (in mm)}{10}$$
$$\Delta = \underline{5 \times 5} = \underline{25} = 2.5\Delta$$
$$10 \quad 10$$



• What is the prismatic effect at a point 2 mm from the optical center of a +3.00 D lens?

$$\Delta = \underline{D \ x \ Decentration (in mm)}$$

$$10$$

$$\Delta = \underline{3 \ x \ 2} = \underline{6} = .6\Delta$$

$$10$$

$$10$$



• Suppose we have a concave lens of

-3.00 which is to be decentered 7 mm. What is the prism power obtained by doing so?

 $\Delta = Dx$ Decentration (in mm)

$$\Delta = \frac{3 \times 7}{10} = \frac{21}{10} = 2.1\Delta$$



• Compute the amount of decentration needed for a -5.00 D to obtain 2.5Δ .

Dec =
$$\frac{10 \times \Delta}{D}$$

Dec = $\frac{10 \times 2.5\Delta}{5} = \frac{25}{5} = 5$ mm



• Compute the amount of decentration needed for a +4.00 D to obtain 2Δ .

Dec =
$$10 \times \Delta$$

D
Dec = $10 \times 2\Delta$ = 20 = 5mm
 4 4



• Compute the amount of decentration needed for a +3.00 D to obtain $.6\Delta$.

Dec =
$$10 \times \Delta$$

D
Dec = $10 \times .6\Delta = 6 = 2$ mm
 $3 \qquad 3$



Base Direction Compared to Where the Patient is looking

- When recording a prism amount, we must also state the direction of the prism relative to the wearer's eye.
- If we go back to our basic knowledge that all lenses are merely combinations of prisms, we should be able to visualize every optical viewing situation.



Ophthalmic Prism Visualizations





Ophthalmic Prism Base Directions

- A prism is placed before the eye with reference to the base.
- Ex. Base In BI
 Base Up BU
 Base Out BO
 Base Down BD



• BI and BO Prism are referenced in relation to the nose of the patient, regardless of minus or

Point to Remember!

















- What is the prismatic effect 2 mm nasal from the optical center of a – 5.00 D lens? (The lens is being moved out)
 - $\Delta = Dx$ Decentration (in mm)

 $\Delta = 5 \times 2 = 10 = 1\Delta$ 10 10

1Δ BI

Minus Lens Optical Center Wide Base In



 What is the prismatic effect 2 mm temporal from the optical center of a – 5.00 D lens?

(The lens is being moved in)

 $\Delta = D x$ Decentration (in mm)

$$\Delta = 5 \times 2 = 10 = 1\Delta$$
$$10 \quad 10$$
$$1\Delta BO$$





• What is the prismatic effect 2 mm nasal from the optical center of a +3.00 D lens?

(The lens is being moved out)

$$\Delta = D x Decentration (in mm)$$

10



Plus Lens OpticalCenter Wide Base Out



 What is the prismatic effect 2 mm temporal from the optical center of a +3.00 D lens?

(The lens is being moved in)

 $\Delta = Dx$ Decentration (in mm)

10

$$\Delta = 3 \times 2 = 6 = .6\Delta$$
10
10
.6\Delta BI



Plus Lens Optical Center Narrow Base In



- What is the prismatic effect 2 mm above the optical center of a -5.00 D lens?
 - $\Delta = D x$ Decentration (in mm)

 $\Delta = 5 \times 2 = 10 = 1\Delta$ $10 \quad 10$ $1\Delta BU$



Minus Lens Optical Center Low Base Up



• What is the prismatic effect 2 mm below the optical center of a -5.00 D lens?

 $\Delta = D x$ Decentration (in mm)

$$\Delta = 5 \times 2 = 10 = 1\Delta$$
$$10 \quad 10$$
$$1\Delta BD$$

Minus Lens Optical Center High Base Down



• What is the prismatic effect 2 mm above the optical center of a +3.00 D lens?

 $\Delta = D x Decentration (in mm)$



Plus Lens Optical Center Low

Base Down



• What is the prismatic effect 2 mm below the optical center of a +3.00 D lens?

 $\Delta = Dx$ Decentration (in mm)



Plus Lens Optical Center High Base Up



Example # 9 With a prescription of +3.00 -1.50 x 90 what amount of decentration will provide 1 prism diopter, BI?



Answer $Dec = 10 \times 1 \Delta$ 1.50 $Dec = 10 \times 1\Delta = 10 = 6.67mm$ 1.50 1.50Why the 1.50 Power?



• With a prescription of-2.75 + 1.00 x 180 what decentration will produce 4 prism diopters base up?







Approximate Power of Cylinder Power

- When cylinder power is incorporated in a prescription, approximate power at 180 or 90 degree is your point a reference.
- This will depend on whether the prismatic effect is Horizontal or Vertical
- We will need to use the Oblique Meridian formula in these cases



 How much prism is present 4 mm on the nasal side of the optical center for the Rx of +2.50 – 100 x 10 (Optical Center is being moved out)

=

- Remember Rule of Thumb?
- 180° (0°) 10° = 10° = .01 + .02 = 03
- Power of the cylinder = 1.00 (.





Plus Lens OpticalCenter Wide Base Out



Rule of Thumb

5°.01	50°.09
.02	.08
.04	.08
.05	.07
.06	.06
.07	.05
.08	.04
↓ .08 ↓	.02
45°.09	90°.01



- The Rx is -5.50 -2.25 x 130. If the optical center is moved out 6 mm, what is the prismatic effect?
 (Optical Center is being moved out)
- Remember Rule of Thumb?
- $180^{\circ} 130^{\circ} = 50^{\circ} = .59$
- Power of the cylinder = 2.25 (.59)

-1.32 + -5.50 = -6.82 $\Delta = 6 \times 6.82 = 40.92 = 4.1\Delta$ 10 10 4.1 Δ BI



Base In



 The Rx is -3.00 -2.00 x 30. What is the prismatic effect looking 3 mm above the optical center of the lens?
 (Optical Center is being moved down)

= -1.50

Minus Lens Optical Center Low

Base Up

- Remember Rule of Thumb?
- $90^{\circ} 30^{\circ} = 60^{\circ} = 75\%$ of the cylinder power

$$-1.50 + -3.00 = -4.50$$

 $\Delta = 3 \times 4.50 = 13.50 = 1.4\Delta$
10 10
1.4 Δ BU

Determining Overall Prismatic Effect

- When the eyeglass wearer is looking through any point other than the optical centers of the lenses, visual discomfort may occur as well as eye fatigue (Asthenopia)
- When prism is induced in each lens in a pair of glasses, we need to determine whether the prism will cancel each other or compound each other
- Regardless of the amount of prism in any one eye, the wearer only experiences the residual or combined effect of lenses in tandem



Canceling and Compounding Situations

- Base directions are either cancelled or compounded from eye to eye
- In canceling situations, subtract the smaller prism amount from the larger amount. Then assign the prism direction to the lens originally having the large prism amount
- In compounding situations, add the two prism amounts together to give the total effect



Prism Situations

Canceling Situations

- Base Up and Base Up
- Base Down and Base Down
- Base In and Base Out

Compounding Situations

- Base Up and Base Down
- Base In and Base In
- Base Out and Base Out


Sample Chart of Prismatic Effect

• Right Eye Left Eye Situation Resulting Effect

• 2∆ up	4 ∆ up	cancel	ing	2 ∆ up Left Eye
• 2 ∆ dn	4 ∆ dn	cancel	ing	2 ∆ dn Left Eye
• 2∆up	2 ∆ up	cancel	ing	No effect
• 2 ∆ in	4∆out	canceling	2∆out	left eye
• 2∆up	4 ∆ down	compounding	6 ∆ tota	l
• 2 ∆ in	4 ∆ in	compo	unding	6 ∆ total
 2 ∆ out 	4Δout	compounding	6Δ	total

- Point to Remember! Compounding Situations
- UP DOWN IN IN OUT OUT ADD/ Everything else subtract



- Given Rx OD +4.00 OS + 4.00
 - Frame PD = 68, Patient PD = 64
 - What is the amount and direction of prism if the above lenses are not decentered in each eye and what is the total prismatic effect?
 - 68 64 = 4 mm ÷ 2 = 2 mm each eye





Answer $\Delta = \frac{d \times D}{10} = \frac{2mm \times 4.00}{10} = 0.8 \Delta BO each eye$

Visual lines are passing through the inside portion of lenses which is, in effect, base out prism

 $0.8 \Delta BO OD$ $0.8 \Delta BO OS$ Total = 1.6 ΔBO



- Given Rx OD 4.00 OS 4.00
 - Frame PD = 68, Patient PD = 64
 - What is the amount and direction of prism if the above lenses are not decentered what is the prismatic effect for each eye and what is the total prismatic effect?
 - 68 64 = 4 mm ÷ 2 = 2 mm each eye





Answer $\Delta = \frac{d \times D}{10} = \frac{2mm \times 4.00}{10} = 0.8 \Delta BI each eye$

Visual lines are passing through the inside portion of lenses which is, in effect, base out prism

 $0.8 \Delta BI OD$ $0.8 \Delta BI OS$ Total = <u>1.6 ΔBI </u>



• A patient is wearing +4.00 OU. What is the prismatic effect in the vertical meridian 10 mm below the optical center of the lens?

$$\Delta = 10 \times 4.00 = 40 = 4\Delta BU$$

10 10





Plus Lens Optical Center High Base Up



• A patient is wearing -5.00 OU. What is the prismatic effect in the vertical meridian 10 mm below the optical center of the lens?

$$\Delta = 10 \times 5.00 = 50 = 5\Delta BD$$

10 10







• A patient is wearing +1.00 OD and +3.75 OS. What is the prismatic effect in the meridian 10 mm below the optica OC 10MM lens? RL

$$\Delta = \frac{10 \times 1.00}{10} = \frac{10}{10} = 1\Delta BU$$

$$10$$

$$\Delta = \frac{10 \times 3.75}{10} = \frac{30.75}{10} = 3.75\Delta E$$

$$10$$
Canceling Situation - The net difference is

2.75 Δ BU



00

00

RL

10MM

- A patient is wearing +1.75 OD and -.75 the prismatic effect in the vertical meric below the optical center of the lens?
- $\Delta = \underline{10 \times 1.75} = \underline{17.50} = 1.75\Delta BU$ 10
 10 $\Delta = \underline{10 \times .75} = \underline{7.5} = .75\Delta BD$ 10
 10
 10



Compounding Situation - The net difference is 2.50 Δ BU





VERTICAL IMBALANCE PRISMATIC TOLERENCE:

- Vertical prism is <u>NOT</u> tolerated well
- Horizontal will vary with pt.

When to Calculate VI:

- 1.50D of Anisometropia or if symptoms
- Formula: (Prentice Formula)
 VI = (Differ Pwr @ 090° x Reading Level) / 10



WAYS to CORRECT VI

- Two Pair of Glasses
- Prism in Segments Only
- Fresnel press-on prisms
- Dissimilar Segments
- R-Compensated Segments
- Slab Of f Prism



How to Calculate Slab Off (Bicentric Grinding)

- Determine power of each lens in 90 ° meridian
- Determine distance from optical center of carrier lens to reading level
- Apply Prentice Formula to calculate amount of vertical prism induced in each eye at the reading level
- The difference in amount of vertical prism in each eye is approximately equivalent to amount of prism to be "slabbed off"
- Conventional Slab Off is always ground base up on the lens with the most minus or least plus in the 90th meridian



Reverse Slab Off

 A lens design that is available to the laboratory from the lens manufacturer in which the prism has already been molded into the semi-finished lens. As the name suggests, the prism base is oriented base down or in the reverse direction of the conventional base up orientation. In this case the slab off is placed in the lens with the least minus or most plus.



Sample Chart of Prismatic Effect

• Right Eye Left Eye Situation Resulting Effect

• 2∆ up	4 ∆ up	cancel	ing	2 ∆ up Left Eye
• 2 ∆ dn	4 ∆ dn	cancel	ing	2 ∆ dn Left Eye
• 2∆up	2 ∆ up	cancel	ing	No effect
• 2 ∆ in	4∆out	canceling	2∆out	left eye
• 2∆up	4 ∆ down	compounding	6 ∆ tota	l
• 2 ∆ in	4 ∆ in	compo	unding	6 ∆ total
 2 ∆ out 	4Δout	compounding	6Δ	total

- Point to Remember! Compounding Situations
- UP DOWN IN IN OUT OUT ADD/ Everything else subtract



Rx O.D. -1.75 -.50 x 180

O.S. -4.75 -.25 x 180 +2.00 Add OU

Reading Level is 10 mm from distance optical center

- Determine power in the 90th meridian for each lens
- 2. R -2.25 L -5.00
- 3. Distance optical center = 10 mm from reading level



 $\Delta = Dx$ Decentration (in mm)

10

D = Power in the specific meridian

 Δ = Prism Diopters

O.D. -2.25×10 = 2.25 \triangle BD

<u>10</u>

O.S. . <u>-5.00 x 10</u> = 5.00 Δ BD 10

UP DOWN IN IN OUT OUT – ADD/ Everything else subtract

5.00 – 2.25 = 2.75 ∆

Rule: Slab off the left eye 2.75 Δ base up for conventional lens (Least Plus/Greatest Minus) or 2.75 Δ BD in Right Eye for reverse slab off.(Greatest Plus/Least Minus)



SLAB-OFF PRISM



Lens Combination	When Using Slab-off	When Using Reverse Slab
Two Minus Lenses	Highest Minus	Lowest Minus
Two Plus Lenses	Lowest Plus	Highest Plus
One Plus, One Minus	The Minus Lens	The Plus Lens

Multi-Focal Style	Slab Placement
Flat Top Bifocal	Slab line should be in line with the top of the bifocal
Trifocals	Slab line should be in line with the bottom of the intermediate portion
Progressives	Slab line should be positioned slightly above the near verification circle



Rx O.D. +1.00 -.25 x 90

O.S. +5.50 - .50 x 90 +3.00 Add OU

Reading Level is 10 mm from distance optical center

- Determine power in the 90th meridian for each lens
- 2. R +1.00 +5.50
- 3. Distance optical center = 10 mm from reading level





$\Delta = D x Decentration (in mm)$

10

D = Power in the specific meridian

 Δ = Prism Diopters

O.D. <u>+1.00 x 10</u> = 1.00 Δ BU

10

O.S. . <u>+5.50 x 10</u> = 5.50 Δ BU

$\underline{10}$ UP DOWN IN IN OUT OUT – ADD/ Everything else subtract 5.50 – 1.00 = 4.5 Δ



SLAB-OFF PRISM



Lens Combination	When Using Slab-off	When Using Reverse Slab
Two Minus Lenses	Highest Minus	Lowest Minus
Two Plus Lenses	Lowest Plus	Highest Plus
One Plus, One Minus	The Minus Lens	The Plus Lens

Multi-Focal Style	Slab Placement
Flat Top Bifocal	Slab line should be in line with the top of the bifocal
Trifocals	Slab line should be in line with the bottom of the intermediate portion
Progressives	Slab line should be positioned slightly above the near verification circle



Checking Slab Off with Lens Clock



• Occasionally, an Rx shows prism in just one lens Splitting Prismight of the lenses and improve cosmetic effect of the prism, opticians may want to **Split the Prism** between the two lenses



Rules for Splitting Prism

- Divide the amount of the prism in half
- Assign one half with the base direction requested in the lens where it was prescribed
- Assign the other half of the prism amount to the other lens with the base in the compounding direction
- Before ordering, always request permission from the refractionist



Example # 1 OD Plano 5 \Delta BU OS Plano

Answer: OD 2.5 \triangle BU OS 2.5 \triangle BD



OD Plano 5 \triangle BU OS Plano 3 \triangle BI

Answer: OD 2.5 Δ BU & 1.5 Δ BI OS 2.5 Δ BD & 1.5 Δ BI



Example # 3 OD -5.00 OS -5.00 4 Δ BI

Answer: OD -5.00 2 Δ BI OS -5.00 2 Δ BI



OD -5.00 -1.00 x 180 3 ∆ BU OS -5.00 - 1.00 x 180

Answer: OD -5.00 – 1.00 x 180 1.5 Δ BU OS -5.00 – 1.00 x 180 1.5 Δ BD



OD +5.00 - .50 x 90 OS +5.00 5 Δ BD

Answer: OD +5.00 – .50 x 90 2.5 Δ BU OS +5.00 2.5 Δ BD



Thank You

Good Luck on the ABO

• For more information, contact the NFOS or visit our website at <u>www.nfos.org</u>

• Power-point by Professor Robert J. Russo – Email: <u>information@nfos.org</u>

