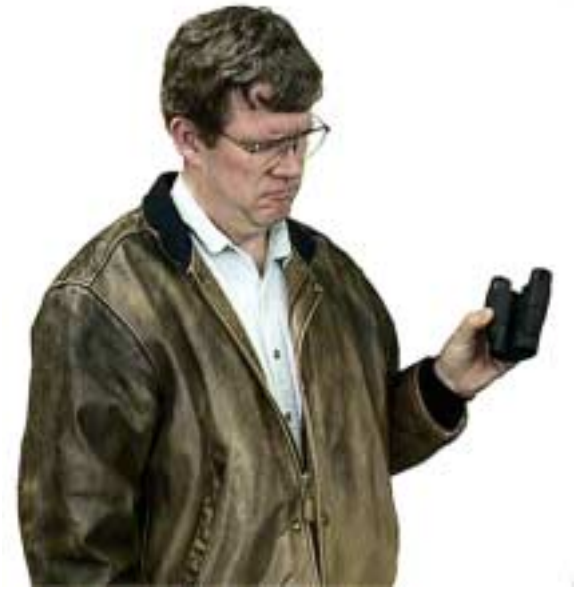
Project ASTRO UTAH
So, You Want to Buy a Telescope ...

Biologists categorize life on Earth by Kingdom, Phylum, Class, Order, Genus, and so on. However, a little-known but critically important taxonomy is all too often ignored by instructors of Biology. Stuck in between "Kingdom" and "Phylum" is the "Telescopum," a division that distinguishes between those members of the Animal Kingdom who purchase telescopes wisely and those who do not.

Biology instructors usually overlook this classification because identifying animals by their Telescopum is so incredibly simple they probably feel the distinction is self-evident. Those who buy telescopes wisely are happy, intelligent, personally and professionally successful, enthusiastic, financially secure, fun to be with and are highly attractive to movie stars and super-models. Those who don't, well…aren't.

Because the consequences of buying a telescope wisely or unwisely are so dramatic, let's quickly review the eight basic rules of wise telescope shopping.



Small binoculars such as this set of 8x25's (8 power magnification, 25 mm apertures) may work well in daylight but don't gather enough light for use at night.

1. Ask Yourself, Do You Really Need a Telescope?

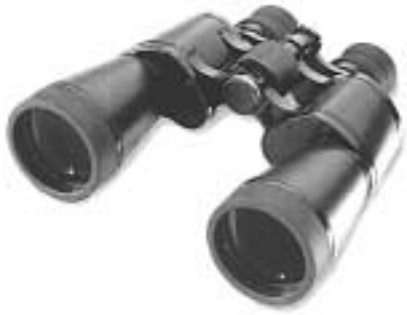
It's amazing how often this question is not asked when it is, in fact, the first question that should be answered. An enormous amount of deeply satisfying sky-gazing can be had with nothing more than a good pair of binoculars. True, binoculars are simply low-power, wide-angle, side-by-side telescopes, but let's not complicate the issue.

The Andromeda Galaxy, so large and bright that even from a distance of 2 million light years it is visible to the naked eye, is impressive when seen through a $150 pair of binoculars. Those same binoculars also provide excellent views of the four Galilean moons of Jupiter, the Pleiades star cluster and the Lagoon Nebula. For exploring the rich star fields of the summertime Milky Way, binoculars are without equal. Remember Comet Hale-Bopp? Almost no one was looking at it through telescopes. Savvy comet watchers were all using binoculars. No telescope can give the observer the wide field of view and instinctive sense of where in the sky they are looking the way binoculars can.

Giant binoculars such as these 11x80's (11 power magnification, 80 mm apertures) are great for night use, but are heavy and require a tripod for a stable view.

In addition to being relatively inexpensive, binoculars are highly portable, simple to operate and store, pretty much goof-proof, and are just plain handy to have around. They make excellent gifts. A few eccentrics have even been known to use binoculars during the *day* and take them to sporting events, on hikes, or even to just watch birds.

If you are not 100% certain that you are ready to be a telescope owner, then spare yourself the expense and effort associated with a telescope and start out with a set of decent 7x50 binoculars. If one night you find yourself straining through your binoculars in an attempt to view the Ring Nebula, then you know you are ready for a telescope.



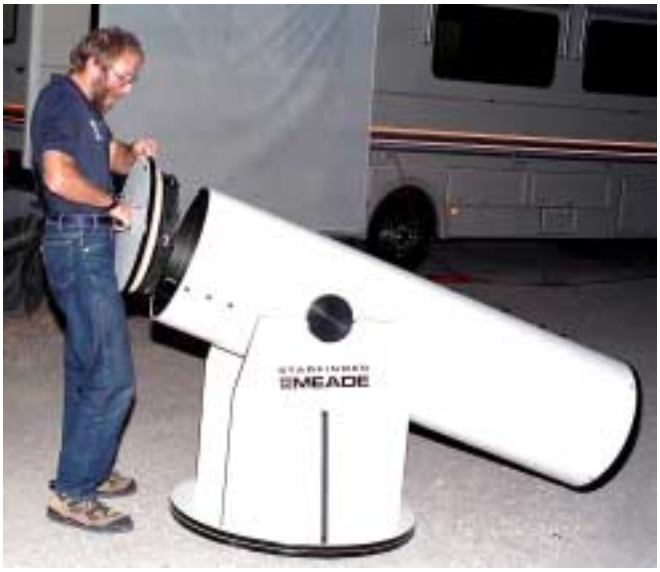
A good quality pair of 7x50 binoculars are ideal for a beginning amateur astronomer. (Image courtesy of Orion Telescopes)

2. Bigger Buckets are Better

The Universe is awash with tiny packets of light called photons. At this moment, trillions and trillions of photons are bouncing off the ink and paper of this newsletter and finding their way into your eyes, making it possible for you to read these words. These photons originated in a nearby light bulb or possibly a mere (in the astronomical scheme of things) 93 million miles away inside the Sun.

When photons of visible light are abundant, we think the world around us is bright. When these same photons become scarce, we perceive this as dark. An analogy can be made between photons and water. Standing outside on a sunny day is similar to standing beneath a waterfall—you are drenched in an instant. A clear moonless night is like a fine misty rain. If you want to collect even a small amount of water from a drizzling rain, you are going to need a big bucket.

A telescope is to starlight as a bucket is to rain. Bigger buckets catch more, whether it is a wooden bucket collecting rain or an optical bucket (a telescope) collecting starlight.



Weber State University astronomer John Sohl removes the primary mirror from a Meade 16" reflector. Note the simple-but-strong "Dobsonian" alta-azimuth mount. Six or eight-inch reflecting telescopes on Dobsonian mounts make excellent first telescopes.

In general, telescopes with large apertures (the diameter of the opening that catches light), are better than telescopes with small apertures. The length of a telescope is not a good predictor of how well it will perform. On the other hand, the aperture is a good initial predictor of a telescope's performance.

Most department-store telescopes have apertures of between 60 and 80 millimeters (two to three inches.) This is not much of a bucket, and their buyers learn too late that these telescopes that worked so well in the department store perform miserably at night. Remember the starlight-water analogy. If you are collecting water under a waterfall (daylight), just about anything will catch enough to give you a drink. If you are trying to catch water in a misty rain (nighttime), those tiny droplets are few and far between, and the diameter of your bucket becomes critical.

Most good-quality telescopes used by amateur astronomers have apertures of at least four inches, and amateur telescopes with apertures of six to twelve inches are common.

Get a telescope with the biggest aperture your budget can afford.

3. Thirty Power of Magnification Per Inch

Have you ever heard the great telescopes of the world referred to by their magnifying power? Of course not, they are known by their aperture. Famous telescopes include the "200 inch" telescope in California at Mt. Palomar, the twin "10 meter" Keck telescopes atop Mauna Kea in Hawaii, and of course, the "2.4 meter" Hubble Space Telescope in orbit above us. Why then, do department stores and cable shopping channels advertise telescopes by their "power" instead of their aperture? They do it because they think we are gullible rubes.

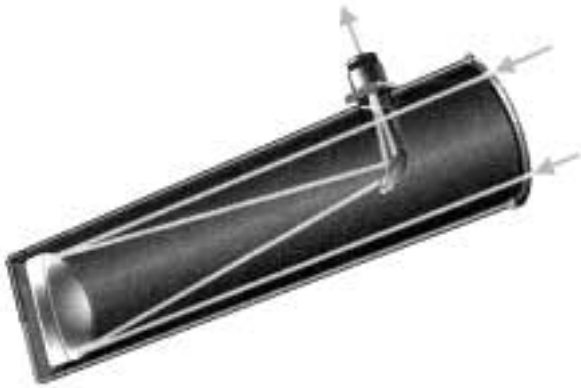
Fortunately, we have the "thirty power per inch of aperture" rule. The maximum useful power (magnification) that a telescope can provide is about 30 power per inch of aperture. That 60 millimeter telescope in the department store may be promoted as "200 power!" but since 60 mm is about 2.3 inches, you shouldn't expect decent nighttime viewing beyond about 70 power (30 x 2.3 = 69).

True, the optics of that 60 mm telescope might in fact be producing 200x magnification, but the point is that anything much beyond about 70x is only going to produce dark, fuzzy images. A 60 mm "bucket" just can't catch enough light from the night sky to make magnifications much beyond 70x of any use to you. During daylight hours, even a 60 mm aperture can gather enough light to support very high magnification. After dark, however, the 30-power-per-inch rule applies. Very few amateur astronomers ever use their telescopes at magnifications higher than about 200x, and most stay well below 100x. (Saturn's rings are breathtaking at 50x.) A typical eight-inch amateur telescope, even at 100x, is using its optics at only about 12 power-per-inch, ensuring a bright, high-resolution image.

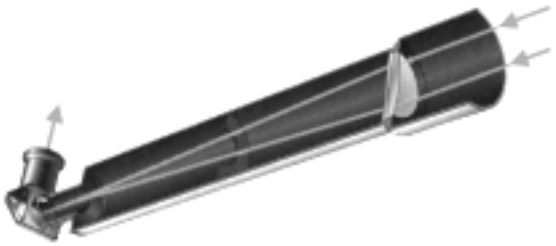
4. Mirrors Give More Bang-for-the-Buck Than Lenses

Another distinction shrewd telescope shoppers keep in mind is that most of the great research telescopes of the world are "reflecting" telescopes that gather light using a single curved mirror instead of "refracting" telescopes that use multiple lenses. What is it that the folks who build such telescopes know that the sales clerk in the department store doesn't?

They know that the "light bucket" of a reflecting telescope requires precision polishing of only one large surface—the mirror at the bottom of the telescope tube that gathers and focuses the light into the eyepiece. Refracting telescopes (large versions of the "spyglass" so popular in pirate movies) gather light by bending it through multiple lenses. Each lens has two surfaces—a front and a back—and each



"Reflector" telescopes gather light in a curved primary mirror at the back of the telescope, reflecting and focusing the light forward onto a secondary mirror and up to the eyepiece. Most affordable, good-quality amateur telescopes are reflectors. (Diagram courtesy of Orion Telescopes)



"Refractor" telescopes gather light using lenses at the front of the telescope that refract (bend) the light so that it focuses in front of an eyepiece at the rear of the telescope. (Diagram courtesy of Orion Telescopes)

surface needs to be polished with the same precision and care as the surface of the primary mirror in a reflecting telescope. Refracting telescopes require at least two such lenses, meaning that in order to attain roughly equivalent optical quality, a refracting telescope needs at least four times as much work as a reflecting telescope. The only way the department-store telescopes can be priced low enough to get people to buy them is for their manufacturers to use inexpensive lenses that haven't been polished and assembled with much precision.

Because reflecting telescopes deliver the most starlight for the lowest price, most amateur astronomers use reflecting telescopes with apertures measuring between six and fourteen inches. These telescopes sell for anywhere between a couple of hundred to several thousands of dollars.

A few amateur astronomers do have, use and lovingly maintain refracting telescopes with apertures between four to eight inches. These telescopes are heavy, large, delicate and time-consuming to set up. A well-made refracting telescope can deliver more finely detailed images of planets and stars than a reflecting telescope of equivalent aperture, but this type of performance comes at a price. A six-inch reflecting telescope can be bought new for a few hundred dollars. However, if you have to ask how much a high-quality six-inch refracting telescope costs, then you can't afford one.

Refractors are capable of producing sharper images than reflecting telescopes of the same aperture, but are big, heavy and expensive. Siegfried Jachmann's nine-inch Clark Refractor offers eye-popping views of the planets, but taking it to a Star Party is not a simple task.

5. The Telescope Must Use 1.25" Interchangeable Eyepieces

The aperture of the telescope determines how much light it collects, but the eyepiece (the part of the telescope you look into) is where most of the magnification process takes place. Changing eyepieces lets the viewer change levels of magnification and the field of view. Amateur astronomers usually have an assortment of eyepieces with them during an observing session.

The magnifying power of a telescope can be easily calculated by dividing the focal length of the telescope by the focal length of the eyepiece. For example, an amateur telescope with a 1,000 mm focal length using a 22 mm eyepiece will produce a magnification of 45 power (1,000 / 22 = 45).

To obtain greater magnification (but with a narrower field of view, a darker image and a smaller opening in the eyepiece to look through), the telescope operator changes to an eyepiece having a shorter focal length. For example, a 1,000 mm focal length telescope using an 8 mm focal length eyepiece will achieve 125 power magnification.

A telescope that accepts interchangeable eyepieces gives the user a wide variety of options for magnification and field of view. (Image courtesy of Orion Telescopes)

Department-store telescopes seldom use interchangeable eyepieces, typically limiting the user to either a single multi-power "zoom" eyepiece or a few eyepieces specifically made for that telescope. These eyepieces were doubtless constructed with the same level of care as the rest of the telescope, which bodes ill for your viewing experience. If they do accept interchangeable eyepieces, they are usually the smaller .965" diameter eyepieces. While there are a few good telescopes worth buying that use these, finding quality .965" eyepieces is more difficult and they cost just as much as 1.25" eyepieces.

Interchangeable 1.25" eyepieces are available in a huge variety of focal lengths and features. Astronomy magazines and astronomy supply catalogs contain page after page of listings for all types of high-quality interchangeable eyepieces, with prices ranging from less than $30 to more than $300 apiece.

The odds are that if the telescope you are thinking about buying uses 1.25" interchangeable eyepieces, it's worth further consideration. If not, then the telescope probably won't perform well at night, no matter how impressive it may seem in the bright lights of the store.

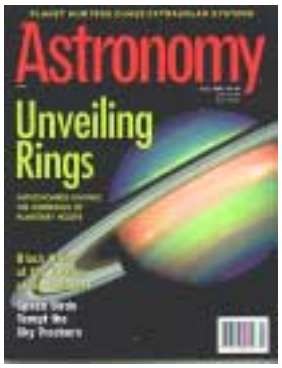
6. Pay Attention to the Mount

A telescope's mount needs to be strong enough to keep the instrument from moving while you are looking through it. A cheap mount will make even the best optics impossible to enjoy. Department-store telescopes are notorious for coming with flimsy mounts attached to equally flimsy tripods that make the telescope wiggle crazily with every gust of wind.

Dobsonian-mounted reflecting telescopes are increasingly popular among amateur astronomers. The Dobsonian mount is a simple, robust design that cradles the telescope on an altitude-azimuth adjustable swivel base. Teflon pads in the mount allow the user to aim the telescope by simply grabbing it by the tube and pointing in the desired direction. The Dobsonian's rigid construction and low center of gravity provide excellent stability for their reflector telescopes and place the eyepiece at a comfortable height for most observers.

The advent of the Dobsonian telescope mount has created a dramatic drop in the price of good-quality reflector telescopes. Their only drawback is that they are not suitable for long-exposure astrophotography, which requires a system of electric motors and gears in order to track objects over time. Unless you are seriously planning on taking up astrophotography as a hobby, a Dobsonian-mounted reflector will give the best return on investment for a beginning amateur astronomer.

7. Do a Little Reading



Buy and read at least two issues of the magazines read by amateur astronomers. This is important because it gives the prospective telescope buyer a chance to see what is available in the way of good quality optics from reputable dealers.

If you knew nothing about automobiles but were thinking of buying one, would you visit "Slick's O.K. Kar Koral" without first reading a few issues of "Car & Driver" and "Consumer Reports"? Let's hope not.

Much derision has been heaped upon "department-store telescopes," but that doesn't help the buyer learn who supplies telescopes worth owning and how much they cost. Fortunately, there is a relatively painless way a novice may learn what is worth buying while at the same time acquiring astronomical knowledge.

The two preeminent monthly magazines read by amateur astronomers are **Astronomy** (www.astronomy.com/Content/static/magazine/default.asp) and **"Sky & Telescope"** (www.skypub.com). In addition to many excellent articles on the subject of astronomy, these magazines contain many advertisements for high-quality telescopes and binoculars.

8. Attend a Star Party

This may well be the most important rule of all. People learn best when they are sharing information with other people. After all, we are social animals, and "Star Parties" hosted by local astronomy clubs or planetariums are great places to meet and talk with other telescope owners. Information about the relative merits and different types of telescopes, eyepieces, mounts and accessories flows freely among participants, and novices with questions about buying telescopes are enthusiastically welcomed.

Which is more likely to give a person genuine telescope-buying proficiency—seeing how well the department-store telescope can show you the "EXIT" sign at the back of the store, or looking through a variety of telescopes that are actually viewing planets, stars and galaxies?

Good telescopes can provide a lifetime's enjoyment. If handled with a little care, a high quality telescope will rarely (if ever) break or require adjustment. Prices for a good telescope range from about $300 and up. (Sometimes way, WAY up, but that's for someone seriously bitten by the astronomy bug.)

Those are the rules. Follow them, and you will attain a state of bliss. Ignore them at your peril.

Recommendations

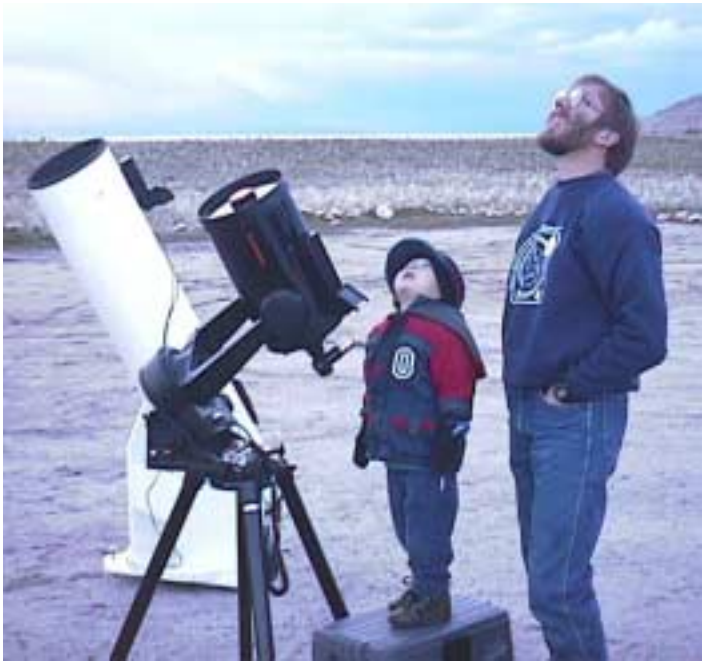
Under $250: A good set of 7x50 binoculars is a must. Consider the Orion *Explorer* ($120), Orion *UltraView* ($180), or Celestron *Ultima* ($240). You can, of course, spend much more than this for binoculars, but these are good examples of high-quality binoculars with minimal sticker-shock.

Under $500: Consider a Dobsonian-mounted reflector, such as the Meade *Starfinder* with 6" ($350) or 8" ($450) aperture. Also consider Orion's *Deep Space Explorer* ($360 for a 6", $470 for an 8" aperture), or the Celestron 8" *Starhopper* ($420). Dobsonian-mounted reflectors give the user a large-aperture telescope with simple, rugged construction for a minimal investment.

Under $1,000: Consider a larger Dobsonian-mounted reflector, such as the Orion 10" *Premium Deep Space Explorer* ($820) or Meade 12" *Starfinder* ($900). A 10" telescope gathers about 57% more light than an 8" telescope (the 12" collects 126% more light), giving the user brighter images of faint deep-sky objects such as galaxies and nebula.

Over $1,000: It's hard to go wrong with a Schmidt-Cassegrain (a type of reflector) telescope made by either Celestron or Meade. These compact instruments are the "workhorse" telescopes of many amateur astronomers and are ubiquitous at Star Parties. Prices for Schmidt-Cassegrain telescopes with 8" or 10" apertures begin at just over $1,000 and continue past $3,000 depending on mounts, features and accessories. When used with the proper motorized drives, they make excellent telescopes for astrophotography.

Sources: Orion Telescopes (www.telescope.com)
Meade Instruments (www.meade.com)
Celestron International (www.celestron.com)



Schmidt-Cassegrain telescopes (foreground) are compact reflector telescopes, that use its secondary mirror to reflect light to the rear of the telescope.