Brien Holden Vision Institute

HAND NEUTRALISATION AND VERTOMETRY

THINK

A widow comes to see you for an eye examination. She brings a pair of spectacles that she bought elsewhere many years ago. She tells you that she thinks her vision has changed.

If you can measure the power of her spectacles:

- you can see if her refractive error has changed, and by how much
- it can give you a starting point for your refraction
- it will help you decide whether or not she needs to get new spectacles.

If you decide to order new spectacles for this widow, you will need to check the new spectacles when they come back from the optical workshop. To measure the power of the spectacles you will need to use hand neutralisation or vertometry.

AIM

This unit will show you two methods for measuring the power of spectacle lenses.

LEARNING OUTCOMES

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

- use trial lenses to determine spectacle lens power
- use a vertometer to measure the power of spectacle lenses.

REVIEW: HAND NEUTRALISATION AND VERTOMETRY

SPHERICAL LENSES	• Spherical lenses correct hyperopia, myopia and presbyopia. • Plus lenses are thicker in the centre and minus lenses are thicker at the edge. • Spherical refractive power is measured in dioptres (D).
ASTIGMATIC LENSES	• Cylindrical lenses correct astigmatism. • A sphero-cylindrical lens can be thought of as being like a spherical lens that is joined to a cylindrical lens. • Sphero-cylindrical lenses correct astigmatism that is combined with hyperopia, myopia or presbyopia. • The thickness of an astigmatic lens is different at different places around its edge. • Cylindrical lenses have two meridians: an axis meridian and a power meridian. • Astigmatic lens power is measured in dioptres cylinder (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
TRIAL LENS SETS	• A trial set is a collection of spherical, cylindrical and prism lenses, as well as some accessory lenses. • Spherical plus and minus trial lenses are either: - Labelled with a "+" or "–" sign, or - Surrounded by a coloured rim (usually plus lenses are black and minus lenses are red).
INTERPUPILLARY DISTANCE (PD)	• PD is the distance (in mm) between a person's pupils. • PD is important, because we must make spectacles with the correct PD. If we make spectacles with the wrong PD, the person will not have comfortable vision, and they might not be able to wear them. • The distance between the optical centres of the lenses in a person's spectacles should be the same as their PD.

MEASURING SPECTACLE LENSES

There are two ways to measure the power of a lens. Both methods can be used to measure spherical and cylindrical lenses.

1. **Hand neutralisation**: a simple technique that can be performed using just a trial lens set.
2. **Vertometry**: a more accurate technique that uses a special instrument called a vertometer.

A vertometer is sometimes called a lensmeter or a focimeter.

HAND NEUTRALISATION

Hand neutralisation is a good way to measure spectacle lens power when you do not have a vertometer. Vertometers can be expensive and need electricity to work.

Hand neutralisation can be performed using only lenses from a trial lens set.

IMAGE MOVEMENT THROUGH LENSES	If you look at an object through a lens and move the lens from side to side (right and left), the image that you see through the lens will also move. A plus lens will make the image move in the opposite direction to the lens movement: → If you move the lens to the right, the image will move to the left. → If you move the lens to the left, the image will move to the right. A minus lens will make the image move in the same direction as the lens movement: → If you move the lens to the right, the image will move to the right. → If you move the lens to the left, the image will move to the left. The image of an object seen through a plano lens will not move.  The movement of a plus lens is called “against” movement. The movement of a minus lens is called “with” movement.
ADDING LENSES TOGETHER	When lenses are placed on top of each other, their powers can be added together.
EXAMPLE 1	If you have a +1.00 D lens and you put a +4.00 D lens on top of it, the total power is: +1.00 D + +4.00 D = +5.00 D. A +1.00 D and a +4.00 D lens together are the same as a +5.00 D lens. Image movement: • A +1.00 D lens gives against movement. • A +4.00 D lens gives against movement. • A +5.00 D lens gives against movement (the same as a +1.00 D lens and +4.00 D lens together).
EXAMPLE 2	If you have a +1.00 D lens, and you put a –5.00 D lens on top of it, the total power is: +1.00 D + –5.00 D = –4.00 D. A +1.00 D and a –5.00 D lens together are the same as a –4.00 D lens. Image movement: • A +1.00 D lens gives against movement. • A –5.00 D lens gives with movement. • A –4.00 D lens gives with movement (the same as a +1.00 D lens and –5.00 D lens together).

HAND NEUTRALISATION (cont.)

EXAMPLE 3	If you have a +3.00 D lens, and you put a –3.00 D lens on top of it, the total power is: +3.00 D + –3.00 D = 0. A +3.00 D and a –3.00 D lens together are the same as a plano lens. Image movement: • A +3.00 D lens gives against movement. • A –3.00 D lens gives with movement. • A plano lens gives no movement (the same as a +3.00 D lens and –3.00 D lens together).
HAND NEUTRALISATION	If you have a lens of an unknown power, you can find out what power it is by "neutralising" it with another lens of a known power. Neutralisation occurs when two lenses are held together and there is no movement of the image through the combined lenses. This will only happen when the two lenses are of equal but opposite power. ***Examples:*** A +3.00 D lens and a –3.00 D lens held together will give no movement. *We can thus "neutralise" the power of the +3.00 D lens by using a –3.00 D lens.* A –7.00 D lens and a +7.00 D lens held together will give no movement. *We can thus "neutralise" the power of the –7.00 D lens by using a +7.00 D lens.* A –2.75 D lens and a +2.75 D lens held together will give no movement. *We can thus "neutralise" the power of the –2.75 D lens by using a +2.75 D lens.* If you know the power of one of the lenses you have neutralised, you will also know the power of the other lens.

HAND NEUTRALISATION METHOD

<table>
<tr>
<td>SET-UP</td>
<td>
Draw a cross on the centre of a piece of paper. Make sure that the lines are perpendicular (at 90°) to each other, and that each line is at least 15 cm long.

Place the cross approximately 1 m away from you (sometimes it is easiest to put it on the floor).
Hold the lens close to your eye and look at the cross through the lens.
Make sure that the cross is in the centre of the lens.

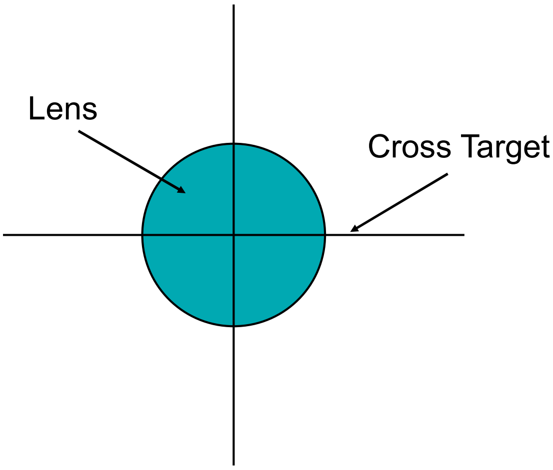

Hold the lens so that the lines of the cross that are seen through the lens line up with the lines outside the lens.
The lines of the cross should look aligned through the lens and outside the lens edge – then the centre of the cross is at the optical centre of the lens.


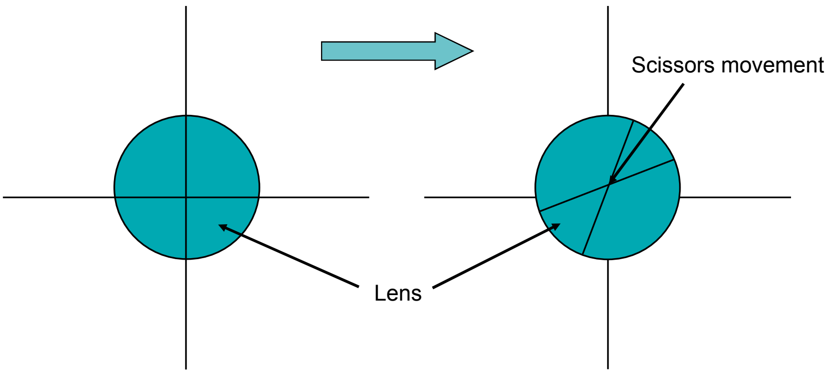
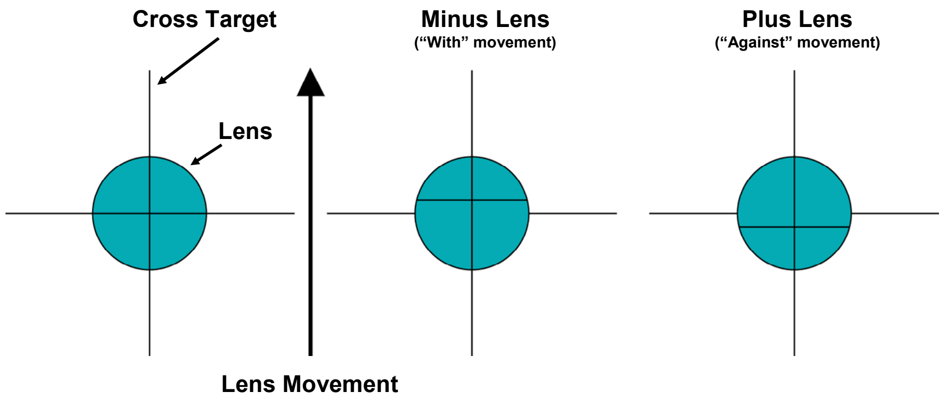
Figure 9.1: The lines of the cross inside and outside the lens are aligned, so the centre of the cross is at the optical centre of the lens
</td>
</tr>
<tr>
<td>SPHERE OR CYLINDER?</td>
<td>
To find out whether the lens you are holding is a spherical or an astigmatic lens, you need to rotate the lens in front of your eye. To rotate the lens you turn it clockwise or anti-clockwise, like the steering wheel of a car.
If the lines of the cross stay perpendicular when you rotate the lens, it is a spherical lens.
If the lines of the cross do not stay perpendicular when you look through the lens, the lens is a cylindrical or sphero-cylindrical lens. This movement is known as “scissors” movement.


Figure 9.2: Rotating a sphero-cylindrical lens will give scissors movement

The movement of an astigmatic lens is called “scissors” movement.
</td>
</tr>
</table>

HAND NEUTRALISATION METHOD (cont.)

PLUS OR MINUS SPHERE?	Once you know that you have a spherical lens (by rotating it), you need to find out if it is a plus or a minus lens. Move the lens up and down and from side to side (right and left) in front of your eye. If the lines of the cross move in the opposite direction to the movement of the lens (“against”), you have a plus lens. If they move in the same direction (“with”), you have a minus lens. If the lines do not move at all, you have a plano lens.  ***Figure 9.3:*** *A cross is viewed through a lens, and the lens is moved upwards.* *A minus lens will give “with” movement and a plus lens will give “against” movement*
FINDING THE POWER OF A SPHERICAL LENS	Now that you know whether you have a plus or minus lens, hold a trial lens of the opposite power against your unknown lens. → If you have a plus lens, you will choose a minus trial lens. → If you have a minus lens, you will choose a plus trial lens. Remember that high power plus lenses are thicker in the centre, and high power minus lenses are thicker at the edge. Looking at the shape of the lens you want to neutralise might help you estimate the power of the lens needed to neutralise it. Now hold the unknown lens and the trial lens that you have chosen to neutralise it together in front of your eye. Move the lenses up and down, and from side to side. If there is still movement when you look through both lenses, you will need to choose a different trial lens. → If there is **against movement** and your unknown lens is a: • plus lens → you need to choose a higher powered minus trial lens • minus lens → you need to choose a lower powered plus trial lens. → If there is **with movement** and your unknown lens is a: • plus lens → you need to choose a lower powered minus trial lens • minus lens → you need to choose a higher powered plus trial lens. Continue to try different trial lenses with your unknown lens until there is no movement of the cross lines when you look through both lenses together. When there is no movement, you have neutralised your lens. The power of your unknown lens will be equal and opposite to the power of the trial lens that neutralises it.
EXAMPLES	• The power of an unknown minus lens that is neutralised by a +4.00 D trial lens is: –**4.00 D**. • The power of an unknown plus lens that is neutralised by a –2.75 D trial lens is: **+2.75 D**.

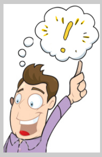
HAND NEUTRALISATION METHOD (cont.)

BRACKETING	You can save time when hand neutralising by using a technique known as bracketing. Bracketing is a logical method that helps you to choose your next trial lens. **Example:** You have an unknown lens that you rotate: you find that it is a spherical lens. When you move the lens you see against movement: it is a plus lens. Because it is a plus lens, you choose a –4.00 D trial lens from your trial lens case. The two lenses together still give you against movement. This means that your unknown lens is a plus lens that is stronger than +4.00 D. You choose a –8.00 D trial lens next. This time, the two lenses together give you with movement. This means that your unknown lens is a plus lens that has a power between +4.00 D and +8.00 D. Now, you ***can*** choose any trial lens between –4.00 D and –8.00 D to try and neutralise your unknown lens, but you will be more efficient if you "bracket" → which means using a logical way of choosing the next lens power to try. To bracket, you choose a lens power that is half way between –4.00 D and –8.00 D → you chose a –6.00 D trial lens. Together, your unknown lens and the –6.00 D lens give you against movement. This means that your unknown lens has a power between +4.00 D and +6.00 D. Bracketing again, you choose a lens that is half way between –4.00 D and –6.00 D → you choose a –5.00 D trial lens. This time you get with movement. This means that your unknown lens has a power between +5.00 D and +6.00 D. You now choose a –5.50 D trial lens. This time you get no movement when you look through both lenses. This means that you have neutralised your unknown lens. The power of your unknown lens is: +5.50 D.

HAND NEUTRALISATION METHOD (cont.)

FINDING THE PRINCIPAL MERIDIANS OF AN ASTIGMATIC LENS

An astigmatic lens will give scissors movement when it is rotated.



REMEMBER:

An astigmatic lens has two principal meridians that are perpendicular (at 90°) to each other.

To find the power of an astigmatic lens, the power of each principal meridian must be found separately.

The principal meridians can be found by rotating the lens until the lines of the cross (that show scissors movement) are lined up perpendicularly. When this happens, the lines of the cross are lined up over both principal meridians of the lens.

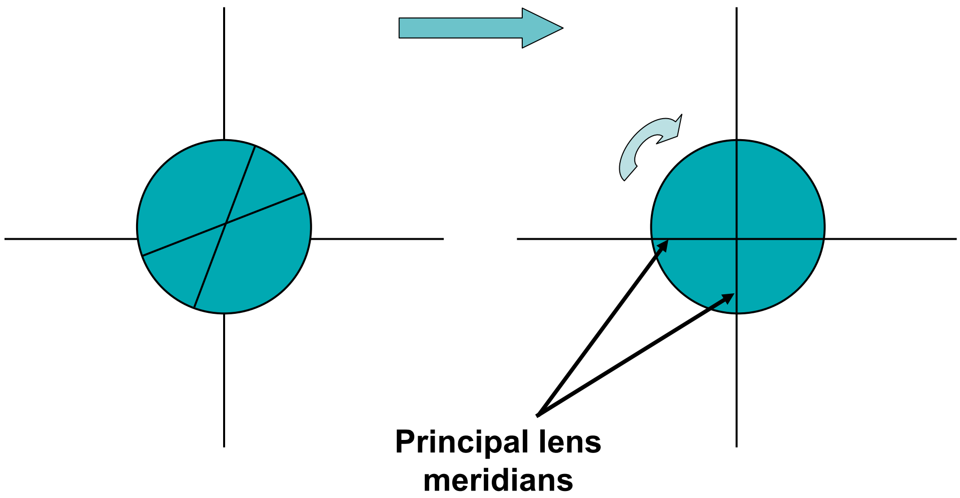


Figure 9.4: *To find the principal meridians of a sphero-cylindrical lens, rotate the lens until the lines of the cross appear perpendicular through the lens*

FINDING THE POWER OF AN ASTIGMATIC LENS

Hold the astigmatic lens with its principal meridians lined up with the cross:

- To find the power of the vertical meridian, move the lens up and down.
- To find the power of the horizontal meridian, move the lens from side to side.

You now need to neutralise each meridian separately.

It is useful to draw an optical cross for recording your findings.

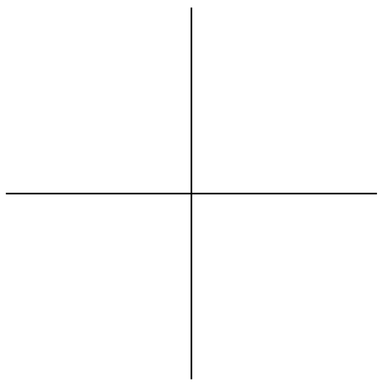
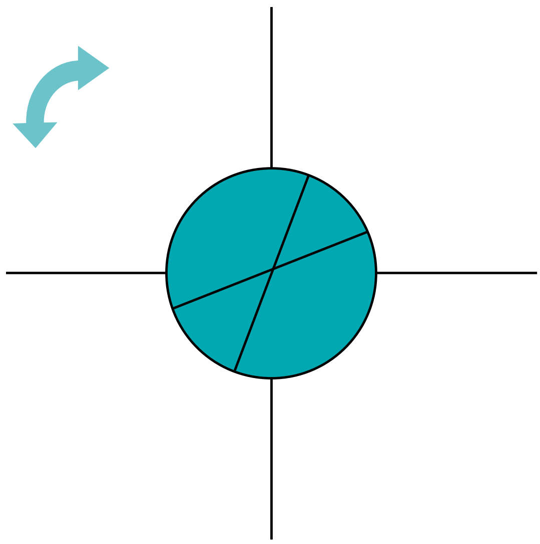
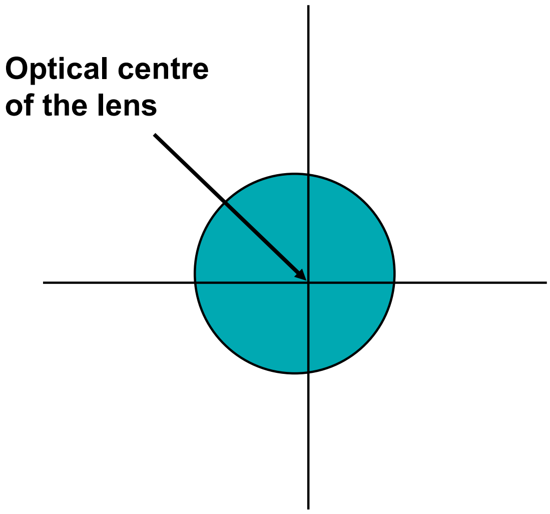
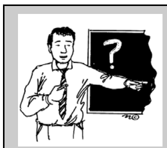
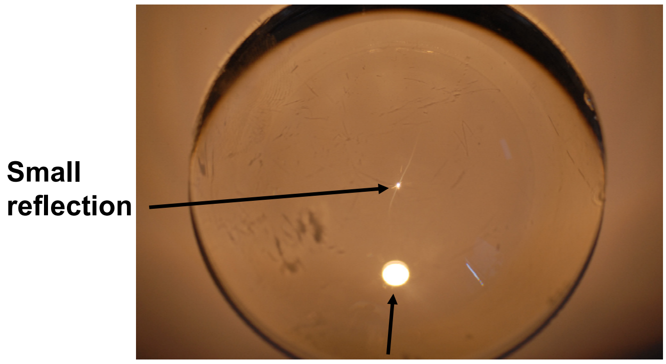
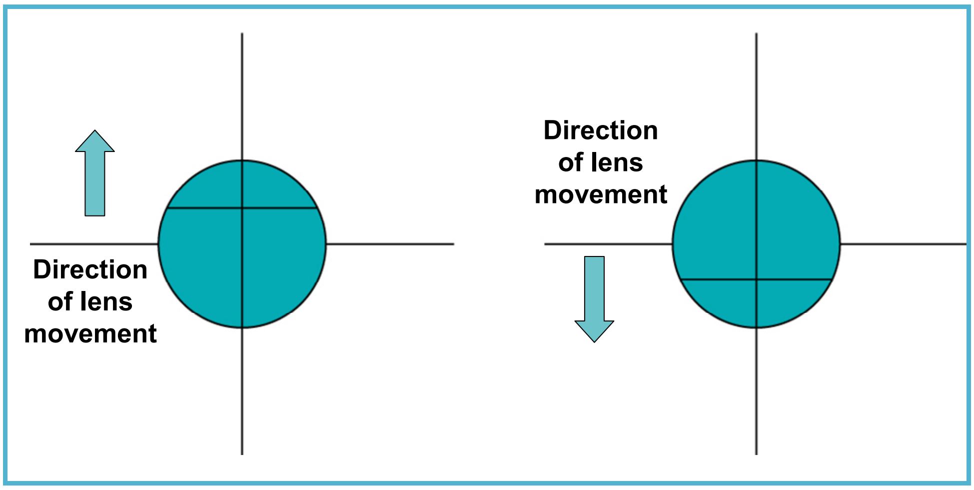


Figure 9.5: *Optical cross*

HAND NEUTRALISATION METHOD (cont.)

EXAMPLE	You have an unknown lens and you want to know where the optical centre is and what its power is. You rotate the lens and see scissors movement → now you know the lens is a cylinder or sphero-cylinder.  ***Figure 9.6:*** *Scissor movement*
FINDING THE OPTICAL CENTRE	You align the lens so that the lines of the cross seen inside the lens are aligned with the lines of the cross seen outside the lens.  ***Figure 9.7:*** *The lines of the cross inside and outside the lens are aligned, so the centre of the cross is at the optical centre of the lens*  ***Notice:*** The cross is not in the centre of the circle. → This means that in this case the optical centre of the lens is not in the middle of the lens.

HAND NEUTRALISATION METHOD (cont.)

FINDING THE OPTICAL CENTRE (cont.)	You can also find the optical centre of a lens by looking at the two reflections of a light source (like a light globe) on the front and back surfaces of the lens. Tilt the lens until you get the smaller reflection in the middle of the larger one.  ***Figure 9.8:*** *Finding the optical centre by reflection* You can mark the optical centre of the lens at the centre of the cross or where the two reflections meet by using a marker or a felt tipped pen.
THE POWER OF THE VERTICAL MERIDIAN	Move the lens up and down and see what type of movement it causes. If you see with movement, its means the vertical meridian has minus power.  ***Figure 9.9:*** *With movement in vertical meridian* Because the lens has minus power in the vertical meridian, you choose a plus power trial lens to neutralise the lens in this meridian. You use the bracketing technique and find that a +4.50 D trial lens neutralises this vertical meridian. → This means that the power of the vertical meridian is –4.50 D. You record this on your optical cross.

HAND NEUTRALISATION METHOD (cont.)

THE POWER OF THE VERTICAL MERIDIAN (cont.)

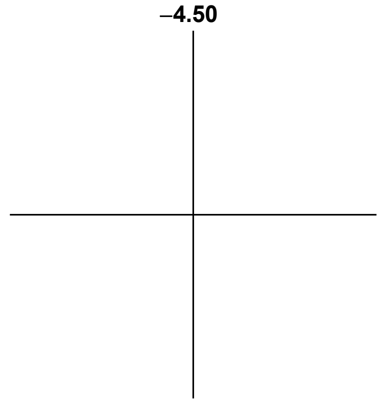


Figure 9.10: *Optical cross with vertical meridian power recorded*

THE POWER OF THE HORIZONTAL MERIDIAN

Move the lens from side to side and see what type of movement it causes.
If you see against movement, it means that the horizontal meridian has plus power.

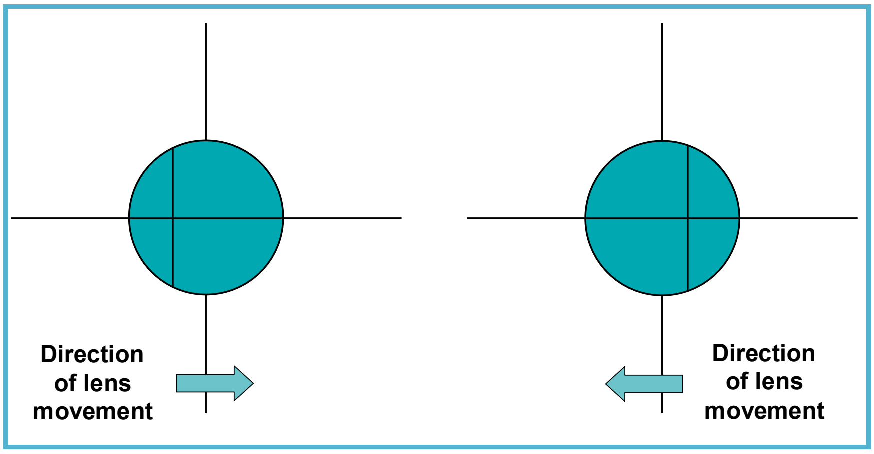


Figure 9.11: *Against movement in horizontal meridian*

Because the lens has plus power in the horizontal meridian, you choose a minus power trial lens to neutralise the lens in this meridian.

You use the bracketing technique and find that a –2.25 D trial lens neutralises this horizontal meridian.

→ This means that the power of the horizontal meridian is +2.25 D.

You record this on your optical cross.

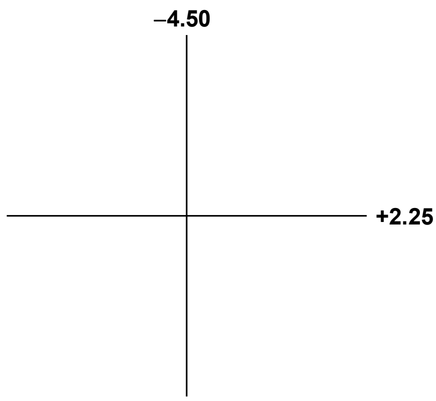


Figure 9.12: *Optical cross with vertical and horizontal meridian powers recorded*

HAND NEUTRALISATION METHOD (cont.)

WHERE IS THE AXIS?	The axis is in the direction of the most plus powered (or least minus powered) meridian. In this example, the most plus powered meridian is in the horizontal (180°) meridian.
HOW WOULD YOU WRITE THE PRESCRIPTION OF THIS LENS?	The amount of cylinder power in the lens is the difference between the powers of the two principal meridians. Looking at the optical cross (Figure 9.12), and knowing that the axis of the lens is at 180°, you would write the prescription of this lens as: **+2.25 / –6.75 x 180.**

VERTOMETRY (FOCIMETRY)

Vertometry is an accurate way to measure the power of spectacle lenses.

Vertometry is performed by using an instrument called a vertometer (also known as a focimeter or a lensmeter).

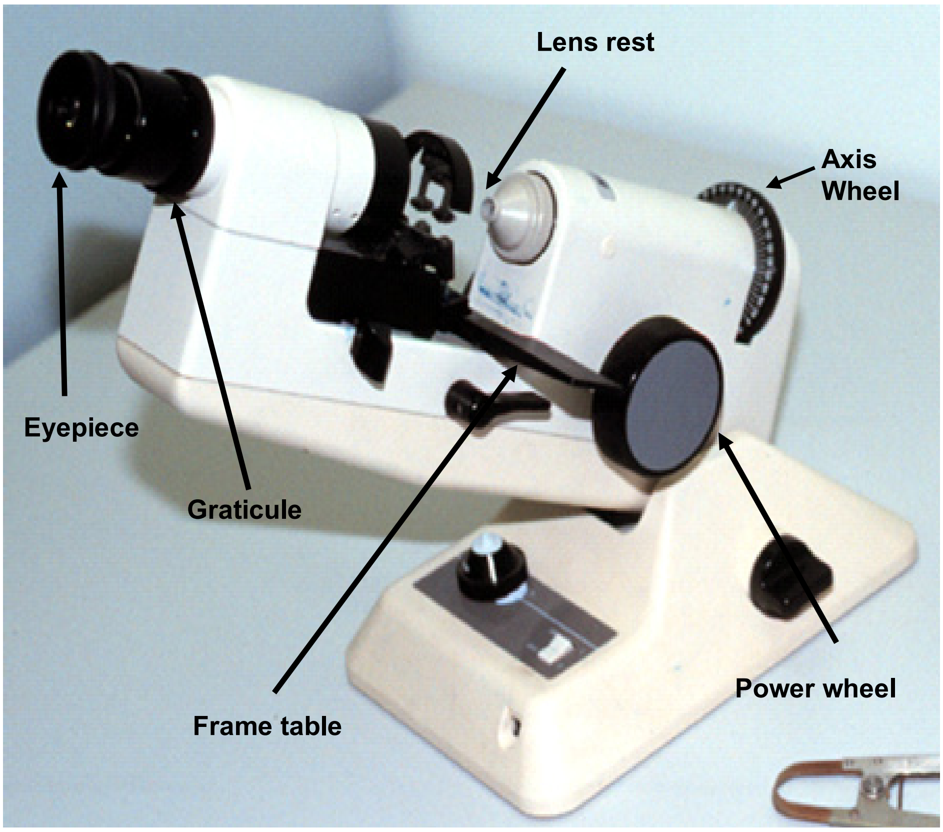


Figure 9.13: *The parts of a vertometer*

When you measure a lens on the vertometer, the edge of the lens rests on the frame table, so that the lens lies over the lens rest. The lens is then clamped in place so that it does not move, and the power wheel is turned to measure the power of the lens.

The eyepiece is the part of the vertometer that you look through to measure the lens power. When you look through the eyepiece you see the black lines and circles of the graticule, and the brightly lit coloured target. The graticule will be visible even when the vertometer is turned off, but you can only see the target when the vertometer is turned on. The target is usually green.

VERTOMETRY (FOCIMETRY) (cont.)

VERTOMETER TARGETS

There are two types of vertometer target:

CROSSED LINE TARGET

Vertometers that use this sort of target need an axis wheel (as seen in Figure 9.13).

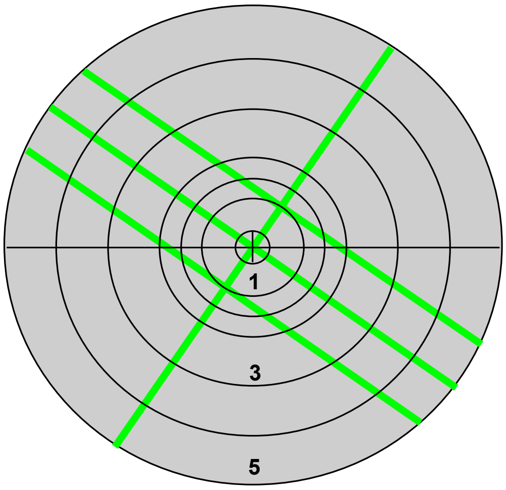


Figure 9.14: *A crossed line target measuring a spherical lens*

If a sphere is being measured, all the lines of the target can be equally focused at the same time. If a sphero-cylinder is being measured, only the lines in one direction can be focused at any one time:

- If the single line is in focus, the three parallel lines will be blurred.
- If the three parallel lines are in focus, the single line will be blurred.

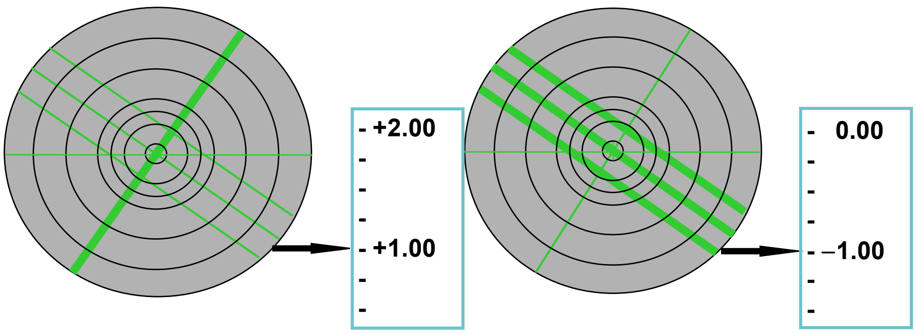


Figure 9.15: *A line target measuring a sphero-cylindrical lens – only one set of lines can be focused at any one time*

VERTOMETRY (FOCIMETRY) (cont.)

DOT TARGET

Vertometers that use this sort of target do not need an axis wheel.

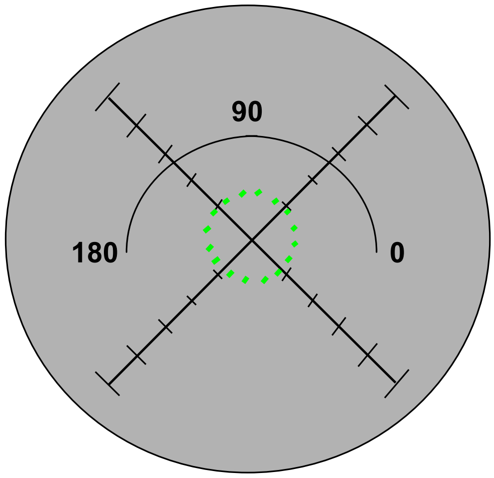


Figure 9.16: *A dot target measuring a spherical lens*

If a spherical lens is being measured, the target will look like a circle of small dots.

If an astigmatic lens is being measured, the target will look like a set of small parallel lines (stretched dots arranged in a circle).

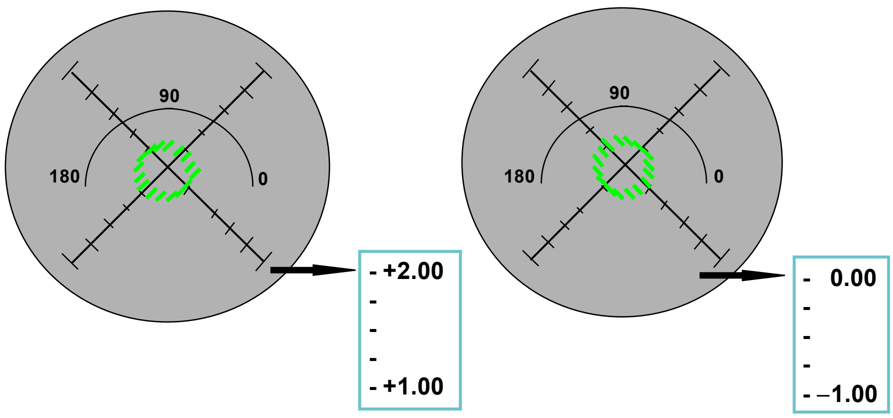


Figure 9.17: *A dot target measuring a sphero-cylindrical lens*

VERTOMETER METHOD

SET-UP

Focusing the Eyepiece

To get an accurate measurement, you must first focus the vertometer's eyepiece for your eye. The focus that your eye needs will probably be different to the focus that another person's eye would need, so it is important that you focus the eyepiece each time you start to use the vertometer.

Step 1: Before you turn the vertometer on, look through the eyepiece to see the black graticule lines and circles. If it is hard to see the graticule, you can hold a piece of white paper in front of the lens rest.

Step 2: Turn the eyepiece anti-clockwise until it stops. You will see that the graticule becomes blurry.

Step 3: Slowly turn the eyepiece clockwise until the graticule just comes into focus. It is important to stop as soon as the graticule becomes clear, otherwise you will need to repeat Steps 2 and 3.

Step 4: Turn on the vertometer to see the coloured target. Turn the power wheel until the lines or dots of the target become clear. If you have focused the eyepiece correctly, the power reading will be zero.

Inserting the Spectacle Frame

Step 1: Turn the spectacles so that the front of the spectacles is facing towards you. The temples (the arms of the spectacle frame) should be pointing away from you.

Step 2: Put the spectacles on the frame table. The bottom of the spectacles should rest on the frame table. Clamp the spectacle lens to keep it pressed against the lens rest.

It is good practice to always measure the right lens first and the left lens second.

When you look at the front of a pair of spectacles, the right lens is on your left hand side.

Step 3: Look through the eyepiece and move the spectacles until the target is in the centre of the black graticule.

Step 4: Change the height of the frame table to keep the frame horizontal in this position (to make sure one side does not drop down).

Step 5: Measure the power of the right lens (see the next set of steps).

Step 6: Unclamp the right lens. Do not change the height of the frame table. Move the spectacle frame and clamp the left lens. Measure the power of the left lens.

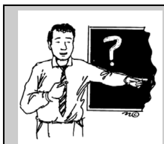
It is important to keep the height of the frame table the same for measuring both the right and left lenses. This is so that you can look for prism in the spectacles later.

MEASURING LENS POWER

Crossed Line Target Vertometer – Spherical Lenses

Step 1: Turn the power wheel to a high plus reading.

Step 2: Slowly decrease the power (reduce the plus by turning the power wheel) until all of the target lines just become clear. (If you turn the wheel further than this, your measurement will not be accurate.)



If all the lines of the target are clear, the lens you are measuring is a spherical lens.

If only some of the lines are clear, the lens you are measuring is an astigmatic lens.

VERTOMETER METHOD (cont.)

MEASURING LENS POWER (cont.)

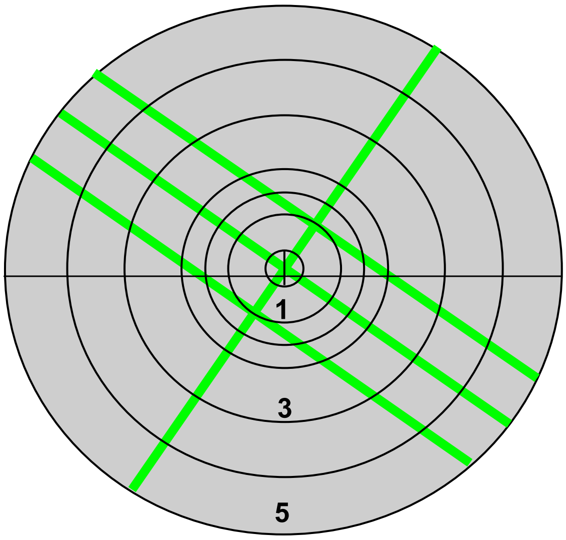


Figure 9.18: *The three parallel lines are clear, straight and unbroken. The single line is also clear, straight and unbroken. This is a spherical lens*

Crossed Line Target Vertometer – Astigmatic Lenses

Step 1: Turn the power wheel to a high plus reading.

Step 2: Slowly decrease the power (reduce the plus by turning the power wheel) until some of the target lines just become clear. (If you turn the wheel further than this, your measurement will not be accurate.)

Step 3: Turn the axis wheel until the three parallel target lines are straight and unbroken.

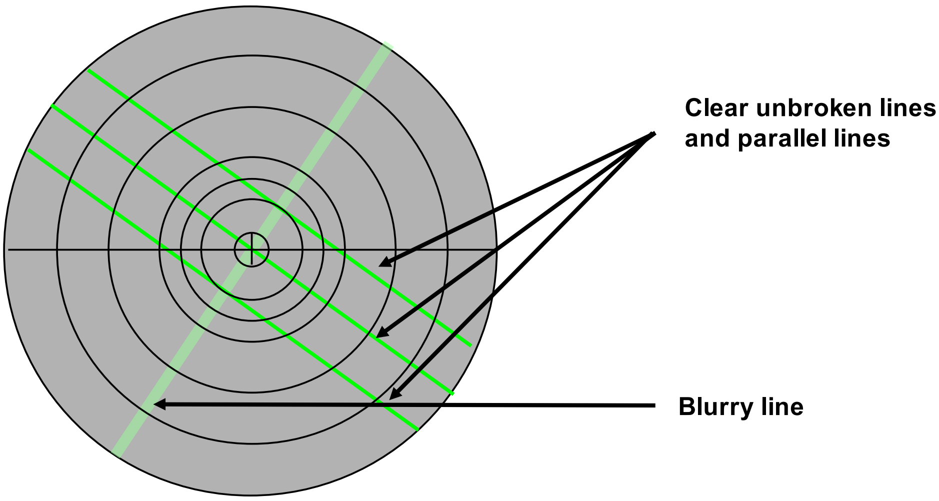


Figure 9.19: *The three parallel lines are clear, straight and unbroken. The single line is blurry. This is an astigmatic lens*

Step 4: If you are measuring an astigmatic lens, the number on the power wheel will tell you the power of the most positive meridian of the lens. This will be the spherical power when you write the astigmatic lens prescription.

VERTOMETER METHOD (cont.)

MEASURING LENS POWER (cont.)

Step 5: Slowly turn the power wheel to decrease the power until the other line is clear. The number on the power wheel will now tell you the power of the least positive meridian of the lens.

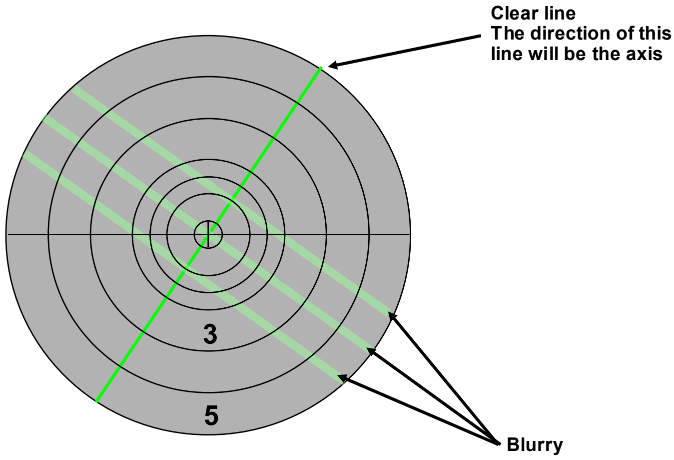
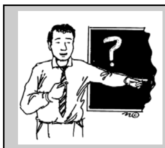


Figure 9.20: *The single line is clear, straight and unbroken. The three parallel lines are blurry*

Step 6: Find the cylindrical power of the lens.



Cylindrical power = second power reading (least positive power) – first power reading (most positive power).

Another way of looking at Step 6 is to look at how far you have turned the power wheel and in which direction.

Step 7: Find the axis of the lens.

The axis of the cylinder is the direction of the second power reading (the least positive power).

You measure the direction of this line by looking at the axis numbers on the graticule inside the eyepiece.

Finding the Sphere Power

Turn the power wheel to a high plus reading and slowly decrease the power until one set of lines becomes clear. Now, rotate the axis drum to ensure the lines are straight and unbroken. Write down the power which is displayed on the power wheel. In this case, the power reading is +1.00 D.

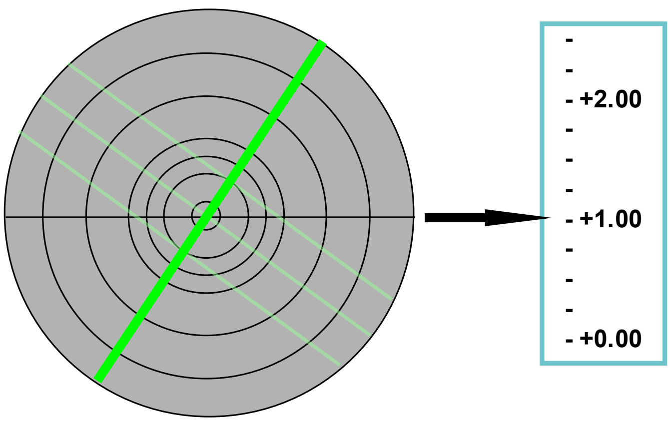


Figure 9.21: *First reading (sphere power)*

VERTOMETER METHOD (cont.)

EXAMPLE 1:

MEASURING AN ASTIGMATIC LENS

Finding the Cylinder Power

Continue to turn the power wheel until the other lines become clear. The second power reading minus the first reading will give the power of the cylinder (and its correct sign).

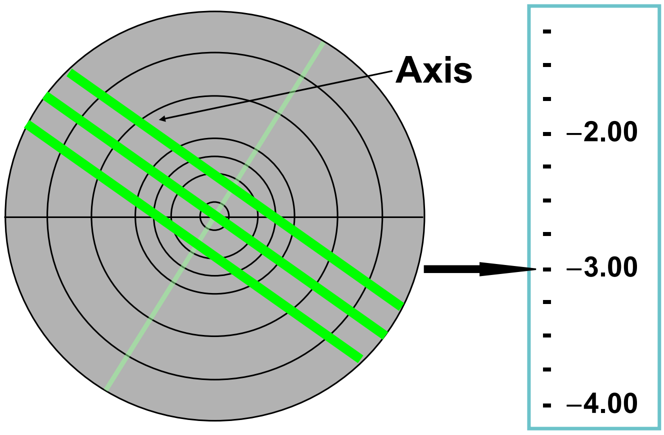


Figure 9.22: *The second reading*

In this case, the second power reading is –3.00 D. So, the cylinder power of the spectacle lens is the second power reading minus the first power reading:

–3.00 – (+1.00) = –4.00 DC.

Or, we have turned the power wheel through 4.00 D in the negative direction (from +1.00 to –3.00).

Finding the Axis

Look at the direction of the lines of the second reading. This is the axis direction.

Look through the eyepiece and turn the long black line of the graticule, so that it is in the same direction as the lines of the target. This makes it easier to read the axis direction on the graticule. In this case, the least positive lines (the second reading) are lying at 120°.

So the power of this lens is +1.00 / –4.00 x 120.

Be careful:

Some line target vertometers let you read the axis of the lens on the axis drum. In this case, the vertometer maker has chosen one set of lines to be for the sphere and the other to be for the cylinder.

But different brands of vertometer select different lines to represent the sphere and the cylinder. (For example, one brand of vertometer might be made so that the three parallel lines represent the sphere; another brand might be made so that these same lines represent the cylinder.)

Unless you know what each of the lines represents you cannot depend on the axis drum reading. You might get the wrong answer.

However, if you use the method described in this unit you will always get the correct result. This is because you are measuring the axis direction with the graticule, which is inside the eyepiece.

VERTOMETER METHOD (cont.)

DOT TARGET VERTOMETER – SPHERICAL LENSES

Step 1: Turn the power wheel to a high plus reading.

Step 2: Slowly decrease the power (reduce the plus by turning the power wheel) until all the dots *just* become clear. (If you turn the wheel further than this, your measurement will not be accurate.)

If you have a ring of round dots, the lens you are measuring is a spherical lens.

If you have a ring of stretched dots (little lines), the lens you are measuring is an astigmatic lens.

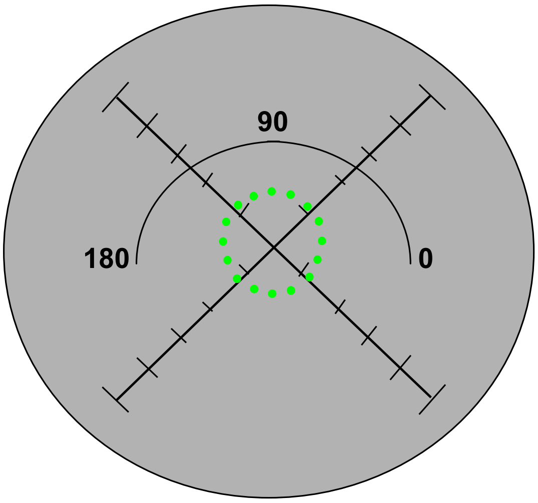


Figure 9.23: *A ring of clear dots. This is a spherical lens*

Step 3: If you are measuring a spherical lens, the number on the power wheel tells you the power of the lens. If it is a spherical lens, you have finished and can now measure the left lens.

DOT TARGET VERTOMETER – ASTIGMATIC LENSES

Step 1: Turn the power wheel to a high plus reading.

Step 2: Slowly decrease the power (reduce the plus by turning the power wheel) until all the dots *just* become clear little lines. (If you turn the wheel further than this, your measurement will not be accurate.) This will be the spherical power when you write the lens prescription.

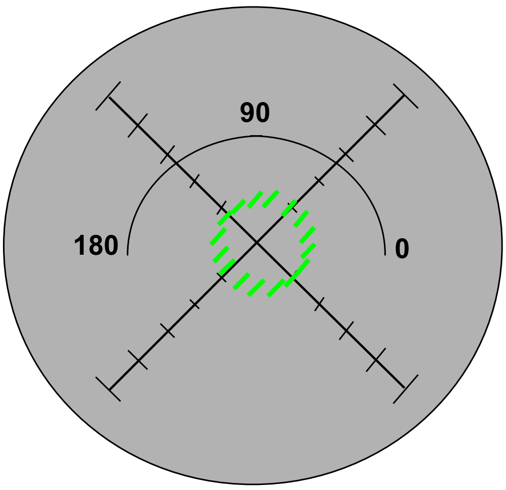


Figure 9.24*: First reading (sphere power)*

VERTOMETER METHOD (cont.)

DOT TARGET VERTOMETER – ASTIGMATIC LENSES (cont.)

Step 3: Slowly turn the power wheel to decrease the power until the second set of stretched dots (little lines) becomes clear. This time the dots will be stretched in a direction 90° to those in Step 2. The number on the power wheel will now tell you the power of the least positive meridian of the lens.

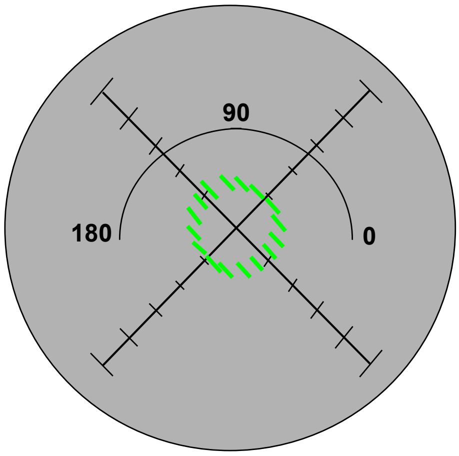


Figure 9.25: *Second power reading (least positive meridian). This time the ring of stretched dots are stretched in a direction 90° to that of the first power reading.*

Step 4: Find the cylindrical power of the lens.

Cylindrical power = second power reading (least positive power) – first power reading (most positive power).

Again, another way of looking at Step 4 is to look at how far you have turned the power wheel and in which direction.

Step 5: Find the axis of the lens. The axis of the lens is the direction of the little lines of the second power reading. You measure the direction of these lines by looking at the axis numbers on the graticule inside the eyepiece.

EXAMPLE 2:

MEASURING AN ASTIGMATIC LENS

Finding the Sphere Power

Turn the power wheel to a high plus reading and slowly decrease the power until one set of stretched dots (or little lines) becomes clear.

Write down the power that is displayed on the power wheel. In this case, the power reading is: +2.50 D**.**

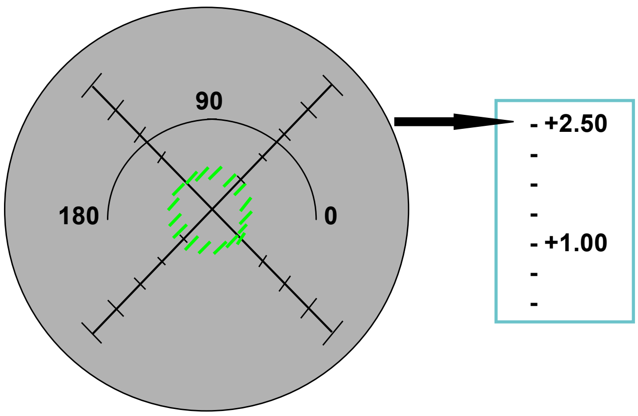


Figure 9.26: *First reading*

VERTOMETER METHOD (cont.)

EXAMPLE 2:

MEASURING AN ASTIGMATIC LENS (cont.)

Finding the Cylinder Power

Continue to turn the power wheel until the second set of stretched dots (little lines) becomes clear. The second power reading minus the first reading will give the power of the cylinder (and its correct sign). In this case, the second reading is +1.00 D.

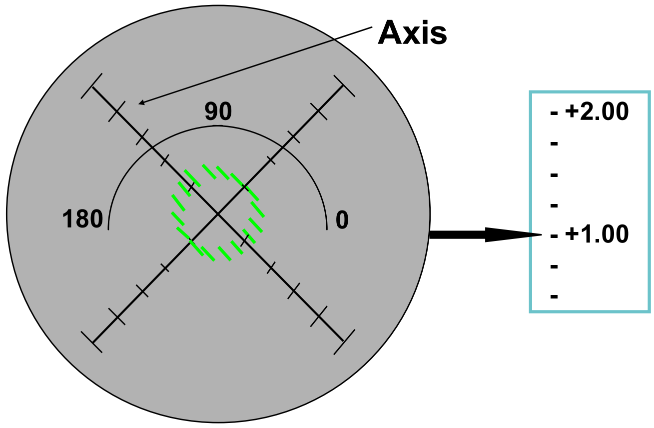


Figure 9.27: *Second reading*

The cylinder power of this lens is (second power reading – first power reading):
+1.00 – (+2.50) = –1.50 DC.

Finding the Axis

Look at the direction of the lines of the second (*least positive*) reading. This is the axis direction. Look through the eyepiece and turn the lines of the graticule, so that they are in the same direction as the lines of the target – this makes it easier to read the axis direction on the graticule. In this case, the least positive lines (the second reading) are lying at 120°.

So the power of this lens is +2.50 / –1.50 x 120.

FINDING THE OPTICAL CENTRE WITH A VERTOMETER

- **Centering a Lens on a Crossed Line Target Vertometer**
  To find the optical centre of a lens using a crossed line target vertometer, you need to move the lens against the lens rest until the centre of the target is over the centre of the graticule. The centre of the target will be the point where the central target lines cross.

- **Centering a Lens on a Dot Target Vertometer**
  To find the optical centre of a lens using a dot target vertometer, you need to move the lens against the lens rest until the centre of the target is over the centre of the graticule. The centre of the target will be the centre of the ring of dots.

  If you have a sphero-cylindrical lens, it is best if you turn the power wheel until you are half way between the first reading and the second reading. At this point the target will look like a ring (although it will be a bit blurry).

- **Marking the Optical Centre**
  Vertometers usually have an ink well and marking pins. When the lens is centred correctly, you can use the marking pins to put a mark (usually small dots) on the lens surface.

  If the vertometer does not have an ink well or marking pins, you can use a marking pen (felt tipped pen) to mark the optical centre of the lens yourself. You will need to make the mark on the lens directly over the lens rest.

If you have a pair of spectacles and you measure the distance between the optical centres of the two lenses, this distance should be the same as the person's PD.

If it is not the same, the spectacles have prism in them.

FINDING PRISM WITH A VERTOMETER

Sometimes prism is added to a person's spectacle lenses to correct an eye muscle problem. Prism like this will only be prescribed by someone who is specially trained to do this. It is rare to have prism prescribed in spectacles.

More often, if there is prism in a pair of spectacles, it means that the lenses were not put into the frame properly. An error like this can cause the person to have asthenopia (eye strain) or even double vision when they wear their spectacles.

Spectacles with unwanted prism in them cannot be dispensed to a person, and need to be remade.

MEASURING VERTICAL PRISM

Step 1: Clamp the right spectacle lens against the vertometer lens rest. The lens should be clamped so that the optical centre of the lens is in the middle of the graticule.

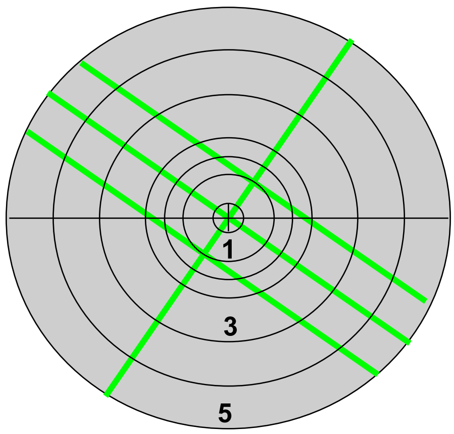


Figure 9.28: *Centred target (optical centre)*

Step 2: Adjust the height of the lens table - make sure that the bottom of the spectacle frame is resting on the lens table.

Step 3: Unclamp the right spectacle lens, and move the frame over to measure the left lens. *Important:* Do *not* change the height of the frame table.

Step 4: Look at the target through the eyepiece. If the target for the left lens looks higher or lower than the right lens, there is vertical prism in the spectacles.

Step 5: Find the direction of the prism.
If the target for the left lens is higher than for the right lens, there is base-up prism in the left lens (compared with the right lens).

If the target for the left lens is lower than for the right lens, there is base-down prism in the left lens (compared with the right lens) – as in the example below.

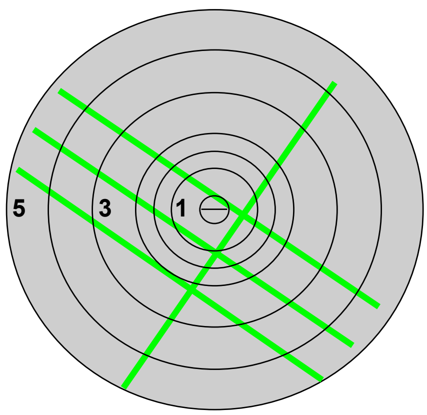
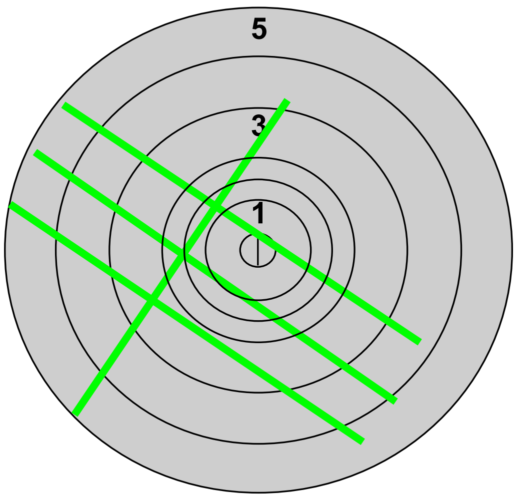


Figure 9.29: *Crossed line target for left lens showing 1^{Δ} base-down prism for the left eye*

FINDING PRISM WITH A VERTOMETER (cont.)

MEASURING VERTICAL PRISM (cont.)	**Step 6:**	Measure the amount of prism. The amount of prism is measured by looking at the circles of the graticule. Usually each circle represents a change of one prism dioptre (1^{Δ}), but sometimes there are also circles representing half-prism dioptre ($½^{\Delta}$). You will know if there are $½^{\Delta}$ steps, because the distance between the rings will be closer. In the example above, the centre of the target for the left lens is lower than for the right lens, and is on the first circle of the graticule. That tells us there is 1^{Δ} of base-down prism in the left eye.
MEASURING HORIZONTAL PRISM	**Step 1:**	Measure the person's PD. If the person is not with you, you should see the PD written on the spectacle prescription (the order form for the spectacles) or on the examination records.
	Step 2:	Mark the optical centres on each spectacle lens.
	Step 3:	Hold a ruler horizontally and put the zero point of the ruler on the optical centre mark of the right lens. Look at the number on the ruler that is the same as the person's PD and mark that point on the left lens with a marker pen (felt tipped pen).
	Step 4:	Clamp the left spectacle lens on the lens rest so that the PD mark that you made on the lens is over the centre of the lens rest.
	Step 5:	Measure the amount and the direction of the prism. If the target is to the left (closer to the right lens), there is base-in prism. If the target is to the right (further away from the right lens), there is base-out prism. If the target is in the centre, there is no horizontal prism.  ***Figure 9.30:*** *Target for left lens showing 1.5^{Δ} base-in prism*

FINDING PRISM WITH A VERTOMETER (cont.)

PROCEDURE – CHECKING THE ADDITION IN BIFOCALS

The procedure described here is for checking front surface bifocals (which most bifocals are).

Step 1: Check the distance powers as normal.

Step 2: Now turn the spectacles around so that the temples of the spectacles are pointing towards you. Place the front surface of the right distance portion against the lens rest (Figure 9.31).

Step 3: Focus the lines or dots of the target that are closest to the vertical direction and determine the power.

Step 4: Move the spectacles up and place the front surface of the segment against the lens stop (Figure 9.32).

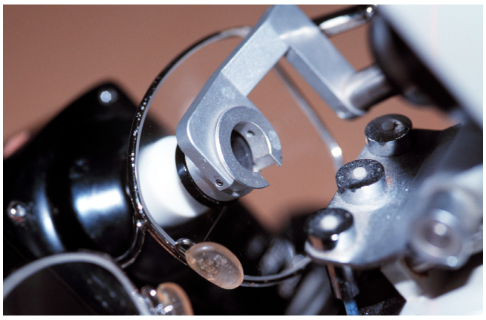


Figure 9.31

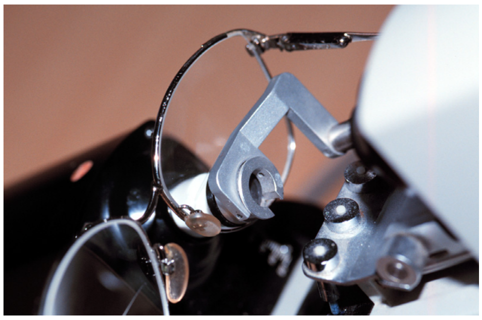


Figure 9.32

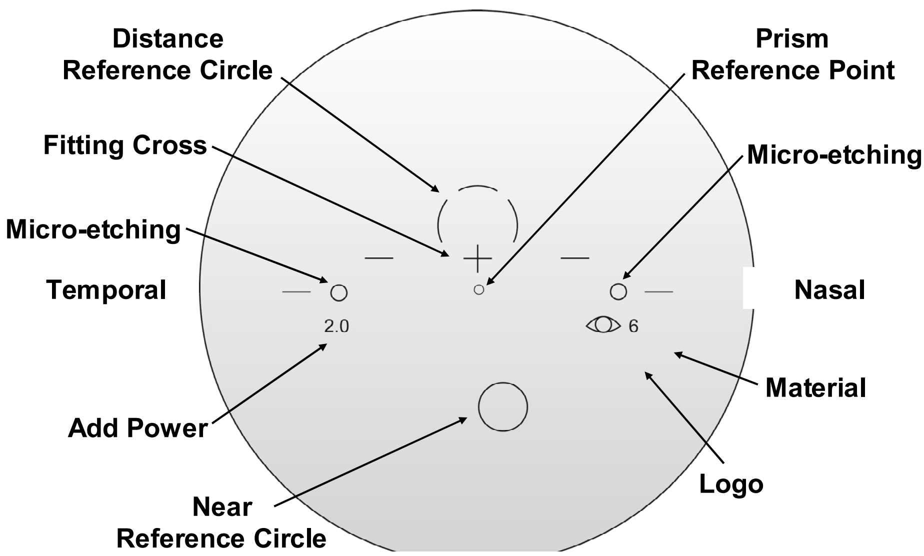
Step 5: Focus the lines or dots of the target that are closest to the vertical direction and determine the power.

Step 6: The difference between the two powers obtained in Steps 3 and 5 is the addition.

PROGRESSIVES LENSES

There are two ways to find the addition power in a progressive lens:

1. The add power is engraved on the lens. It is usually located on the temporal side of the lens (Figure 9.33).
2. Subtract the front vertex power of the distance reference circle from the front vertex power of the near reference circle.



RE LENS

Figure 9.33: *Progressive lens markings*

SUMMARY: HAND NEUTRALISATION AND VERTOMETRY

MEASURING SPECTACLE LENSES

There are two ways to measure the power of a lens:

- Hand neutralisation.
- Vertometry.

HAND NEUTRALISATION

- Plus lenses give against movement.
- Minus lenses give with movement.
- A lens can be neutralised by finding a lens of equal and opposite power.
- A lens that has been neutralised will give no movement.
- Use a cross to:
  - find out whether you have a spherical or sphero-cylindrical lens;
  - find the power of the principal meridians.
- The principal meridians of an astigmatic lens must be neutralised separately.

VERTOMETRY

- Focus the eyepiece.
- Clamp the right spectacle lens:
  - The front of the spectacles must face towards you.
  - Move the spectacles until the target is in the centre of the black graticule.
  - The spectacles must be horizontal on the frame table.
- Measure the lens power (turning the wheel slowly from plus towards minus).
- Find the optical centre of the lens.
- Clamp the left spectacle lens.
- Measure the lens power and find the optical centre of the left lens.
- Check for and measure vertical prism.
- Use the optical centre marks that you made and the person's interpupillary distance to check for horizontal prism.
- To check the addition of bifocals, turn the spectacles around and measure the distance and near powers again. The difference is the add.

TEST YOURSELF QUESTIONS

1. **If you are holding a +4.00 lens against an unknown minus lens and you see "with" movement, is the minus lens ...** *(tick appropriate box)*

(a) stronger than –4.00 ☐

OR

(b) weaker than –4.00 ☐

2. **You must always ______________________ the eyepiece before using the vertometer.**

3. **What are the three steps for finding the power of an astigmatic lens on a vertometer?**

a. ____

b. ____

c. ____

4. **If you are holding a –5.50 D lens against an unknown lens and you see no movement of the cross, what is the power of the lens?** *(tick appropriate box)*

(a) –4.00 ☐

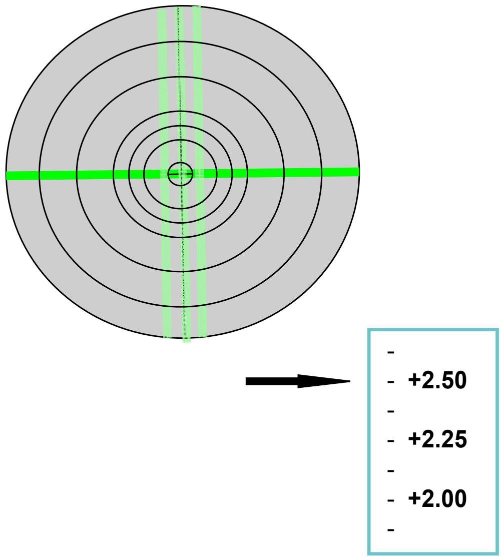
(b) +6.00 ☐

(c) +5.50 ☐

(d) –5.50 ☐

5. **What is the power of this lens?**

First reading



Second reading