

# Orion® BX90 90mm Equatorial Refractor

#52588



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Congratulations on your purchase of an Orion telescope. Your new BX90 Equatorial Refractor is a terrific starter instrument for exploring the exotic wonders of the night sky. Designed to provide a wide field of view and excellent portability, it will provide many hours of enjoyment for the whole family.

If you have never owned a telescope before, we would like to welcome you to amateur astronomy. Take some time to familiarize yourself with the night sky. Learn to recognize the patterns of stars in the major constellations. With a little practice, a little patience, and a reasonably dark sky away from city lights, you'll find your telescope to be a never-ending source of fascination, exploration, and relaxation.

These instructions will help you set up, properly use, and care for your telescope. Please read them over thoroughly before getting started.

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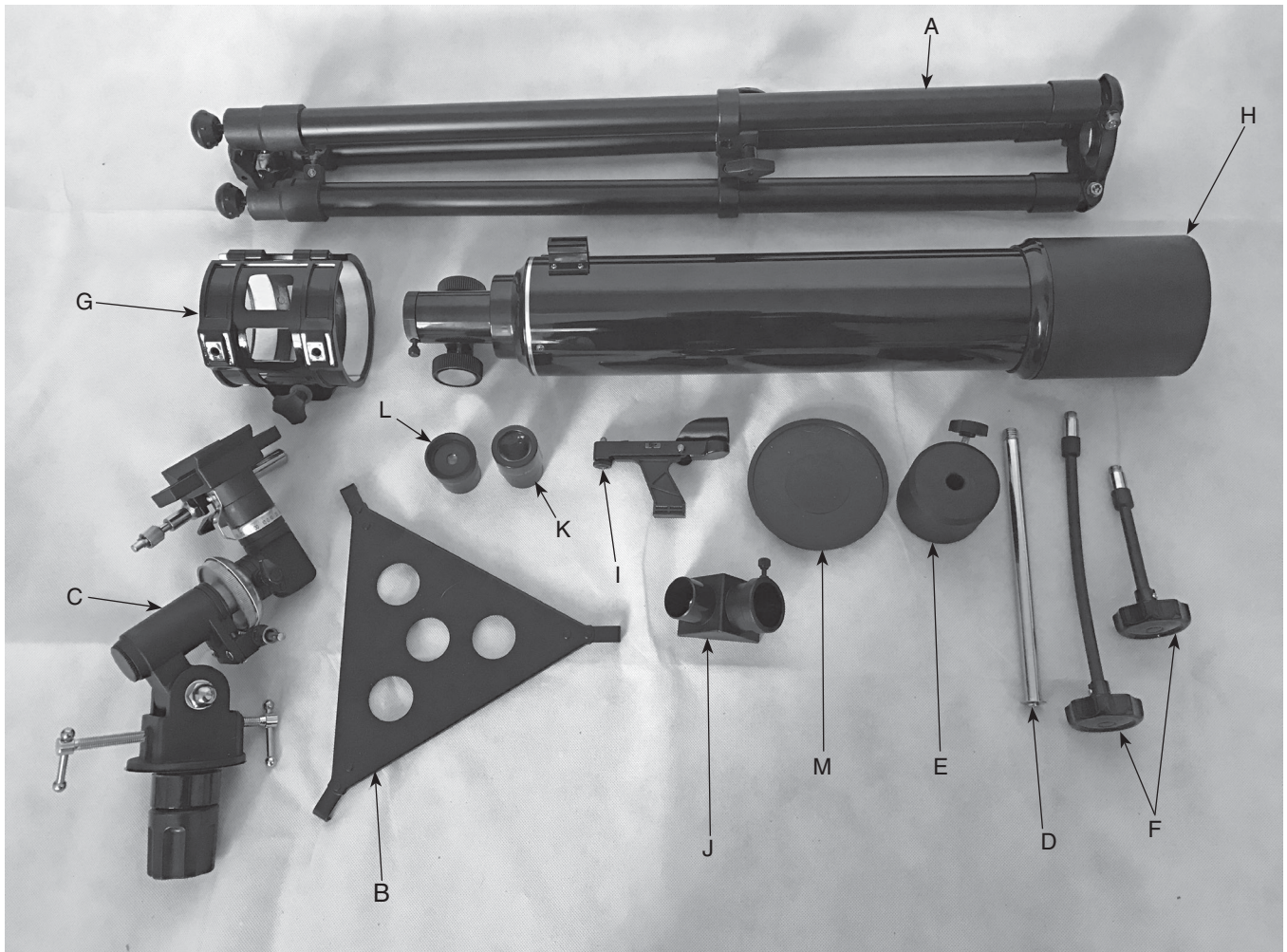
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## 1. Included Parts

Unpack all of the parts and lay them out in your workspace. Make sure all the parts listed below and shown in **Figure 1** are present. Save the shipping box and packaging material. In the unlikely event that you need to return the telescope, you must use the original packaging. Initial assembly of the telescope is easy and should take only about 20 minutes.

Part	Quantity
A – Tripod	1
B – Accessory tray	1
C – Equatorial mount	1
D – Counterweight shaft	1
E – Counterweight	1
F – Slow-motion cables	2
G – Tube mounting clamp	1
H – Optical tube assembly	1
I – Red dot finder scope	1
J – Star diagonal	1
K – 25mm Kellner eyepiece	1
L – 10mm Plossl eyepiece	1
M – Dust cover	1

**WARNING:** *Never look directly at the Sun through your telescope—even for an instant—without a professionally made solar filter that completely covers the front of the instrument, or permanent eye damage could result. Young children should use this telescope only with adult supervision.*

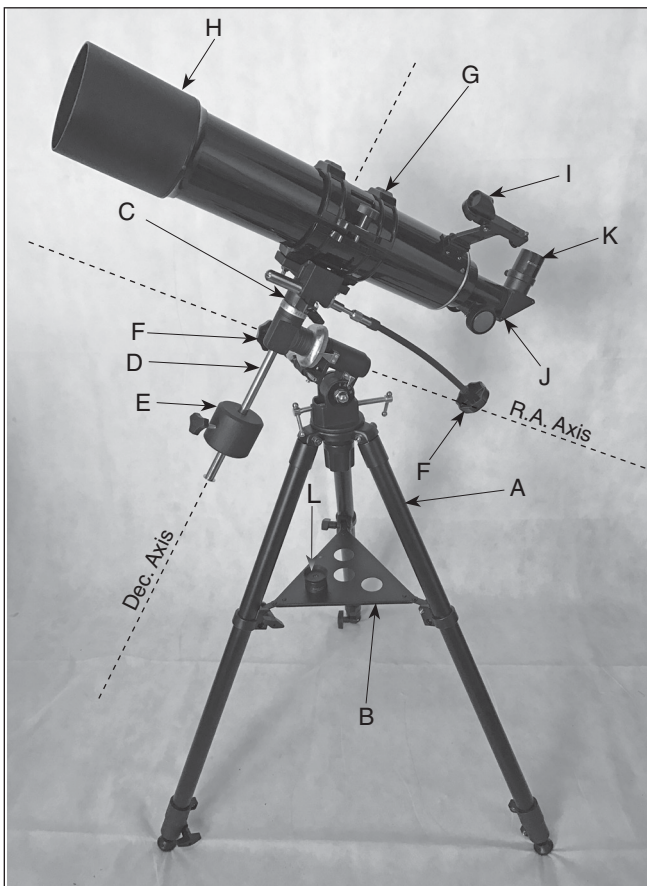


**Figure 1.** Parts of the BX90 EQ refractor

## 2. Assembly

Refer to **Figures 1** and **2** and the parts list at left for identification of specific parts during assembly.

1. Stand the tripod (A) upright and spread the legs apart. Keep the tripod legs at their shortest (fully retracted) length for now; you can extend them to a more desirable length later, after the mount is fully assembled.
2. To attach the accessory tray (B), place a hooked tab on one of the three corners of the tray over the screw in the leg collar, as shown in **Figure 3A**. Connect the tray to the other two legs in the same manner (**3B**), then tighten all three of the tray lock knobs (**3C**) to secure the tray in place.
3. Now you'll install the equatorial mount (C) onto the tripod. Remove the azimuth tension knob from the bottom of the mount; the thin plastic gasket should be kept on (**Figure 4**). Then place the mount on the tripod's mounting platform, inserting the base into the hole in the mounting platform. Then replace the tension knob, turning the knob clockwise to tighten the mount on the tripod (**Figure 5**).
4. Next, thread the counterweight shaft (M) into its receptacle as shown in **Figure 6A**.
5. To slide the counterweight (E) onto the counterweight shaft, first remove the Philips screw and washer from the



**Figure 2.** The fully assembled BX90 EQ refractor.

end of the shaft. You may need a Philips screwdriver for this. Make sure the counterweight lock knob is loosened enough so that the metal pin inside the counterweight is clear of the shaft hole. Slide the counterweight about half-way up the shaft and secure it in place with the lock knob (**Figure 6B**). Then replace the washer and screw at the end of the counterweight shaft.

6. Attach the slow motion cables (F) to the gear shafts. The longer cable should be attached to the declination gear shaft; the shorter cable to the right ascension gear shaft (see **Figure 7**). Orient the cable so that the slots in the threaded end of the cable line up with the two pins on the shaft (**Figure 8A**). Then thread the knurled nut on the shaft onto the cable's threads until tight (**Figure 8B**).

Now the mount is properly attached to the tripod and outfitted for use. Next, you'll attach the tube mounting clamp (G) and optical tube (H) to the EQ mount.

7. Remove the wing nuts and washers from the two screws of the tube mounting clamp.
8. Now insert the screws into the holes in the equatorial mount's saddle plate (**Figure 9A**). Then replace the washers and wing nuts on the screws and tighten them to secure the mounting clamp (**Figure 9B**).
9. Open the mounting clamp and lay the telescope optical tube in the clamp. Then close the clamp around the tube and lock it by turning the clamp lock bolt clockwise and thread it into the clamp's bottom flange, as shown in **Figure 10**.
10. With the tube now secure in the mounting clamp, attach the red dot finder scope (I) to the optical tube. Do this by orienting the finder scope as shown in **Figure 11** and slide the bracket foot back into the finder scope base as far as it will go.
11. Insert the star diagonal (J) into the focuser drawtube and tighten the thumbscrew on the drawtube collar. Then insert the 25mm eyepiece (K) into the diagonal and secure it by lightly tightening the thumbscrew on the diagonal (**Figure 12**).

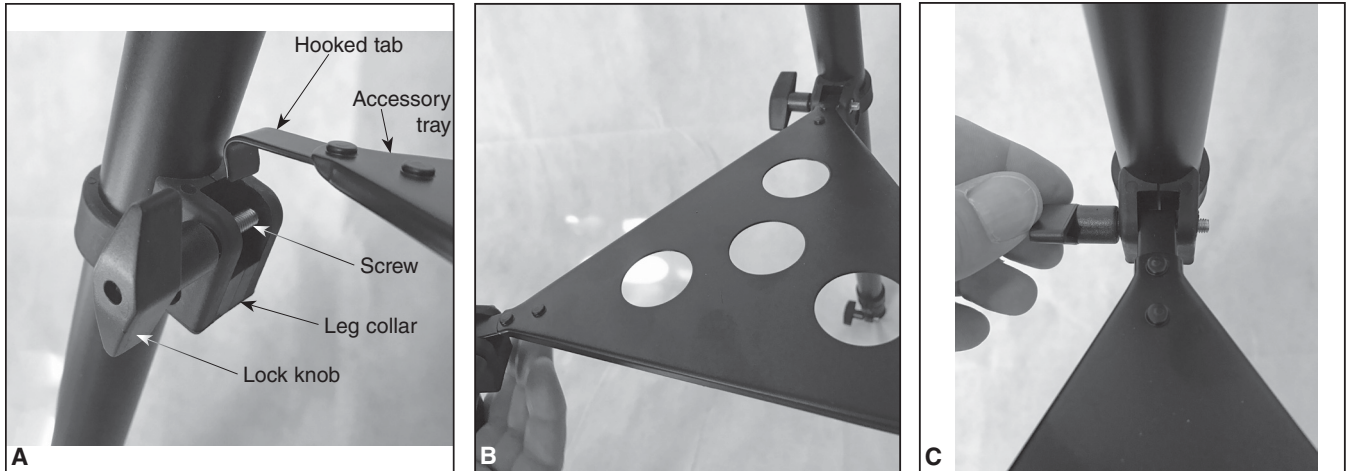
The telescope is now completely assembled! Before it can be effectively used, however, there are a couple of things to do to prepare the telescope for operation.

## 3. Preparing the Telescope for Operation

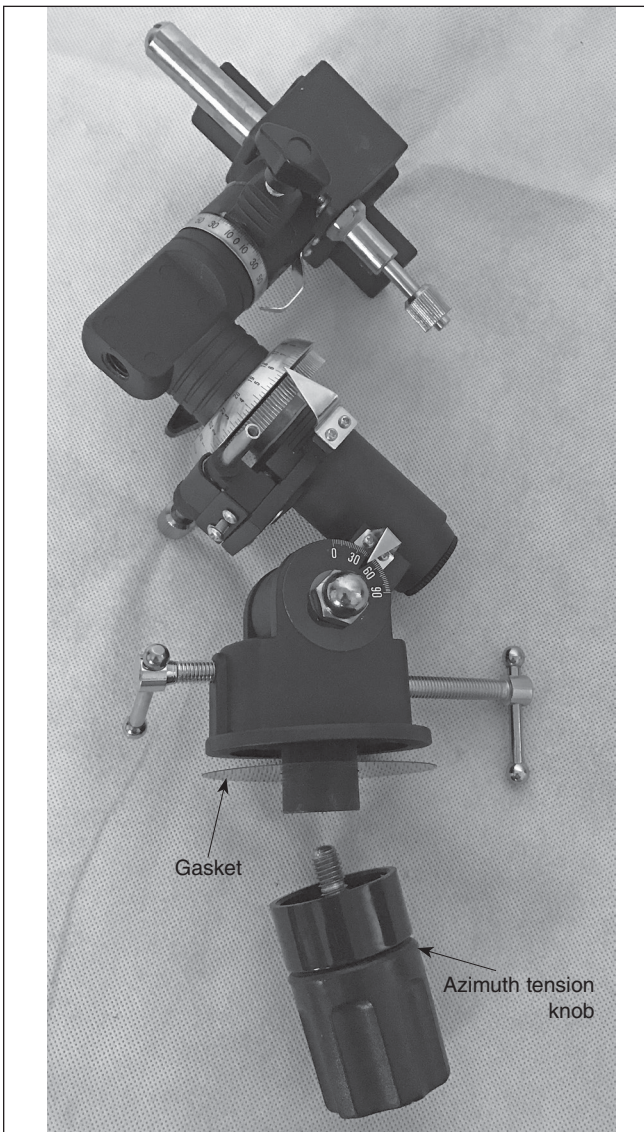
### Aligning and Using the Red Dot Finder Scope

The included red dot finder scope (I) makes pointing your telescope almost as easy as pointing your finger! It's a non-magnifying aiming device that superimposes a tiny LED-illuminated red dot on the sky, showing exactly where the telescope is pointed. It permits easy object targeting prior to observation in the higher-power main telescope.

Before you can use the red dot finder scope, you must remove the tab sticking out from the battery compartment (**Figure 13**).



**Figure 3.** **A)** Hook the tray corner over the screw in the leg collar, **B)** Repeat for the other two legs, then **C)** Tighten all three tray lock knobs.



**Figure 4.** To install the equatorial mount, first remove the azimuth tension knob.

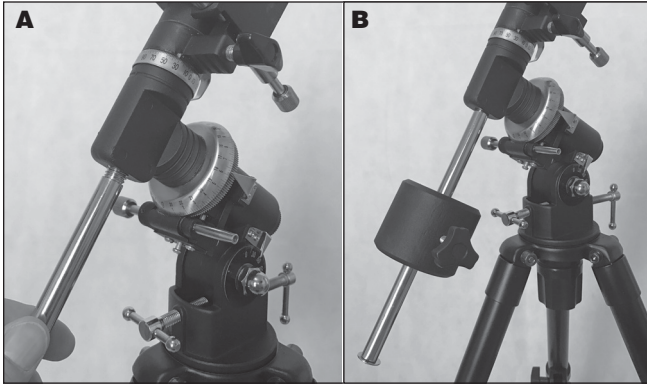
Doing so will allow the pre-installed 3V CR-2032 button cell battery to make contact with the finder scope's electronic circuitry to power the finder's red LED illuminator. The tab can then be discarded.

To use the red dot finder scope properly, it must be aligned with the main telescope. This is easiest to do during daylight hours, before observing at night. Follow this procedure:

1. First, remove the dust cap (M) from the front of the telescope.
2. With the star diagonal and 25mm eyepiece already in place from step 11 above, point the telescope at a well-defined land target (e.g., the top of a telephone pole) that's at least a quarter mile away. Center the target in the eyepiece by turning the slow-motion cables as needed to point the telescope. For larger telescope movement, release the R.A. and Dec. axis lock knobs (**Figure 7**) and move the telescope tube by hand to the approximate location, then retighten the lock knobs and make finer pointing adjustments with the slow motion cables.



**Figure 5.** Place the equatorial mount on the tripod, then secure it with the azimuth tension knob.

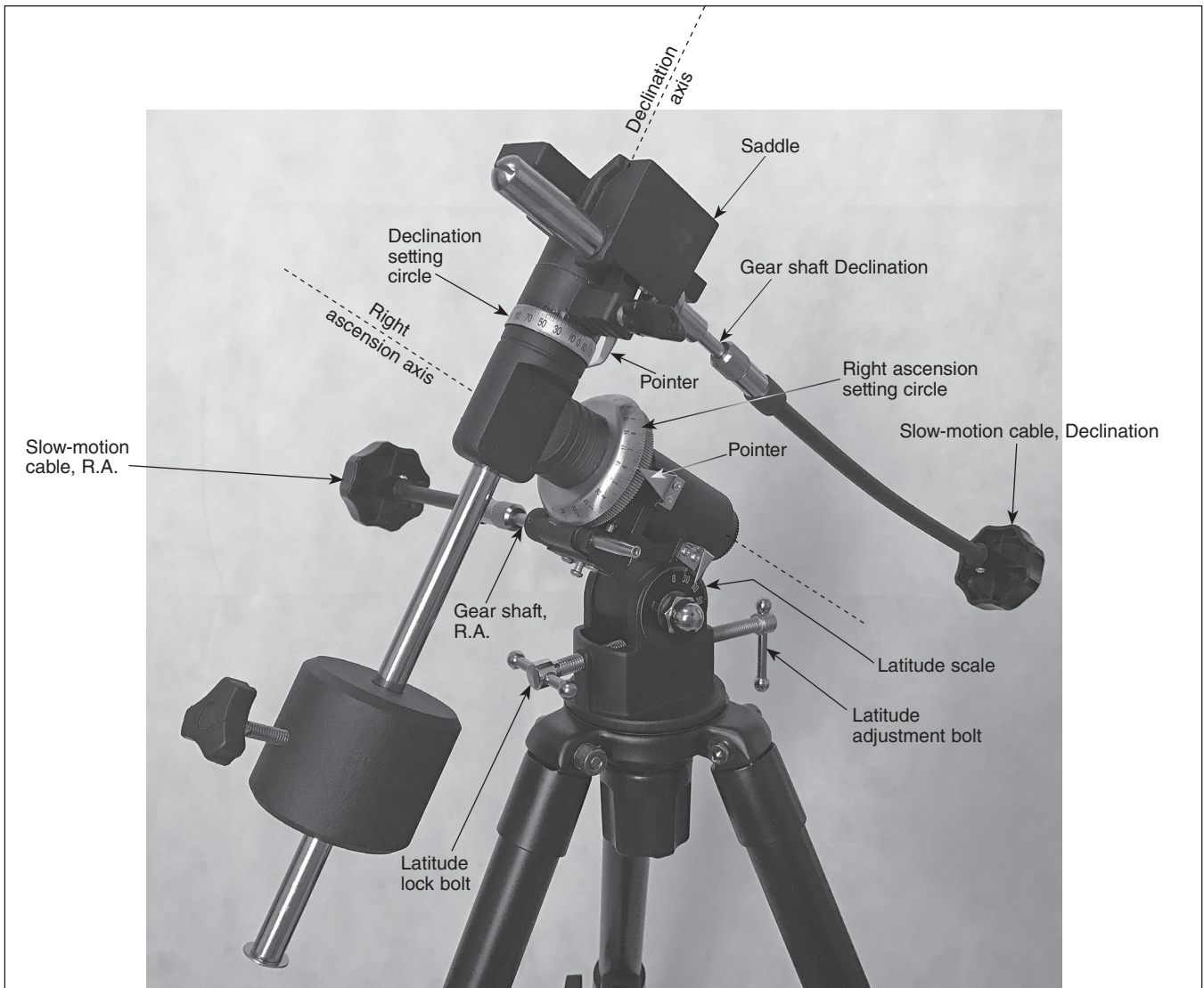


**Figure 6. A)** Thread the counterweight into its receptacle. **B)** Remove the screw and washer from the end of the shaft, then slide the counterweight on and secure it with the counterweight lock knob.

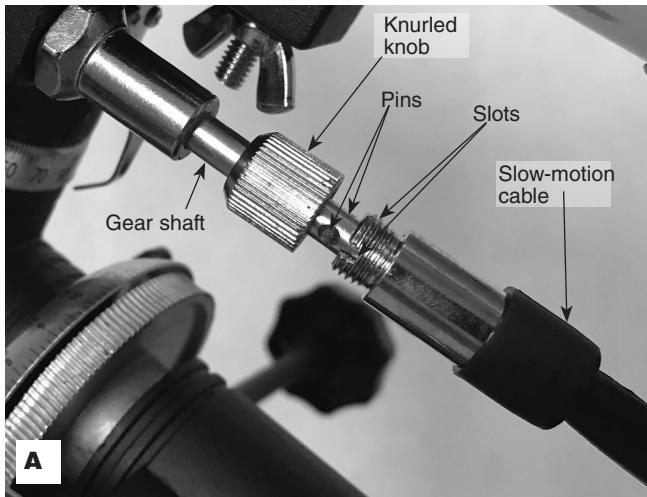
**Note:** The image in the telescope will appear mirror reversed, i.e., reversed left to right. This is normal for refractor telescopes used for astronomical observing with a standard star diagonal. (For terrestrial observing we recommend using an optional “correct image” diagonal, which will serve up a correctly oriented view.)

3. Now that a distant target is centered in the main telescope’s eyepiece, turn on the red dot finder scope by sliding the power switch to ON (refer to **Figure 13**). Position your eye at a comfortable distance from the rear of the unit. Look through the round window of the finder scope with both eyes open to see the illuminated red dot. The target object should appear in the field of view somewhere near the red dot.

**NOTE:** This finder has two brightness settings. When the switch is set all the way over to the ON position, the red dot is brightest. But in between the OFF and ON positions is a middle setting in which the red dot is dim. Typically the dim



**Figure 7.** The BX90’s equatorial mount.

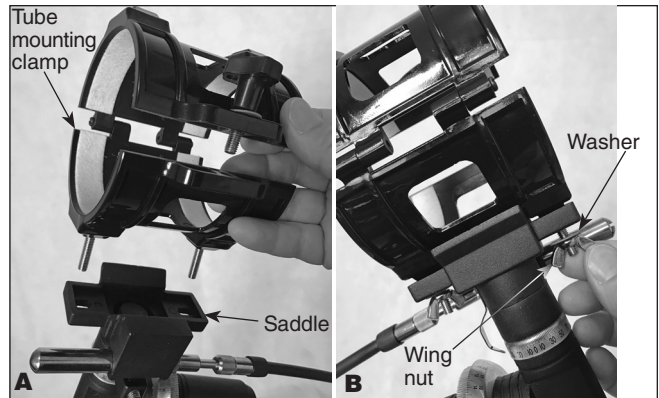


**Figure 8. A)** Slide the slow-motion cable onto the gear shaft as shown, **B)** then thread the knurled nut into the threaded end of the cable until tight.

*setting is used under dark skies and the brighter setting is used under light-polluted skies or in daylight.*

4. You'll want to center the target object on the red dot. To do so, without moving the telescope, use the finder scope's vertical and horizontal adjustment knobs (shown in **Figure 13**) to position the red dot on the object.
5. When the red dot is centered on the distant object, check to make sure the object is still centered in the telescope's eyepiece. If it isn't, re-center it then adjust the finder scope's alignment again. When the object is centered in the telescope eyepiece and on the finder scope's red dot, the finder scope is properly aligned with the telescope. The red dot finder scope's alignment should be checked before every observing session.

At the end of your observing session, be sure to slide the power switch on the red dot finder scope to OFF to preserve battery life.

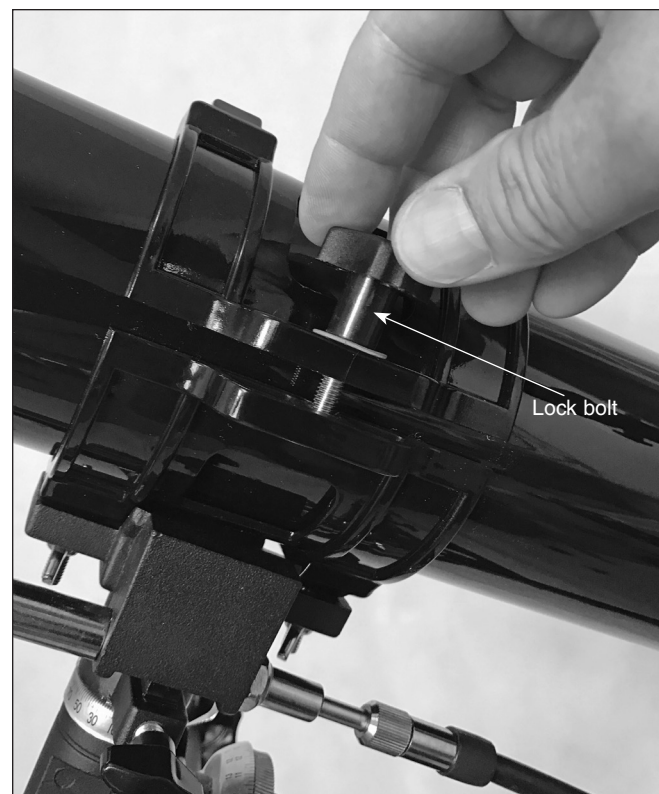


**Figure 9. A)** Install the tube mounting clamp onto the mount saddle. **B)** Secure the clamp to the saddle with the two wing nuts.

### Balancing the Telescope

In order for the telescope to move smoothly on its mechanical axes, it must first be balanced as follows:

1. Keeping one hand on the telescope optical tube, loosen the R.A. lock knob. Make sure the Dec. lock knob is locked, for now. The telescope should now be able to rotate freely about the R.A. axis. Rotate it until the counterweight shaft is parallel to the ground, i.e., horizontal (**Figure 14A**).
2. Now loosen the counterweight lock knob and slide the weight along the shaft until it exactly counterbalances the telescope. That's the point at which the shaft remains hori-



**Figure 10.** Lay the optical tube in the open clamp, then close the clamp and lock it in with the clamp lock bolt.



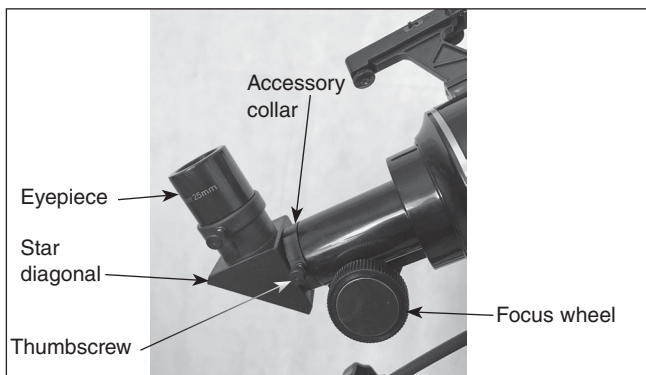
**Figure 11.** Slide the red dot finder scope's bracket into its base.

horizontal even when you let go of the telescope with both hands.

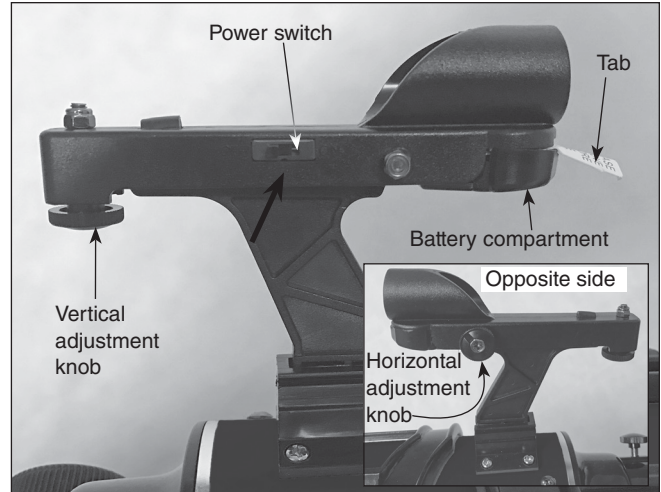
3. Retighten the counterweight lock knob. The telescope is now balanced on the R.A. axis.
4. To balance the telescope on the Dec. axis, first tighten the R.A. lock knob, with the counterweight shaft still in the horizontal position.
5. With one hand on the telescope optical tube, loosen the Dec. lock knob. The telescope should now be able to rotate freely about the Dec. axis (**Figure 14B**). If the tube rotates on its own due to imbalance, you will need to reposition it a little forward or back in the tube clamp until it is balanced. (You'll have to loosen the clamp's lock bolt a few turns to do this.) Then re-tighten the Dec. lock knob.

When you are actually observing with the telescope, you can adjust the eyepiece and focuser orientation by unlatching the tube clamp and rotating the optical tube to the desired position. Be sure to hold onto the tube when you unlatch the clamp!

The telescope is now balanced on both axes. Now when you loosen the lock knob on one or both axes and manually point the telescope, it should move without resistance and should not drift from where you point it.



**Figure 12.** Install the diagonal and eyepiece in the focuser as shown.



**Figure 13.** The red dot finder scope has vertical and (inset) horizontal adjustment knobs for aligning it with the telescope.

## 4. Understanding and Using the Equatorial Mount

When you look at the night sky, you no doubt have noticed the stars appear to move slowly from east to west over time. That apparent motion is caused by the Earth's rotation (from west to east). An equatorial mount is designed to compensate for that motion, allowing you to easily "track" the movement of astronomical objects, thereby keeping them from drifting out of the telescope's field of view while you're observing.

An equatorial mount has two perpendicular axes: right ascension and declination (**Figure 7**). The R.A. axis, also known as the "polar" axis, can be aligned to be parallel with the Earth's axis of rotation, thus allowing easy tracking of the night sky. This is accomplished by slowly rotating the telescope on its R.A. axis. The process of aligning the mount's R.A. axis with the Earth's rotational (polar) axis is called polar alignment.

### Polar Alignment

For Northern Hemisphere observers, approximate polar alignment is achieved by pointing the mount's R.A. axis at the North Star (Polaris). It lies within  $1^\circ$  of the north celestial pole (NCP), which is an extension of the Earth's rotational axis out into space. Stars in the Northern Hemisphere appear to revolve around the NCP.

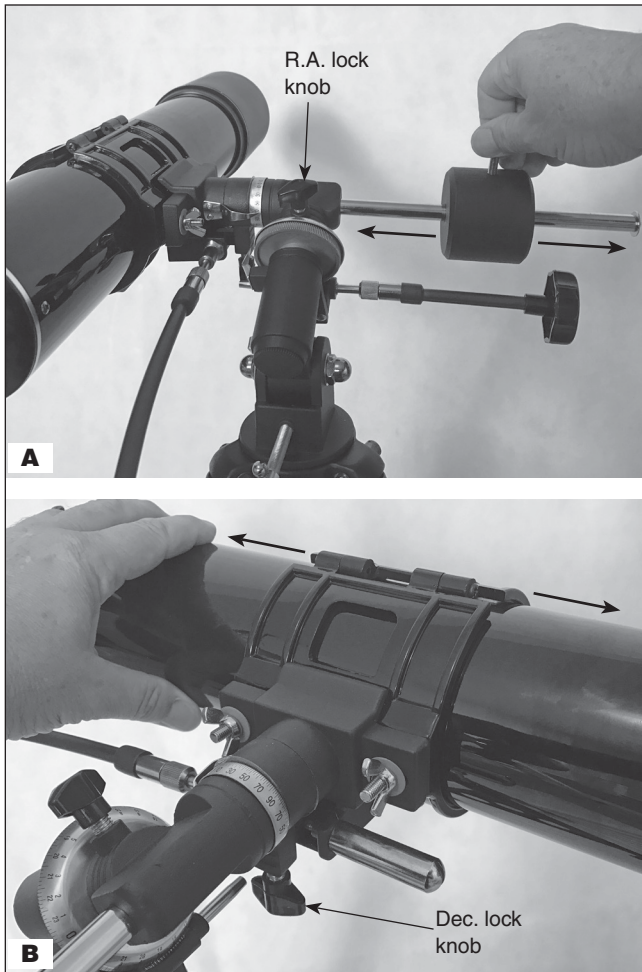
To find Polaris in the sky, look north and locate the pattern of the Big Dipper (**Figure 15**). The two stars at the end of the "bowl" of the Big Dipper point approximately to Polaris.

Observers in the Southern Hemisphere aren't so fortunate to have a bright star so near the south celestial pole (SCP). The star Sigma Octantis lies about  $1^\circ$  from the SCP, but it is barely visible with the naked eye (magnitude 5.5).

To polar align the BX90's equatorial mount:

1. Roughly level the equatorial mount by adjusting the length of the three tripod legs as needed.





**Figure 14.** To balance the telescope on the mount, you first **A)** balance it on the R.A. axis, then **B)** on the Declination axis.

2. Loosen the latitude lock bolt located on the front of the mount (see **Figure 7**). Turn the latitude adjustment bolt (on the opposite side of the mount) until the pointer on the latitude scale is indicating the latitude of your observing location. If you don't know your latitude, you can look it up on the internet. For example, if your latitude is 35° North, set the pointer to 35. Then lightly retighten the latitude lock bolt. The latitude setting should not have to be adjusted again unless you move to a different viewing location some distance away.
3. Loosen the Dec. lock knob and rotate the telescope optical tube until it is parallel with the R.A. axis, as it is in **Figure 2**. The pointer on the Dec. setting circle should read 90°. Retighten the Dec. lock knob.
4. Loosen the azimuth lock knob at the base of the equatorial mount (**Figure 7**) and rotate the mount so the R.A. axis points roughly at Polaris. If you cannot see Polaris directly from your observing site, consult a compass and rotate the mount so the telescope points North. Retighten the azimuth lock knob.

**NOTE:** You can do the polar alignment with the telescope attached to the equatorial mount.

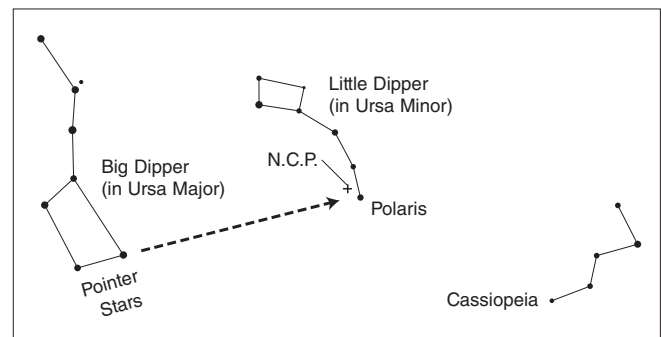
The equatorial mount is now polar aligned. **From this point on in your observing session, you should not make any further adjustments to the azimuth or the latitude of the mount, nor should you move the tripod.** Doing so will render the polar alignment inaccurate. The telescope should be moved only about its R.A. and Dec. axes.

### Using the R.A. and Dec. Slow-Motion Control Cables

The R.A. and Dec. slow-motion control cables allow fine adjustment of the telescope's position to center objects within the field of view. Before using the cables, manually "slew" the mount to point the telescope in the vicinity of the desired target. Do this by loosening the R.A. and Dec. lock knobs (**Figure 7**) and moving the telescope about the mount's R.A. and Dec. axes. Once the telescope is pointed somewhere close to the object to be viewed, retighten the mount's R.A. and Dec. lock knobs.

The object should now be visible somewhere in the field of view of the red dot finder scope. If it isn't, use the slow-motion controls to scan the surrounding area of sky. **Note: when using the slow motion cables, the R.A. and Dec lock knobs should be tightened, not loose.** When the object is visible in the finder scope, use the slow-motion controls to center the red dot on it. Now, look in the telescope's eyepiece and use the slow-motion controls to center it in the eyepiece.

The Dec. slow-motion control cable can move the telescope a maximum of 25° or so. This is because the Dec. slow-motion mechanism has a limited range of mechanical travel. (The R.A. slow-motion mechanism has no limit to its amount of travel.) If you can no longer rotate the Dec. control cable in a desired direction, you have reached the end of travel, and the slow-motion mechanism must be reset. This is done by first rotating the control cable several turns in the opposite direction from which it was being turned. Then, manually slew the telescope closer to the object you wish to observe (remember to first loosen the Dec. lock knob). You should now be able to use the Dec. slow-motion control cable again to fine adjust the telescope's position.



**Figure 15.** To find Polaris in the night sky, look north and find the Big Dipper. Extend an imaginary line from the two "Pointer Stars" in the bowl of the Big Dipper. Go about five times the distance between those stars and you'll reach Polaris, which lies within 1° of the north celestial pole (NCP).

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## Tracking Celestial Objects

When you observe a celestial object through the telescope, you'll see it drift slowly across the field of view. To keep it in the field, assuming your equatorial mount is polar aligned, just turn the R.A. slow-motion control cable clockwise. The Dec. slow-motion control cable is not needed for tracking. Objects will appear to move faster at higher magnifications, because the field of view is narrower.

## Optional Electronic Drives for Automatic Tracking

An optional DC electronic drive can be mounted on the R.A. axis of the equatorial mount to provide hands-free tracking. Objects will then remain stationary in the field of view without any manual adjustment of the R.A. slow-motion control cable.

## Understanding the Setting Circles

The two setting circles (**Figure 7**) on an equatorial mount enable you to locate celestial objects by their "celestial coordinates." Every object resides in a specific location on the "celestial sphere." That location is denoted by two numbers: its right ascension (R.A.) and declination (Dec.). In the same way, every location on Earth can be described by its longitude and latitude. R.A. is similar to longitude on Earth, and Dec. is similar to latitude. The R.A. and Dec. values for celestial objects can be found in any star atlas or star catalog.

The mount's R.A. setting circle is scaled in hours, from 1 through 24, with small marks in between representing 10-minute increments. The numbers closest to the R.A. axis gear apply to viewing in the Southern Hemisphere, while the numbers above them apply to viewing in the Northern Hemisphere.

The Dec. setting circle is scaled in degrees, with each mark representing 2.5° increments. Values of Dec. coordinates range from +90° to -90°. The 0° mark indicates the celestial equator. When the telescope is pointed north of the celestial equator, values of the Dec. setting circle are positive, while when the telescope is pointed south of the celestial equator, values of the Dec. setting circle are negative.

So, the coordinates for the Orion Nebula are:

R.A. 5h 35.4m Dec. -5° 27'

That's 5 hours and 35.4 minutes in right ascension, and -5 degrees and 27 arc-minutes in declination (there are 60 arc-minutes in 1 degree of declination).

Before you can use the setting circles to locate objects, the mount must be properly polar aligned, and the R.A. setting circle must be calibrated. The Dec. setting circle has been permanently calibrated at the factory, and should read 90° whenever the telescope optical tube is parallel with the R.A. axis.

## Calibrating the Right Ascension Setting Circle

1. Identify a bright star in the sky near the celestial equator (Dec. = 0°) and look up its coordinates in a star atlas.
2. Loosen the R.A. and Dec. lock knobs on the equatorial mount, so the telescope optical tube can move freely.

3. Point the telescope at the bright star whose coordinates you know. Lock the R.A. and Dec. lock knobs. Center the star in the telescope's field of view with the slow-motion control cables.
4. Rotate the setting circle until the metal arrow indicates the R.A. coordinate listed in the star atlas for the object.

## Finding Objects with the Setting Circles

1. Now that both setting circles are calibrated, look up in a star atlas the coordinates of an object you wish to view.
2. Loosen the R.A. lock knob and rotate the telescope until the R.A. value from the star atlas matches the reading on the R.A. setting circle. Remember to use the upper set of numbers on the R.A. setting circle. Retighten the lock knob.
3. Loosen the Dec. lock knob and rotate the telescope until the Dec. value from the star atlas matches the reading on the Dec. setting circle. Remember that values of the Dec. setting circle are positive when the telescope is pointing north of the celestial equator (Dec. = 0°), and negative when the telescope is pointing south of the celestial equator. Retighten the lock knob.

Most setting circles are not accurate enough to put an object dead-center in the telescope's eyepiece, but they should place the object somewhere within the field of view of the red dot finder scope, assuming the equatorial mount is accurately polar aligned. Use the slow-motion controls to center the object in the finder scope, and it should appear in the telescope's field of view.

The R.A. setting circle must be re-calibrated every time you wish to locate a new object. Do so by calibrating the setting circle for the centered object before moving on to the next one.

## Confused About Pointing the Telescope?

Beginners occasionally experience some confusion about how to point the telescope overhead or in other directions. One thing you DO NOT do is make any adjustment to the mount's latitude setting or to its azimuth position (don't touch the azimuth lock knob). That will throw off the mount's polar alignment. Once the mount is polar aligned, the telescope should be moved only about the R.A. and Dec. axes by loosening one or both of the R.A. and Dec. lock knobs and moving the telescope by hand, or keeping the knobs tightened and moving the telescope using the slow-motion cables.

# 5. Astronomical Observing

For many, this will be your first foray into the exciting world of amateur astronomy. The following information and observing tips will help get you started.

## Choosing an Observing Site

When selecting a location for observing, get as far away as possible from direct artificial light such as street lights, porch lights, and automobile headlights. The glare from these lights will greatly impair your dark-adapted night vision. Set up on a grass or dirt surface, not asphalt, because asphalt radiates more heat. Heat disturbs the surrounding air and degrades the images seen

through the telescope. Avoid viewing over rooftops and chimneys, as they often have warm air currents rising from them. Similarly, avoid observing from indoors through an open (or closed) window, because the temperature difference between the indoor and outdoor air will cause image blurring and distortion.

If at all possible, escape the light-polluted city sky and head for darker country skies. You'll be amazed at how many more stars and deep-sky objects are visible in a dark sky!

### “Seeing” and Transparency

Atmospheric conditions vary significantly from night to night. “Seeing” refers to the steadiness of the Earth’s atmosphere at a given time. In conditions of poor seeing, atmospheric turbulence causes objects viewed through the telescope to “boil.” If you look up at the sky and stars are twinkling noticeably, the seeing is poor and you will be limited to viewing at lower magnifications. At higher magnifications, images will not focus clearly. Fine details on the planets and Moon will likely not be visible.

In conditions of good seeing, star twinkling is minimal and images appear steady in the eyepiece. Seeing is best overhead, worst at the horizon. Also, seeing generally gets better after midnight, when much of the heat absorbed by the Earth during the day has radiated off into space.

Especially important for observing faint objects is good “transparency”—air free of moisture, smoke, and dust. All tend to scatter light, which reduces an object’s brightness. Transparency is judged by the magnitude of the faintest stars you can see with the unaided eye (5th or 6th magnitude is desirable).

### Star-Testing the Telescope

When it is dark, point the telescope at a bright star and accurately center it in the eyepiece’s field of view. Slowly de-focus the image with the focus knob. If the telescope’s optics are correctly aligned, the expanding disk should be a perfect circle (**Figure 16**). If the image is unsymmetrical, the optics are out of alignment. The dark shadow cast by the secondary mirror should appear in the very center of the out-of-focus circle, like the hole in a donut. If the “hole” appears off-center, the optics are out of alignment.

If you try the star test and the bright star you have selected is not accurately centered in the eyepiece, the telescope will appear to need collimating, even though the optics may be perfectly aligned. It is critical to keep the star centered, so over time you will need to make slight corrections to the telescope’s position in order to account for the sky’s apparent motion.

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### Cooling the Telescope

All optical instruments need time to reach “thermal equilibrium.” The bigger the instrument and the larger the temperature change, the more time is needed. Allow at least 30 minutes for your telescope to acclimate to the temperature outdoors before you start observing with it.

### Let Your Eyes Dark-Adapt

Don’t expect to go from a lighted house into the darkness of the outdoors at night and immediately see faint nebulas, galaxies, and star clusters—or even very many stars, for that matter. Your eyes take about 30 minutes to reach perhaps 80% of their full dark-adapted sensitivity. As your eyes become dark-adapted, more stars will glimmer into view and you’ll be able to see fainter details in objects you view in your telescope.

To see what you’re doing in the darkness, use a red-filtered flashlight rather than a white light. Red light does not spoil your eyes’ dark adaptation like white light does. A flashlight with a red LED light is ideal. Beware, too, that nearby porch, streetlights, and car headlights will ruin your night vision.

### Eyepiece Selection

Magnification, or power, is determined by the focal length of the telescope and the focal length of the eyepiece being used. Therefore, by using eyepieces of different focal lengths, the resultant magnification can be varied. It is quite common for an observer to own five or more eyepieces to access a wide range of magnifications. This allows the observer to choose the best eyepiece to use depending on the object being viewed and viewing conditions. Your BX90’s EQ refractor comes with 25mm and 10mm eyepieces, which will suffice nicely to begin with. You can purchase additional eyepieces later if you wish to have more magnification options.

Magnification is calculated as follows:

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

For example, the BX90 EQ has a focal length of 600mm, which when used with the supplied 25mm eyepiece yields:

$$\frac{600 \text{ mm}}{25 \text{ mm}} = 24x$$

The magnification provided by the 10mm eyepiece is:

$$\frac{600 \text{ mm}}{10 \text{ mm}} = 60x$$

The maximum attainable magnification for a telescope is directly related to how much light it can gather. The larger the aperture,

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the more magnification is possible. In general, a figure of 50x per inch of aperture is the maximum attainable for most telescopes. Going beyond that will yield simply blurry, unsatisfactory views. Your BX90EQ EQ has an aperture of 90mm, or 3.5 inches, so the maximum magnification would be about 175x (3.5 x 50). This level of magnification assumes you have ideal atmospheric conditions for observing (which is seldom the case).

Keep in mind that as you increase magnification, the brightness of the object viewed will decrease; this is an inherent principle of the laws of physics and cannot be avoided. If magnification is doubled, an image appears four times dimmer. If magnification is tripled, image brightness is reduced by a factor of nine!

So start by using the 25mm eyepiece, then try switching to the 10mm eyepiece later if you want to boost the magnification.

### **Focusing the Telescope**

To focus the telescope, turn the focus wheels (**Figure 12**) forward or back until you see your target object (e.g., stars, the Moon, etc.) in the eyepiece. Then make finer adjustments until the image is sharp. If you're having trouble achieving initial focus, rack the focuser drawtube all the way in using the focus wheels, then while looking into the eyepiece slowly turn the focus wheels so that the drawtube extends outward. Keep going until you see your target object come into focus. Note that when you change eyepieces you may have to adjust the focus a bit to get a sharp image with the newly inserted eyepiece.

### **What to Expect**

So what will you see with your telescope? You should be able to see bands on Jupiter, the rings of Saturn, craters on the Moon, the waxing and waning of Venus, and many bright deep-sky objects such as star clusters and nebulas. Do not expect to see colors in faint objects as you do in photographs, however. Most galaxies and nebulas will appear gray in color. Unlike a camera, which can record colors of faint objects in long exposures, our eyes are not sensitive enough to see such color except in a few of the brightest ones.

### **Objects to Observe**

Now that you are all set up and ready to go, one critical decision must be made: what to look at?

#### **A. The Moon**

With its rocky surface, the Moon is one of the easiest and most interesting objects to view with your telescope. Lunar craters, maria, and even mountain ranges can all be clearly seen from a distance of 238,000 miles away! With its ever-changing phases, you'll get a new view of the Moon every night. The best time to observe our one and only natural satellite is during a partial phase, that is, when the Moon is not full. During partial phases, shadows are cast on the surface, which reveal more detail, especially right along the border between the dark and light portions of the disk (called the "terminator"). A full Moon is too bright and devoid of surface shadows to yield a pleasing view. Make sure to observe the Moon when it is well above the horizon to get the sharpest images.

Use an optional Moon filter to dim the Moon when it is very bright. It simply threads onto the bottom of the eyepieces (you must first remove the eyepiece from the focuser to attach a filter). You'll find that the Moon filter improves viewing comfort, and helps to bring out subtle features on the lunar surface.

#### **B. The Planets**

The planets don't stay put like the stars, so to find them you should refer to the monthly star charts at OrionTelescopes.com, or to charts published monthly in *Astronomy*, *Sky & Telescope*, or other astronomy magazines. Venus, Mars, Jupiter, and Saturn are the brightest objects in the sky after the Sun and the Moon. Other planets may be visible but will likely appear star-like. Because planets are quite small in apparent size, optional higher-power eyepieces or a Barlow lens are recommended and often needed for detailed observations.

#### **B. The Sun**

You can change your nighttime telescope into a daytime Sun viewer by installing an optional full-aperture solar filter over the front opening of the telescope. The primary attraction is sunspots, which change shape, appearance, and location daily. Sunspots are directly related to magnetic activity in the Sun. Many observers like to make drawings of sunspots to monitor how the Sun is changing from day to day.

**Important Note: Do not look at the Sun with any optical instrument without a professionally made solar filter, or permanent eye damage could result.**

#### **D. The Stars**

Stars will appear like twinkling points of light. Even powerful telescopes cannot magnify stars to appear as more than a point of light. You can, however, enjoy the different colors of the stars and locate many pretty double and multiple stars. The famous "Double-Double" in the constellation Lyra and the gorgeous two-color double star Albireo in Cygnus are favorites. Defocusing a star slightly can help bring out its color.

#### **E. Deep-Sky Objects**

Under dark skies, you can observe a wealth of fascinating deep-sky objects, including gaseous nebulas, open and globular star clusters, and different types of galaxies. Most deep-sky objects are very faint, so it is important you find an observing site well away from light pollution.

To find deep-sky objects with your telescope, you first need to become reasonably familiar with the night sky. Unless you know how to recognize the constellation Orion, for instance, you won't have much luck locating the Orion Nebula. A simple planisphere, or star wheel, can be a valuable tool for learning the constellations and seeing which ones are visible in the sky on a given night. Once you have identified a few constellations, a good star chart, atlas, or astronomy app will come in handy for helping locate interesting deep-sky objects to view within the constellations.

Do not expect these objects to appear like the photographs you see in books and on the internet; most will look like dim gray smudges. Our eyes are not sensitive enough to see color in deep-sky objects except in a few of the brightest ones. But

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as you become more experienced and your observing skills get sharper, you will be able to ferret out more and more subtle details and structure.

## 6. Worthwhile Optional Accessories

- **Moon Filter** – A 1.25" Moon filter will cut down the strong glare of sunlight reflected from the Moon, making Moon viewing more comfortable and revealing more surface detail. The filter threads into the bottom of the Kellner eyepieces that came with your telescope.
- **Motor Drive** – A motor drive, which attaches to the right ascension axis of an equatorial telescope mount, enables your telescope to “track” the motion of stars and other celestial objects as they drift slowly from east to west in the night sky. This keeps them in the eyepiece field of view indefinitely, instead of drifting out of sight.
- **Barlow Lens** – A 2x Barlow lens doubles the magnifying power of any eyepiece it’s used with, giving you a big power boost to get in closer to your target object. You just insert it between the diagonal and the eyepiece.
- **Planisphere** – A nifty “star wheel” that shows what stars and constellations are visible in the sky at any time of any night. Just set the date and time see a mini representation of your local night sky. Great for identifying what you see and planning an evening’s observing session.
- **Star Map** – More detailed than a planisphere, a star map is essential for locating interesting celestial objects to observe with your telescope. Nowadays many mobile astronomy apps feature customizable star maps that you can access on your smartphone or tablet while you’re at the telescope.

## 7. Telescope Care and Maintenance

If you give your telescope reasonable care, it will last a lifetime. Store it in a clean, dry, dust-free place, safe from rapid changes in temperature and humidity. Do not store the telescope outdoors, although storage in a garage or shed is OK. Small components like eyepieces and other accessories should be kept in a protective box or storage case. Keep the dust cover on the front of the telescope when it is not in use.

Your refractor telescope requires very little mechanical maintenance. The optical tube has a smooth painted finish that is fairly scratch-resistant. If a scratch does appear on the tube, it will not harm the telescope. If you wish, you may apply some auto touch-up paint to the scratch. Smudges on the tube can be wiped off with a soft cloth and household cleaning fluid.

### Cleaning Optics

Any quality optical lens cleaning tissue and optical lens cleaning fluid specifically designed for multi-coated optics can be used to clean the lenses of your telescope and eyepieces. Never use regular glass cleaner or cleaning fluid designed for eyeglasses.

Before cleaning, remove any loose particles or dust from the lens with a blower bulb or soft brush. Then apply some cleaning fluid to a tissue, never directly on the optics. Wipe the lens gently in a circular motion, then remove any excess fluid with a fresh lens tissue. Oily fingerprints and smudges may be removed using this method. Use caution; rubbing too hard may scratch the lens. On larger lenses, clean only a small area at a time, using a fresh lens tissue on each area. Never reuse tissues.

When bringing the telescope inside after an evening’s viewing it is normal for moisture to accumulate on the lenses due to the change in temperature. We suggest leaving the telescope and eyepieces uncovered overnight to allow the condensation to evaporate.

## 8. Specifications

Objective lens: 90mm (3.5") diameter, achromatic

Effective focal length: 600mm

Focal ratio: f/6.7

Lens coatings: Fully antireflection coated

Focuser: Rack-and-pinion, accepts 1.25" accessories

Eyepieces: 25mm Kellner and 10mm Plossl, 1.25" barrel diameter, threaded for Orion filters

Eyepiece coatings: Fully antireflection coated

Diagonal: Mirror, 1.25"

Eyepiece magnification: 24x (with 25mm eyepiece) and 60x (with 10mm eyepiece)

Finder scope: Red dot finder scope, two brightness levels

Mount: German equatorial

Tripod: Aluminum

Motor drive: Optional

Total instrument weight: 15 lbs. 8 oz.

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## One-Year Limited Warranty

This Orion product is warranted against defects in materials or workmanship for a period of one year from the date of purchase. This warranty is for the benefit of the original retail purchaser only. During this warranty period Orion Telescopes & Binoculars will repair or replace, at Orion's option, any warranted instrument that proves to be defective, provided it is returned postage paid. Proof of purchase (such as a copy of the original receipt) is required. This warranty is only valid in the country of purchase.

This warranty does not apply if, in Orion's judgment, the instrument has been abused, mishandled, or modified, nor does it apply to normal wear and tear. This warranty gives you specific legal rights. It is not intended to remove or restrict your other legal rights under applicable local consumer law; your state or national statutory consumer rights governing the sale of consumer goods remain fully applicable.

For further warranty information, please visit [www.OrionTelescopes.com/warranty](http://www.OrionTelescopes.com/warranty).



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