Brien Holden Vision Institute

OPTICAL CROSSES AND TRANSPOSITION

THINK

A woman comes to your clinic to buy a pair of spectacles. She had her eyes examined at another clinic last week and shows you the prescription for spectacles that she was given.

You notice that the prescription has been written using plus cylinder notation – but at your clinic you use minus cylinder notation.

How will you transpose the plus cylinder prescription into a minus cylinder prescription so that you can make the spectacles for the woman?

AIM

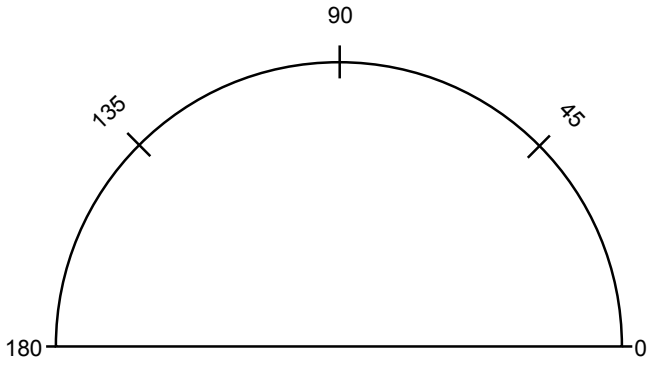
This unit will show you how to use optical crosses and how to transpose spectacle prescriptions.

LEARNING OUTCOMES

When you have worked through this unit you should be able to:

- draw and use an optical cross to examine the powers of the principal meridians of a sphero-cylindrical lens
- transpose plus and minus cylinder prescription notations.

REVIEW: OPTICAL CROSSES AND TRANSPOSITION

SPHERICAL LENSES	• A spherical lens has the same refractive power along all of its meridians. • A spherical lens does not have an axis meridian.
CYLINDRICAL LENSES	• Cylindrical lenses correct astigmatism. • Cylindrical lenses have two meridians: an axis meridian and a power meridian. • There is no refractive power along the axis meridian. There is only refractive power along the power meridian.
SPHERO-CYLINDRICAL LENSES	• A sphero-cylindrical lens can be thought of as being the same as a spherical lens that is joined to a cylindrical lens. • Sphero-cylindrical lenses correct astigmatism that is combined with another refractive error (myopia, hyperopia or presbyopia). • The two principal meridians of a sphero-cylindrical lens have different powers: → Power meridian has the maximum focusing power → Axis meridian has the minimum focusing power • Astigmatic lenses can be cylindrical or sphero-cylindrical lenses.
POWER OF ASTIGMATIC LENSES	• We measure astigmatism lens power in dioptres cylinder. The short way of writing this is DC. • The power of a sphero-cylindrical lens is written like this: **Sphere power** → **+2.00 D** / **–1.25 DC x 70** (**Cylinder power**, **Axis**) ***or:*** **+2.00 D / –1.25 DC x 70** ***or simply:*** **+2.00 / –1.25 x 70** We read this lens power as: “Plus two, minus one point two five, axis 70”. • The axis of a lens is always between 1° and 180° • We use standard axis notation for the axis direction.
STANDARD AXIS NOTATION	

OPTICAL CROSSES

SPHERO-CYLINDRICAL LENSES

We know that a sphero-cylindrical lens can be thought of as a cylindrical lens and a spherical lens joined together.

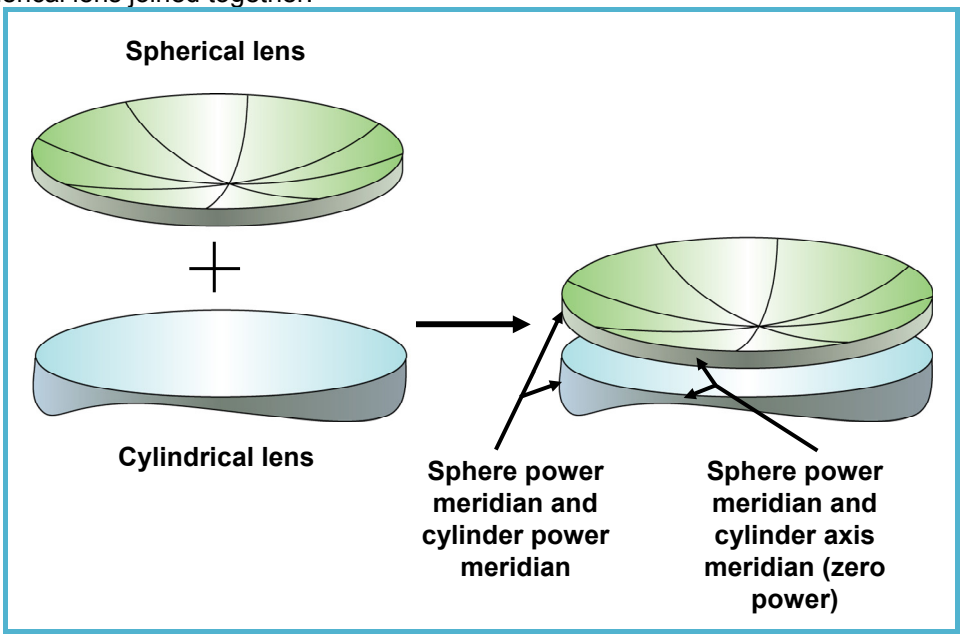


Figure 6.1: *A sphero-cylindrical can be thought of as a cylindrical lens and a spherical lens joined together*

A sphero-cylindrical lens has power in two different principal meridians. These meridians are always perpendicular (at 90°) to each other.

OPTICAL CROSS:

An optical cross is a diagram which shows the orientation (direction) of the principal meridians of an astigmatic lens and the focusing power of the lens in these meridians. It can help you to understand the actual powers that an astigmatic lens has.

Drawing an optical cross:
An optical cross is drawn with two perpendicular lines that represent the two principal meridians of an astigmatic lens.

Steps:

1. Draw a line in the direction of the axis of the cylindrical lens
   → this is your axis meridian line.

2. Draw a second line perpendicular (at 90º) to the first line
   → this is your power meridian line.

3. Write the sphere power next to the axis meridian line.

Add the cylindrical power to the sphere power and write this number next to the power meridian line.

REMEMBER:

The axis meridian of a cylindrical lens has no power.

In Step 3 you are actually adding the power of the cylindrical lens at its axis meridian (which is zero) to the sphere power (which is the same in all meridians).

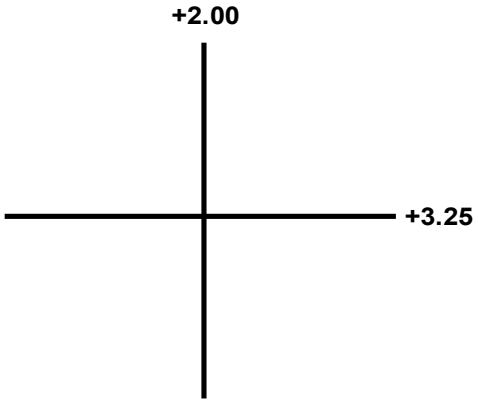
To make it simple, for Step 3 we just say that we are using the sphere power only.

OPTICAL CROSSES (cont.)

EXAMPLE 1

Draw an optical cross for this sphero-cylindrical lens: +3.25 / −1.25 × 180

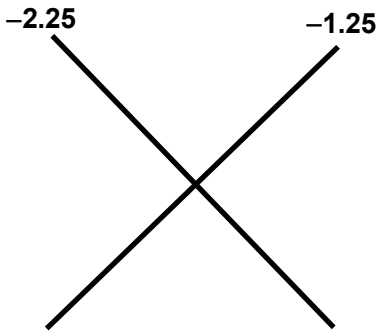
Steps:
1. Draw a line in the direction of the axis of the cylindrical lens
   → The axis meridian line will be at 180°
2. Draw a second line perpendicular to the first line
   → The power meridian is at 90°
3. Write the sphere power next to the axis meridian line
   → +3.25
4. Add the cylindrical power to the sphere power and write this number next to the power meridian line
   → +3.25 + (−1.25) = +2.00



Now we can see that this sphero-cylindrical lens has power in both principal meridians:
- +2.00 DC power at 90°
- +3.25 DC power at 180°.

EXAMPLE 2

Draw an optical cross for this sphero-cylindrical lens: −1.25 / −1.00 × 60.
Steps:
1. Draw a line in the direction of the axis of the cylindrical lens
   → The axis meridian line will be at 60°
2. Draw a second line perpendicular to the first line
   → The power meridian is at 150°
3. Write the sphere power next to the axis meridian line
   → −1.25
4. Add the cylindrical power to the sphere power and write this number next to the power meridian line
   → −1.25 + (−1.00) = −2.25



Now we can see that this sphero-cylindrical lens has power in both principal meridians:
- −1.25 DC power at 60°
- −2.25 DC power at 150°.

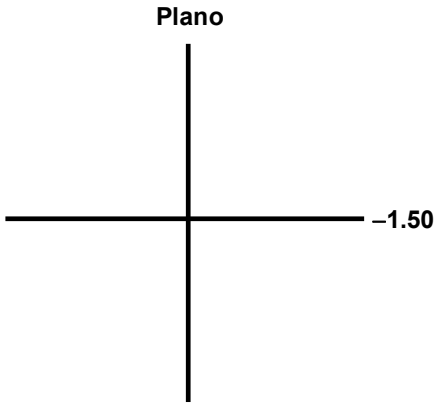
OPTICAL CROSSES (cont.)

EXAMPLE 3

Draw an optical cross for this cylindrical lens: plano / –1.50 × 90.

Steps:

1. Draw a line in the direction of the axis of the cylindrical lens
   → The axis meridian line will be at 90° (vertical)
2. Draw a second line perpendicular to the first line
   → The power meridian is at 180° (horizontal)
3. Write the sphere power next to the axis meridian line
   → Plano
4. Add the cylindrical power to the sphere power and write this number next to the power meridian line
   → 0.00 + (–1.50) = –1.50

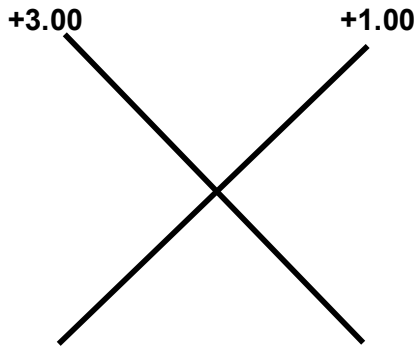


Now we can see that this cylindrical lens has power in just one of its principal meridians:
- no (plano) power at 90° and
- –1.50 DC power at 180°.

EXAMPLE 4

Draw an optical cross for this sphero-cylindrical lens: +1.00 / +2.00 × 45.
(Note: this sphero-cylindrical lens has been written in plus cylindrical notation.)
Steps:

1. Draw a line in the direction of the axis of the cylindrical lens
   → The axis meridian line will be at 45°
2. Draw a second line perpendicular to the first line
   → The power meridian is at 135°
3. Write the sphere power next to the axis meridian line
   → +1.00
4. Add the cylindrical power to the sphere power and write this number next to the power meridian line
   → +1.00 + (+2.00) = +3.00.



Now we can see that this sphero-cylindrical lens has power in both principal meridians:
- +1.00 DC power at 45°
- +3.00 DC power at 135°.

The axis meridian always has less focusing power than the power meridian.

MINUS AND PLUS CYLINDER NOTATION	Optical prescriptions can be written in two ways: - Minus cylinder notation - Plus cylinder notation. We usually use minus cylinder notation, but some practitioners choose to use plus cylinder notation. Both ways are correct, but in your clinic you should choose just one – we recommend that you choose minus cylinder notation. The examples below show the two ways that an optical prescription can be written. These four notation examples are the same as the optical cross examples that were drawn on the previous pages.

	MINUS CYLINDER NOTATION		**PLUS CYLINDER NOTATION**
Example 1	+3.25 / –1.25 x 180	*is the same as*	+2.00 / +1.25 x 90
Example 2	–1.25 / –1.00 x 60	*is the same as*	–2.25 / +1.00 x 150
Example 3	Plano / –1.50 x 90	*is the same as*	–1.50 / +1.50 x 180
Example 4	+3.00 / –2.00 x 135	*is the same as*	+1.00 / +2.00 x 45

TRANSPOSITION

Transposition is used to change a prescription from:

- minus cylinder notation to plus cylinder notation; or
- plus cylinder notation to minus cylinder notation.

METHOD FOR TRANSPOSITION	**Steps:** 1. Add the sphere power to the cylinder power → This will be the new sphere power. 2. Change the sign of the cylinder power. 3. Change the axis by 90°.
EXAMPLE 1	**+3.25 / –1.25 × 180** is written in minus cylindrical notation. Transpose it to plus cylindrical notation. Steps: 1. Add the sphere power to the cylinder power → This is the new sphere power +3.25 + (–1.25) = +2.00 2. Change the sign of the cylinder → –1.25 changes to +1.25 3. Change the axis by 90° → 180° changes to 90°. So +3.25 / –1.25 × 180 becomes +2.00 / +1.25 × 90.
EXAMPLE 2	**–1.25 / –1.00 × 60** is written in minus cylindrical notation. Transpose it to plus cylindrical notation. Steps: 1. Add the sphere power to the cylinder power → This is the new sphere power –1.25 +(–1.00) = –2.25 2. Change the sign of the cylinder → –1.00 changes to +1.00 3. Change the axis by 90° → 60° changes to 150° So –1.25 / –1.00 × 60 becomes –2.25 / +1.00 × 150.
EXAMPLE 3	**Plano / –1.50 × 90** is written in minus cylindrical notation. Transpose it to plus cylindrical notation. Steps: 1. Add the sphere power to the cylinder power → This is the new sphere power 0.00 + (–1.50) = –1.50 2. Change the sign of the cylinder → –1.50 changes to +1.50 3. Change the axis by 90° → 90° changes to 180° So pl / –1.50 x 90 becomes –1.50 / +1.50 x 180.
EXAMPLE 4	**+1.00 / +2.00 × 45** is written in plus cylindrical notation. Transpose it to minus cylindrical notation. Steps: 1. Add the sphere power to the cylinder power → This is the new sphere power +1.00 + (+2.00) = +3.00 2. Change the sign of the cylinder → +2.00 changes to –2.00 3. Change the axis by 90° → 45° changes to 135° So +1.00 / +2.00 × 45 becomes +3.00 / –2.00 × 135.

The optical cross for a lens will never change – only the notation that it is written in can change. This is because we are not changing the powers of the lenses, we are only changing the way they are written.

SUMMARY: OPTICAL CROSSES AND TRANSPOSITION

OPTICAL CROSS

Sphero-Cylindrical Lenses:

- A sphero-cylindrical lens has power in two principal meridians that are perpendicular to each other.
- A sphero-cylindrical lens can be thought of as a cylindrical lens and a spherical lens that are joined together.

Optical Cross:

An optical cross is a diagram which shows the orientation (direction) of the principal meridians of an astigmatic lens and the focusing power of the lens in these meridians.

Drawing an Optical Cross:

- An optical cross is drawn with two perpendicular lines that represent the two principal meridians of an astigmatic lens.
- Steps:
  1. Draw a line in the direction of the axis of the cylindrical lens: this is the axis meridian line
  2. Draw a second line perpendicular to the first line: this is the power meridian line
  3. Write the sphere power next to the axis meridian line.
  4. Add the cyl power to the sphere power and write this number next to the power meridian line.

Minus and Plus Cylinder Notation:

- Optical prescriptions can be written in two ways:
  - minus cylinder notation; or
  - plus cylinder notation.

- Both notations are correct, but in your clinic you should use just one – minus cylinder notation is recommended.

TRANSPOSITION

- Transposition is used to change a prescription from:
  - minus cylinder notation to plus cylinder notation; or
  - plus cylinder notation to minus cylinder notation.

Method for Transposition

Steps:

1. Add the sphere power to the cylinder power
   → This will be the new sphere power.
2. Change the sign of the cylinder power.
3. Change the axis by 90º.

TEST YOURSELF QUESTIONS

1. Why are the two lines of an optical cross always perpendicular (at 90°) to each other?

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_____

2. Draw optical crosses for the following prescriptions:

a) +4.00 / –1.00 × 90	b) –3.00 / –1.25 × 60	c) Plano / –1.75 × 135
d) +2.00 / –2.00 × 180	**e) +1.00 / –1.50 × 45**	**f) −1.00 / − 1.50 x 90**

3. Transpose the following prescriptions into minus cyl notation:

+2.00 / +0.75 × 90 _____

–3.50 / +1.50 × 150 _____

Plano / +1.25 × 60 _____

+2.00 / +2.00 × 45 _____

+1.00 / +1.50 × 80 _____

NOTES