You can look at the Moon and learn something about where the Sun is—even after the Sun has disappeared below the horizon. A thin crescent hanging in the western sky after sunset tells you that the Moon is still fairly close to the Sun's direction. A full Moon rising in the east as the Sun sets in the west tells you that they are on nearly opposite sides of your sky. The shape is giving you information about position. Once you understand that connection, the Moon stops looking like an object that randomly changes appearance and begins revealing a pattern you can follow. Moon phases are the changing portions of the Moon's sunlit half that we can see from Earth. The Moon itself stays round. It does not grow into a full circle and then lose pieces. What changes is our view of the boundary between its daytime and nighttime sides as it travels around us. The familiar crescent, half Moon, and full Moon are different views of the same sunlit sphere. NASA Science

Begin with the light. The Moon does not generate the visible glow we call moonlight; its surface reflects sunlight. Under ordinary conditions, the Sun illuminates approximately half of the Moon, just as it illuminates approximately half of Earth. One side experiences daylight while the other experiences night. Meanwhile, we can see only the hemisphere facing us—a hemisphere being half of a sphere. Those two halves, the half facing the Sun and the half facing Earth, are not always the same half. Sometimes they overlap almost completely, so the face we see appears fully illuminated. Sometimes they barely overlap, leaving only a narrow bright crescent. Sometimes we are looking mainly at the nighttime half. This is the relationship to hold onto before memorizing names: the Sun lights the Moon, the Moon orbits Earth, and our viewing angle changes. An orbit is the path one object follows around another under gravity. As the Moon advances along that path, we see its illuminated surface from a continually changing direction. NASA Science for Kids

You can make that relationship visible in a room with a lamp and a light-colored ball. Let the lamp represent the Sun, your head represent Earth, and the ball represent the Moon. Keep the lamp in one place and hold the ball at arm's length. When the ball is between you and the lamp, the side facing you looks dark because the light is striking the other side. Slowly turn while keeping the ball in front of you. A bright sliver appears, then a larger illuminated area, then a half-lit face. Continue until the lamp is behind you, holding the ball high enough that your head does not block the light, and the face you see becomes fully illuminated. Keep turning and the bright area decreases again. The lamp did not dim, the ball did not change shape, and nothing had to cover it. Your position relative to the illuminated half changed. If your head's shadow does fall across the ball, you have accidentally demonstrated an eclipse, which is a different event from the normal phase cycle. NASA JPL Education

The cycle conventionally begins with the new Moon, when the Moon lies in roughly the Sun's direction as viewed from Earth. Its sunlit side faces mostly away from us, leaving the near side—the side facing Earth—mostly dark. The Moon is still present, generally traveling across the daytime sky near the Sun, but we ordinarily cannot distinguish it against the glare. "New" describes the beginning of the phase cycle; it does not mean a

new physical Moon has appeared. As the Moon continues along its orbit, a small part of its sunlit side becomes visible. This is the waxing crescent. Waxing means the illuminated portion we see is increasing, and crescent describes a shape smaller than a half circle, with two pointed ends. An evening crescent is therefore an early stage in the Moon's growth toward full illumination from our perspective. Look for it toward the west after sunset. Over successive evenings, it generally becomes thicker and remains visible later. Its changing appearance and changing schedule are connected consequences of its motion around Earth. starchild.gsfc.nasa.gov

About a week after new Moon, the Moon reaches first quarter. This name causes unnecessary confusion because the visible Moon looks half illuminated, not one-quarter illuminated. "Quarter" refers to its progress through the phase cycle: it has completed approximately the first quarter of the journey from one new Moon to the next. Its apparent separation from the Sun is now about ninety degrees, a quarter of the way around the sky. We see roughly half of the Moon's visible disk in sunlight and half in darkness. A disk is simply the circular face an object presents to our eyes; the actual Moon remains a sphere. As it advances beyond first quarter, the bright area becomes larger than half but is not yet full. This is the waxing gibbous phase. Gibbous means bulging, a useful description of a Moon whose bright face has swollen beyond a semicircle. Waxing tells you the direction of change, while gibbous tells you the shape. A waxing gibbous Moon is a mostly illuminated Moon becoming fuller. aa.usno.navy.mil

Roughly two weeks after new Moon, we reach full Moon. The Moon is now on the opposite side of Earth from the Sun, so the sunlit half is directed almost entirely toward us. Think of the evening sky: the Sun is setting in one direction while the full Moon is rising in the opposite direction. That arrangement explains why a full Moon is generally available throughout the night. "Full" refers to the face we see, not to the entire spherical surface receiving daylight at once; the other side still experiences night. Astronomers assign full Moon an exact time based on the positions of the Sun and Moon. To our eyes, however, it can look full for several nights because the appearance changes only slightly near that point. A calendar may identify Tuesday as the full Moon even though Monday and Wednesday both look impressively round. The calendar is marking a precise alignment, while your eyes are judging a shape whose small differences are difficult to detect. Both observations make sense. Royal Museums Greenwich

After full Moon, the visible sunlit portion begins decreasing. That change is called waning, and the first stage is the waning gibbous Moon: still more than half illuminated, but becoming smaller in its bright appearance. About three weeks into the cycle, it reaches last quarter, also called third quarter. Again, we see a half-lit disk, but now the illumination is decreasing. First quarter and last quarter therefore resemble each other in how much is lit while occupying different parts of the cycle. The Moon then becomes a waning crescent, a narrowing sliver commonly seen in the eastern sky before sunrise. Eventually it returns to roughly the Sun's direction, and another new Moon begins. The vocabulary becomes much easier when you separate the two questions each name answers: what shape do we see, and is the illuminated portion increasing or decreasing?

Crescent means less than half; gibbous means more than half but less than full. Waxing means increasing; waning means decreasing. Those four words describe much of the cycle without requiring eight unrelated facts to be memorized. The Planetary Society

The phases also give you a rough Moon schedule. Near new Moon, it rises and sets approximately with the Sun. Near first quarter, it rises around midday, is high in the sky around sunset, and sets around midnight. Near full Moon, it rises around sunset, is high around midnight, and sets around sunrise. Near last quarter, it rises around midnight, is high around sunrise, and sets around midday. These are broad relationships rather than exact clock times; location, season, and the details of the Moon's orbit affect what you observe. Still, they are powerful enough to make predictions. If you see a half Moon high in the evening sky, first quarter is the likely answer. If you see a half Moon high in the morning sky, last quarter is the likely answer. You are using its position and timing to determine whether the illuminated portion is growing or shrinking. The Moon's appearance is one clue; when it is in the sky is another. NASA JPL Education

That schedule explains why seeing the Moon in daylight is completely normal. The Moon is not assigned exclusively to nighttime. Depending on its position in the cycle, a considerable portion of its time above your horizon can occur while the Sun is also above it. Sunlight scattered through Earth's atmosphere makes the sky bright and hides most stars from our eyes, but the Moon can remain bright enough to stand out. A first-quarter Moon is a good afternoon target, while a last-quarter Moon can remain visible well into the morning. Thin crescents are harder to see in a bright sky because they are faint and appear close to the Sun's direction. A full Moon, by contrast, spends most of its visible hours on the nighttime side of our daily schedule. The question is therefore not why the Moon sometimes appears during the day, but why we learn to associate it so exclusively with darkness. Once you begin looking at different hours, the daytime Moon becomes a regular part of the pattern. NASA

Two different motions are responsible for what you notice over an evening and over a month. Earth's rotation makes the Moon appear to travel generally from east to west across the sky, just as it does the Sun and stars. At the same time, the Moon is moving eastward along its orbit relative to the background stars. Imagine checking its position at the same time on successive evenings: it will usually have shifted eastward compared with nearby stars, even though during each individual evening you watch it move westward toward setting. There is no contradiction. The faster apparent daily sweep comes from Earth turning beneath the sky; the slower change from day to day comes from the Moon's own orbital motion. Moonrise typically occurs later on successive days, often described with an average of about fifty minutes. That is a useful approximation, not a fixed daily appointment: the difference varies with the Moon's path and your location. This changing schedule explains why a Moon that was easy to see one evening may require a later outing several nights afterward. Analemma of the Moon

The complete phase cycle takes about 29.5 days, so it does not fit neatly into a thirty- or thirty-one-day calendar month. Astronomers call this a synodic month, the interval from

one repetition of a phase to the next, such as new Moon to new Moon. You may also hear that the Moon orbits Earth in about 27.3 days. That figure describes the sidereal month, measured against the distant stars. The difference exists because Earth is moving around the Sun while the Moon is moving around Earth. After the Moon has completed one circuit relative to the stars, the Earth-Moon system has advanced along its path around the Sun. The Moon must travel a little farther before the same Sun-Earth-Moon arrangement returns. Think of completing a lap only to discover that the direction you must face at the finish has shifted while you were moving. About two additional days are needed to recover that alignment. Both measurements are correct; they answer different questions about what counts as completing the journey. starchild.gsfc.nasa.gov

The cycle also helps separate the far side of the Moon from its night side. The Moon rotates once on its axis in approximately the same time it takes to orbit Earth relative to the stars. This synchronized motion, called tidal locking, keeps approximately the same hemisphere facing us. It does not mean the Moon fails to rotate. To picture the motion, walk around a chair while keeping your face pointed toward it. By the time you return to your starting point, you have turned your body through a complete rotation even though the chair has always seen your front. Similarly, the Moon rotates while keeping its near side toward Earth. The far side is the hemisphere generally facing away from us, and it receives sunlight during its own daytime. At new Moon, much of that far side is illuminated while the near side is dark. At full Moon, the arrangement is approximately reversed. "Far" describes where a surface faces; "dark" describes whether sunlight is reaching it at that time. NASA Science

This brings us to a common misunderstanding: ordinary Moon phases are not caused by Earth's shadow covering the Moon. Earth's shadow becomes involved during a lunar eclipse, when the full Moon passes through it. A solar eclipse occurs at new Moon when the Moon passes in front of the Sun from a particular viewing location. If the Moon circles Earth every month, why do we not get both eclipses every month? Its orbit is tilted about five degrees relative to the plane of Earth's orbit around the Sun. A plane here means an imagined flat surface containing an orbit. Because the two planes differ, the Moon usually passes above or below the alignment needed for an eclipse. New Moon and full Moon provide the appropriate general arrangement, but an eclipse requires a more precise lineup. During a total lunar eclipse, the Moon can turn reddish because sunlight filtered and bent through Earth's atmosphere reaches the shadowed surface. That color change is an eclipse effect, separate from the ordinary progression between crescent, quarter, and full. NASA Science

Everyone on Earth experiences essentially the same lunar phase at the same moment, but the Moon's orientation can look different from different locations. Someone in the Northern Hemisphere and someone in the Southern Hemisphere view it from different angles, so what appears upright to one can look rotated to the other. In familiar Northern Hemisphere views, waxing phases usually appear illuminated on the right and waning phases on the left; Southern Hemisphere views generally reverse that pattern. Near the equator, a crescent can appear more like a bowl, and its tilt also changes with its position

in the sky. This is why memorizing only “right means growing” can cause confusion when traveling or looking at photographs from elsewhere. The more dependable understanding is the geometry: the illuminated side faces toward the Sun. Your horizon and the direction you tilt your head can change how that geometry is oriented in your view. The phase belongs to the Sun-Earth-Moon arrangement; its apparent tilt belongs partly to the observer’s viewpoint. NASA Science

Sometimes a crescent reveals more than its bright sliver. You may see the rest of the Moon’s disk glowing faintly, almost as though someone has drawn a dim circle around the bright edge. This is earthshine. Sunlight reflects off Earth, travels to the Moon, and then reflects back toward your eyes. The bright crescent is receiving direct sunlight, while the dimmer portion is receiving sunlight indirectly through Earth. Consider how much has happened before that faint glow reaches you: light has traveled from the Sun to our planet, from our planet to the lunar surface, and from the Moon back to Earth. Our planet is participating in the view rather than merely serving as the place from which we watch. Earthshine also provides visible evidence that the “missing” part of a crescent Moon has not disappeared. The entire sphere is there, but most of its near side is experiencing lunar night and is only weakly illuminated by reflected light from home. NASA Science

The border between lunar daylight and darkness has a name: the terminator. It is one of the most interesting places to examine through binoculars or a telescope because sunlight strikes the landscape at a low angle there. Crater walls and mountains cast long shadows, making differences in height easier to recognize. The effect resembles how low morning or evening sunlight makes the texture of a rough wall more visible than direct light does. Near full Moon, the surface facing us receives sunlight from closer to our viewing direction, so many shadows are shortened or hidden. The Moon looks brilliant, but some of its relief—the changes in the landscape’s height—can be harder to distinguish. A crescent or quarter Moon may therefore reveal more striking surface detail than a full Moon. As the phase changes, the terminator moves across the visible surface and brings different features into favorable lighting. You can revisit the same Moon and notice a different landscape because the sunlight has changed. NASA Science

Moon phases are connected with ocean tides through the same changing arrangement of the Sun, Earth, and Moon. Tides arise largely from differences in the Moon’s and Sun’s gravitational pulls across Earth. Near new and full Moon, their tidal effects reinforce one another, generally producing a larger difference between high and low water. These are called spring tides, with “spring” referring to the water’s greater rise and fall, not the spring season. Near first and last quarter, the solar and lunar tidal effects partially offset one another, producing a smaller tidal range called neap tides. Notice that both a bright full Moon and an ordinarily invisible new Moon can be associated with spring tides. The amount of moonlight does not create the tidal effect; the spatial arrangement does. Local coastlines, water depth, weather, and other conditions affect actual tides, and the strongest local response may lag behind the phase. The Moon’s shape can tell you about

the general cycle, but a local tide prediction is needed for a particular shoreline. oceanservice.noaa.gov

Several popular Moon names describe something other than phase. A supermoon commonly means a full Moon occurring near the closest part of its orbit to Earth, called perigee. The orbit is elliptical, meaning it is slightly stretched rather than perfectly circular, so the Moon's distance changes. A closer full Moon can appear somewhat larger and brighter than a more distant one, but it is still in the full phase. A blue Moon, under one common definition, is the second full Moon within a calendar month; another established definition concerns an extra full Moon within a season. Neither name normally means the surface looks blue. The huge-looking Moon near the horizon is another issue: much of that impression comes from the Moon illusion, a perceptual effect that makes it look larger near the horizon than high overhead. Its full explanation remains debated, but the Moon has not suddenly expanded. Phase, orbital distance, calendar labels, and apparent size are separate features that can occur together in one impressive view. NASA Science

The most useful way to make this knowledge stay with you is to follow one cycle with your own eyes. Begin whenever the Moon is available; you do not have to wait for new Moon. Record the date, time, general direction, and shape in a few sentences or a quick sketch. Notice whether the bright portion is growing or shrinking over several observations, and whether the Moon is appearing earlier or later in your routine. Include afternoon and morning observations instead of checking only after dark. Clouds may interrupt the record, but they do not prevent you from recognizing the pattern. Before each observation, make a small prediction: if yesterday's evening Moon was slightly more than half illuminated and growing, today's should be a little fuller. If it was full several nights ago, expect a later appearance and the beginning of a shrinking bright face. You are doing something more valuable than reciting names—you are testing an explanation against the sky. Eventually, a crescent over the western horizon will tell you where you are in the cycle, why the Moon is there at that hour, and what you are likely to see when you look again. NASA JPL Education