

Buying A Telescope

Rule Number One - Don't buy a telescope from a department store! Cheap telescopes advertised as having unrealistically high magnifications are almost always junk, and department stores tend to market this kind of junk to impulse buyers. Quality telescopes are advertised by inches (or millimeters) of aperture, and no telescope can use over 50x magnification per inch of aperture. Even then, the best nights permit only about 300x before atmospheric effects hinder seeing, and you'll find that most nights in Ohio permit only about 150x-200x regardless of the telescope.

Rule Number Two - Buy the most aperture you can afford. All things being equal, a telescope with a larger aperture will show you more. Larger mirrors or objective lenses *a)* gather more light, and *b)* provide more resolution. Light gathering ability is important for observing dim deep space objects like galaxies, nebulae, and clusters of stars. Small telescopes show these objects as unsatisfying dim smudges, while 6 inch or larger telescopes show detail within the objects. In addition to being brighter, larger telescopes resolve more detail on planets. My 70mm (about 3 inch) aperture TeleVue Ranger is small and compact and shows the rings of Saturn, but it cannot resolve the major divisions on Saturn's rings into the components that I can see in my 8" aperture telescope. The Ring Nebula is just a smudge in the Ranger, but becomes a clearly recognizable ring in the 8" reflector. Aperture wins — big time.

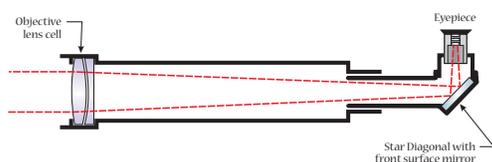
Rule Number Three - Don't buy more telescope than you can comfortably carry and set up. If it is too awkward to set up, the telescope won't get used. Two things hinder usability - *a)* weight of the components you have to carry, and *b)* time consuming and complex setup steps. Determining the threshold of what's easily usable and what's not is a very personal task, but you should give it realistic consideration.

Rule Number Four - Set aside some money for the other things needed to make observing fruitful. Star charts, a finder, an observing stool, or another eyepiece can add to the cost of a telescope.

Descriptions of Different Telescope Designs

Telescopes come in different configurations that can confuse a first-time buyer.

The Refractor Telescope



Refractor - This design is what most people think of when the word “telescope” is mentioned. A glass objective lens assembly focuses light toward the back of the telescope. A mirror intercepts the incoming light and diverts it to the eyepiece. The eyepiece and mirror are mounted in a focuser that adjusts to get the image sharp. Objective lens quality is very important to refractor performance. The best designs use extremely expensive flouirite glass objectives. Objectives made from ED

(Extra-low Dispersion) glasses provide good performance, while an achromat comprised of common optical glasses is acceptable at lower magnifications or longer focal ratios like f/10.

Advantages: Refractors don't require much “cool-down” time to provide sharp views. My TeleVue Ranger is ready to use on a below-freezing night within half an hour.

Because they don't have diffraction-producing obstructions, quality refractors are unsurpassed in sharpness when compared to other designs of equal aperture. They make great planetary and lunar scopes, especially for someone limited to viewing the sky from within the city.

A refractor rarely requires collimation of its optical elements.

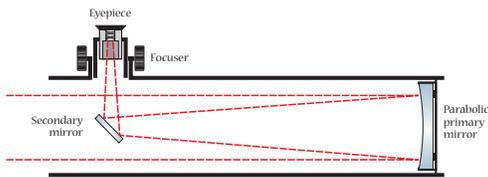
Disadvantages: A quality refractor is usually very expensive per inch of aperture.

Not ordinarily available in large apertures over 5 inches. Because of the limited aperture, most

deep-sky objects are rendered as fairly dim smudges.

Exposed front elements are susceptible to dewing, and must be shielded with a deep lens shade.

The Newtonian Telescope



Newtonian Reflector - This simple design usually provides the most aperture for a given price, especially if coupled with a simple Dobsonian alt-az mount. It does not have many parts – just a parabolic mirror mounted at the rear of a tube (the “primary” mirror), a front-surface “secondary” mirror mounted on a “spider”, and a focuser that holds the eyepiece.

Advantages: Its simple design means the most aperture for the buck.

Light gathering capability of 6" and up models

means great performance on dim deep-sky objects.

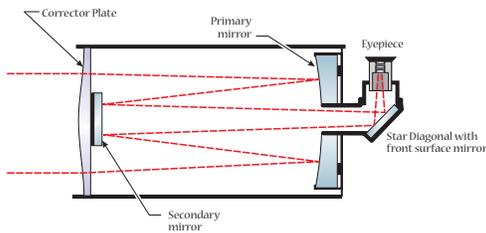
Because most of the optics are nestled deep within the tube, dewing is not a severe problem.

Disadvantages: The significant mass of the primary mirror hinders cooling, but because most Newtonian designs are open to the air, cool-down time is moderate - longer than a refractor, but shorter than a closed design like a Schmidt-Cassegrain.

Most Newtonians require frequent collimation of the optical elements for optimum high-magnification work.

Long, bulky tubes are somewhat awkward to pack into a small car.

The Schmidt-Cassegrain Telescope



Schmidt-Cassegrain and Maksutov-Cassegrain Reflectors

- Both are more complex designs than Newtonians or Refractors. These designs are popular because of their compactness. A lens-like corrector plate bends light onto the primary mirror. After light reflects from the mirror, it travels once again up the scope to the secondary mirror integrated with the corrector plate. The returning reflection is directed to the star diagonal mirror and on to the eyepiece.

Advantages: Compact tubes are easy to carry.

Stubby tubes mount easily onto equatorial platforms for astro-photography or for computerized GOTO capability.

Good planetary performance because of the typically high focal ratio.

Many accessories available because of the popularity of Meade and Celestron brands.

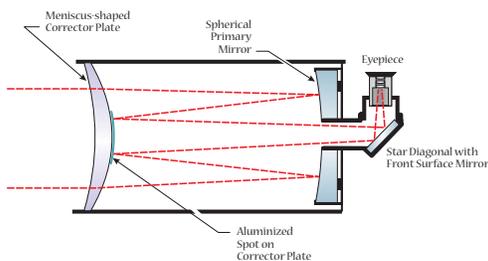
Disadvantages: Exposed front element susceptible to dewing.

Very long cool-down time because of the enclosed optical design.

Somewhat expensive because of the complexity, but less expensive than an equivalent refractor.

Requires collimation for best performance.

The Maksutov-Cassegrain Telescope



Mounts for Telescopes

To add to the confusion, there are several types of mounts to hold these different telescopes. Three types dominate – **Altitude-Azimuth** (generally called Alt-Az), **German Equatorial** (mostly called Equatorial or EQ these days), and **Dobsonian** (Dob). The Dobsonian is actually a simple Alt-Az mount for Newtonians popularized by sidewalk telescope evangelist John Dobson. Dobsonian mounts are often constructed of plywood or particle board with Teflon pads for bearings. Both Alt-Az and Dobsonian mounts are usually moved by hand to keep a celestial object in view. A quick nudge every minute or two is sufficient.

An equatorial mount tracks an object in view with the motion of just one axis. It must be aligned with polar north when it is setup to achieve this. Many have built-in finder scopes to help align the mount's axis with Polaris, and have slow-motion controls to help track an object. Once an EQ mount is setup, it is simple to keep an object in the center of the field and most useful when you need to carefully study an object for a considerable time, or if you want to use mathematical coordinates to find an object. Some EQ mounts are undersized for serious astro work and wobble enough to make focusing and viewing difficult. Be sure that the one you want has a sturdy tripod and head for your needs. If you are considering astro photography of deep space objects, expect to spend about \$1000 & up for the EQ mount alone! If you want to star hop in a short amount of time, an Alt-Az or Dobsonian is easier to use, and much simpler to set up.

Buying Suggestions

If you have up to \$200 to Spend - don't buy a telescope. You won't be satisfied with the performance and children with such a scope will lose interest quickly. Most sub-\$200 telescopes come with wobbly mounts, don't focus smoothly or don't have enough optical quality.

Instead, consider buying a pair of binoculars and a book like *Nightwatch* by Terance Dickinson and a planisphere. Keep in mind that quality binoculars will cost over \$100 (I love my \$169 Orion Ultraview 10x50's — 10 power with 50mm diameter objectives. They focus stars better than my \$130 Nikon Egret II binoculars). However, even cheap binoculars can show much more of the sky than you can see naked eye. With binoculars of average quality, you should still be able to see the moons of Jupiter, the Andromeda galaxy, lunar craters, and more.

Or you could consider a \$130 planetarium program like *TheSky* that can provide hours of educational fun for anyone.

Too expensive? Try *Starry Night* software for \$90 or maybe *RedShift* for \$50. You can learn the constellations with the help of the computer, and then go outdoors to try finding them.

Budget's tighter than that? Get a subscription to *Sky and Telescope* or *Astronomy* magazine and a night sky Planisphere for a total under \$50. But don't buy a new telescope in that price range!

If you have \$200 to \$400 to spend - Here's where things start to get interesting. There are a number of good telescopes available in this price range starting with the petite Short Tube 80mm rich-field refractor from Orion at \$199 plus \$9.22 shipping (but no tripod or mount) or the 4½ inch Orion XT4.5 Dobsonian (\$199 plus \$17.60 shipping for the 17.5 lb. scope). Discovery sells a 6" Dobsonian DHQ for \$299+\$39 shipping.

The short tube 80mm is very compact and is best with low-power, wide-views of the sky. Top useful power peaks around 60x and it exhibits a bit of color fringing on bright objects like the planets and moon, but it is a good buy for the price. It will show the rings of Saturn easily.

Orion's 4.5" Dobsonian will show more objects and provide better planetary magnification and resolution because of its larger aperture. The Discovery 6" DHQ has even more aperture and will show still more, but it will occupy considerably more space in the house or car. Still, it is an excellent buy and a good performer if you have the room.

If you would like to build a telescope to learn construction skills or to gain quality time with your

children, try some of Stargazer Steve's offerings. The 3-inch reflector kit SGR-3 is \$263 shipped and includes a hardwood tripod with alt-az mount. Other kits are available. You will need to buy an eyepiece, but the quality from Stargazer Steve is said to be good. Still, the 6" Discovery dob would show more objects because of its larger aperture.

Whatever you decide, don't forget to add in the cost of extra eyepieces if desired, a sky map or planisphere, subscription, and any other accessories that might be needed.

If you have \$400-\$700 to spend - You'll find tons of telescopes in this price range. For the best view for the money, pick up a 6" or 8" or maybe even a 10" Dobsonian from Discovery, Celestron, Orion, or Meade. I have the Discovery 8" Dob, and I can manage to carry both the tube and the mount in one trip. The tube weighs 18 lbs, and the base is 28 lbs. The Celestron tube is larger in diameter allowing faster cooling (in theory), and has a better pivot balance system. Be sure to compare accessories like included eyepieces, quality of focuser (Discovery - rack and pinion, Celestron - helical), secondary mirror support (Discovery - four vane, Celestron - single stalk) etc. before buying.

If you want an EQ mounted Newtonian in this price range, be prepared to give up a little aperture in trade. Discovery, Meade, Celestron and Orion have models on EQ mounts. Discovery has an 8" for \$599 plus shipping, and Orion has a svelt 4.5 inch on an EQ mount for \$388 plus shipping.

Also in this price range are some high-quality small instruments like the Meade ETX 90mm Maksutov-Cassegrain (around \$600) and the TeleVue 70mm Ranger refractor (about \$700), but they are at the top end of this price range. Some people criticize the plastic parts of the Meade ETX and the lack of smoothness of the drives, but it is a best seller. Perhaps because of its optional AutoStar computer with star database and GOTO capability, it has a high-tech appeal for many purchasers.

The Ranger is an excellent ED glass refractor of good optical quality. The fit and finish of the Ranger are top notch, but because of its fairly short focal length, it is limited to about 120x and it will color fringe somewhat on bright objects like planets and the moon. It is perfect however for wide sweeps of the Milky Way. It doesn't come with a mount for this price range, but the TeleVue TelePod head (about \$150) on a quality tripod make tracking objects easy. The scope is a travelers dream because of its compact size, and it cools down quickly for serious work

I've won the lottery! – I can spend over \$700 - For high-quality Dobsonian telescopes, check out the top of the line Obsession, Starsplitter, and Starmaster telescopes on the web. You place an order for one, specify custom parts like focusers, mirror vendors, and setting circles (a digital way to find objects in the sky when connected to a computer), and these firms custom build it for you. It may take months for construction to be completed, depending on what was ordered. The best smaller mirrors (6" - 12.5") are made by Zambuto, while Pegasus, Galaxy and a couple of other firms make custom quality large mirrors up to 36 inches in diameter. The largest Dobsonians (over 12 inches or so) are usually truss structures so that they are lighter and can be dismantled for travel. Large tube type Dobsonians over 10 or 12 inches take two people to carry and assemble because of their weight.

If you have over \$700 to spend, also consider a Celestron or Meade Schmidt-Cassegrain telescopes – especially those with compute tracking and GOTO capability. They will take a while to set up, but the computer will find the objects for you and track them in the field. These telescopes are commonly used for astrophotography.

Accessories - A telescope by itself is nice to use, but you can achieve much more if you have some additional items. Sky charts or planispheres are a great aid to finding objects in the sky. Without them, you won't know where to look, and you won't know what you've found once you see it. For beginners, books like Turn Left at Orion by Guy Consolmagno and Dan Davis, or Nightwatch by Terence Dickinson can make observing fun. Both books tell how to find things, and both describe the objects you see. Other useful accessories may include a red flashlight so that you don't lose your night vision (red tape

attached over a mini-flashlight will work fine), and a stool to use if you have a low observing position like that of a 6" or 8" Dobsonian (I have a \$10 step-stool from K-Mart that I also use for other needs around the house). For the telescope itself, you might find that a Telrad or Orion EZ-Finder works better than the cheap finder scopes that come with most telescopes.

Newtonian users should consider a collimation tool to align their optics. A company called Tectron (find them on the web) makes an excellent set of three tools and a booklet for around \$100 (I bought mine used for \$60 from a fellow with whom I corresponded on the sci.astro.amateur newsgroup). They also sell the tools separately with the Cheshire tool probably being the most useful of the three.

Consider buying a planetarium software program to help you see what's up for your location at any given time of night. There are several software vendors who have trial versions available for download on the web.

A subscription to Sky and Telescope or to Astronomy magazine will inform you of upcoming celestial events and provide a wealth of information about the sky above us. Both publications have monthly star charts showing the location of the planets, moon, and other objects. The Sky and Telescope web site has many items for sale, such as the laminated Messier card that I find very useful.

Don't forget warm clothing for chilly nights! Warm boots and hats will go a long way toward helping your endurance under cold skies.

Probably the most expensive telescope accessories are extra eyepieces. They range in price from \$50-\$100 for a basic Plossl or an Orthoscopic, \$200-\$350 for wide-view TeleVue Nagler eyepieces (82 degree apparent field), Panoptic (65 degree), and Radian (60 degree) eyepieces, and prices can run much higher for specialty eyepieces. For most telescopes and a tight budget, consider a Plossl type eyepiece (50 degrees apparent field). Avoid older design Kellner and Erfle type eyepieces. Your telescope will likely come with a 1-1/4 inch diameter focusers for eyepieces, but some high-end models are available with larger 2 inch diameter focusers. (NOTE: Avoid all telescopes that have only a .965 inch focuser. Those telescopes are usually imported department-store junk, and few quality eyepieces are available in the .965 size.)

Telescope math

telescope focal length = objective diameter (or mirror diameter) x f-number.

magnification = telescope focal length ÷ eyepiece focal length

(NOTE: don't mix mm and inches in the formulas! Convert them first using one inch =25.4mm)

What else should I consider?

To get the most from your telescope and to keep the sky viewable for your children, get involved in the fight against light pollution. Unnecessary and badly designed outdoor lighting spoils our view of the night sky. Good lighting fixtures reflect the rays from the light downward onto the ground where it does the most good, with none spilled above the horizontal.

There is an organization called the International Dark Sky Association dedicated to preserving the nighttime sky, and they have information on the web about various lighting fixtures and maps of the nighttime earth showing how much damage already exists. Get involved on the local level to make sure that elected officials are aware that the issue is important to you.

Telescope Buying Information and Contacts

Telescope Reviews or Buying advice on the web: (Highly recommended for further research!!)

Ed Ting's Telescope Review <http://www.scopereviews.com>
Heretic's Telescope Buying Guide <http://www.mich.com/~mje/scope.html>
Perkins' Observatory <http://www.perkins-observatory.org>
Tod Gross' Weather and Astronomy page <http://www.weatherman.com/>

Sellers:

Local:

McAllister Camera, 594 W. Schrock Rd, Westerville, OH, (614)-794-1865
Brands: (large stock!) Meade, Celestron, TeleVue

Kramer's Photo, 2909 Murdoch Ave, Parkersburg, WV26101, (304) 428-2061
Brands: Celestron

Mail Order or Web:

Anacortes Telescope and Wild Bird
3202 Commercial Avenue
Anacortes, WA 98221
(360) 588-9000 Fax: (360) 588-9100 <http://www.buytelescopes.com>

Discovery Telescopes, Inc
615 South Tremont St. Oceanside, CA 92054
(760) 967-6598 Fax: (760) 967-6798 <http://www.discovery-telescopes.com>

Eagle Optics
2120 W. Greenview Dr. #4
Middleton, WI 53562
(608) 836-6568 <http://www.eagleoptics.com>

Orion Telescopes and Binoculars - Several retail locations in California, mostly mail order.
(800) 447-1001 <http://www.telescope.com>

Stargazer Steve
1752 Rutherglen Cres,
Sudbury, ON, P3A 2K3, CANADA
<http://stargazer.isys.ca>

Quality Refractor Manufacturers:

Astro-Physics (price: if you have to ask...)
Takahashi (superb reputation, somewhat pricey)
TeleVue (models from \$600 to \$3,000)
Vixen (reasonable prices, not quite the reputation of the top three)
Orion (usually rebadged Vixens or other brands — from \$200 up)
Meade
Celestron

Low Cost, Good Quality Dobsonian Manufacturers:

Orion - look for their Skyquest XT series of Dobsonians (XT4.5 (4½") for \$199+\$17.60, XT6 (6") for \$369+\$39, XT8 (8") for \$499+\$49 shipping.

Discovery - 6" DHQ (\$299+\$39 shipping) and 8" DHQ (\$399+\$49 shipping).

Meade

Celestron

Stargazer Steve 4-1/4" kit (\$229 plus shipping) & 6" kit. Sells direct.

High Quality, High Cost Dobsonian Manufacturers:

Obsession - <http://www.globaldialog.com/~obsessiontscp/OBHP.html>

Starmaster - <http://www.starmastertelescopes.com>

Starsplitter - <http://www.starsplitter.com>

Used Telescope Equipment:

Astromart - <http://www.astromart.com>

Astronomy Mall - <http://www.astronomy-mall.com/>

Trial or Free Astronomy Software

StarMap Pro 7 Demo - <http://www.wsoftware.com>

JupSat (shows position of the moons of Jupiter) - <http://indigo.ie/~gnugent/JupSat95>

International Dark Sky Association:

http://www.darksky.org/~ida/ida_2/index.html