

# New Zealand Science Curriculum: Astronomy Year 8

## What are the Phases of the Moon?

### Part 1: Phases of the Moon

Our solar day (our Earth's day) lasts for 24 hours, but a lunar day is 50 minutes longer. The lunar day is the time that the Moon takes to complete one rotation about its axis. In fact, the Moon takes the same time to complete one orbit around the Earth (also 24 hours and 50 minutes), because of an effect known as tidal locking. The result is that we only ever see one side of the Moon because the Moon rotates on its axis at the same rate as the Moon orbits the Earth. Every month, the Moon moves east relative to the Sun. During the month, it rises and sets approximately one hour later every day.

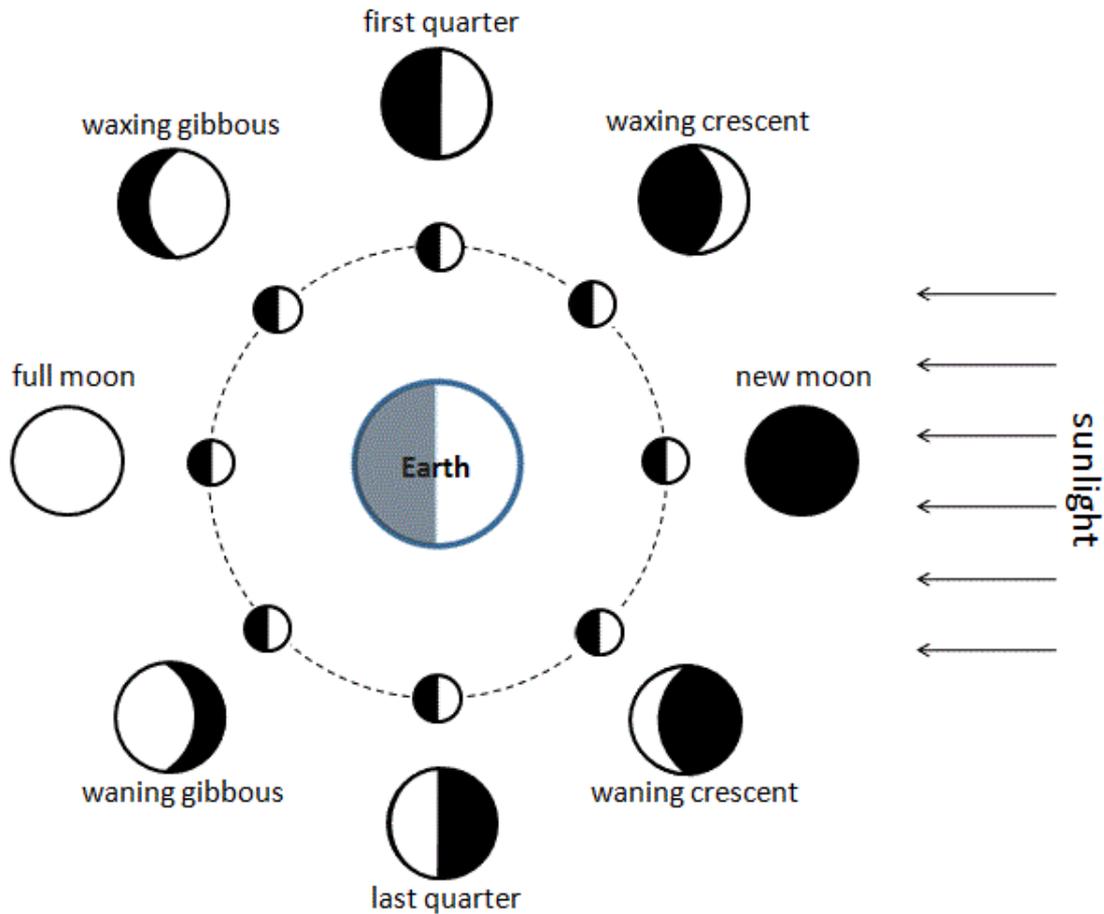
Note that the Moon's phases do not quite match the period of its orbit around the Earth. The Moon orbits the Earth every 27.3 days (a sidereal month) but its phases come back every 29.5 days (lunar month). However, over a period of about a month, the Moon looks different to us. Sometimes it looks like a complete bright disc, sometimes totally dark and sometimes a crescent shape. We refer to these different shapes as the Phases of the Moon. Figure 1 (sourced from Shutterstock) shows photographs of ten Phases of the Moon.



Figure 1: Photographs of ten of the Main Phases of the Moon

## Part 2: Detailed Explanation of the Eight Main Phases of the Moon

Figure 2 (sourced from Wikipedia) gives a diagram of the main the Phases of the Moon, viewed from the Northern Hemisphere.



**Figure 2: Diagram of the Eight Main Phases of the Moon**

The Moon orbits the Earth during each lunar month (29.5 days) and rotates on its axis in exactly the same amount of time (also 29.5 days). In Figure 2 the Moon is rotating on its axis anti-clockwise and it is also orbiting the Earth anti-clockwise. Thus, the phases (the shapes that we see) go from New Moon to Waxing Crescent to First Quarter etc, and eventually to Waning Crescent and finally back to New Moon.

During the lunar month, the Sun shines its light on the side of the Moon that always faces directly towards the Sun. At different times in the lunar month, we see parts of the side of the Moon that receives sunlight, but we see it from different angles. The Moon appears different in shape each day because the angle between the Earth and the Moon varies as the Moon orbits the Earth and so we see the Moon from different angles. The side of the Moon facing the Sun is always lit up by the Sun, but most of the time we can see only bits of the sunlit side.

The phases occur only on the side of the Moon that we can see (i.e. the side of the Moon that always faces us) and each phase comes back every lunar month (every 29.5 days).

In Figure 2, the Earth is located in the center of the diagram and the Moon orbits the Earth. The Sun is on the right-hand side of the diagram and lights up the side of the Moon that faces the Sun. Of course, the Sun also lights up the Earth. The phases are shown as viewed from the Northern Hemisphere of the Earth.

### **New Moon**

The New Moon occurs when the Moon lies directly between the Sun and the Earth and all three (Sun, Moon and Earth) are in close alignment. At the time of the New Moon, we see the Moon in darkness, rather than as a bright disc. During the New Moon, the Sun lights up only the far side of the Moon that we never see and the New Moon always looks very close to the Sun. In fact, we can think of a lunar month as the total time between two New Moons. Also - eclipses of the Sun (solar eclipses) can only take place at New Moon.

### **Waxing Crescent Moon**

When we have a Waxing Crescent Moon, the Moon looks like a crescent. The size of this crescent increases (waxes) for a few days.

### **First Quarter Moon**

In the First Quarter Moon (or Half Moon) we see half of the lit side of the Moon. We see it just after the Waxing Crescent. The First Quarter Moon is seen a week after the New Moon.

### **Waxing Gibbous Moon**

We see the Waxing Gibbous Moon when we can see more than half of the sunlit side of the Moon. The shape increases (waxes) in size from day to day. The Waxing Gibbous phase is visible between the First Quarter and Full Moon phases.

### **Full Moon**

At the Full Moon we see the Moon completely lit up, because the Sun shines directly on the Moon. The Full Moon rises at the same time as the Sun sets and sets at the same time as the Sun rises. We can see the Full Moon for most of the night.

### **Waning Gibbous Moon**

We see the Waning Gibbous Moon when we see more than half of the sunlit side of the Moon. The shape decreases (waned) in size from day to day.

### **Last Quarter Moon**

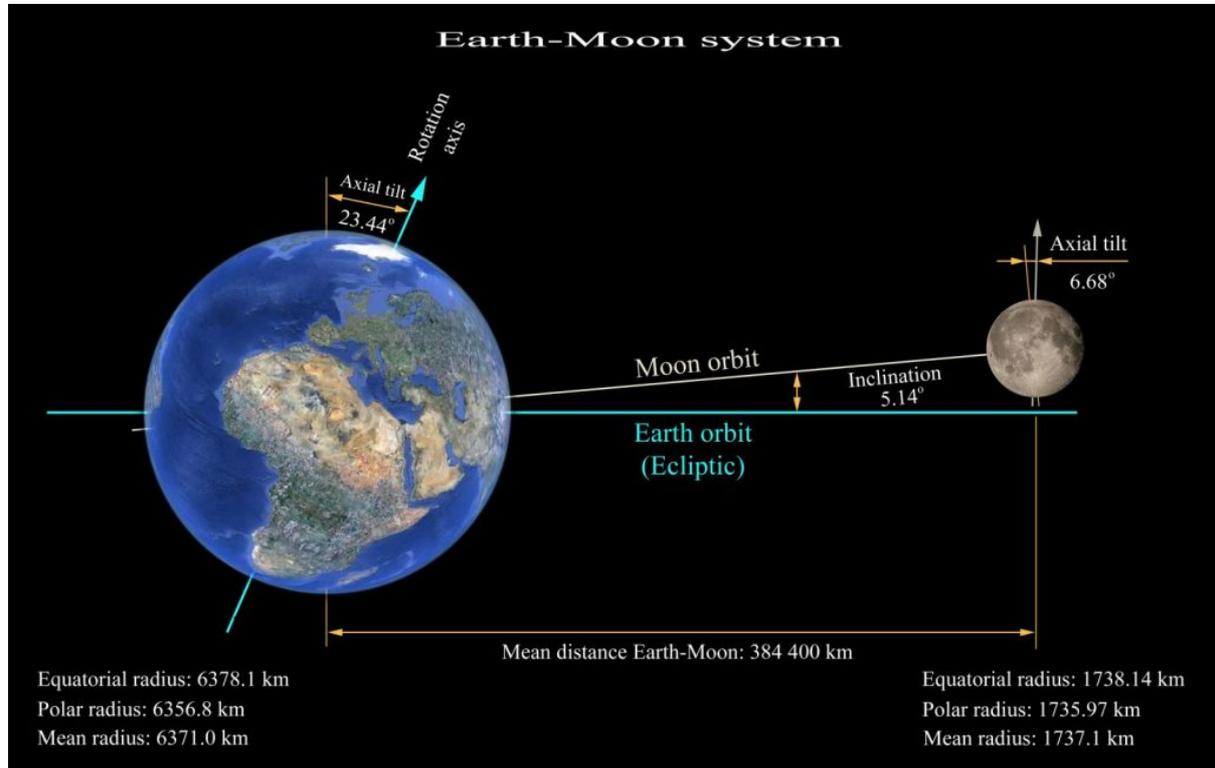
We see the Last Quarter Moon (or Half Moon) when we see half of sunlit side of the Moon. The Last Quarter Moon is visible after the Waning Gibbous phase.

### **Waning Crescent Moon**

We see the Waning Crescent Moon when the Moon looks like and Crescent and the Crescent decreases (waned) in size from day to day.

### Part 3: Why do we not see Eclipses every Month?

The plane of the Moon's orbit around the Earth does not align exactly with the plane of the Ecliptic – the plane of the Earth's year-long orbit around the Sun. In fact, the two planes are at an angle of approximately 5.1° to each other. Figure 3 (sourced from Westminster Astronomical Society, Inc) shows the Ecliptic and the plane of the Moon's orbit around the Earth.



**Figure 3: The Ecliptic and the Plane of the Moon's Orbit around the Earth**

Because the two planes are not in exact alignment, in most months the Moon does not move in front of the Sun to produce a solar eclipse (when the Sun mostly blackened out by the Moon). Similarly, in most months the Earth does not align in front of the Moon to produce a lunar eclipse (where the Moon mostly blackened out by the Earth). Only sometimes do we get the alignment needed to produce an eclipse. Every year, we get at least two lunar eclipses and sometimes five occur in a year, but total lunar eclipses are not so common.

Solar eclipses are more common than lunar eclipses, and we get roughly two to four of them every year, each affecting only a small area of the ground (perhaps 100 – 150 km). At any point on the Earth, a total solar eclipse occurs about once every hundred years, though in some places they may occur every few years.

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