

The fundamentals of astronomy for beginners

# EXPLAINER

## Understanding the Moon's monthly cycle

There's a logic behind what our satellite looks like and where it'll be at any given time

**G**o and look at the Moon. On average 384,400 km from Earth, it's stunning to the naked eye and through binoculars or a small telescope, spectacular. It seems serene but is hurtling eastward at 3,682 km/h and, since its almost circular orbit is tipped a mere 5° relative to Earth's, it more or less follows the ecliptic (the Sun's apparent path) across the sky.

You may have noticed that the Moon always keeps the same face turned towards us. This is because it rotates once on its axis in exactly the same time it takes to orbit Earth – 27 days and seven hours. This synchronisation is called tidal locking and is a result of Earth's gravitational effect on the young satellite when it was forming.

During its elliptical journey around Earth, the Moon moves through 'phases', the term we use to describe how much of the lunar disc appears illuminated as seen from Earth. In fact, the Moon is always half lit, we just don't see it that way. Whatever phase we're seeing, the opposite phase is happening on the far side. And while we only ever see one terminator (the name given to the dividing line between the light and dark parts of the lunar surface) sweeping right to left across the lunar disc at any time, there are actually two of them circumnavigating the Moon exactly 180° apart; the morning terminator (which ushers in the lunar day) and the evening terminator (which brings

the night behind it). So sorry, Pink Floyd, there is no permanently dark side of the Moon.

### Phases set to stun

What many people don't realise (even though it's completely logical), is that there's also a relationship between the Moon's phases and moonrise times.

**New Moon:** In this phase, our satellite is invisible. With the Sun and Moon on the same side of Earth, they rise together but we cannot see the Moon as it's hidden in the Sun's glare. There's not much to see anyway, as its face towards us is totally in shadow.

**Waxing crescent:** Continuing its journey, the Moon's western (right) edge becomes sunlit to create a sliver-thin crescent. The morning terminator starts its creep of 15.5km/h from west to east.

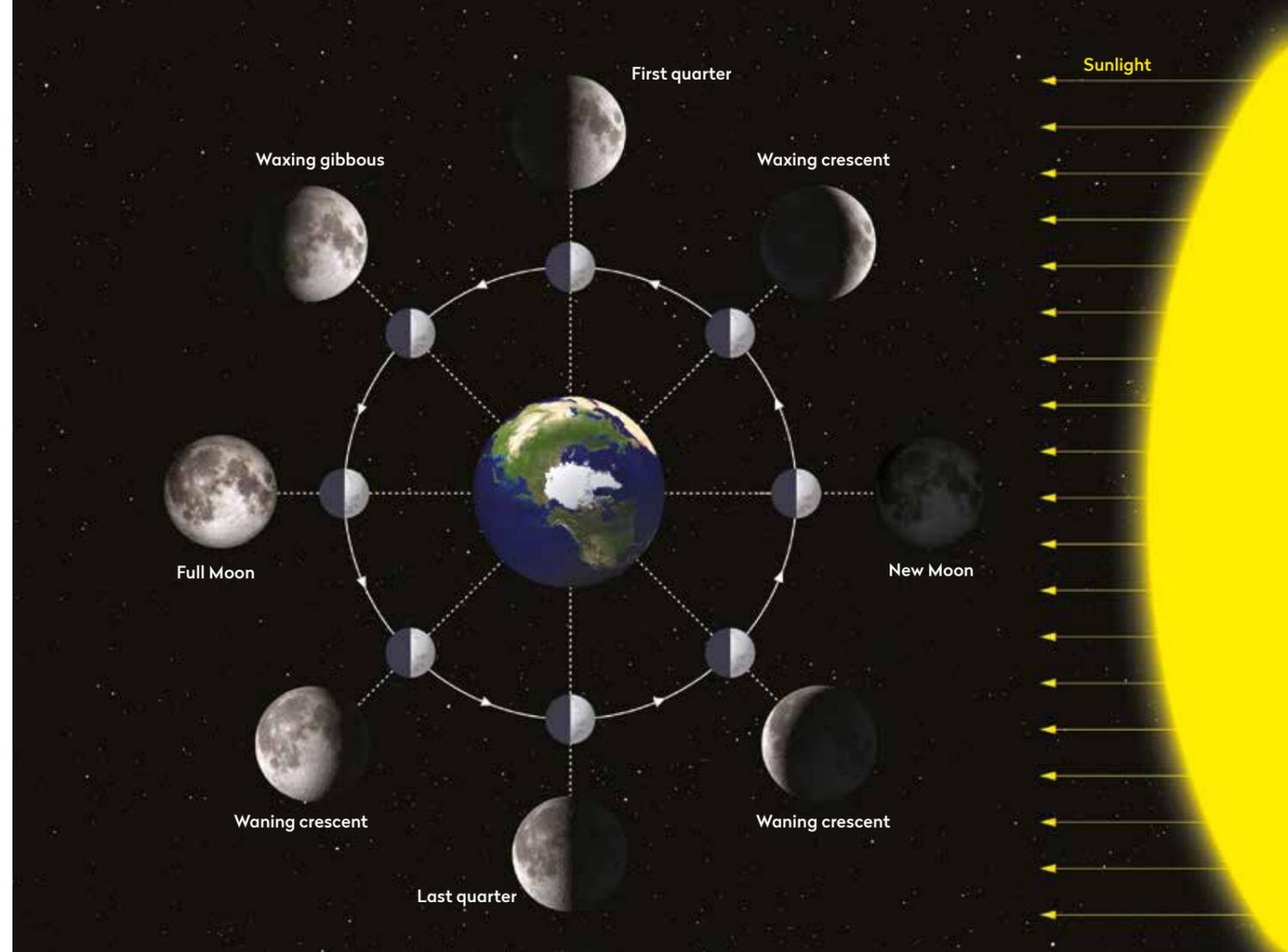
**First quarter:** This one confuses non-astronomers, because it clearly looks like half a Moon, yet it's called a quarter Moon. That's because the terminator has completed a quarter (90°) of its 360° journey around the Moon. (By this logic a full Moon should be called a half Moon, but that's just silly, right?) In this phase, the Moon rises at noon and sets at midnight. Along the terminator, low-angled sunlight creates long shadows, throwing nearby crater and mountains into sharp relief – perfect for lunar observations.

**Waxing gibbous:** In this phase the Moon is almost fully illuminated. The daylight area appears egg-shaped (gibbous) and is increasing in size (waxing) daily.



**Jane Green** is a fellow of the Royal Astronomical Society and author of the Haynes Astronomy Manual

▼ The Moon may always keep the same face turned to us, but the terminator makes sure that face keeps changing



▲ The inner circle shows what the Moon looks like seen from above its north pole, while the outer circle shows the phase we see from Earth at that time

**Full Moon:** Halfway through the morning terminator's journey, the Moon is on the opposite side of Earth from the Sun, with its near side fully illuminated and dazzling. Shadow-less, bleached and flat-looking, it's not good for observation – that's a shame because in this phase it rises as the Sun sets, sets as the Sun rises and is visible all night long!

**Waning gibbous:** The Moon's western edge is being consumed by darkness as the evening terminator comes into view. The sunlit, egg-shaped area is diminishing (waning).

**Last quarter:** It's seven days and nine hours since full Moon and, now 90° west of the Sun, just the Moon's eastern (left) half is illuminated. At this phase it rises at midnight and sets at noon and, like the first quarter phase, offers staggering views.

**Waning crescent:** With just the eastern edge sunlit you'll admire a beautiful 'C-shaped' crescent. Diminishing daily (waning) it will soon disappear as the lunar cycle concludes and the Moon returns to 'new'.

While the Moon may keep the same face turned to us, it remains a daily changing delight to observe. 🌙

## Lunar Libration

Over the course of a lunar cycle, the Moon simultaneously wobbles both latitudinally and longitudinally. These oscillations are known as librations.

Libration in latitude – nodding – occurs because the Moon's axis is slightly inclined relative to Earth's, enabling us to peer just a

little over its north and, later in the month, south poles.

Libration of longitude – shaking – occurs because the Moon travels fastest when closest to Earth and slowest when farthest away.

Daily (diurnal) libration occurs because of our planet's rotation. We see the Moon from slightly different perspectives when it rises

► Crater Moretus at the Moon's south pole shown at different ends of the lunar libration period

and when it sets, and this difference in perspective manifests as a slight apparent rotation in the satellite, first to the west and then to the east.

The combined effect of all the above means that instead of seeing just 50 per cent of the Moon, over time we actually get to see about 59 per cent.

