

Shadows, Moon phases and eclipses explained

Grade 6 science (Year 7 · Class 6) · Lesson

Quick answer: A shadow forms when an opaque object blocks straight-line light. The Moon shows phases because half of it is always lit by the Sun, and we see different amounts of that half as it orbits Earth over about 29.5 days. A solar eclipse happens at new Moon, and a lunar eclipse at full Moon.

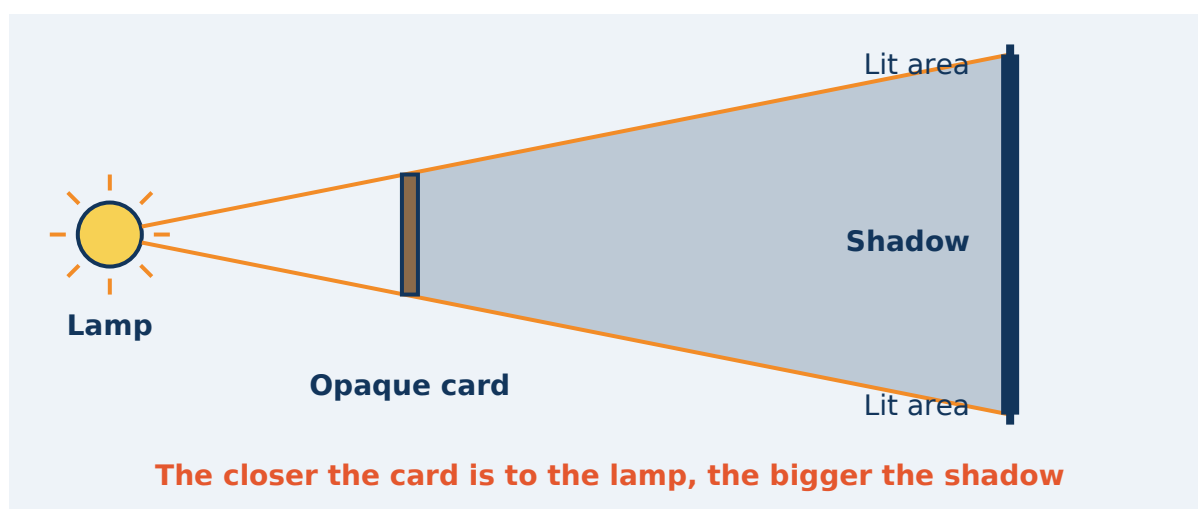
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How does a shadow form?

Light travels in straight lines. When an opaque object gets in the way, the rays touching its edges continue straight on, and the space behind the object receives no light. That dark region is a **shadow**.

Definition

A **shadow** is a region where light is blocked by an opaque object. The shadow has the shape of the object, and it is darkest where no light at all can reach.



A shadow is the dark region behind an opaque object where straight rays are blocked.

The size of a shadow depends on where the object stands. Move the object towards the lamp and the shadow grows, because more rays are blocked. Move it towards the screen and the shadow shrinks to nearly the size of the object. The same idea works outdoors: at noon the Sun is high and shadows are short, while in the early morning and late afternoon the Sun is low and shadows are long.

Worked example 1

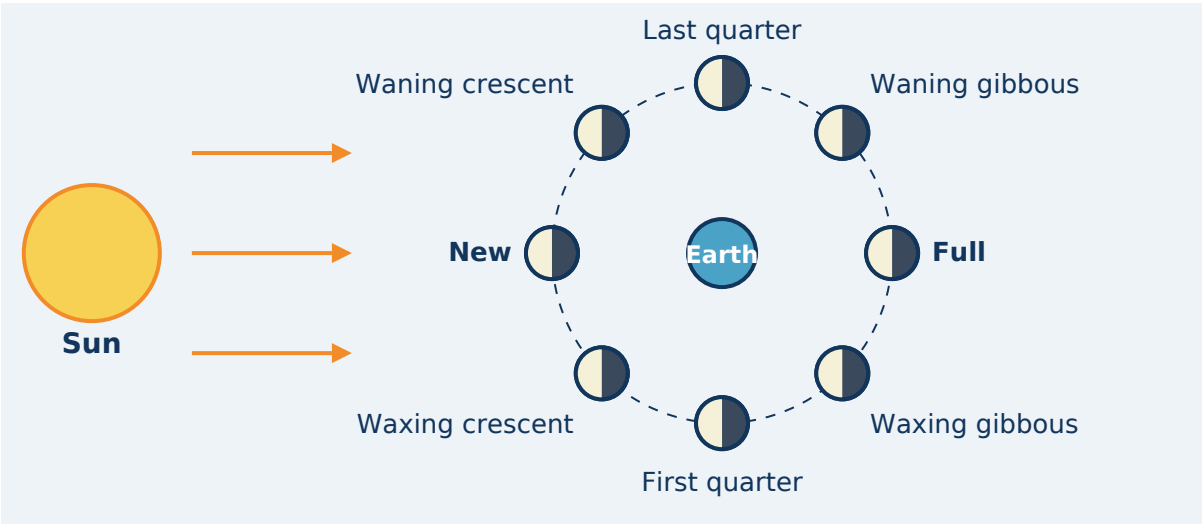
A pole 2.0 m tall casts a shadow 1.5 m long. At the same moment, a building casts a shadow 30 m long. Find its height.

The ratio height : shadow is the same for both, so $2.0 \div 1.5 = h \div 30$.

$$h = 2.0 \times 30 \div 1.5 = 40 \text{ m.}$$

Why does the Moon change shape?

The Moon makes no light of its own. The Sun always lights one half of it, the half that faces the Sun, just as it lights half of the Earth. As the Moon orbits Earth, we look at this lit half from a changing angle, so we see different amounts of it. These changes are the **phases** of the Moon.



Seen from above the North Pole, the Moon always has one half lit, but from Earth we see different amounts of it.

Key law

Half of the Moon is always lit by the Sun. The phase we see depends on **where the Moon is in its orbit**, not on Earth's shadow. One full cycle of phases takes about **29.5 days**.



Moon phases in order over one cycle, as seen from the northern hemisphere.

Phase	Approximate day of the cycle	What we see
New Moon	0	Nothing: the lit half faces away
Waxing crescent	3.7	A thin lit sliver, growing
First quarter	7.4	Half a disc lit
Waxing gibbous	11.1	More than half lit
Full Moon	14.8	The whole disc lit

Phase	Approximate day of the cycle	What we see
Waning gibbous	18.5	More than half lit, shrinking
Last quarter	22.1	Half a disc lit
Waning crescent	25.8	A thin sliver, shrinking

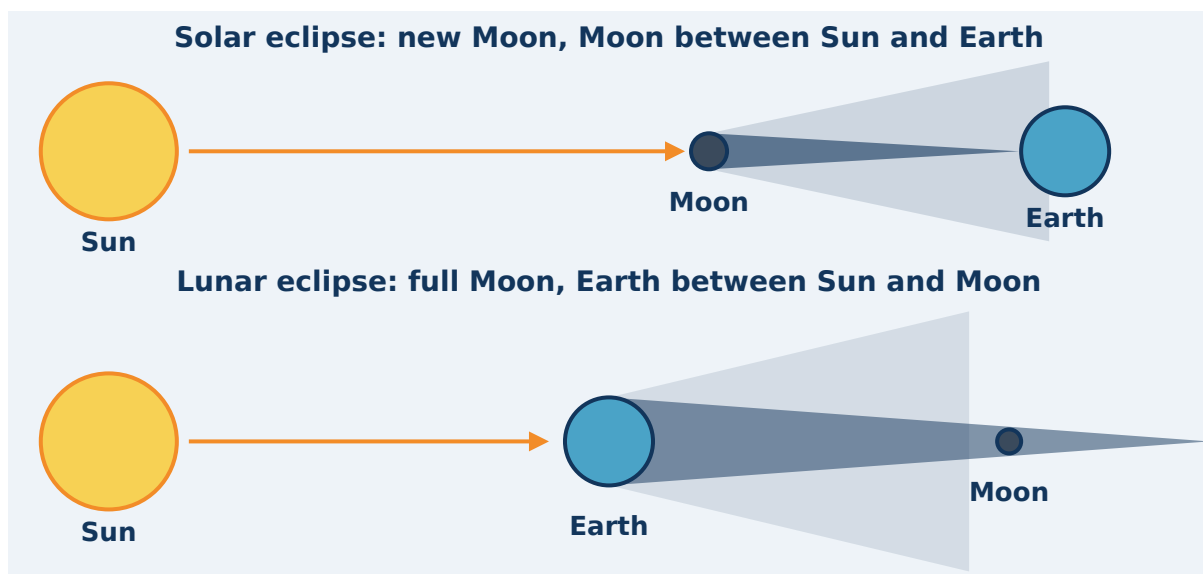
Worked example 2

Ngozi sees a new Moon on 3 March. What phase will she see on 25 March?

Days since the new Moon: $25 - 3 = 22$. The table gives day 22.1 as the last quarter, so she will see **a last quarter Moon**.

What is an eclipse?

An **eclipse** happens when the Sun, Earth and Moon line up so that one of them casts its shadow on another. In a *solar eclipse*, the Moon passes between the Sun and Earth and its shadow falls on part of Earth. In a *lunar eclipse*, Earth lies between the Sun and the Moon, so the Moon moves into Earth's shadow.



Eclipses need the Sun, Earth and Moon to line up. Sizes and distances are not to scale.

A shadow has two parts. In the dark centre, the *umbra*, the Sun is completely hidden. In the paler outer ring, the *penumbra*, the Sun is only partly hidden. Standing in the Moon's umbra you see a total solar eclipse; in the penumbra you see a partial one.

We do not get an eclipse every month because the Moon's orbit is tilted by about 5° compared with Earth's path around the Sun. Most months the Moon passes just above or below the line between the Sun and Earth.

Common mistake

Moon phases are **not** caused by Earth's shadow. Earth's shadow only reaches the Moon during a lunar eclipse, which is rare. Phases happen every month because of our viewing angle.

Lina's tip

A solar eclipse can only happen at new Moon, and a lunar eclipse only at full Moon. Link the pair: Sun, Moon, Earth in that order means solar; Sun, Earth, Moon means lunar.

Is it safe to look at an eclipse?

Never look at the Sun directly, even during a partial eclipse. Use special eclipse glasses or project the Sun's image through a pinhole onto a card. A lunar eclipse is safe to watch with the naked eye.

Key points to remember

- A shadow is a region where an opaque object blocks light.
- Half of the Moon is always lit; its phase depends on its position in its orbit.
- The cycle of phases takes about 29.5 days.
- Solar eclipse: Moon between Sun and Earth, at new Moon.
- Lunar eclipse: Earth between Sun and Moon, at full Moon.

Shadows, Moon phases and eclipses explained: frequently asked questions

Why do shadows get longer in the evening?

In the evening the Sun is low in the sky, so its rays hit objects at a shallow angle. The rays blocked by an object then land far behind it, so the shadow is long.

What causes the phases of the Moon?

The Sun always lights half of the Moon. As the Moon orbits Earth, we see more or less of that lit half. Earth's shadow does not cause the phases.

How long is the cycle of Moon phases?

About 29.5 days pass between one new Moon and the next. This cycle is the origin of the idea of a month.

What is the difference between a solar and a lunar eclipse?

In a solar eclipse the Moon passes between the Sun and Earth and blocks sunlight. In a lunar eclipse Earth passes between the Sun and the Moon, so the Moon falls into Earth's shadow.

Why is there not an eclipse every month?

The Moon's orbit is tilted by about 5° compared with Earth's orbit around the Sun. Most months the Moon passes above or below the line joining the Sun and Earth, so the shadows miss.