EXPLORE SCIENTIFIC

6-inch
Table Top Newtonian

Instruction Manual

#ES-ON15205TT

CR2032 3V x1 INCLUDED

⚠ WARNING:
SUN HAZARD – Never look directly at the sun with this device.
CHOKING HAZARD – Small parts. Not for children under 3 years.
The lens contains lead that may be harmful. Wash hands after touching.

⚠ CA WARNING:
This product can expose you to chemicals including lead, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

⚠ WARNING:
This product contains a button battery. If swallowed, it could cause severe injury or death in just 2 hours. Seek medical attention immediately.

⚠ IMPORTANT SAFETY INSTRUCTIONS

READ AND FOLLOW THE INSTRUCTIONS BEFORE USE.
KEEP THESE INSTRUCTIONS FOR LATER USE.

• **SUN WARNING: WARNING – NEVER ATTEMPT TO OBSERVE THE SUN WITH THIS DEVICE! OBSERVING THE SUN – EVEN FOR A MOMENT – WILL CAUSE INSTANT AND IRREVERSIBLE DAMAGE TO YOUR EYE OR EVEN BLINDNESS.** EYE DAMAGE IS OFTEN PAINLESS, SO THERE IS NO WARNING TO THE OBSERVER THAT THE DAMAGE HAS OCCURRED UNTIL IT IS TOO LATE. DO NOT POINT THE DEVICE AT OR NEAR THE SUN. DO NOT LOOK THROUGH THE DEVICE AS IT IS MOVING. CHILDREN SHOULD ALWAYS HAVE ADULT SUPERVISION WHILE OBSERVING.

• **RESPECT PRIVACY:** WHEN USING THIS DEVICE, RESPECT THE PRIVACY OF OTHER PEOPLE. FOR EXAMPLE, DO NOT USE IT TO LOOK INTO PEOPLE'S HOMES.

• **CHOKING HAZARD:** CHILDREN SHOULD ONLY USE DEVICE UNDER ADULT SUPERVISION. KEEP PACKAGING MATERIALS LIKE PLASTIC BAGS AND RUBBER BANDS OUT OF THE REACH OF CHILDREN AS THESE MATERIALS POSE A CHOKING HAZARD.

• **RISK OF BLINDNESS:** NEVER USE THIS DEVICE TO LOOK DIRECTLY AT THE SUN OR IN THE DIRECT PROXIMITY OF THE SUN. DOING SO MAY RESULT IN A PERMANENT LOSS OF VISION.

• **RISK OF FIRE:** DO NOT PLACE DEVICE, PARTICULARLY THE LENSES, IN DIRECT SUNLIGHT. THE CONCENTRATION OF LIGHT RAYS COULD CAUSE A FIRE.

• **DO NOT DISASSEMBLE THIS DEVICE:** IN THE EVENT OF A DEFECT, PLEASE CONTACT YOUR DEALER. THE DEALER WILL CONTACT THE CUSTOMER SERVICE DEPARTMENT AND CAN SEND THE DEVICE IN TO BE REPAIRED IF NECESSARY.

• **DO NOT SUBJECT THE DEVICE TO TEMPERATURES EXCEEDING 60 °C (140 °F).**

• **DISPOSAL:** KEEP PACKAGING MATERIALS, LIKE PLASTIC BAGS AND RUBBER BANDS, AWAY FROM CHILDREN AS THEY POSE A RISK OF SUFFOCATION. DISPOSE OF PACKAGING MATERIALS AS LEGALLY REQUIRED. CONSULT THE LOCAL AUTHORITY ON THE MATTER IF NECESSARY AND RECYCLE MATERIALS WHEN POSSIBLE.

• THE WEEE SYMBOL IF PRESENT INDICATES THAT THIS ITEM CONTAINS ELECTRICAL OR ELECTRONIC COMPONENTS WHICH MUST BE COLLECTED AND DISPOSED OF SEPARATELY.
• NEVER DISPOSE OF ELECTRICAL OR ELECTRONIC WASTE IN GENERAL MUNICIPAL WASTE. COLLECT AND DISPOSE OF SUCH WASTE SEPARATELY.
• MAKE USE OF THE RETURN AND COLLECTION SYSTEMS AVAILABLE TO YOU, OR YOUR LOCAL RECYCLING PROGRAM. CONTACT YOUR LOCAL AUTHORITY OR PLACE OF PURCHASE TO FIND OUT WHAT SCHEMES ARE AVAILABLE.
• ELECTRICAL AND ELECTRONIC EQUIPMENT CONTAINS HAZARDOUS SUBSTANCES WHICH, WHEN DISPOSED OF INCORRECTLY, MAY LEAK INTO THE GROUND. THIS CAN CONTRIBUTE TO SOIL AND WATER POLLUTION WHICH IS HAZARDOUS TO HUMAN HEALTH, AND ENDANGER WILDLIFE.
• IT IS ESSENTIAL THAT CONSUMERS LOOK TO RE-USE OR RECYCLE ELECTRICAL OR ELECTRONIC WASTE TO AVOID IT GOING TO LANDFILL SITES OR INCINERATION WITHOUT TREATMENT.

BUTTON/COIN BATTERY WARNING: THIS PRODUCT CONTAINS A BUTTON OR COIN CELL BATTERY. A SWALLOWED BUTTON OR COIN CELL BATTERY CAN CAUSE INTERNAL CHEMICAL BURNS IN AS LITTLE AS TWO HOURS AND LEAD TO DEATH. DISPOSE OF USED BATTERIES IMMEDIATELY. KEEP NEW AND USED BATTERIES AWAY FROM CHILDREN. IF YOU THINK BATTERIES MIGHT HAVE BEEN SWALLOWED OR PLACED INSIDE ANY PART OF THE BODY, SEEK IMMEDIATE MEDICAL ATTENTION.
• A SWALLOWED BUTTON OR COIN CELL BATTERY CAN CAUSE INTERNAL CHEMICAL BURNS IN AS LITTLE AS TWO HOURS AND LEAD TO DEATH DUE TO CHEMICAL BURNS AND POTENTIAL PERFORATION OF THE ESOPHAGUS.
• DISPOSE OF USED BATTERIES IMMEDIATELY, FLAT/DRAINED BATTERIES CAN STILL BE DANGEROUS
• KEEP NEW AND USED BATTERIES AWAY FROM CHILDREN.
• IF YOU THINK BATTERIES MIGHT HAVE BEEN SWALLOWED OR PLACED INSIDE ANY PART OF THE BODY, SEEK IMMEDIATE MEDICAL ATTENTION.
• IF YOU SUSPECT YOUR CHILD HAS SWALLOWED OR INSERTED A BUTTON BATTERY IMMEDIATELY CALL THE POISONS CONTROL HOTLINE AND SEEK IMMEDIATE MEDICAL ATTENTION.
• EXAMINE DEVICES AND MAKE SURE THE BATTERY COMPARTMENT IS CORRECTLY SECURED, E.G. THAT THE SCREW OR ANOTHER MECHANICAL FASTENER IS TIGHTENED. DO NOT USE IF COMPARTMENT IS NOT SECURE.
• TELL OTHERS ABOUT THE RISK ASSOCIATED WITH BUTTON BATTERIES AND HOW TO KEEP THEIR CHILDREN SAFE.

Need Customer Support?

Our customer service experts will answer any question. Call us toll free **866.252.3811.**
Monday – Friday; 8am – 5pm Central Time

Or visit our online Customer Service Center at
www.explorescientific.supportsync.com

We know you'll enjoy your new Explore Scientific telescope for years to come.

Please familiarize yourself with the directions before beginning assembly.

As you know, the telescope arrives in two boxes: the smaller box contains the wooden parts and hardware for the Dobsonian base, and the larger box contains the telescope and accessories. We suggest you keep all boxes and packing materials in case you need to store, transport, or ship the telescope.

If you are new to amateur astronomy, we suggest learning the constellations that are visible in the night sky this time of year. Think of the constellations as states in a country, while the objects you want to observe are like counties and cities within them. While pointing the telescope is not hard, pointing it at a specific celestial target is a skill you need to learn. That comes from patience and practice.

It's also important to remember, because of light pollution around cities, the farther away you are from the city lights the more things you will see.

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WARNING:

DO NOT USE THIS TELESCOPE OR ANY ACCOMPANYING FINDER SCOPE TO LOOK AT OR NEAR THE SUN UNLESS YOU ARE USING A SPECIAL SOLAR FILTER! EVEN MOMENTARY VISUAL CONTACT WITH THE SUN'S LIGHT RAYS CAN INSTANTLY CAUSE IRREVERSIBLE DAMAGE TO YOUR EYE(S). EYE DAMAGE CAN BE PAINLESS, SO THERE IS NO WARNING TO THE OBSERVER THAT DAMAGE HAS OCCURRED UNTIL IT IS TOO LATE. TAKE EXTRA CARE WHEN USING THE TELESCOPE OR A FINDER SCOPE DURING DAYLIGHT HOURS, AND DO NOT POINT EITHER AT OR NEAR THE SUN. DO NOT LOOK THROUGH EITHER WHEN YOU ARE MOVING THE INSTRUMENTS DURING THE DAYTIME. NEVER ALLOW ANYONE TO USE THE TELESCOPE OR A FINDER SCOPE DURING THE DAYTIME WITHOUT WARNING THEM OF THE HAZARDS OF AIMING EITHER AT OR NEAR THE SUN. MAKE SURE THAT THEY ARE ADEQUATELY TRAINED ON THE USE OF THESE INSTRUMENTS BEFORE ALLOWING THEM TO START OBSERVING. CHILDREN SHOULD ALWAYS HAVE INFORMED AND TRAINED ADULT SUPERVISION WHILE OBSERVING.

1. Unpacking

Carefully remove all items from the boxes and spread the parts out on a flat surface.

Verify that you have all the parts listed in Figure 1.1. If something is missing, double-check the shipping boxes. If the item still cannot be found, contact Explore Scientific Customer Service at 866.252.3811. Leave a detailed message including your name, address, phone number, and email address.

Parts List:

A – Optical Tube Assembly with Cradle Rings
B – Base
C – 25mm Plössl eyepiece, 1.25”
D – 10mm Plössl eyepiece, 1.25”
E – Red-Dot Finderscope
F – Eyepiece Rack and Mounting Screws (x2)
G – Dust Cap
H – Smartphone Adapter

Figure 1.1

2. Assembly

Remove the telescope and base from the shipping box. Carefully place the telescope onto a flat surface. Remove the protective plastic.

Remove the protective plastic from the base.

The telescope is wrapped in white tissue paper. Remove the paper by unscrewing the bolts on the two rings, then gently lift the telescope out of the rings. Remove the paper, then place the telescope back in the rings. Close the rings and tighten the bolts – but do not overtighten.

Attaching The Telescope

To attach the telescope to the base, locate the dovetail saddle and loosen the saddle lock knob until it no longer protrudes into the saddle plate (Figure 2.1).

Slide the Vixen-style dovetail mounting bar into the dovetail saddle, making sure that the open end of the telescope is pointing up.

While still holding onto the telescope, tighten the saddle lock knob until it is holding the telescope in place.

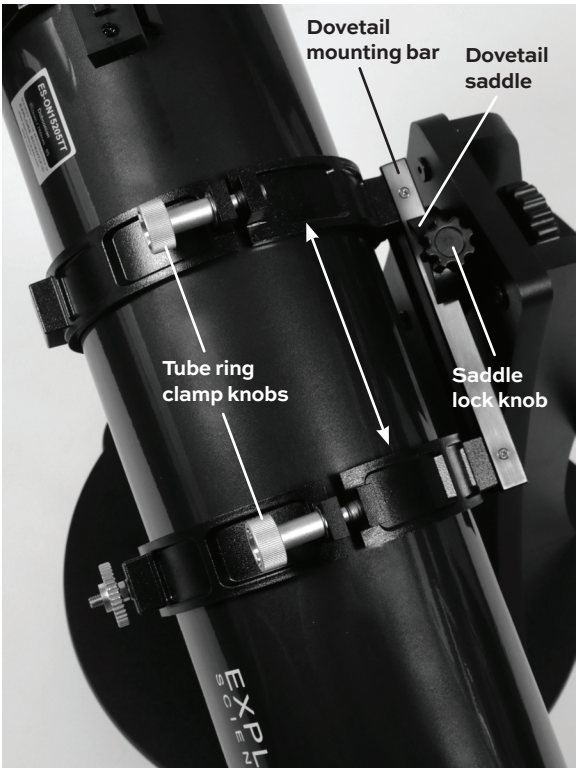


Figure 2.1

3. Install The Red-Dot Findercope

To install the finderscope, slide the mini Vixen-style dovetail foot into the dovetail base on the telescope, then tighten the thumbscrew to secure the finderscope (Figure 3.1). Remove the plastic tab sticking out from the battery compartment by pulling on it. Discard the tab. The 3-volt CR2032 button battery is now connected to the internal circuit, ready to power on the red LED.

Install the red-dot finder into the mini-dovetail plate on the telescope by sliding it in, then tighten the thumb screw.

Figure 3.1

4. Attach The Eyepiece Rack

The eyepiece rack has two keyways that slide over two pre-installed screws on the mounting base. After sliding the rack in place, use a Phillips screwdriver to tighten the screws (Figure 4.1). Locate the two silver screws on the side of the telescope base. Slide the eyepiece rack over the screws. Use a Phillips screwdriver to tighten the screws enough to hold the rack in place.

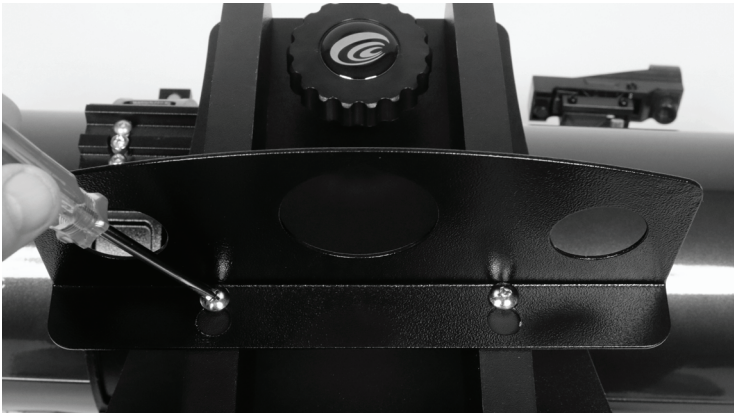


Figure 4.1

5. Insert An Eyepiece

Your telescope package arrived with two 1.25-inch Plossl eyepieces – one with a focal length of 25 mm, the other with 10 mm. Information about magnification can be found later in this manual.

Remove the eyepiece from the protective case and remove the plastic bag. On the end of the focuser you'll find a silver thumbscrew. Loosen the thumbscrew and remove the protective cap. Insert the silver barrel of the eyepiece into the focuser, being sure to fully seat the eyepiece. Lightly tighten the thumbscrew to secure it.

Place an eyepiece into the focuser. Lightly tighten the thumbscrew to keep the eyepiece in place (Figure 5.1).

Adjusting Focuser Orientation

The orientation of the focuser can be changed to a position of comfortable viewing. Loosen the bolts on the tube rings (Figure 2.1) until you can rotate the telescope tube by gripping it on both ends. When the focuser is in the position you want, tighten the tube ring bolts. Do not overtighten.

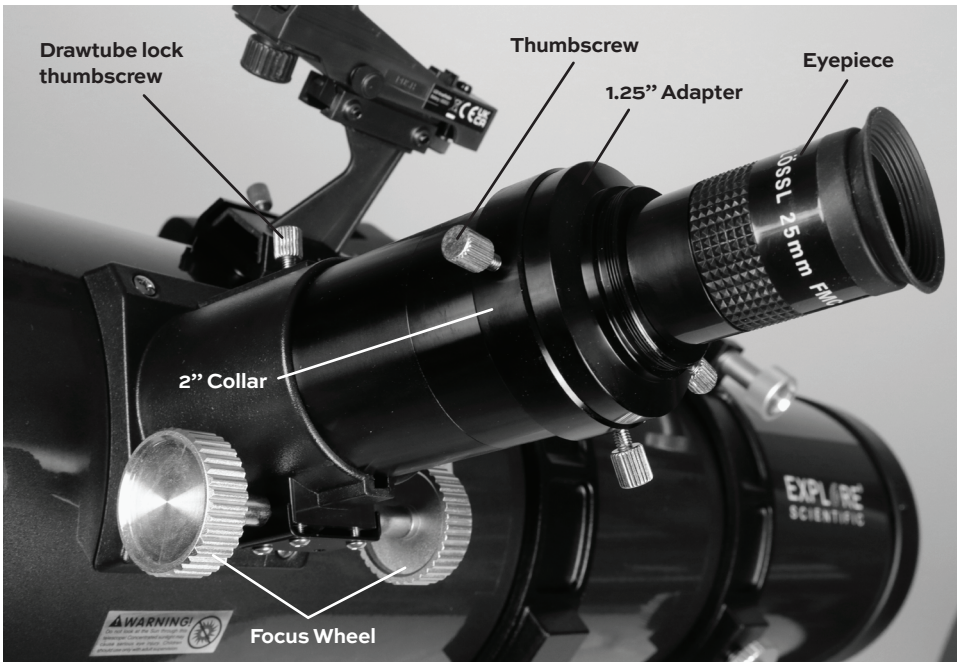


Figure 5.1

6. Balance The Optical Tube

You need to balance the telescope on the mount so that it does not change location when you point it toward the sky.

To balance the telescope, loosen the saddle lock knob enough so you can slide the dovetail mounting bar forward or backward. Once you achieve balance, tighten the saddle lock knob. (Refer to Figure 2.1)

Alternatively, you can loosen the tube ring clamp knobs on the cradle rings enough so you can slide the tube forward and backward, which shifts the center of gravity. Once balanced, be sure to tighten the bolts. Do not overtighten.

7. Aligning And Using The Red Dot Finderscope

WARNING: NEVER point the telescope at the Sun and look through it without proper protection: Permanent eye damage will result unless you have the correct protective film on the front of the telescope.

In the evening, take the telescope outside and find a location where you can see a long way – at least a quarter of a mile – and see some unique object. While the base does not have to be perfectly level, you should ensure that the surface is not sharply angled. Suggestions include a telephone pole, stop sign, radio tower – something that will be easy to find with the telescope.

Grasp the front of the telescope to move it both up and down (altitude) and left and right (azimuth). You will find that it is EASY to move. Point the telescope at the alignment target – let's say the top of the radio tower. Center it in the eyepiece and focus.

Turn on the finder using the on-off switch. Your finder does NOT project a laser line in the sky – it simply projects a red dot onto a clear screen in the finder.
Observe where the red dot is pointing by looking through it from the back of the telescope. Many people find it more comfortable to do this with both eyes open; however, if that proves difficult it is perfectly fine to close one eye.
If the red dot happens to be on top of the alignment target, there's nothing to adjust. But if it is not on top of the target, you will have to adjust where the red dot is aimed.

The finder has two adjustment knobs – one moves it left and right; the other, up and down (Figure 7.1). Use these two knobs to move the red dot onto the alignment target – without moving the telescope. Look through the eyepiece to ensure you did not move the scope. If you did, simply recenter the target, then carefully adjust the finder. Once you have the red dot on the alignment target AND the target is centered in the eyepiece – you have successfully aligned the finder.

When you are done using the finder, be sure to turn it off.

Replacing the Finderscope Battery
Sooner or later, you are going to have to replace the battery in your finder. The CR2032 battery is generally available wherever batteries are sold.

The battery is held in a small tray. One side of the tray is labeled "PUSH." Use your finger to push it out. It will slide part way out. Gently pull it out from the other side. Remove the old battery, then install the new battery. Ensure that the positive side of the battery is facing up.

Insert the tray back into the finder, being sure to insert the side with "PUSH" in first.

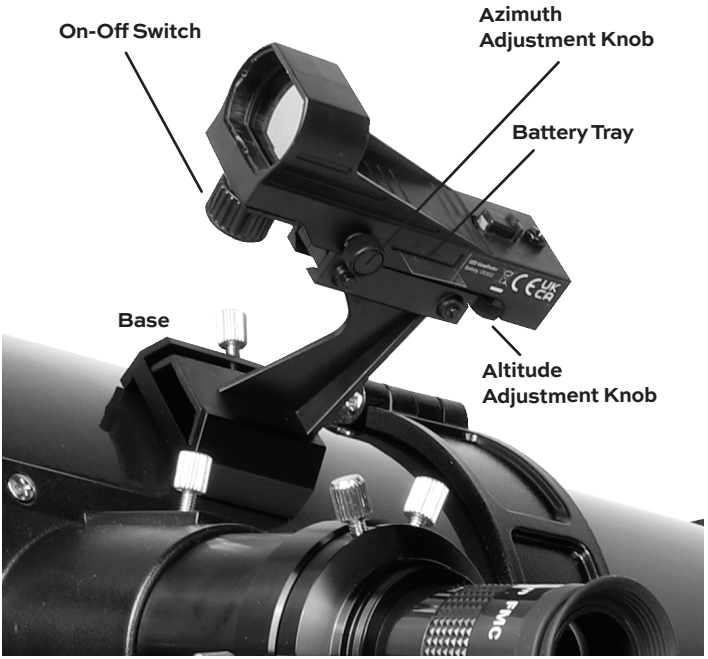


Figure 7.1

⚠ WARNING:
- **INGESTION HAZARD** – This product contains a button cell or coin battery.
- **DEATH** or serious injury can occur if ingested.
- A swallowed button cell or coin battery can cause **Internal Chemical Burns** in as little as **2 hours.**
- **KEEP** new and used batteries **OUT OF REACH of CHILDREN.**
- **Seek immediate medical attention** if a battery is suspected to be swallowed or inserted inside any part of the body.

8. Focus The Telescope

Insert the 25mm Plossl eyepiece into the focuser, being sure to gently tighten the thumbscrew that holds it in place (Figure 8.1).

On each side of the focuser are large knobs. These knobs turn a shaft that causes the focuser to move in and out. Looking through the eyepiece, and point the telescope at something at least half a mile away. Slowly turn the focus knobs until the target comes into focus. To ensure it's in perfect focus, keep turning until the target is slightly out of focus. Now slowly turn it in the opposite direction, stopping when you've got the target as focused as you can get it.

On top of the focuser is a small, silver knob (Figure 8.1). This knob is called the drawtube lock thumbscrew, and locks the focuser in place. In most instances you will not need to use this lock system. Only use it if you have a heavy 2-inch eyepiece that is causing it to move.

To use an optional 2" eyepiece or 2" Barlow lens, remove the 1.25" adapter by loosening the three thumbscrews on the 2" collar. This picture shows the 2" collar with the 1.25" adapter removed (Figure 8.2).

Everything Is Upside-down!

When you look in the eyepiece you will notice that everything is upside-down or rotated at an angle. This is normal – it is how a Newtonian telescope works. If you're looking at things on land, it is VERY obvious; but if you're looking in the night sky this effect is not noticed by your brain. Why not? Because your brain knows what's level or at a strange angle when you're looking at things on the land because of the horizon, trees, houses, etc. But when you're looking at the moon, or anything else in the sky, your mind does not use that as a reference, thus it is not bothered by the image being upside-down.

9. Aiming The Telescope

With the finder installed and aligned, you can easily find things in the sky. Point the telescope in the general direction of what you want to observe. Look through the finder, then move the telescope until the red dot is on your target. The object should be in the eyepiece.

If it's visible, but not centered, center it. Let's say this is a bright star. Carefully adjust the location of the red dot until it covers the star. Once you have the star centered in the eyepiece and the red dot covering it, you have fine-tuned the finder alignment.

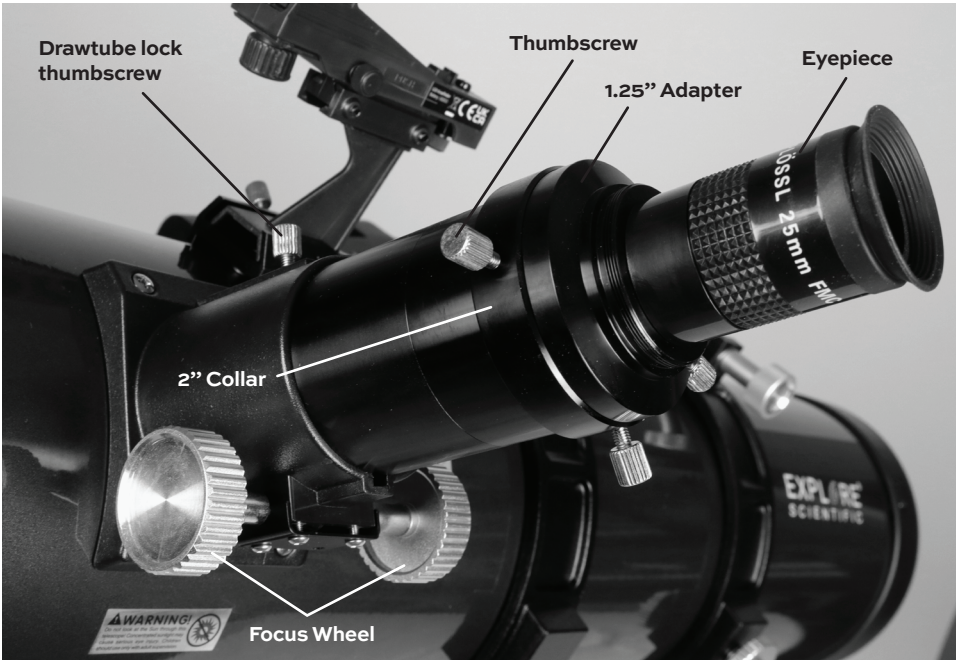


Figure 8.1

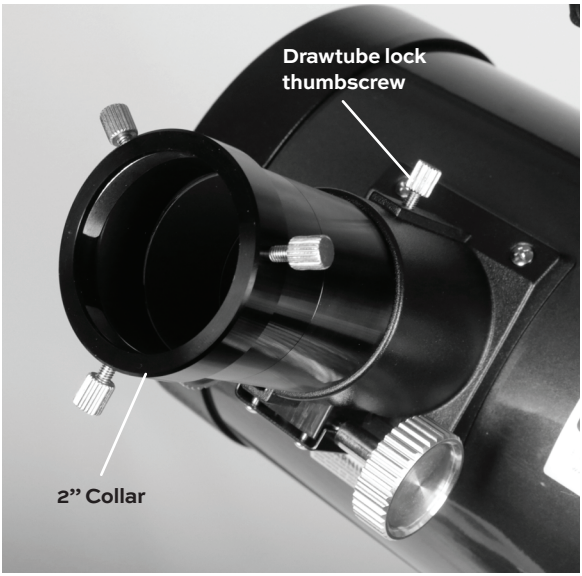


Figure 8.2

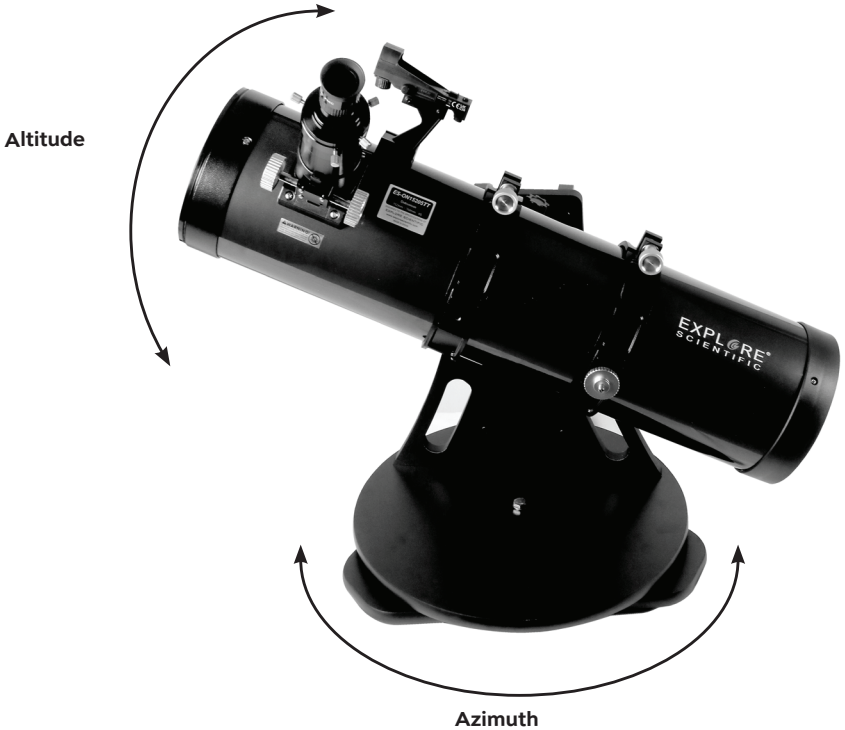
With the target in the eyepiece, focus the eyepiece and marvel at the wonders revealed by your 6-inch Tabletop Telescope.

Like any skill, the more you practice the better you get. We suggest you go out every clear night you can for at least a few weeks – even if for a few minutes – and observe. This will build your skill set, which in turn will make your viewing much more pleasurable.

10. Altitude And Azimuth Motions

As noted earlier, your telescope mount moves in two directions altitude (remember, this is up and down) and azimuth (left and right).

Grasp the front of the telescope, then move it up and down and left and right. You can do both motions at the same time. No need to push hard – you'll find it takes very little force to move it. This means that, as you're looking through the eyepiece, you can easily move the telescope in very small amounts to keep the celestial wonder centered.



You can adjust the amount of pressure it takes to move the altitude axis by tightening or loosening the altitude tension knob (Figure 10.1). You need enough tension to keep the telescope from moving too easily, or even by itself. Yet, too much tension can make it difficult to move precisely. So, adjust the tension a little at a time until you find the sweet spot. Rotation of the azimuth axis is preset at the factory to allow very easy, smooth movement left and right.

Figure 10.1

Tabletop or On The Ground?

While we named the telescope a Tabletop Telescope, it can be used on the ground. When it is on the ground, you'll find you need to kneel to look into the eyepiece. Many will find that option perfectly acceptable. Others, well, that might not be possible.

With it on a tabletop, the eyepiece raises to a comfortable height. But, the table will make the telescope jiggle if someone bumps the table. Jiggle is one of the enemies of good viewing. With it on a table, you may find that a chair or tall stool offers a comfortable position. Using it on a standard picnic table with attached benches is not practical because every time you move, the table moves, too.

So pick a stable table.

11. Determining Magnification

The word magnification describes how much closer a telescope makes an object appear. There are two parts to calculating magnification: focal length of the telescope and focal length of the eyepiece (the number on the side of the eyepiece).

To calculate magnification, divide the focal length of the telescope by the focal length of the eyepiece.

$$\frac{\textbf{Telescope Focal Length}}{\textbf{Eyepiece Focal Length}} = \textbf{Magnification}$$

For example, this 6-inch Dobsonian telescope has a focal length of 760 mm. Using the 25 mm eyepiece, the math is:

760 mm / 25 mm = 76x

Telescope Focal Length **Eyepiece Focal Length** **Magnification**

That means what you're looking at is magnified 76 times – called 76x.
If you use an eyepiece of a different focal length, simply remember the formula: telescope focal length divided by the number on the side of the eyepiece.

Eyepieces can be purchased that have a shorter focal length, which means it will offer more magnification. Many beginning telescope users think that high power is where it's at: Sometimes, that's true.

But that high power creates some tough situations.

1. The object gets dimmer
2. Focusing becomes more of a challenge
3. Keeping the target in the eyepiece is hard because not only have you highly magnified the size, you have magnified the speed it moves by the same amount. So, you're going to have to move your telescope more often.
4. You will magnify the seeing conditions in the air between you and space. If the stars are twinkling, then that's going to impact how the moon, planets, galaxies and all the other heavenly wonders look.

That's why you should start your evening's observing using the eyepiece with the lower magnification (the biggest number on the side). Why? Because at low power you have a better chance of getting an object in the eyepiece and centered.

If you start out at a high power, the chance of finding your target in the eyepiece is slim. Once centered, go to the next lower focal length eyepiece and center it again. You can keep doing this until you reach a point that the viewing is not good.

Limits of Magnification
Each telescope system has a theoretical limit to its magnification power. A good rule of thumb is a telescope's useful magnification is 2 times the aperture in millimeters. This 6-inch Dobsonian telescope is 152 mm in diameter, meaning the maximum magnification is going to be 304x.

$$\frac{\textbf{Telescope Focal Length}}{\textbf{Telescope Diameter (x2)}} = \textbf{Max. Eyepiece Focal Length}$$

What eyepiece would give that magnification? Here's the math: Focal length of the telescope divided by 304.

760 mm / 304 mm = 2.5 mm

Telescope Focal Length	Telescope Diameter(x2)	Max. Eyepiece Focal Length

You need an eyepiece with a focal length of 2.5 mm. Trust us when we say that is pushing things to the limit. Unless you have absolutely perfectly stable, clear conditions and a sky free from light pollution, achieving that magnification is not going to happen. Under typical skies, the object is going to be blurry, dim, and jumping around – and zipping out of the eyepiece in mere seconds.

Low to medium powers – like those offered by the eyepiece that came with your telescope – offer the most pleasurable experience.

12. Collimating The Optics

All Newtonian telescopes have two mirrors: A primary mirror (the big one) and a secondary mirror.

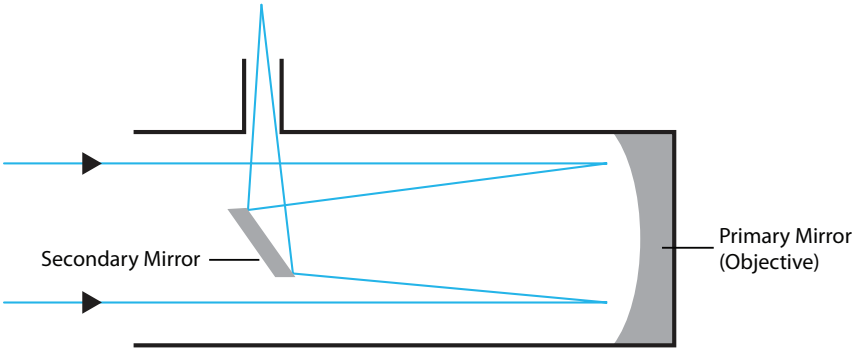
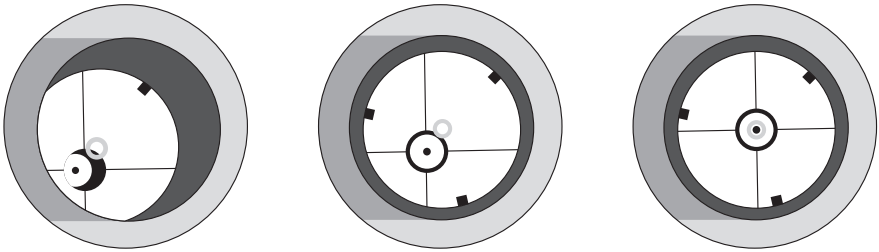


Figure 12.1

The primary mirror on your telescope is center marked with a small ring. Why? This center mark offers a way to get very precise collimation if you are using an optional collimation tool – like a laser collimator. Don't worry about the ring being visible when you look through an eyepiece – the ring is hidden by the secondary mirror.

Although the optics in your telescope were collimated in the factory, they may have moved during shipment. The procedure is straightforward and should take only a few minutes – once you learn it. We find it easiest to work on collimation in a brightly lit room. This is especially true when you are learning how to do it. Collimation is done in three steps.

Out of collimation examples. **Collimated example.**



Rough Collimation

Collimating the secondary mirror (Figure 12.1): If the telescope is collimated you should see the concentric images of your eye, reflections of the secondary mirror and primary mirror, primary mirror center mark and the focuser (Figure 12.2). If the telescope does not look like Figure 12.2 or looks like one of the out of collimation examples below, contiune on to the next steps.

1: Draw tube barrel
2: Primary mirror reflection
3: 4 vanes of secondary mirror holder
4: Secondary mirror reflection
5: Your eye
6. Primary mirror center ring mark

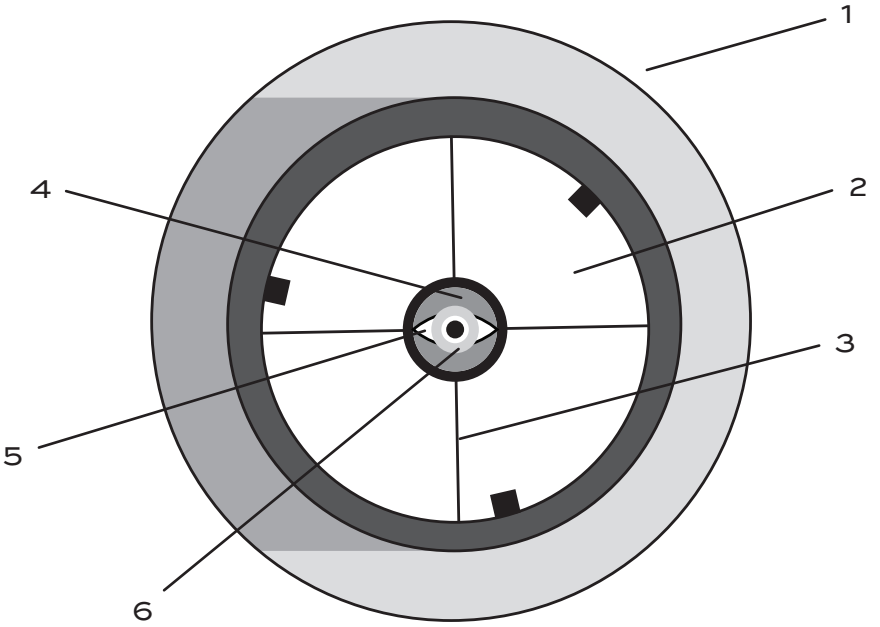
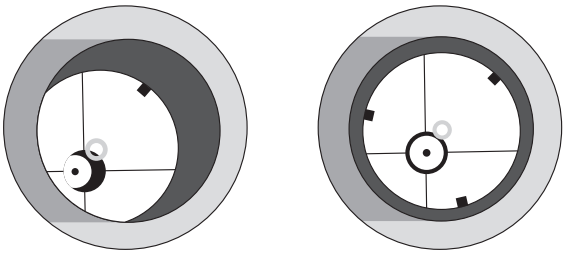


Figure 12.2



Out of collimation examples.

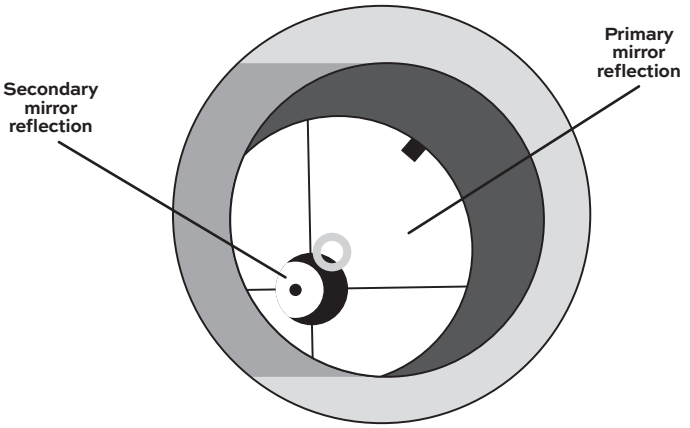
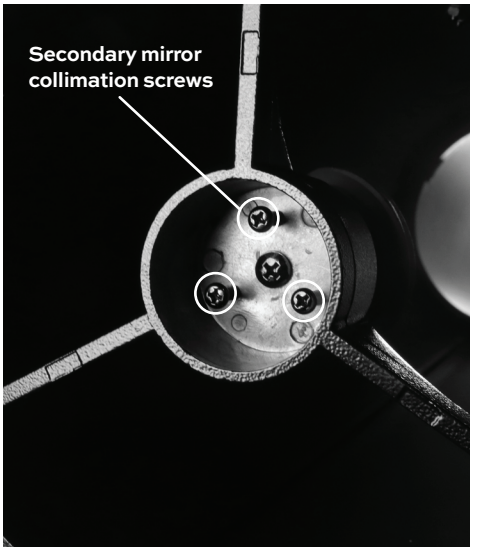


Figure 12.3

Remove the eyepiece from the focuser and, from about a foot away, and with one eye, look through the focuser draw tube. The secondary mirror reflection (your eye) needs to appear round. If the secondary mirror reflection does not appear round (Figure 12.3), tilt it with the three collimation screws (Figure 12.4) that are located on the sky side of the secondary mirror holder.

Do this by first loosening one of the secondary mirror's collimation screws, then tighten the other two. **ALWAYS** loosen one, then tighten at least one if not two. Use a Phillips screwdriver for this task.



IMPORTANT: Turn these screws by very small amounts: No more than 1/8th of turn.

Figure 12.4

If you see that the secondary mirror reflection appears off center from the primary mirror reflection (Figure 12.5), this will be corrected further in the process. This process can only be accomplished by trial and error. If your first effort to adjust the secondary makes it move in the wrong direction, simply loosen another screw to determine the effect it has. Soon you'll be moving it into the correct position.

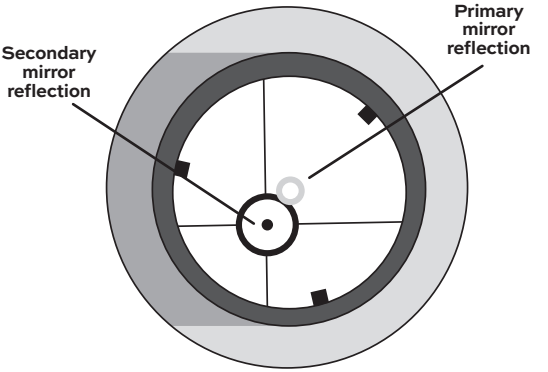


Figure 12.5

Once the image is round, be sure all the screws are tight.

Adjusting the primary mirror
The goal is to line up the ring mark with the secondary mirror, as shown in Figure 12.2.

Adjust the tilt of the primary mirror by using the three spring-loaded knobs on the bottom end of the telescope (Figure 12.6). Next to the spring-loaded knobs are three small Phillips screws that serve as locks. First loosen the Phillips screws by no more than 2 turns.

While looking through the focuser draw tube, turn one of the spring-loaded knobs about ¼ of a turn and observe what happened. If it moved closer, slowly turn it. Chances are you are going to have to tighten, or loosen, all three screws to get the mirror tilted correctly. This will require trial and error – and patience.

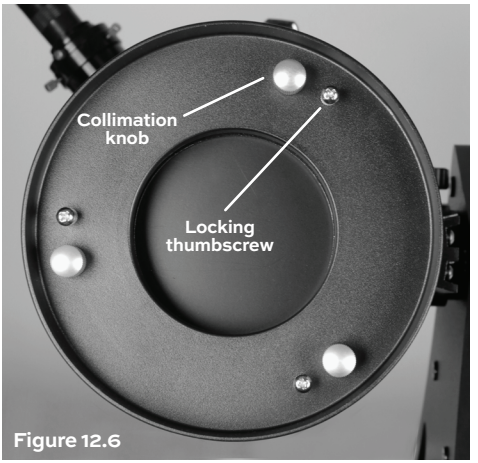


Figure 12.6

Once you have it centered, gently tighten the Phillips screws. **DO NOT** overtighten them. Remember, the goal is to get the reflection of the secondary mirror centered on the primary mirror.

Do not have a quest for perfection! Close enough is good enough, especially for an inexperienced person. Get it close, then get out under the stars. Your skills will improve and you'll be able to get better collimation.

You can achieve precise collimation, but it requires use of optical collimation tools, including a laser collimator, a Cheshire eyepiece, or a collimation cap. Note that if you handle the telescope roughly, you are going to knock it out of collimation. Treat it gently.

Fine Collimation
For fine collimation, it is important that the telescope has cooled down to ambient air temperature. This is because heat exchange from the primary mirror to the air outside goes up the tube. Just like heat rising off hot pavement creates waves that look like mirages, the heat traveling up can cause distortion.

During fine collimation, locate Polaris and view it with high magnification. If the telescope is collimated well, you will see a system of dim rings of light surrounding a central bright spot — the airy disc. You will also notice a dim cross of light coming from this airy disc. This is the diffraction that is caused by the vanes that hold the secondary mirror in place. We have left this cross out of the next figures for clarity. What we want to see is shown in Figure 12.9 – a central airy disc that is surrounded by concentric rings. However, it is much more likely that the picture will be different – more like Figure 12.7. It is essential that you always center the star because outside of the optical axis all stars do show some distorted images. Note: You will get those images only during moments of perfect steady air because air turbulence will distort this image; however, the collimation goal remains the same – getting a concentric star image. So let us assume you have good seeing and your eyepiece shows you something like Figure 12.7.

Try turning the main mirror spring-loaded collimation knobs (after loosening the Phillips screw locks). When you are turning the correct screw in the proper direction, you will notice that the distracting "tail" is getting shorter. (Figure 12.8)

Figure 12.7

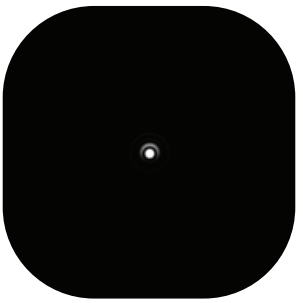


Figure 12.8

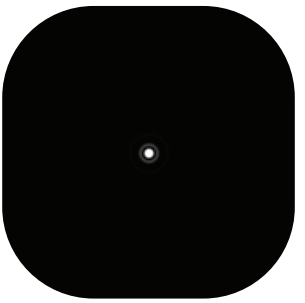


Figure 12.9

Remember to recenter the star after you have turned a screw. When the telescope is perfectly aligned, you will see the picture of Figure 12.9 (when the air is perfect). While using your telescope you will get a feel for this – it does not make sense to spend a lot of time on collimation when the air is moving too much.

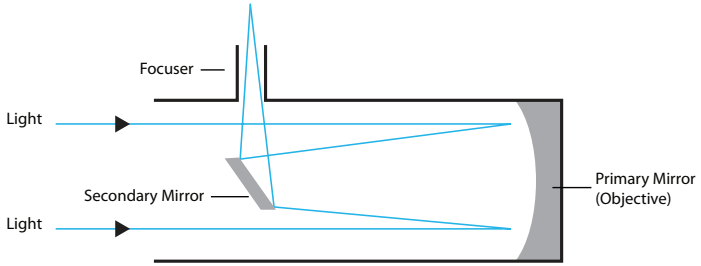
Important: Outside the optical axis (the middle of the field of view) all stars will be distorted and show tails directed to the edge of the field of view. If you are using cheap eyepieces those star images will be even more distorted because the off-axis aberrations of the telescope and the eyepiece will add up. For this reason, it is essential to recenter Polaris after every turn of a collimation screw because the turning of the screw will also shift the star from its centered position. As mentioned before, it may not be possible to get a sharp star image during periods of turbulent air. In this case try to achieve a symmetrical image during collimation. If you don't see any more improvement, abort the process. During nights of unsteady seeing, it is not recommended to use high magnification. Try to enjoy low magnification objects like nebulae, clusters and galaxies on those nights instead of fretting over the bad conditions.

13. Care and Maintenance

It will not be long before you can see dust on the primary mirror – especially if you use a bright flashlight. The bright flashlight makes the dust look MUCH worse than it is. It takes a lot of dust on a mirror for it to need cleaning. If you look down the tube and can see your reflection in normal room light, it does not need cleaning.

If you believe your telescope primary mirror needs cleaning, contact Customer Support (866.252.3811) for assistance.

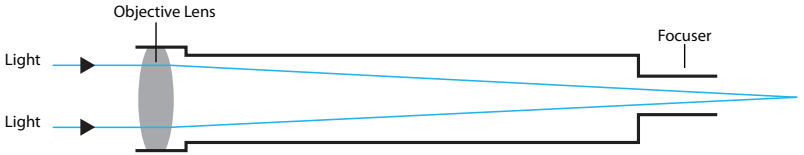
14. Telescope Basics



Types Of Telescopes:

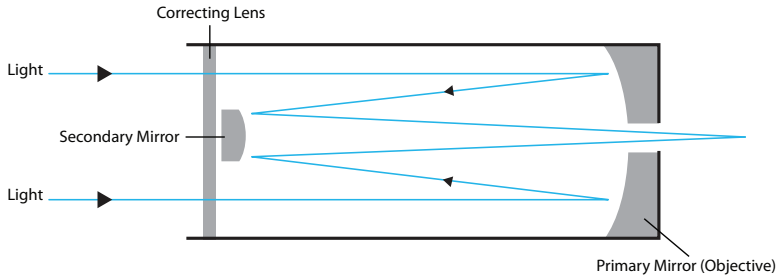
Reflector

A reflector telescope uses mirrors to gather and focus light. Light enters the telescope through its open front end and travels to the concave primary mirror at the back. From there the light is reflected back up the tube to a flat secondary mirror, which sits at a 45° angle in relation to the eyepiece. Light bounces off of this secondary mirror and out through the eyepiece. A reflector telescope is designed for astronomical use. Terrestrial objects may appear inverted, sideways or at an angle depending on how your tube is oriented due to optical design. This rotation is perfectly normal on all Newtonian reflectors and will not affect astronomical viewing.



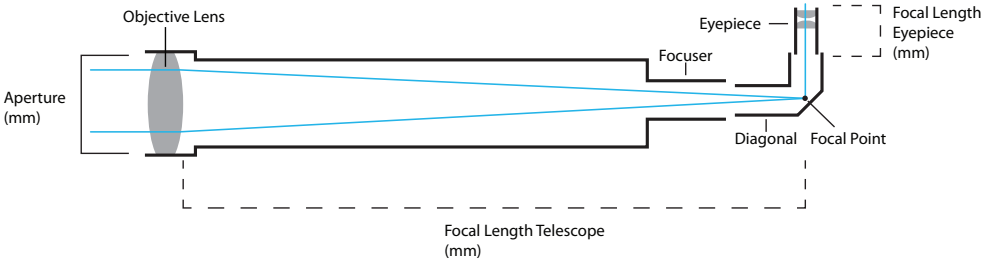
Refractor:

A refracting telescope uses a collection of lenses to gather and focus light. A refractor's views will be upside down if a diagonal is not in use. A standard diagonal will generate a "right side up" image, however, it will rotate the image on the vertical axis (mirror image). To get the "right side up" image without the rotation, you will need to use a special diagonal with an erect image prism.



Catadioptric:
A catadioptric telescope uses a combination of mirrors and lenses to gather and focus light. Popular catadioptric designs include the Maksutov-Cassegrain and Schmidt-Cassegrain.

Refractor Telescope



Telescope Terms to Know:

Aperture:
This figure, which is usually expressed in millimeters, is the diameter of a telescope's light-gathering surface (objective lens in a refractor or primary mirror in a reflector). Aperture is the key factor in determining the brightness and sharpness of the image.

Objective Lens:
The objective lens is the main light-gathering component of a refractor telescope. It is actually composed of several lens elements.

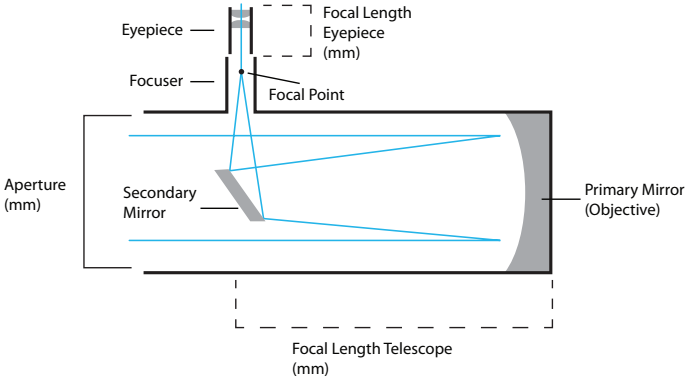
Diagonal:
This accessory houses a mirror that deflects the ray of light 90 degrees. With a horizontal telescope tube, this device deflects the light upwards so that you can comfortably observe by looking downwards into the eyepiece. The image in a standard diagonal mirror appears upright, but rotated around its vertical axis (mirror image). To get an image without this rotation, you will need to use a special diagonal with an erect image prism.

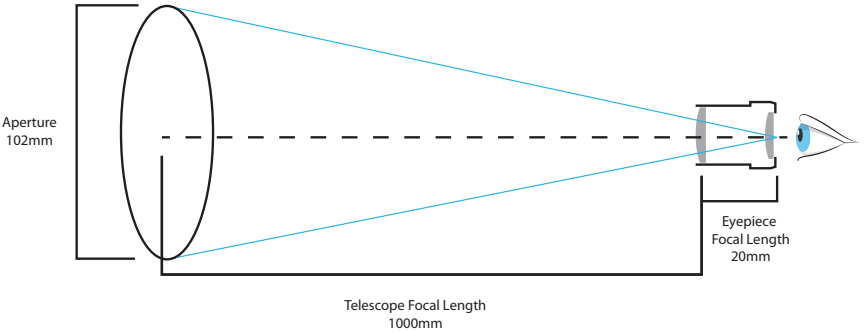
Eyepiece:
An eyepiece is an optical accessory comprised of several lens elements. It determines the magnification of a particular observing setup.

Primary Mirror:
The primary mirror is the principle light-gathering surface of a reflector telescope.

Secondary Mirror:
A secondary mirror is a small mirror that sits at a 45° angle in relation to the primary mirror of a reflecting telescope. Light from the primary mirror is reflected back up the tube to the secondary mirror. The light is directed from this mirror up into the eyepiece.

Reflector Telescope





Magnification:
The magnification corresponds to the difference between observation with the naked eye and observation through a magnifying device like a telescope. If a telescope configuration has a magnification of 30x, then an object viewed through the telescope will appear 30 times larger than it would with the naked eye. To calculate the magnification of your telescope setup, divide the focal length of the telescope tube by the focal length of the eyepiece. For example, a 20mm eyepiece in a telescope with a 1000mm focal length will result in 50x power, which will make the object appear 50 times larger. If you change the eyepiece, the power goes up or down accordingly.

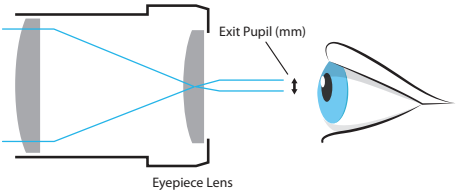
$$\text{Focal Ratio} = \frac{\text{Telescope Focal Length}}{\text{Telescope Aperture}}$$

Focal ratio
The focal ratio of a telescope is determined by dividing the telescope's focal length by its aperture (usually expressed in millimeters). It plays a key role in determining a telescope's field of view and significantly impacts imaging time in astrophotography. For example, a telescope with a focal length of 1000mm and a 100mm clear aperture has a focal ratio of f/10.

$$\text{Magnification} = \frac{\text{Telescope Focal Length}}{\text{Eyepiece Focal Length}}$$

Focal length (Telescope):
The focal length is the distance in millimeters between the objective lens or primary mirror and the point at which entering light rays converge — otherwise known as the focal point. The focal lengths of the telescope tube and the eyepiece are used to determine magnification.

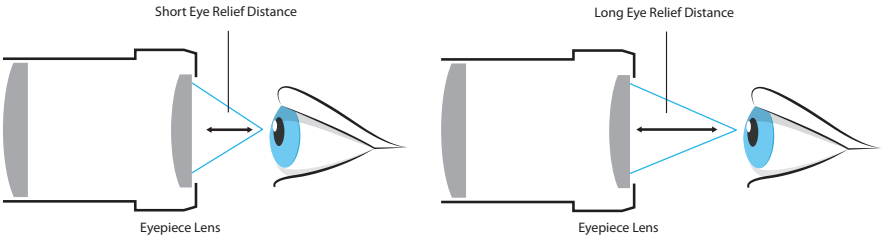
Focal length (Eyepiece):
The focal length is the distance in millimeters between the center of the first lens element in an eyepiece and the focal point. The focal lengths of the telescope tube and the eyepiece are used to determine magnification. Short eyepiece focal lengths produce higher magnifications than long eyepiece focal lengths.

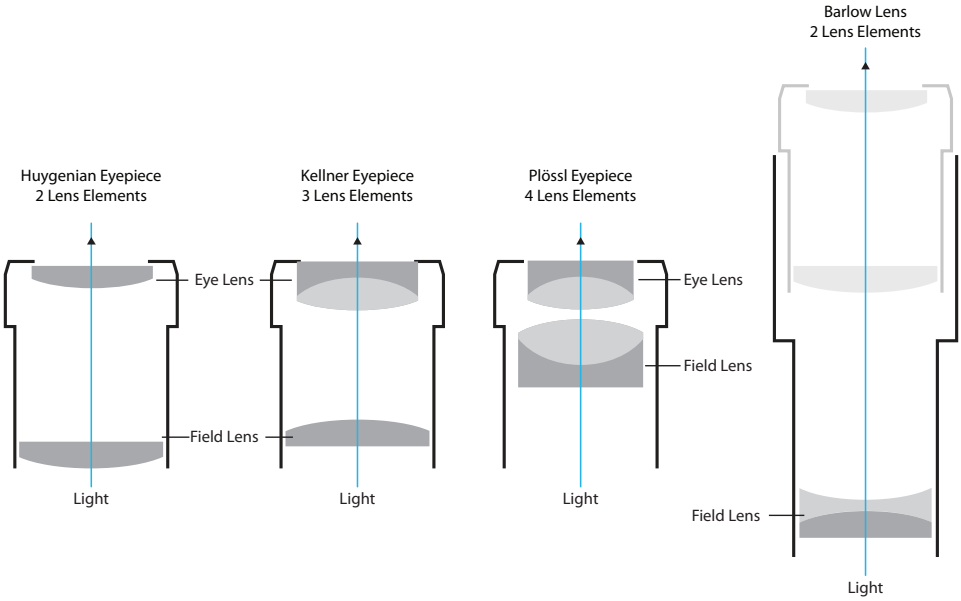


$$\text{Exit Pupil} = \frac{\text{Eyepiece Focal Length}}{\text{Telescope Focal Ratio}}$$

Exit Pupil
The exit pupil is the diameter of the beam of light coming out of the eyepiece. To calculate exit pupil, divide the focal length of your eyepiece by your telescope's focal ratio. For example, if you use a 20mm eyepiece with an f/5 telescope, the exit pupil would be 4mm.

Eye Relief
Eye relief is all about a comfortable viewing experience because it is the distance at which you need to position your eye from the eyepiece's outermost surface to enjoy the full field of view. This characteristic is of special concern to observers who wear glasses to correct an astigmatism, because a long enough eye relief is necessary to allow room for glasses.





Huygenian Eyepieces:
A Huygenian eyepiece uses two plano-convex lenses separated by an air gap. They have a fairly narrow apparent field of view.

Kellner Eyepieces:
A Kellner eyepiece uses three lens elements - two of which are paired together in an achromatic doublet design to minimize chromatic aberrations. They typically produce an apparent field of view around 45°.

Plössl Eyepieces:
A Plossl eyepiece uses two doublets (a pairing of lens) for a total of four lens elements. This eyepiece design delivers sharp views and an apparent field of view of approximately 50°, which works well for both planetary and deep sky viewing.

Barlow Lens:
A Barlow lens effectively increases the focal length of a telescope. It is inserted between the eyepiece and the focuser/diagonal (depending on the optical setup) and multiplies the magnification power of the eyepiece. For example, a 2x Barlow will double the magnification of a particular eyepiece.

15. Specifications

ES-ON15205TT - 6” Table Top Dobsonian

Focal Length:	760mm
Aperture:	152mm
Focal Ratio:	f/5
Focuser:	2” Rack and pinion, with 1.25” adapter
Optical Tube Material:	Rolled steel
Mirror Figure:	Paraboloid
Mirror Coatings:	Aluminum with SiO2 overcoat
Minor Axis of Secondary Mirror:	53mm
Eyepiece:	1.25” 25mm Plossl 1.25” 10mm Plossl
Magnification with Supplied Eyepiece:	30x(25mm) and 76x(10mm)
Finderscope:	Red Dot
Base Handle:	Yes
Optical Tube Weight:	22 lbs., 1 oz.
Tube Length:	27”

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Contents, colors and specifications may vary.

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