science museum ™

ROCKET TELESCOPE

Information

What does it do?
With this reflecting telescope you can see objects in the night sky more clearly than with the naked eye. Telescopes let you see more detail by catching more light than your eye alone, and focussing it to the eyepiece for you to see.

How does it work?
When you look at something, the light from that object enters your eye and is focussed on your retina, which detects the light and sends the information to your brain (where you construct an image in your mind). Very little light hits your retina from a small object, so you can't make out much detail. If your eye was larger, you could focus more light from an object onto your retina, which would let you make out more detail (or smaller objects). We can't do this, but telescopes create the effect of having larger eyes – more light is captured, so even very small and/or dim objects can be seen.

Technical notes
There are two main categories of telescope: Refractors and Reflectors. The first type, refractors, use two or more lenses to collect and focus the light from an object to the eye of the observer (or a digital camera sensor), and can trace their design back to the telescopes of Galileo's era. Reflectors, developed by Isaac Newton in the 17th century, use mirrors to focus the light. As magnifications increase, impurities in the glass of lenses can cause distortion (commonly a "rainbow-like" halo around objects) requiring expensive and difficult treatments and coatings to correct. Reflectors telescopes avoid this problem, and are generally cheaper to manufacture for a given sized aperture (the main lens or mirror used to catch the incoming light). As a result, most high-performance optical telescopes, including the Hubble Space Telescope, are reflector designs.

Fact files
Lenses were invented independently in Europe and China, sometime around 1250. As far as anyone knows, it took 350 years for someone to combine lenses to make a telescope. Two Dutch spectacle makers, Hans Lipperhey and Jacob Metius, may independently have been the first people to create telescopes by fixing two lenses in a frame or tube to see long distances.

The first telescopes were used as battlefield tools, but the Italian astronomer Galileo was the first person to use a telescope to look at the stars. With this advantage he was the first person to see the craters on the moon, the moons of Jupiter and Saturn's rings.

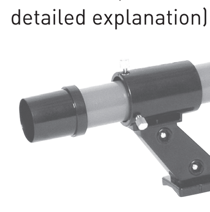
National Curriculum coverage
This product is suitable for exploring science at KS2 and KS3 of the National Curriculum. Use it to discover more about Light and Sound (physical processes).

In the Science Museum
The Science Museum has a large number of telescopes, microscopes and other optical devices. You can see a large selection at www.ingenious.org.uk including many that are not currently on display in the Museum. Highlights of the collection include replicas of Galileo's and Newton's original telescopes.

Contents

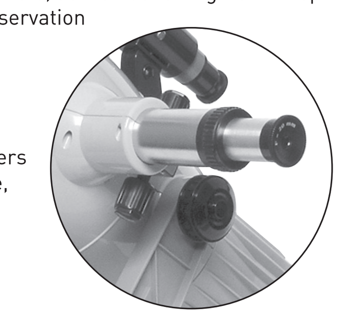
4 Interchangeable Eyepieces, 20mm,12.5mm, 9mm and 4mm eyepieces produce powers of 25X, 40X, 56X and 125X respectively.

6 X 25mm Finderscope with crosshairs (Refer to later detailed explanation)



3X Barlow Lens
The Barlow lens increases the magnification of the telescope. A 56X magnification can be increased to 167X with a 3X Barlow lens.The highest magnification power of the Barlow lens should only be used for large and bright objects such as the moon and the brightest planets, as well as for nights with optimal observation

Alt-Azimuth Mount
The telescope is fitted with an Altitude(Alt)-Azimuth mount. "Altitude" refers to the vertical movement of the telescope, while "Azimuth" refers to the horizontal movement.



The following magnification values are achieved when using the Barlow eyepiece extensions and the exchangeable eyepieces:

Eyepiece Chart and Theoretical Power Limits:

Eyepiece	Power	Power with 3x Barlow
20mm	25x	75x
12.5mm	40x	120x
9mm	56x	167x
4mm	125x	375x

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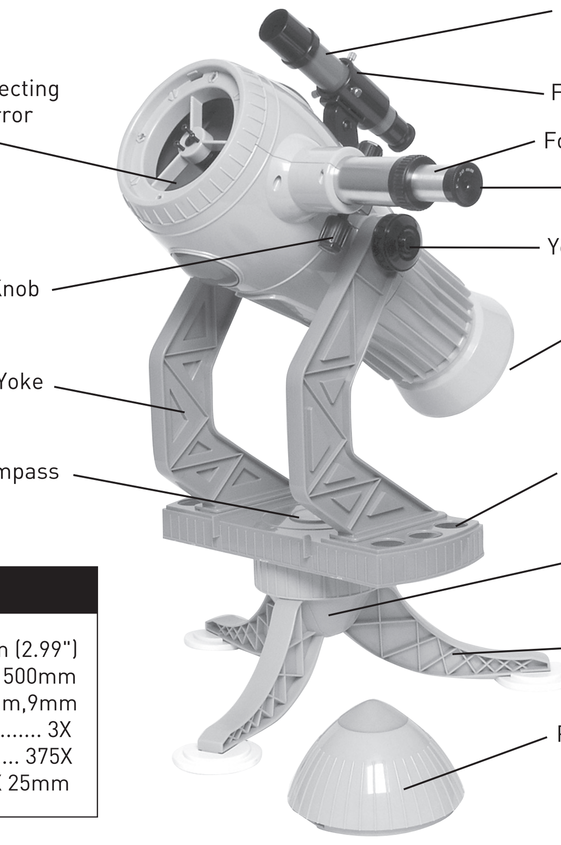

Technical Specifications

Objective Diameter .... 76mm (2.99")
Focal Length 500mm
Eyepieces..................4mm,20mm,12.5mm,9mm
Barlow 3X
Maximum Magnification 375X
Finderscope 6X 25mm

Instructions

1) Connect the three Tripod Legs to the Tripod Stand. (Fig. 2 & 3)

2) Remove the Protective Cap from the telescope main body. (Fig. 4)

3) Remove the Finderscope and the Finderscope Bracket from the box. Remove the 3 knurled thumb screws from the finderscope bracket. Then position the finderscope onto the bracket and tighten the 3 knurled thumb screws securely. Slide the finderscope bracket onto the main telescope body. (Fig. 5)

4) Insert the Eyepiece into the Focusing Tube. Secure by tightening the corresponding fastening screws.

5) For use of the Barlow Lens, remove the eyepiece and insert the Barlow into the Focusing Tube. Secure by tightening the small retaining screw. Insert Eyepiece into open end of Barlow. (Fig. 6)

Your telescope is now fully assembled and ready for use. For maximum enjoyment and full utilization of your telescope, please refer to the "SPACE MAP" included in the box.

CAUTION: Viewing the sun can cause permanent eye damage. Do not view the sun with the Telescope, Finderscope or even with the naked eye.

NOTE: Image will appear upside down.

Best use of the telescope
Since telescopes are high in magnification and narrow in field of view, it is rather difficult to catch a particular star among a great number of stars and to follow its movement. The crux of succeeding in the observation is to master the use of a telescope.

Handling
Do not handle the telescope violently. In particular, when the body tube is carried, be sure not to bump or drop it.

Observation site
Since it takes considerable time to observe a star, the telescope should be set at a properly selected site.

1. Select an open site where light is at a minimum and the largest possible celestial area can be seen.
2. Place such parts as the eyepiece on the Accessory Tray, or keep them in a small box.

Adjusting the finderscope
Since the telescope has a limited field of view, it can be quite difficult to locate a given star or planet. For this reason the telescope is fitted with a Finderscope with reticule for orientation. It is advisable to complete the following settings in daylight:

1. Insert the Eyepiece with the lowest magnification in the Focusing Tube. Look at a stationary, easily recognizable object that is not further away than 300 m. Turn the telescope with the horizontal axle, and move the vertical axle until the object is in the middle of the field of view, and then focus the image. Tighten the adjusting screw on the mount so that the telescope remains in this position (the higher the object is above the horizon, the easier it is to locate).

2. Now look through the finderscope. If the object seen through the telescope is not visible, then release the adjusting screws and move the finderscope until the object can be seen. Now retighten the adjusting screws while ensuring that the object remains visible in the centre of the finderscope. To simplify this procedure, use the adjusting screws to adjust the object in the centre. The finderscope will move in the direction of the screw in which it is being turned. All screws can be finally tightened as soon as the setting with the eyepiece coincides with that of the finderscope. (Fig. 7)

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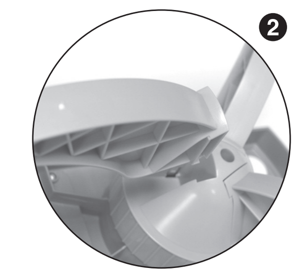

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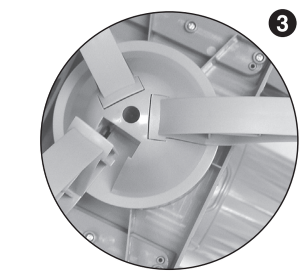

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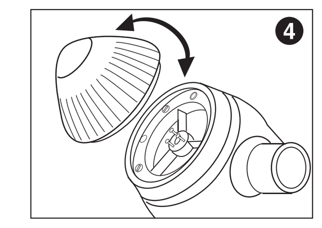

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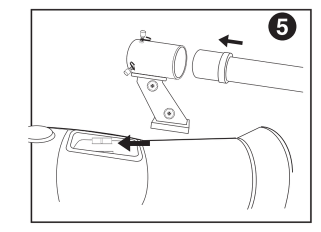

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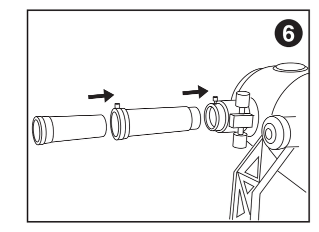

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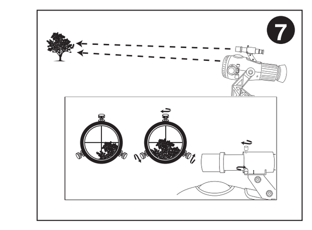


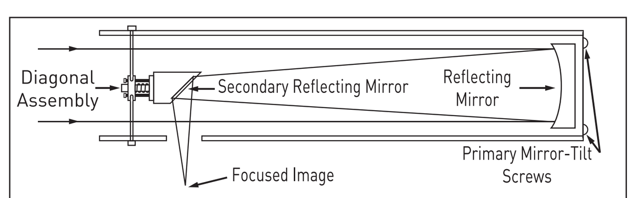
How to adjust the focus
Although it appears easy to adjust the focus, it is rather laborious in practice until one gets used to it. Focus on any distant image in the daytime and repeat this practice to develop skill in it.

1. Adjust the focus by moving the Focusing Tube back and forth. This may be done by turning the Focus Knob.
2. Since stars are always moving, focus on a neon sign or lamp over 1,000meters away. When the image is focused roughly, adjust the focus by moving the Focusing Tube back and forth slightly until the image is made clear. Then, without shifting the tube, point it to catch a star, and the focus will normally be found to be correct.
3. First adjust the focus with an eyepiece of lower magnification and then change it to another one having the required magnification.
4. Whenever the eyepiece is changed, readjust the focus by moving the Focusing Tube slightly.

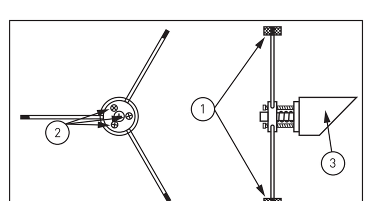
Before observation
Remove the big protective cap from the opening. It is advisable to start by using a low powered eyepiece on a distant terrestrial object. The image given by the telescope will appear upside down.

Aligning the optics

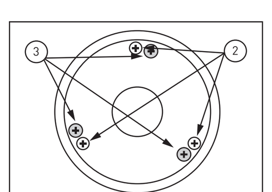
All telescopes are optically aligned at the factory prior to shipment. It is unlikely that you will need to align the optics after receipt of the instrument. However, if the telescope received unusually rough handling in shipment, it is possible that the optics must be re-aligned for best optical performance. In any case this alignment procedure is simple, and requires only a few minutes the very first time the telescope is used. Please familiarize yourself with the following collimation procedure, so that you will recognize a properly collimated instrument and can adjust the collimation yourself, if necessary.



❽ The Reflecting Telescope



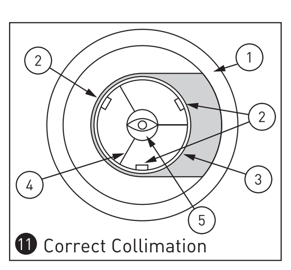
❾ Diagonal Assembly



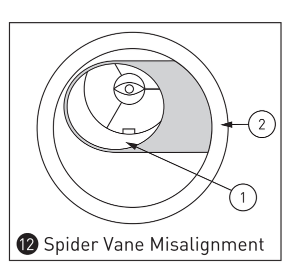
❿ Primary Reflecting Mirror

a) Correct collimation
The properly collimated (aligned) mirror system in the telescope assures the sharpest images. This occurs when the primary mirror and diagonal mirror are tilted so that the focused image (Fig. 8) falls directly through the centre of the focusing tube, (Fig. 1). These mirror tilt adjustments are made with the Diagonal Assembly (Fig. 9) and the Primary Reflecting Mirror (Fig. 10), and will be discussed later.

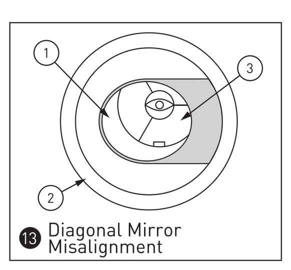
To inspect the view of the mirror collimation, look down the focusing tube without the eyepiece. The edge of the focusing tube (1, Fig. 11), will frame the reflections of the primary mirror with the 3 mirror clips (2, Fig. 11), the secondary reflecting mirror (3, Fig. 11), the spider vanes (4, Fig. 11), and your eye (5, Fig. 11). Properly aligned, all of these will appear concentric (i.e. centred) as illustrated in Figure 11. Any deviation from the concentric reflections will require adjustments to the Diagonal Assembly (Fig. 9) and / or the Primary Reflecting Mirror. (Fig. 10)



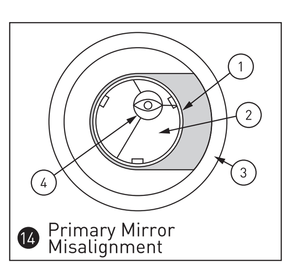
⓫ Correct Collimation



⓬ Spider Vane Misalignment



⓭ Diagonal Mirror Misalignment



⓮ Primary Mirror Misalignment

b) Spider vane adjustments
If the secondary reflecting mirror (1, Fig. 12) is left or right of centre within the focusing tube (2, Fig. 12), loosen the spider vane adjustment/lock knobs (1, Fig. 9) located on the outside surface of the main tube and slide the entire secondary reflecting mirror up or down the tube along the slotted holes, until the secondary reflecting mirror is centred in the focusing tube.
If the secondary reflecting mirror (1, Fig. 12) is above or below within the focusing tube, thread in one of the spider vane adjustment / lock knobs while unthreading the other. Only make adjustments to 2 knobs at a time until the secondary mirror is in the focusing tube. When the spider vane is correctly positioned, it will look like Fig. 13. (Note that the secondary reflecting mirror shown in Fig. 13 is misaligned.)

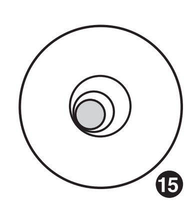
c) Secondary reflecting mirror holder adjustments
If the secondary reflecting mirror (1, Fig. 13) is centred in the focusing tube (2, Fig. 13), but the primary mirror is only partially visible in the reflection (3, Fig. 13), the 3 Phillips-head diagonal tilt screws (2, Fig. 9) must be unthreaded slightly to the point of where you can rotate the secondary reflecting mirror holder (3, Fig. 9) from side-to-side by grasping the secondary reflecting mirror holder with your hand and rotating until you see the primary reflecting mirror become as centred in the reflection of the secondary reflecting mirror as possible. Once you are at the best position, thread in the 3 Phillips-head diagonal tilts screws to lock the rotational position. Then, if necessary, make adjustments to these 3 Phillips-head screws to refine the tilt-angle of the diagonal mirror until the entire primary reflecting mirror can be seen centred within the secondary reflecting mirror reflection. When the secondary reflecting mirror is correctly aligned, it will look like Fig. 14. (Note that the primary reflecting mirror shown in Fig. 14 is misaligned.)

d) Primary reflecting mirror adjustments
If the secondary reflecting mirror (1, Fig. 14) and the reflection of the primary reflecting mirror (2, Fig. 14) appear centred within the focusing tube (3, Fig. 14), but the reflection of your eye and the reflection of the secondary reflecting mirror (4, Fig. 14) appear off-centre, you will need to adjust the primary reflecting mirror tilt Phillips-head screws of the primary reflecting mirror cell (3, Fig. 10). These primary tilt screws are located behind the primary reflecting mirror, at the lower end of the telescope main body. See Fig. 8. To adjust the primary mirror tilt screws, first unscrew several turns, the 3 lower primary mirror cell locking screws (2, Fig. 10) that are next to each primary mirror tilt Philips-head screw. Then by trial-and-error, turn the primary mirror tilt Philips-head screws (3, Fig. 10) until you develop a feel for which way to turn each screw to centre the reflection of your eye. Once centred, as in Fig. 11, turn the 3 lower primary mirror cell locking screws (2, Fig. 10) to relock the tilt-angle adjustment.

Star testing the collimation
With the collimation performed, you will want to test the accuracy of the alignment on a star. Use the 20mm eyepiece and point the telescope at a moderately bright star, then centre the star in the telescope's field-of-view. With the star centred follow the method below:

- Bring the star image slowly out of focus until one or more rings are visible around the central disc. If the collimation was performed correctly, the central star disc and rings will be concentric circles, with a dark spot dead centre within the out-of-focus star disc (this is the shadow of the secondary reflecting mirror), as shown in Fig. 17. (An improperly aligned telescope will reveal elongated circles (Fig. 15), with an off-centre dark shadow.)

- If the out-of-focus star disk appears elongated (Fig. 15), you will need to adjust the primary reflecting mirror Philips-head tilt screws of the primary mirror cell (3, Fig.10).
- To adjust the primary mirror tilt screws (3, Fig. 10), first unscrew several turns the 3 lower primary mirror cell locking screws (2, Fig. 10), to allow free turning movement of the tilt knobs.
- Using Alt-Azimuth Mount with fine adjustable altitude control, move the telescope until the star image is at the edge of the field-of-view in the eyepiece, as in Fig. 16.
- As you make adjustments to the primary mirror tilt screws (3, Fig. 10), you will notice that the out-of-focus star disk image will move across the eyepiece field. Choose one of the 3 primary mirror tilt screws that will move the star disk image to the centre of the eyepiece field.
- Repeat this process as many times as necessary until the out-of-focus star disk appears as in Fig. 17, when the star disk image is in the centre of the eyepiece field.
- With the star testing of the collimation complete, tighten the 3 lower primary mirror locking screws (2, Fig. 10).



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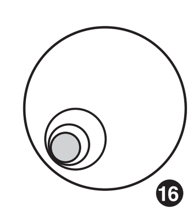

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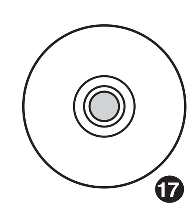

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Care & cleaning of optics

Optical components of a telescope get dirty over time. Dirt or dust on a lens should be removed only with the utmost care. A considerable amout of dirt or dust would have to accumulate on the optical surface before your view would be compromised.

1) Keeping any dust caps on during storage and transport will reduce dust collection.
2) Condensation may collect on the optical surface when the telescope is not in use. Remove the dust caps and allow the moisture to evaporate naturally. Point the telescope downwards to minimize the accumulation of airborne dust.
3) Once all moisture has evaporated, replace the dust caps.
4) Filtered compressed air may be used to remove surface dust from lenses and mirrors. Remove the dust cap and the dew shield. Once removed, point the can away from the lens and genly expel some air and any condensatin or dust that has accumulated on the discharge tube. Spray the lens or mirror with short bursts of air to carefully remove the dust particles. DO NOT HOLD THE TRIGGER OF THE COMPRESSED AIR CAN FOR EXTENDED PERIODS BECAUSE PROPELLANT FROM THE CAN MIGHT ESCAPE AND DAMAGE THE OPTICAL SURFACE.

If, after several attempts, you cannot remove the particles, take the telescope to an optical professional for cleaning.

If you keep the dust caps on your telescope when it is not in use and avoid handling the lenses or mirrors, only minimal optical maintenance of your telescope should be required. Extensive cleaning is usually only necessary every few years.

WARNING:

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Only for use by children over 8 years old
Caution: Do not look at the sun without a sun filter, as it may cause serious injury to your eye. A sun filter is not included with this telescope.

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