Chapter 7
Chapter: The Earth-Moon-Sun System

Section 1: Earth in Space

Section 2: Time and Seasons

Section 3: Earth’s Moon
Earth’s Size and Shape

Ancient Measurements

• A **sphere** is a round, three-dimensional object, the surface of which is the same distance from the center in all directions.
First, no matter where you are on Earth, objects fall straight down to the surface, as if they are falling toward the center of a sphere.

Second, Earth’s shadow on the Moon during a lunar eclipse is always curved.
Ancient Measurements

- Finally, people in different parts of the world see different stars above their horizons.
Gravity is the attractive force between two objects that depends on the masses of the objects and the distance between them.

**Earth’s Physical Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (pole to pole)</td>
<td>12,714 km</td>
</tr>
<tr>
<td>Diameter (through equator)</td>
<td>12,756 km</td>
</tr>
<tr>
<td>Circumference (poles)</td>
<td>40,008 km</td>
</tr>
<tr>
<td>Circumference (equator)</td>
<td>40,075 km</td>
</tr>
<tr>
<td>Mass</td>
<td>5.983 ( \times 10^{24} ) kg</td>
</tr>
<tr>
<td>Average density</td>
<td>5.52 g/cm(^3)</td>
</tr>
<tr>
<td>Average distance to the Sun</td>
<td>149,600,000 km</td>
</tr>
<tr>
<td>Average distance to the Moon</td>
<td>384,400 km</td>
</tr>
<tr>
<td>Period of rotation</td>
<td>23 h, 56 min</td>
</tr>
<tr>
<td>Period of revolution</td>
<td>365 days, 6 h, 9 min</td>
</tr>
</tbody>
</table>
Earth has a magnetic field that protects us from harmful radiation from the Sun.

This field resembles that surrounding a bar magnet.
Earth’s Magnetic Field

- Earth’s magnetic field is running from Earth’s north magnetic pole to its south magnetic pole.
- This axis is tilted about 11.5° from Earth’s geographic axis of rotation.
Large-scale movements, called polar wandering, are thought to be caused by movements in Earth’s crust and upper mantle.
The Aurora

• Ejected particles from the Sun produce other charged particles in Earth’s outer atmosphere.

• These charged particles spiral along Earth’s magnetic field lines toward Earth’s magnetic poles.
The Aurora

- They collide with atoms in the atmosphere and emit light.
- This light is called the aurora borealis (northern lights) in the northern hemisphere and the aurora australis (southern lights) in the southern hemisphere.
Earth Orbits the Sun

- Earth’s orbit is shaped like an ellipse.
- An **ellipse** is an elongated, closed curve with two foci.
- Earth is closest to the Sun—about 147 million km away—around January 3 and is farthest from the Sun—about 152 million km away—around July 4 of each year.
Earth as a Planet

- Earth is the only planet whose characteristics make it possible for life as we know it to survive.
- Earth’s oceans absorbed much of the carbon dioxide in Earth’s early atmosphere.
Question 1

Which term describes the shape of Earth?

A. axis
B. ellipse
C. sphere
D. waxing
The answer is C. Earth is a round, three-dimensional object and casts a curved shadow on the Moon during an eclipse.
The imaginary vertical line around which Earth spins is its ___________.

A. axis  
B. ellipse  
C. longitude  
D. meridian
The answer is A. This line cuts directly through the center of Earth.
The spinning of Earth on its axis is its ___________.

A. equinox  
B. orbit  
C. revolution  
D. rotation
The answer is D. One complete rotation takes 24 hours.
Around 3000 B.C., the Babylonians devised a method of timekeeping. Because their counting methods were based on 60, they divided a circle into 360 parts called degrees. The symbol for degree (°) was taken from their symbol for the Sun.
Measuring Time on Earth

- Earth spins and makes one complete turn in about 24 hours.

- This spinning causes the Sun to appear to move across the sky from east to west.
2

Measuring Time on Earth

- If Earth spins approximately $360^\circ$ in 24 hours, then it spins through $15^\circ$ in one hour.

- A **time zone** is an area $15^\circ$ wide in which time is the same.

- For convenience, time zones are modified to fit around city, state, and country borders, and other key sites.
Measuring Time on Earth

Time Zones
The Date Line

• A day is added to the time at the International Date Line.

• This line is drawn down through the Pacific Ocean directly opposite the Prime Meridian, the starting point for this worldwide system of measuring time.

• Time based on this method is called Coordinated Universal Time (UTC).
Rotation is the spinning of Earth on its axis, an imaginary line drawn through Earth from its rotational north pole to its rotational south pole.

The apparent movement of the Sun from noon one day until noon the next day is called a solar day.
• **Revolution** is the motion of Earth in its orbit around the Sun.

• As Earth revolves in its orbit, the Sun appears to move through the skies compared to the seemingly fixed positions of the stars.
The apparent path of the Sun during this year is called the ecliptic.

The **ecliptic** is defined as the plane of Earth’s orbit around the Sun.
Why do seasons change?

• Seasons change on Earth because the number of hours of daylight each day varies and also because the angle at which sunlight strikes.

• Earth’s axis is tilted 23.5°.
Changing Angle of Sunlight

- The hemisphere tilted toward the Sun receives sunlight at higher angles than the hemisphere tilted away from the Sun.
- The greater intensity of sunlight is one reason why summer is warmer than winter, but it is not the only reason.
More Hours of Daylight in Summer

- As the year progresses, the number of hours of daylight each day becomes fewer.

- It reaches a minimum around December 21 for the northern hemisphere.
More hours of Daylight in Summer

• The hemisphere of Earth that is tilted toward the Sun receives more hours of daylight each day than the hemisphere tilted away from the Sun.

• This longer period of daylight is the second reason why summer is warmer than winter.
Time and Seasons

Equinoxes and Solstices

• The Sun reaches an **equinox** when it is directly above Earth’s equator, and the number of daylight hours equals the number of nighttime hours all over the world.

• The **solstice** is the point at which the Sun reaches its greatest distance north or south of the equator, the Tropic of Cancer and Tropic of Capricorn, respectively.
Question 1

A(n) ________ occurs when the Moon’s entire surface facing Earth reflects light.

A. eclipse  
B. full moon  
C. new moon  
D. old moon
The answer is B. During a full moon, the Moon’s entire surface facing Earth reflects light.
Question 2

When do eclipses occur?

Answer

Eclipses occur when Earth or the Moon temporarily blocks the sunlight from reaching the other. They are described as solar or lunar eclipses, depending on which body is temporarily not visible.
Question 3

In a solar eclipse, a person standing in the ____________ experiences a total eclipse.

A. Earth’s penumbra
B. Earth’s umbra
C. Moon’s penumbra
D. Moon’s umbra
The answer is D. This is the darkest portion of the Moon’s shadow.
Movement of the Moon

Rotation and Revolution

• It takes 27.3 days for the Moon to revolve once around Earth.

• Because Earth also revolves around the Sun, it takes more than two more days for the Moon to line up with Earth and the Sun.

• A complete lunar phase cycle takes 29.5 days.
The Moon keeps the same side facing Earth because it takes 27.3 days to rotate once on its axis.
How does the Moon affect Earth?

Tides

• A **tide** on Earth is caused by a giant wave produced by the gravitational pulls of the Sun and the Moon.

• This rise of sea level is called high tide.

• About six hours later, as the trough of the wave approaches, sea level drops, causing a low tide.
Tides

- The Sun is much farther.
- Because of this, the Moon has greater effect on Earth’s tides than the Sun.
- When the Moon and the Sun pull together, high tides are much higher and low tides are much lower.
- This is called a spring tide.
Moonlight

- **Moon phases** are the changing appearances of the Moon as seen from Earth.
- The phase you see depends on the relative positions of the Moon, Earth, and the Sun.
Phases of the Moon

- A new moon occurs when the Moon is between Earth and the Sun.

- The side of the Moon facing away from Earth is lighted and the side of the Moon facing Earth receives no light from the Sun.
**Waxing Phases**

- Waxing—the lighted portion that we see appears larger each night.
- The first phase we see after a new moon is called the waxing crescent.
- About a week after a new moon is the first-quarter.
- The moon is in the waxing gibbous phase from the first quarter up until full moon.
Waning Phases

- After a full moon, the lighted portion that we see begins to appear smaller.
- The phases are said to be waning.
- When only half of the side of the Moon facing Earth is lighted, the third-quarter phase occurs.
- The waning crescent occurs before another new moon.
• The word *month* is derived from the same root word as *Moon*.
Eclipses

Solar Eclipses

- A **solar eclipse** occurs when the Moon moves directly between the Sun and Earth and casts a shadow on part of Earth.

- The darkest portion of the Moon’s shadow is called the **umbra**.
Lunar Eclipses

• When Earth’s shadow falls on the Moon, a **lunar eclipse** occurs.

• A partial lunar eclipse occurs when only a portion of the Moon moves into Earth’s umbra.
The Moon’s Surface
Craters, Maria, and Mountains

- Many depressions on the Moon were formed by meteorites, asteroids, and comets, which strike the surfaces of planets and their satellites.
- These depressions are called craters.
Craters, Maria, and Mountains

- **Maria** are the dark-colored relative flat regions on the Moon’s surface.
- Surrounding the large depressions that later filled with lava are areas that were thrown upward in the original collision and formed mountains.
- Impacts on the Moon throughout its history led to the accumulation of debris known as regolith.
The Moon’s Interior

- This model shows that the Moon’s crust is about 60 km thick on the side facing Earth and about 150 km thick on the side facing away.
- A solid mantle may extend to a depth of 1,000 km.
The Moon’s Interior

- A partly molten zone of the mantle extends farther down.
- Below this is an iron-rich, solid core.
Exploring the Moon

• Data from *Clementine* confirmed that the crust on the side facing Earth is much thinner than on the far side.

• *Clementine* also provided information on the mineral content of Moon rocks.
Exploring the Moon

• The *Lunar Prospector* spacecraft orbited the Moon, taking photographs of the lunar surface.

• *Lunar Prospector* confirmed that the Moon has a small, iron-rich core about 600 km in diameter.
Origin of the Moon

Giant Impact Theory

- The Moon formed about 4.6 billion years ago when a Mars-sized object collided with Earth.
- After colliding, the cores of the two bodies combined and settled toward the center of the larger object.
- Gas and other debris were thrown into orbit.
- The remainder condensed into a large mass, forming the Moon.
The space mission that accomplished the landing of U.S. astronauts on the Moon was __________.

A. Apollo
B. Lunar Orbiter
C. Surveyor
D. Voyager
The answer is A. The astronauts of *Apollo 11* landed on the Moon.
Question 2

What is an impact basin?

Answer

An impact basin, or impact crater, is a depression left behind by an object striking the Moon.
The mission of the spacecraft *Clementine* was to map the surface of __________.

A. Earth  
B. Mars  
C. the Moon  
D. Venus
The answer is C. *Clementine* took high-resolution photographs enabling the compilation of a detailed map of the Moon’s surface.