LESSON 2
THE EARTH-SUN-MOON SYSTEM

Chapter 8

Astronomy

OBJECTIVES

- Investigate how the interaction of Earth, the Moon, and the Sun causes lunar phases.

- Describe conditions that produce lunar and solar eclipses.

MAIN IDEA

The Moon revolves around Earth, causing different tides, eclipses, and phases of the Moon.

VOCABULARY

- crater
- phase of the Moon
- lunar eclipse
- solar eclipse
- tide
- gravity

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WHAT IS THE MOON LIKE?

- The greatest amount of information about the Moon has come from data gathered by the six Apollo missions between 1969 and 1972.
- The Moon has no magnetic field, though it may have had one in the past.
- Rock samples from the Moon have given us clues about Earth's early history.

- When people looked at the Moon without a telescope it appeared to have a face, but when they looked at the Moon with a telescope the face disappears.
    - This is because of the light and dark colored areas with bowl shaped pits.
- When the Apollo astronauts visited the Moon, they took close up pictures of many of these features.
    - Some of them looked the same as you look at them from Earth, but some are different.

LUNAR LANDSCAPE

- Several different features have been identified on the Moon.
- Impacts from space form craters.
- When an object hits the Moon's surface, the impact sends out waves.
    - The waves form rings or rims around some craters.

- Earth’s protective atmosphere causes most of the incoming objects to burn up.

- When objects do hit Earth, the craters are eroded by wind and water.

- Maria are large, dark, flat surfaces on the Moon.
- The singular form mare means sea in Latin.
- The smoothness of the maria led people to think they were seas of water.
- Scientists believe that maria formed when space objects collided with the Moon’s surface.
- They then filled with lava, cooled, and gave maria their smooth appearance and dark color.

- The Moon’s highlands are light colored regions near the lunar poles.
- Compared to the maria light colored regions are higher in elevation.
- Highlands have more craters than the maria.
- Scientists believe that highlands are older landforms.

- Mountains on the Moon are found around edges of large maria.
- The mountains probably formed from the same impacts that formed the maria.
- Mountain ranges on the Moon are named after mountain ranges on Earth.

- Valleys on the Moon are cigar shaped depressions.
- Perhaps the most famous is the Alpine Valley on the northeastern edge of the Mare Imbrium.
- New evidence suggests that the floors of some very deep Moon valleys may contain small amounts of ice.

QUICK CHECK

Cause and Effect

What probably caused mountains to form around the edges of the maria?

The mountains around the edges of the maria were probably caused by the impacts of bodies from space.

Critical Thinking

Do you think the Moon has had tectonic activity recently? Explain.

The moon probably has not had tectonic activity.

There is no magnetic field and no evidence of recent volcanic activity, although the Moon once had lava flows.

Also, the craters are still there and are not being shifted or moved around, and they are not being filled with lava.

WHAT CAUSES THE PHASES OF THE MOON?

- When you look up at the sky, you might realize the Moon’s shape changes.
- The shapes of the Moon we see in the sky is the phase of the Moon.

- The Moon does not change shape.
- It reflects the light of the Sun.
- Half of the Moon faces the Sun and is lightened by its rays.
    - The other half is always dark.
- During a new moon, the Moon is between the Sun and Earth.

- During the *waxing phase*, the lighted side of the Moon becomes more and more visible.
  - If you see less than half of the Moon lighted, it's a *waxing crescent Moon*.
  - When you see the entire right half of the waxing Moon, it's a *first quarter Moon*.
  - As the Moon orbits Earth, more than half of the side facing Earth becomes visible; this phase is a *waxing gibbous Moon*.

- Finally, the Moon reaches the opposite side of its orbit and its entire lighted side faces Earth, it is a *full Moon*.
- It takes 14.5 days to get from the new Moon to the full Moon.

- After the full Moon, we see less and less of the Moon's lighted side.
  - The Moon is then in its *waning phases*.
  - The first phase to appear is the *waning gibbous Moon*.
  - Followed by the *third quarter Moon*, in which the left half of the lighted side is visible.
  - Next is the *waning crescent Moon*, which decreases until the new Moon appears.

- The waning phases take about 14.5 days.
- Our concept of a month comes from the length of the cycle of phases of the Moon, about 29 days.

QUICK CHECK

Cause and Effect

What causes the phases of the Moon?

The phases of the Moon are caused by the relative position of the Sun, Earth, and the Moon.

Critical Thinking

If the direction of sunlight in the diagram were reversed, what would happen to the full Moon?

If the direction of sunlight in the diagram were reversed, instead of showing a full Moon it would appear as a new Moon.

WHAT CAUSES ECLIPSES?

- When one object crosses in front of another, the first object can sometimes block the view of the second.
    - In the case of space objects, this causes an eclipse.
- When one object passes through the shadow cast by another object, this also causes an eclipse.

- Twice each month, the Moon crosses the path of Earth’s orbit.
    - When this occurs at the time of a full moon the Moon passes directly through Earth’s shadow, so that no sunlight falls directly on the Moon.

- The Moon becomes dark until it moves out of Earth’s shadow.

- The shade of color depends on how the sunlight interacts with Earth’s atmosphere on its way towards the Moon.

- When the Moon passes through a part of Earth’s shadow, a partial lunar eclipse occurs.

- Partial lunar eclipses are far more common than total eclipses.

SOLAR ECLIPSES

- When Earth passes through the Moon's shadow a solar eclipse occurs.
    - For a total solar eclipse to occur the Moon must be directly between the Sun and observer on Earth during a new moon.
- When the body of the Sun appears completely dark, one can see the gases in the Sun's outer atmosphere.

- Total solar eclipses are rare and short.
- Even when total eclipses occur, it does not appear that way from every location on Earth.
    - You may see a total solar eclipse if you are in the Moon's umbra, dark shadow.
    - If you are not in the Moon's umbra, you may only see a partial solar eclipse.
- Often, the Moon and the Sun do not line up exactly making the Sun's disk only partly hidden.
- Never look directly at the Sun, even during a total solar eclipse.

QUICK CHECK

- Cause and Effect
    - What causes a lunar eclipse? What causes a solar eclipse?
- Lunar eclipses are created when the Moon goes in to Earth's shadow.
- Solar eclipses are created when the Moon goes between the Sun and Earth, casting a shadow on Earth.

- Critical Thinking
    - Are total solar eclipses visible from all locations on Earth? Explain.
- No, a total solar eclipse can be seen from only a small part of Earth. The umbra of the Moon’s shadow is relatively small and casts only a small shadow over Earth’s surface.

WHAT CAUSES THE TIDES?

- Waves come higher up on the shore at some times than at others.
    - This is called a tide.

- The pull of gravity between the Earth and the Moon causes tides.
- Gravity is the force of attraction among all objects.
- The greater an object's mass, the greater its gravitational pull.
    - Your body has gravity and so does Earth.
    - However, Earth is much more massive, so its gravitational pull is much stronger than yours.

- Gravity exists between the Sun and the planets and also between a planet and its moons.
- Gravity changes with distance.
- Gravity between Earth and the Moon makes the water bulge on the Moon facing side of Earth.
- A bulge also forms on the sides facing away from the Moon.
- The water level rises where the bulge is and falls where it is not.
- This causes the regular rise and fall of the tides.

- Twice a month, due to the location of both the Sun and Moon, tides are especially strong or weak.
- When the Sun, Earth, and Moon are all in a line, a spring tide occurs and tides are higher than usual.
- When the gravitational pull of the Sun and Moon are at right angles, a neap tide occurs and tides are lower than usual.

QUICK CHECK

- Cause and Effect
    - What causes the tides?
- The tides are primarily created by the pull of the Moon and Earth on each other.

- Critical Thinking
    - Which type of tide might occur during a new Moon?
- A spring tide will most likely occur during a new Moon.